ABSTRACT BOOK DRAFT*

Cartagena Colombia
July | 24-28 | 2023

6th Mangrove, Macrobenthos and Management Conference

24-28 July 2023, Cartagena/Colombia
https://mmm6.co/

*Please, report any inconsistency with your abstract to info@mmm6.co

Organizers:

RED COLOMBIANA DE ESTUARIOS Y MANGLARES
MangEst COLOMBIA

CEMarin
Corporation Center of Excellence in Marine Sciences

6th Mangrove, Macrobenthos and Management Conference

24-28 July 2023, Cartagena/Colombia
https://mmm6.co/

“Mangrove ecosystems for Human Well-being in a Changing Planet” is the first MMM to be held in Latin America and the Caribbean, a region where mangroves meet various biodiversity hotspots biodiverse areas in the world.

The sixth Mangrove Macrobenthos and Management conference (MMM6): “Mangrove Ecosystems for Human Well-being in a Changing Planet” is bringing together stakeholders from different sectors of society from many countries across the five continents in a single forum to present and discuss research advances and proposals for the conservation and management of mangrove forests, as well as to advocate for mangroves as Nature-based Solutions to climate change.

MMM6 is the first conference of the series to be held in Latin America and the Caribbean, a neotropical region where mangroves have evolved among some of the most biodiverse tropical forests in the world. In particular, mangroves in Colombia are found in both the Caribbean and the Tropical Eastern Pacific Marine Ecoregions.

Editors: Blanco-Librero, J.F., Valencia-Palacios, A.M., Gil-Ramirez, A.S., Mancera-Pineda, E., & Beltran, T.

MMM6 Book of Abstracts

Welcome to MMM6 Conference! We are pleased to receive you all to this huge Mangrove conference, we had 446 abstracts submitted. All the accepted abstracts are listed in the following pages in alphabetical order according to the lead author, and each title has the presentation code indicated in the event schedule.

We would like to thank to the Scientific Committee and all the reviewers, who ensured that each abstract went through a strict review for this great event. We would also like to thank to all the sponsors listed in the next page for making possible the MMM6.

Have an excellent week, we hope you enjoy this great conference.

Sponsors:

Universidad Nacional de Colombia
Universidad de los Andes
Universidad del Valle
Universidad de Antioquia 1803
Universidad Autónoma de Occidente
UdeC Universidad de Cundinamarca
Universidad de Cartagena Fundada en 1827
WWF
INCIMAR Instituto de Ciencias del Mar y Limnología
Jardín Botánico — Jardín Botánico de San Andrés, Universidad Nacional de Colombia
ULB Université Libre de Bruxelles
Invemar
Global Mangrove Watch
2021 2030 United Nations Decade of Ocean Science for Sustainable Development
Observatorio de Actividades Marítimas y Portuarias
Global Mangrove Alliance
USGS science for a changing world
CECIMAR Instituto de Estudios en Ciencias del Mar
TROPIMUNDO.eu Erasmus Mundus Joint Master Degree in Tropical Biodiversity and Ecosystems

MMM6 – Colombia 2023

The Mangrove Macrobenthos and Management (MMM) conference series is the world's largest gathering of researchers and practitioners dedicated to the science and conservation of mangrove ecosystems (Friess et al., 2021: Estuarine, Coastal and Shelf Science 248 106742).

The first meeting was convened in 2000 in order to analyze the health of mangrove ecosystems in different parts of the world. The five meetings held in different countries over the last 20 years (2019 Singapore; 2016 St. Augustine, USA; 2012 Galle, Sri Lanka; 2006 Collangatta, Australia; 2000 Mombasa, Kenya) have been made possible to identify the main trends in research and management at global and local scales.

MMM6 – Colombia 2023

Venues

Universidad de los Andes
(Caribbean Campus)

Universidad de Cartagena
(San Agustin Cloister)

THEMES

Mangrove ecosystems for Human Well-being in a Changing Planet

With the aim of harmonizing global initiatives, the topics selected for the MMM6 conference correspond to the Ocean Decade Challenges for collective impact of the United Nations:

Challenge 1

Protecting and restoring mangrove forests and their biodiversity

Challenge 2

Understanding and solving marine pollution in mangrove wetlands

Challenge 3

Achieving sustainable socio-economic development and equity

Mangrove ecosystems for Human Well-being in a Changing Planet

Challenge 4

Unlocking climate action and implementing mangrove-based solutions to climate change

Challenge 5

Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Challenge 6

Changing human relationships with mangrove wetlands

COMMITTEES

Conference Chairs and Organizing Committee

Dr. José Ernesto Mancera
Conference President

Dr. Juan Felipe Blanco
Scientific Committee Chair

Andrés Osorio
Universidad Nacional de Colombia| CEMarin
Financial leader

Fredy Duque
Universidad de Cundinamarca

Jaime Cantera
Universidad del Valle | CEMarin

Jenny Leal
Universidad de Antioquia

Jorge H. Maldonado
Universidad de los Andes

Juan Felipe Blanco Libreros
Universidad de Antioquia | CEMarin

Laura Victoria Perdomo
Universidad Nacional de Colombia

Marly Mardini
Observatorio de Actividades Marítimas y Portuarias | Universidad de Cartagena

Paula Cristina Sierra
Instituto de Investigaciones Marinas (INVEMAR)

Enrique Javier Peña
Universidad del Valle | CEMarin
Logistic leader

Gabriel Navas
Universidad de Cartagena

Jairo Humberto Medina
Jardín Botánico de San Andrés | Universidad Nacional de Colombia

José Ernesto Mancera Pineda
Universidad Nacional de Colombia | CEMarin

Jorge Higino Maldonado
Universidad de los Andes | CEMarin

Laura Ramírez Giraldo
CEMarin

Luis Alfonso Zapata
WWF

Martha Palacios
Universidad Autónoma de Occidente

Tania Beltrán Rozo
CEMarin

Scientific Committee

The scientific committee is composed of renowned mangrove scientists from the Americas, Europe, Africa, Asia and Oceania, chaired by Dr. Juan F. Blanco-Libreros, Universidad de Antioquia (Medellín, Colombia).

Dr. Jorge López Portillo
Instituto de Ecología, México

Dr. Jorge Alfredo Herrera
CINVESTAV, México

Ph.D. Ken W. Krauss
Wetland and Aquatic Research Center, US Geological Survey, USA

Professor Luiz Drude de Lacerda
Federal University of Ceará, Brazil

Ph.D. Marília Cunha Lignon
Universidade Estadual Paulista "Júlio de Mesquita Filho" – UNESP, Brazil

Ph.D. Stu Hamilton
East Carolina University, USA

Ph.D. Samantha Chapman
Villanova University, USA

Ph.D. David Lagomasino
East Carolina University, USA

Ph.D. Edward Castaneda
Florida International University, USA

Scientific Committee

The scientific committee is composed of renowned mangrove scientists from the Americas, Europe, Africa, Asia and Oceania, chaired by Dr. Juan F. Blanco-Libreros, Universidad de Antioquia (Medellín, Colombia).

D.Sc Farid Dahdouh-Guebas
Université Libre de Bruxelles, Belgium

PhD. Janine Adams
Nelson Mandela University, South Africa

Dr. Gustavo A. Castellanos-Galindo
Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Germany

Prof. Dr. Martin Zimmer
Leibniz-Centre for Tropical Marine Research, Germany

PD. Dr. Tim Jennerjahn
Leibniz-Centre for Tropical Marine Research, Germany

Dr. Véronique Hefter
Leibniz-Centre for Tropical Marine Research, Germany

Prof. Dr. Norman Duke
James Cook University, Australia

Prof. Dr. Catherine Lovelock
The University of Queensland, Australia

Dr. Maria Fernanda Adame
Griffith University, Australia

Scientific Committee

The scientific committee is composed of renowned mangrove scientists from the Americas, Europe, Africa, Asia and Oceania, chaired by Dr. Juan F. Blanco-Libreros, Universidad de Antioquia (Medellín, Colombia).

PhD. Tadashi Kajita
University of the Ryukyus, Japan

Dr. Kerrylee Rogers
University of Wollongong, Australia

Ph.D. Rafael Araujo
University of Miami, USA

Dr. Thorsten Balke
University of Glasgow, Scotland

Prof. Dr. S. Bijoy Nandan
Cochin University of Science and Technology, India

Prof. Karen Diele
Edinburgh Napier University, Scotland

Dr. Marc Simard
Jet Propulsion Laboratory, California Institute of Technology, USA

Dr. Hanan Almahasheer
Imam Abdulrahman Bin Faisal University, Saudi Arabia

Local Scientific Committee

The international members of the Scientific Committee are accompanied by a host group of mangrove researchers from various institutions in Colombia:
José E. Mancera Pineda, Ph.D. (Universidad Nacional de Colombia), Dr. Jaime R. Cantera Kintz (Universidad del Valle), Dr. Martha L. Palacios Peñaranda (Universidad Autónoma de Occidente), Dr. Paula C. Sierra Correa (Instituto de Investigaciones Marinas y Costeras, INVEMAR), Dr. Gabriel R. Navas S. (Universidad de Cartagena), Dr. Andrés Fernando Osorio (Universidad Nacional de Colombia), Dr. José M. Riascos (Universidad de Antioquia), MSc. Ricardo Álvarez León (Fundación Verdes Horizontes), Dr. Jaime H. Polanía V. (Universidad Nacional de Colombia), Dr. Jorge H. Maldonado (Universidad de los Andes) and Dr. David Sánchez Núñez (Universidad Nacional de Colombia)

Schedule

COLOR CODE & DESCRIPTION	THEME 1	THEME 2	THEME 3	THEME 4	THEME 5	THEME 6
	Protecting and restoring mangrove forests and their biodiversity	Understanding and solving marine pollution in mangrove wetlands	Achieving sustainable socio-economic development and equity	Unlocking climate action and implementing mangrove-based solutions to climate change	Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness	Changing human relationships with mangrove wetlands

Monday 24th

HOUR	Session	Rhizophora & Avicennia forests
8:00		José Ernesto Mancera - Welcome message
8:15 / 8:45		Dan Friess - Celebrating the diversity of the world's mangroves
9:00		Coffee break
9:15	SESSION 1	Norman C Duke - What is so special about the mangrove genus Pelliciera (Tetrameristaceae) in equatorial America?
9:30	SESSION 1	Edward Castaneda - Hurricane Irma effects on mangrove forest structure in the Florida Everglades, USA
9:45	SESSION 1	Vicki Bennion - Decadal Scale Trends in Surface Elevation and Mangrove Tree Growth in Moreton Bay, Queensland, Australia.
10:00	SESSION 1	Kevin J. Buffington - Mangrove responses to sea-level rise: projections of blue carbon and species composition from resilient and vulnerable ecosystems
10:15	SESSION 1	Anoop Raj Singh - Mangrove vegetation response to sea level decrease caused by coastal uplift in North Andaman Islands, India
10:30	SESSION 1	Mériadec Sillanpää -Biotic and abiotic influences on forest growth dynamics across different aged mangrove stands in west papua, indonesia
10:45	SESSION 2	David Alejandro Sanchez - Effects of climate variability and hydrologic rehabilitation measures on long-term mangrove trajectories: from reproduction to recruitment and landscape cover changes
11:00	SESSION 2	Renee L. Piccolo - Finding the window of feasibility for restoration in the face of biophysical, socioeconomic, and governance constraints
11:15	SESSION 2	Gabriela J. Reyes - Despite Being Smaller in Area, Urbanized Mangroves Provide Important Functions Along the Atlantic Coast of Florida
11:30	SESSION 2	Nasreen Peer - Drivers and impacts of brachyuran distribution in South African mangroves
11:45	SESSION 2	Nadine Heck - Global drivers of mangrove loss in protected areas vary across governance and IUCN categories
12:00	SESSION 2	Jennifer Howard - Costs of restoring global mangrove forests
12:15	SESSION 2	Di Nitto - Joining forces for the Red List of Mangrove Ecosystems
12:30 / 13:00		Lunch
14:00	SESSION 3	Suhua Shi - Evolution of coastal forests based on a full set of mangrove genomes
14:15	SESSION 3	Ronny Peters - The impact of species- and site-specific hydraulic plant parameters on the forest structure – what do we (need to) know?
14:30	SESSION 3	Alejandra G Vovides -Thorsten Balke - Identifying establishment thresholds of mangrove pioneer species – Implications for restoration
14:45	SESSION 3	Karen Diele - Point of (no) return? Mangrove restoration practices set different trajectories for the (re) establishment of benthic diversity and ecosystem functionality
15:00	SESSION 3	Ulrich Salzmann - Tracing the legacy of environmental change and human impact in mangroves of North Sulawesi, Indonesia
15:15	SESSION 3	Valerie Hagger - Drivers of global mangrove loss and gain in social-ecological systems
15:30	SESSION 3	Robert Twilley - Coastal morphology explain global mangrove blue carbon
15:45		Break
16:00 / 16:15 / 16:30 / 16:45		Moving to Cartagena University
17:00 / 17:45		Lightining Talks (SESSION 4)
18:00 / 18:45		Poster exhibition (SESION 5)
19:00 / 19:15 / 20:00 / 18:45 / 19:00 / 19:15 / 19:30 / 19:45 / 20:00		Cultural activities - Acto Inaugural

Tuesday 25th

HOUR	Session	Rhizophora forest (Flexible and Hemiciclo rooms)	Session	Avicennia forest (Auditorio and Magistral rooms)
8:00 / 8:15		Sara Fratini - Genetics and genomics approaches are powerful tools for conservation of mangrove biodiversity		
8:45		Coffee break		
9:00	SESSION 6A	Marie-Christin Wimmler - Are root grafts cooperative traits for mangroves to cope with water stress?	SESSION 6B	Nur Hannah Abd Rahim - Brachyuran crabs as indicator species for microplastics pollution at Setiu Wetlands, Peninsular Malaysia
9:15	SESSION 6A	Daniel Marin Zuluaga - Landscapes of fear in mangrove ecosystems: conservation and restoration applications based in case studies	SESSION 6B	Stefano Cannicci - Mangroves in an industrialized setting: the impact of heavy metals on flora and fauna of mangrove forests in the Greater Bay Area, PR China
9:30	SESSION 6A	Shing Yip Lee - The microphytobenthos drive key ecosystem processes in tropical mangroves	SESSION 6B	Martha Palacios - Microplastics in mangrove ecosystem sediments, pacific coast of Colombia
9:45	SESSION 6A	Anusha Rajkaran - Assessing the health and biodiversity of mangrove forests across a disturbance gradient in South Africa to prioritise actions for restoration	SESSION 6B	Thanne Walawwe Gedera Fathima Mafaziya Nijamdeen - 4 social methods, 14 districts with 24 stakeholder groups over 34 months study reveal that conservation through legal means is insufficient for successful mangrove co-management
10:00	SESSION 6A	Andre Jacques Fallaria - Unveiling a hidden world: The assemblage and diversity of epiphytic lichens in different mangrove habitats of Oriental Mindoro, Philippines	SESSION 6B	Martin Zimmer - Effects of the benthic macrofauna on organic matter fluxes in mangrove sediments
10:15	SESSION 6A	Jacob J. Bukoski - Shred waves, not carbon: Co-occurrence of surf breaks and mangrove conservation opportunities	SESSION 6B	Lina Marcela Escobar - Carbon sequestration and storage in two mangrove forests in the colombian pacific ocean
10:30	SESSION 6A	Uta Berger - Advances and challenges in computer-based forest modelling to understand and predict mangroves responses to environmental changes	SESSION 6B	Ninon Martinez - Belize Blue Carbon: Establishing a national carbon stock estimate for mangrove ecosystems
10:45	SESSION 7A	Hannah Bowen - Sap flow characteristics of root-grafted Avicennia germinans individuals	SESSION 7B	Brooke Conroy - Quantifying the capacity of australian mangrove wetlands to store below-ground carbon and maintain substrate elevation with sea-level rise
11:00	SESSION 7A	Véronique Helfer - Mangrove sediment metagenomics – delving into the still largely unknown microbial functional diversity	SESSION 7B	Ingrid Julieth Estrada Galindo - Carbon stocks in mangrove ecosystems with different sedimentary setting in the Colombian Caribbean
11:15	SESSION 7A	Danielle E. Ogurcak - Using causal modeling to understand resilience of mangrove ecosystems to hurricane impact	SESSION 7B	Tim Jennerjahn - The "true" 'Blue Carbon' storage in mangrove sediments: autochthonous vs. allochthonous contributions, labile vs. stable organic matter
11:30	SESSION 7A	Steve Schill - Drones and Doves: Creating a more accurate national-scale mangrove inventory for The Bahamas	SESSION 7B	Main Uddin - Importance of mangrove plantations for blue carbon sequestration and climate change mitigation in Bangladesh
11:45	SESSION 7A	Lola Fatoyinbo - A new regional map of mangrove extent for Southeast Asia shows losses of 44% between the 1970s and 1996	SESSION 7B	Luri Nurlaila Syahid - Spatiotemporal pattern of mangrove blue carbon in Southeast Asia as a nature-based solution
12:00	SESSION 7A	Henrique Bravo - Size does not matter: functional diversity indices help predict endangered mangrove forests around Hong Kong	SESSION 7B	Radhika Bhargava - Failed adaptations to mangrove shoreline erosion: Implications for socio-economic vulnerability in the Sundarbans
12:15	SESSION 7A	Catherine Lovelock - Enhancing sustainable mangrove restoration success through objective-based Global Mangrove Restoration Guidelines	SESSION 7B	Siddharth Narayan - The spatial and temporal distribution of mangrove coastal protection benefits against storms
12:30		Lunch		
13:00		*"Dans le sel, nos racines" (In salt, our roots)* *A documentary film by Sabali Expeditions (Premier)*		
14:00	SESSION 8A	Lianne Ball - Applying Ecological Mangrove Restoration Protocols Within a Structured Decision-Making Framework for Improved Outcomes	SESSION 8B	Samantha Chapman - Incorporating WETFEET project results into a new sea level rise model to estimate nutrient sinks in mangrove ecosystems
14:15	SESSION 8A	Jaramar Villarreal-Rosas - Social feasibility and ecological suitability are key for identifying mangrove restoration priorities, even under tight decision-making deadlines	SESSION 8B	Erik Yando - Carbon dynamics across the mangrove-tidal flat ecotone in a tropical seascape
14:30	SESSION 8A	Maria-Esther Espinoza-Celi - Where can new mangroves establish within a large tropical river delta?: Quantifying hydrodynamic and geomorphological thresholds for new mangrove establishment	SESSION 8B	Zachary Cannizzo - International Collaboration to Enhance the Management and Carbon Accounting of Mangrove Ecosystems
14:45	SESSION 8A	Jean-Philippe Belliard - On the impacts of ENSO on mangrove sediment accretion and adaptability to sea level rise	SESSION 8B	Lisa Schile-Beers - Monetizing Carbon Storage: Progress and pitfalls in mangrove carbon project development
15:00	SESSION 8A	Rupesh K Bhomia - Carbon Dynamics in Mangrove Ecosystems of Andaman Islands: A living laboratory for studying natural disturbance and ecological succession	SESSION 8B	María Rosa Cárdenas Tomažič - MangRes: Mangrove restoration as a nature-based solution in biosphere reserves in Latin America and the Caribbean
15:15	SESSION 8A	Dominic Andradi-Brown - Linking national-scale policy interventions to mangrove conservation outcomes	SESSION 8B	Timothy Thomson - Nutrient enriched mangrove sediments show evidence of carbon loss and altered biogeochemical properties
15:30	SESSION 8A	Victoria Alejandra Sierra Luna - Functional analysis of benthic macrofauna in mangroves of the tropical Eastern Pacific (Colombian Pacific coast)	SESSION 8B	Fernando Arenas - Did sea level rise cause the disappearance of South California´s mangroves during the Early Holocene?
15:45		Break		
16:00 – 16:45		Moving to Cartagena University		Moving to Cartagena University
17:00 / 17:45		Lightining Talks (SESSION 9)		
18:00 / 18:45		Poster exhibition (SESION 10)		Semanglares V Workshop
19:00 – 20:00		Semanglares V Workshop		

Wednesday 26th

FIELD TRIPS

Thursday 27th

HOUR	Session	Rhizophora forest (Flexible and Hemiciclo rooms)	Session	Avicennia forest (Auditorio and Magistral rooms)
8:00 / 8:15		Jen Howard - Challenges to responsible scaling of mangrove protection and restoration		
8:45		Coffee break		
9:00	SESSION 11A	Steven Pennings - Loss of mangroves due to hard freeze leads to coastal erosion	SESSION 11B	Moritz Nusser - Effects of burrowing mud lobsters (Thalassina anomala) on carbon fluxes in mangrove sediments at Setiu Wetland, Terengganu, Malaysia
9:15	SESSION 11A	Jorge López Portillo - Long-term Monitoring of Hydrological Rehabilitation and Mangrove Restoration in Coastal Lagoon in the Gulf of Mexico	SESSION 11B	Nadim Daniel Katzer - Effects of mangrove crabs (Ucides cordatus) on carbon fluxes in mangrove sediments.
9:30	SESSION 11A	Adriana Parra - A Method for Long Term Monitoring of Mangrove Forest Change Dynamics Using Multisource Remote Sensing: The Ciénaga Grande de Santa Marta, Colombia	SESSION 11B	Josh Breithaupt - Combining loss-on-ignition with sedimentary and geomorphic settings to characterize mangrove soils: Part 1, Organic Carbon
9:45	SESSION 11A	Jasper Feyen - Using gedi-based forest structural metrics, sentinel-1/2 data and field inventory data to map mangrove aboveground biomass in suriname	SESSION 11B	Daniel Murdiyarso -Rupesh Bhomia Incorporating coastal blue carbon in the forest reference emissions level and market potentials
10:00	SESSION 11A	Cheryl Doughty - An updated global perspective on mangrove range limits: Using multiresolution mapping to address discrepancies in the spatial and bioclimatic limits of mangroves on the edge	SESSION 11B	Sigit Sasmito - Does mangrove conversion to oil palm and coconut plantations alter blue carbon at a similar degree to aquaculture?
10:15	SESSION 11A	Atticus Stovall - Exploring 3D Structural Signatures of Mangroves across the Planet	SESSION 11B	Nico Koedam - The millennial tale of mangrove peat sets hypotheses on coastal geomorphology and vegetation dynamics in Gazi (Kenya)
10:30	SESSION 11A	Pete Bunting - Global Mangrove Watch (GMW) Mangrove Alerts: Near Real-Time Alerts of Mangrove Loss	SESSION 11B	Julio César Herrera Carmona - Climate change vulnerability, risks and adaptation strategies for the management of mangrove ecosystems in Colombia
10:45	SESSION 12A	Thomas Worthington - The Mangrove Restoration Tracker Tool: meeting local practitioner needs and tracking progress of global targets	SESSION 12B	Meenakshi Poti - Understanding the post-tsunami mangrove socio-ecological system recovery in the Nicobar archipelago drawing on the adaptive cycle heuristic
11:00	SESSION 12A	Julien Andrieu - Can the botanical occurrence data of the GBIF enhance accuracy of mangrove mapping by remote sensing with open-access satellites?	SESSION 12B	Julián Reingold - Mangroves and Coastal Resilience: Challenges for Reporting on Socio-Ecosystem Services across Latin America, Africa and Asia
11:15	SESSION 12A	Ken W. Krauss - Net ecosystem exchange of CO2 in mangroves: estimation from leaf, tree, and stand water use characteristics	SESSION 12B	Asma' Jamal - Understanding local community perspectives of mangrove ecosystem disservices in Kuala Selangor, Malaysia: A pilot study
11:30	SESSION 12A	Kerrylee Rogers - Development and Validation of a Model of the Response of Adjacent Mangroves and Saltmarshes to Sea-Level Rise	SESSION 12B	Thorsten Balke - Mangrove research framing has changed from crisis to ecosystem services: a text mining analysis
11:45	SESSION 12A	Sandip Kumar Basak - In Indian Sundarbans xenogamous pollination is preferred in Bruguiera gymnorrhiza and Avicennia spp., the most successful ones used commonly for mangrove afforestation ventures	SESSION 12B	Ana María C. Ortiz - Difference in the use of mangrove forest and its relationship with resource availability and change of ancestral practices in Afro-descendant and Embera-indigenous communities.
12:00	SESSION 12A	Nicolas Moity - A first assessment of biomass and carbon estimation for Galapagos' mangrove forests	SESSION 12B	Kinsey Blumenthal - Mangroves and human health through a medical ecology framework
12:15	SESSION 12A	Giovanna Wolswijk - How does forest management impact soil carbon in mangroves? A (10 m) deep study in the Matang Mangrove Forest Reserve, Malaysia	SESSION 12B	Andrés Fraiz - Characterization of freshwater coastal wetlands in areas adjacent to the mangrove ecosystem in Tonosí, Pacific coast, Republic of Panama
12:30 / 13:00		Lunch		
14:00 – 14:30		Juan Camilo Cardenas - Understanding the human logic in the local coastal commons: Lessons from experiments in the field		
14:45	SESSION 13A	Virginie Tsilibaris - ROM: a mobile App designed for mangrove managers	SESSION 13B	Armando Soares dos Reis-Neto - Historical Ecology of Brazilian mangroves: past, present and future
15:00	SESSION 13A	Ricardo Climent - Mangrove.World video-game: A transformative medium to engage the public in sustainability	SESSION 13B	Nicole Chabaneix - The Climate-Smart Mangrove Decision-Support Tool: helping mangrove practitioners climate-smart mangrove conservation and restoration
15:15	SESSION 13A	Rafael J. Araújo - Mangrove city: using virtual reality to demystify and normalize mangroves as critical parts of our coastal landscape	SESSION 13B	Janwar Moreno - Estimating the Value of Mangrove Assets Applying the System of Environmental Economic Accounting in the Cienaga Grande of Santa Marta
15:30	SESSION 13A	Layla Olefs - Ecological Influencers - What people know and think about mangroves on social media.	SESSION 13B	Barend van Maanen - Mangroves and Mud: investigating the impacts of human activities on estuarine landscape development
15:45		Break		
16:00 – 16:45		Moving to Cartagena University		Moving to Cartagena University
17:00 / 17:45		Lightining Talks (SESSION 14)		
18:00 / 18:45		Poster exhibition (SESION 15)		Semanglares V Workshop
19:00 – 20:00		Semanglares V Workshop		

Friday 28th

HOUR	Session	Rhizophora forest (Flexible and Hemiciclo rooms)	Session	Avicennia forest (Auditorio and Magistral rooms)
8:00 / 8:15		Andre Rovai - Drivers of change and uncertainties on blue carbon dynamics across the world's mangroves: A walk through spatial and temporal scales		
8:45		Coffee break		
9:00	SESSION 16A	Marc Simard - A New Global Map of Mangrove Canopy Height	SESSION 16B	Laurel Wood Gutenberg - Remote Sensing of Belowground Carbon in Mangrove Forests- Case Study of Pohnpei, Federated States of Micronesia
9:15	SESSION 16A	Cristian Camilo Montes-Chaura - Use of semi-automated remote sensing techniques for the quantification of mangrove cover in colombia: input for territorial ecosystem management.	SESSION 16B	Lourdes Celeste Ortega Trasviña - Mangrove conservation and restoration in collaboration with community women groups in the Northwest of Mexico
9:30	SESSION 16A	David Lagomasino - Quantifying the human footprint of mangrove change	SESSION 16B	Melva Treviño - Thinking Outside the Blue Economy Box: Achieving Equity in Mangrove Management
9:45	SESSION 16A	Juan Carlos Mejía-Rentería - Assessing Mangrove Ecological Condition based on Canopy Roughness using Drone-Based Digital Surface Models: examples from the Caribbean and Pacific Coasts	SESSION 16B	Mark Spalding - Mapping Mangrove Wealth: collaborative efforts to determine global values
10:00	SESSION 16A	Nathan Thomas - All of our Mangrove maps are right!	SESSION 16B	Alejandra Navarrete - Communicating Science to Policymakers
10:15	SESSION 16A	Rachel Collin - Application of Open Access Data for National and Sub-National Scale Mapping of Mangrove Cover	SESSION 16B	Hector Arsenio Tavera Escobar - Updating of the public policy instrument for the integral management of mangroves in Colombia
10:30	SESSION 16A	Paulo J. Murillo-Sandoval - Global trends of greening and browning in mangrove ecosystems		TBA
10:45	SESSION 17	Cheuk Yiu Cheung - True Mangrove species in global marine databases: a critical appraisal		TBA
11:00	SESSION 17	Lola Fatoyinbo - New system to map mangrove degradation in the Caribbean and Gulf of Mexico		TBA
11:15	SESSION 17	Alison K.S. Wee - Environmental DNA (eDNA) metabarcoding of ichthyofauna in Asian mangrove ecosystems revealed spatial challenges in community-level analysis		TBA
11:30	SESSION 17	Tadashi Kajita - Challenges to Understand Global Mangrove Biodiversity by eDNA Metabarcoding		TBA
11:45	SESSION 17	Gustavo A. Castellanos-Galindo - The role of mangrove typology and biogeography in structuring mangrove fish assemblages in the American continent		TBA
12:00	SESSION 17	Stefan Sorge - Identifying most influential factors and related innovation development patterns in mangrove governance innovations in Colombia		TBA
12:15	SESSION 17	Tom Van Der Stocken-Future changes in seawater properties across mangroves globally and implications for dispersal		TBA
12:30 / 13:00		Lunch		Lunch
14:00	SESSION 18	Ilka Feller - Mangroves and the Mangrove Finch in the Galapagos:		
14:15	SESSION 18	Farid Dahdouh-Guebas and ca. 200 collaborators - Everything you always wanted to know about mangroves* (*but were afraid to ask)		
14:30 / 14:45		TBA		
15:00		Concluding remarks		
15:15 / 15:30		Awards and recognitions		
15:45		Break		
16:00 – 16:45		Announcement of MMM7 host country		
17:00 / 17:45		Moving to Cartagena University		
18:00 – 20:00		Closing Ceremony		

VENUE: Universidad de los Andes

Monday 24th

Code	Hour	Keynote Address	Room	Theme
		Session chair: Ken W. Krauss		
8:15		Dan Friess - Celebrating the diversity of the world's mangroves		
		Session 1 - Chair: Catherine Lovelock		
1.1	9:15	Norman C Duke - What is so special about the mangrove genus Pelliciera (Tetrameristaceae) in equatorial America?	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	I. Protecting and restoring mangrove forests and their biodiversity
1.2	9:30	Edward Castaneda - Hurricane Irma effects on mangrove forest structure in the Florida Everglades, USA		
1.3	9:45	Vicki Bennion - Decadal Scale Trends in Surface Elevation and Mangrove Tree Growth in Moreton Bay, Queensland, Australia.		
1.4	10:00	Kevin J. Buffington - Mangrove responses to sea-level rise: projections of blue carbon and species composition from resilient and vulnerable ecosystems		
1.5	10:15	Anoop Raj Singh - Mangrove vegetation response to sea level decrease caused by coastal uplift in North Andaman Islands, India		
1.6	10:30	Mériadec Sillanpää -Biotic and abiotic influences on forest growth dynamics across different aged mangrove stands in west papua, indonesia		

Code	Hour	Session 2 - Chair: Jorge López Portillo	Room	Theme
2.1	10:45	David Alejandro Sanchez - Effects of climate variability and hydrologic rehabilitation measures on long-term mangrove trajectories: from reproduction to recruitment and landscape cover changes	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	I. Protecting and restoring mangrove forests and their biodiversity
2.2	11:00	Renee L. Piccolo - Finding the window of feasibility for restoration in the face of biophysical, socioeconomic, and governance constraints		
2.3	11:15	Gabriela J. Reyes - Despite Being Smaller in Area, Urbanized Mangroves Provide Important Functions Along the Atlantic Coast of Florida		
2.4	11:30	Nasreen Peer - Drivers and impacts of brachyuran distribution in South African mangroves		
2.5	11:45	Nadine Heck - Global drivers of mangrove loss in protected areas vary across governance and IUCN categories		
2.6	12:00	Jennifer Howard - Costs of restoring global mangrove forests		
2.7	12:15	Di Nitto - Joining forces for the Red List of Mangrove Ecosystems		

Code	Hour	Session 3 - Chair: Marília Cunha Lignon	Room	Theme
3.1	14:00	Suhua Shi - Evolution of coastal forests based on a full set of mangrove genomes	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	I. Protecting and restoring mangrove forests and their biodiversity
3.2	14:15	Ronny Peters - The impact of species- and site-specific hydraulic plant parameters on the forest structure – what do we (need to) know?		
3.3	14:30	Alejandra G Vovides -Thorsten Balke - Identifying establishment thresholds of mangrove pioneer species – Implications for restoration		
3.4	14:45	Karen Diele - Point of (no) return? Mangrove restoration practices set different trajectories for the (re)establishment of benthic diversity and ecosystem functionality		
3.5	15:00	Ulrich Salzmann - Tracing the legacy of environmental change and human impact in mangroves of North Sulawesi, Indonesia		
3.6	15:15	Valerie Hagger - Drivers of global mangrove loss and gain in social-ecological systems		
3.7	15:30	Robert Twilley - Coastal morphology explain global mangrove blue carbon		V. Achieving sustainable socio-economic development and equity

Tuesday 25th

Code	Hour	Keynote Address	Room	Theme
		Session chair: Samantha Chapman		
8:00		Sara Fratini - Genetics and genomics approaches are powerful tools for conservation of mangrove biodiversity	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	
		Session 6A - Chair: David Lagomasino		
6.1A	9:00	Marie-Christin Wimmler - Are root grafts cooperative traits for mangroves to cope with water stress?	Rhizophora forest (Flexible and Hemiciclo rooms)	I. Protecting and restoring mangrove forests and their biodiversity
6.2A	9:15	Daniel Marin Zuluaga - Landscapes of fear in mangrove ecosystems: conservation and restoration applications based in case studies		
6.3A	9:30	Shing Yip Lee - The microphytobenthos drive key ecosystem processes in tropical mangroves		
6.4A	9:45	Anusha Rajkaran - Assessing the health and biodiversity of mangrove forests across a disturbance gradient in South Africa to prioritise actions for restoration		
6.5A	10:00	Andre Jacques Fallaria - Unveiling a hidden world: The assemblage and diversity of epiphytic lichens in different mangrove habitats of Oriental Mindoro, Philippines		
6.6A	10:15	Jacob J. Bukoski - Shred waves, not carbon: Co-occurrence of surf breaks and mangrove conservation opportunities		
6.7A	10:30	Uta Berger - Advances and challenges in computer-based forest modelling to understand and predict mangroves responses to environmental changes		

Code	Hour	Session 6B - Chair: Stu Hamilton	Room	Theme
6.2B	9:00	Nur Hannah Abd Rahim - Brachyuran crabs as indicator species for microplastics pollution at Setiu Wetlands, Peninsular Malaysia	Avicennia forest (Auditorio and Magistral rooms)	II. Understanding and solving marine pollution in mangrove wetlands
6.3B	9:15	Stefano Cannicci - Mangroves in an industrialized setting: the impact of heavy metals on flora and fauna of mangrove forests in the Greater Bay Area, PR China		
6.4B	9:30	Martha Palacios - Microplastics in mangrove ecosystem sediments, pacific coast of Colombia		
6.5B	9:45	Thanne Walawwe Gedera Fathima Mafaziya Nijamdeen - 4 social methods, 14 districts with 24 stakeholder groups over 34 months study reveal that conservation through legal means is insufficient for successful mangrove co-management		III. Achieving sustainable socio-economic development and equity
6.6B	10:00	Martin Zimmer - Effects of the benthic macrofauna on organic matter fluxes in mangrove sediments		II. Understanding and solving marine pollution in mangrove wetlands
6.7B	10:15	Lina Marcela Escobar - Carbon sequestration and storage in two mangrove forests in the colombian pacific ocean		IV. Unlocking climate action and implementing mangrove-

6.8B	10:30	Ninon Martinez - Belize Blue Carbon: Establishing a national carbon stock estimate for mangrove ecosystems		based solutions to climate change

Code	Hour	Session 7A - Farid Dahdouh-Guebas	Room	Theme
7.1A	10:45	Hannah Bowen - Sap flow characteristics of root-grafted Avicennia germinans individuals	Rhizophora forest (Flexible and Hemiciclo rooms)	I. Protecting and restoring mangrove forests and their biodiversity
7.2A	11:00	Véronique Helfer - Mangrove sediment metagenomics – delving into the still largely unknown microbial functional diversity		
7.3A	11:15	Danielle E. Ogurcak - Using causal modeling to understand resilience of mangrove ecosystems to hurricane impact		
7.4A	11:30	Steve Schill - Drones and Doves: Creating a more accurate national-scale mangrove inventory for The Bahamas		
7.5A	11:45	Lola Fatoyinbo - A new regional map of mangrove extent for Southeast Asia shows losses of 44% between the 1970s and 1996		
7.6A	12:00	Henrique Bravo - Size does not matter: functional diversity indices help predict endangered mangrove forests around Hong Kong		
7.7A	12:15	Catherine Lovelock - Enhancing sustainable mangrove restoration success through objective-based Global Mangrove Restoration Guidelines		

Code	Hour	Session 7B - Chair: Gustavo A. Castellanos-Galindo	Room	Theme
6.1B	10:45	Brooke Conroy - Quantifying the capacity of australian mangrove wetlands to store below-ground carbon and maintain substrate elevation with sea-level rise	Avicennia forest (Auditorio and Magistral rooms)	IV. Unlocking climate action and implementing mangrove-based solutions to climate change
6.2B	11:00	Ingrid Julieth Estrada Galindo - Carbon stocks in mangrove ecosystems with different sedimentary setting in the Colombian Caribbean		
6.3B	11:15	Tim Jennerjahn - The "true" 'Blue Carbon' storage in mangrove sediments: autochthonous vs. allochthonous contributions, labile vs. stable organic matter		
6.4B	11:30	Main Uddin - Importance of mangrove plantations for blue carbon sequestration and climate change mitigation in Bangladesh		
6.5B	11:45	Luri Nurlaila Syahid - Spatiotemporal pattern of mangrove blue carbon in Southeast Asia as a nature-based solution		
6.6B	12:00	Radhika Bhargava - Failed adaptations to mangrove shoreline erosion: Implications for socio-economic vulnerability in the Sundarbans		III. Achieving sustainable socio-economic development and equity
6.7B	12:15	Siddharth Narayan - The spatial and temporal distribution of mangrove coastal protection benefits against storms		IV. Unlocking climate action and implementing mangrove-based solutions to climate change

Code	Hour	Session 8A - Chair: Martin Zimmer	Room	Theme
8.1A	14:00	Lianne Ball - Applying Ecological Mangrove Restoration Protocols Within a Structured Decision-Making Framework for Improved Outcomes	Rhizophora forest (Flexible and Hemiciclo rooms)	I. Protecting and restoring mangrove forests and their biodiversity
8.2A	14:15	Jaramar Villarreal-Rosas - Social feasibility and ecological suitability are key for identifying mangrove restoration priorities, even under tight decision-making deadlines		
8.3A	14:30	Maria-Esther Espinoza-Celi - Where can new mangroves establish within a large tropical river delta?: Quantifying hydrodynamic and geomorphological thresholds for new mangrove establishment		
8.4A	14:45	Jean-Philippe Belliard - On the impacts of ENSO on mangrove sediment accretion and adaptability to sea level rise		
8.5A	15:00	Rupesh K Bhomia - Carbon Dynamics in Mangrove Ecosystems of Andaman Islands: A living laboratory for studying natural disturbance and ecological succession		
8.6A	15:15	Dominic Andradi-Brown - Linking national-scale policy interventions to mangrove conservation outcomes		
8.7A	15:30	Victoria Alejandra Sierra Luna - Functional analysis of benthic macrofauna in mangroves of the tropical Eastern Pacific (Colombian Pacific coast)		

Code	Hour	Session 8B - Chair: Tim Jennerjahn	Room	Theme
8.1B	14:00	Samantha Chapman - Incorporating WETFEET project results into a new sea level rise model to estimate nutrient sinks in mangrove ecosystems	Avicennia forest (Auditorio and Magistral rooms)	IV. Unlocking climate action and implementing mangrove-based solutions to climate change
8.2B	14:15	Erik Yando - Carbon dynamics across the mangrove-tidal flat ecotone in a tropical seascape		
8.3B	14:30	Zachary Cannizzo - International Collaboration to Enhance the Management and Carbon Accounting of Mangrove Ecosystems		
8.4B	14:45	Lisa Schile-Beers - Monetizing Carbon Storage: Progress and pitfalls in mangrove carbon project development		
8.5B	15:00	Juan Carlos Castro Hernández &Henry Preciado - MangRes: Mangrove restoration as a nature-based solution in biosphere reserves in Latin America and the Caribbean		I. Protecting and restoring mangrove forests and their biodiversity
8.6B	15:15	Timothy Thomson - Nutrient enriched mangrove sediments show evidence of carbon loss and altered biogeochemical properties		II. Understanding and solving marine pollution in mangrove wetlands
8.7B	15:30	Fernando Arenas - Did sea level rise cause the disappearance of South California´s mangroves during the Early Holocene?		IV. Unlocking climate action and implementing mangrove-based solutions to climate change

Thursday 27th

		Session chair: Kerrylee Rogers		
Code	Hour	Keynote Address	Room	Theme
8:00		Jen Howard - Challenges to responsible scaling of mangrove protection and restoration	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	
		Session 11A - Chair: Thorsten Balke		
11.1A	9:00	Steven Pennings - Loss of mangroves due to hard freeze leads to coastal erosion	Rhizophora forest (Flexible and Hemiciclo rooms)	I. Protecting and restoring mangrove forests and their biodiversity
11.2A	9:15	Jorge López Portillo - Long-term Monitoring of Hydrological Rehabilitation and Mangrove Restoration in Coastal Lagoon in the Gulf of Mexico		
11.3A	9:30	Adriana Parra - A Method for Long Term Monitoring of Mangrove Forest Change Dynamics Using Multisource Remote Sensing: The Ciénaga Grande de Santa Marta, Colombia		V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
11.4A	9:45	Jasper Feyen - Using gedi-based forest structural metrics, sentinel-1/2 data and field inventory data to map mangrove aboveground biomass in suriname		
11.5A	10:00	Cheryl Doughty - An updated global perspective on mangrove range limits: Using multiresolution mapping to address discrepancies in the spatial and bioclimatic limits of mangroves on the edge		
11.6A	10:15	Atticus Stovall - Exploring 3D Structural Signatures of Mangroves across the Planet		

11.7A	10:30	Pete Bunting - Global Mangrove Watch (GMW) Mangrove Alerts: Near Real-Time Alerts of Mangrove Loss		

Code	Hour	Session 11B - Chair: Andrés Fernando Osorio	Room	Theme
11.1B	9:00	Moritz Nusser - Effects of burrowing mud lobsters (Thalassina anomala) on carbon fluxes in mangrove sediments at Setiu Wetland, Terengganu, Malaysia	Avicennia forest (Auditorio and Magistral rooms)	IV. Unlocking climate action and implementing mangrove-based solutions to climate change
11.2B	9:15	Nadim Daniel Katzer - Effects of mangrove crabs (Ucides cordatus) on carbon fluxes in mangrove sediments.		
11.3B	9:30	Josh Breithaupt - Combining loss-on-ignition with sedimentary and geomorphic settings to characterize mangrove soils: Part 1, Organic Carbon		
11.4B	9:45	Daniel Murdiyarso -Rupesh Bhomia Incorporating coastal blue carbon in the forest reference emissions level and market potentials		
11.5B	10:00	Sigit Sasmito - Does mangrove conversion to oil palm and coconut plantations alter blue carbon at a similar degree to aquaculture?		
11.6B	10:15	Nico Koedam - The millennial tale of mangrove peat sets hypotheses on coastal geomorphology and vegetation dynamics in Gazi (Kenya)		
11.7B	10:30	Julio César Herrera Carmona - Climate change vulnerability, risks and adaptation strategies for the management of mangrove ecosystems in Colombia		

Code	Hour	Session 12A - Chair: David Sánchez Núñez	Room	Theme
12.1A	10:45	Thomas Worthington - The Mangrove Restoration Tracker Tool: meeting local practitioner needs and tracking progress of global targets	Rhizophora forest (Flexible and Hemiciclo rooms)	I. Protecting and restoring mangrove forests and their biodiversity
12.2A	11:00	Julien Andrieu - Can the botanical occurrence data of the GBIF enhance accuracy of mangrove mapping by remote sensing with open-access satellites?		V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
12.3A	11:15	Ken W. Krauss - Net ecosystem exchange of CO2 in mangroves: estimation from leaf, tree, and stand water use characteristics		
12.4A	11:30	Kerrylee Rogers - Development and Validation of a Model of the Response of Adjacent Mangroves and Saltmarshes to Sea-Level Rise		
12.5A	11:45	Sandip Kumar Basak - In Indian Sundarbans xenogamous pollination is preferred in Bruguiera gymnorrhiza and Avicennia spp., the most successful ones used commonly for mangrove afforestation ventures		I. Protecting and restoring mangrove forests and their biodiversity
12.6A	12:00	Nicolas Moity - A first assessment of biomass and carbon estimation for Galapago's mangrove forests		
12.7A	12:15	Giovanna Wolswijk - How does forest management impact soil carbon in mangroves? A (10 m) deep study in the Matang Mangrove Forest Reserve, Malaysia		

Code	Hour	Session 12B - Chair: Marc Simard	Room	Theme
12.1B	10:45	Meenakshi Poti - Understanding the post-tsunami mangrove socio-ecological system recovery in the Nicobar archipelago drawing on the adaptive cycle heuristic	Avicennia forest (Auditorio and Magistral rooms)	VI. Changing human relationships with mangrove wetlands
12.2B	11:00	Julián Reingold - Mangroves and Coastal Resilience: Challenges for Reporting on Socio-Ecosystem Services across Latin America, Africa and Asia		
12.3B	11:15	Asma' Jamal - Understanding local community perspectives of mangrove ecosystem disservices in Kuala Selangor, Malaysia: A pilot study		
12.4B	11:30	Thorsten Balke - Mangrove research framing has changed from crisis to ecosystem services: a text mining analysis		
12.5B	11:45	Ana María C. Ortiz - Difference in the use of mangrove forest and its relationship with resource availability and change of ancestral practices in Afro-descendant and Embera-indigenous communities.		
12.6B	12:00	Kinsey Blumenthal - Mangroves and human health through a medical ecology framework		
12.7B	12:15	Andrés Fraiz - Characterization of freshwater coastal wetlands in areas adjacent to the mangrove ecosystem in Tonosí, Pacific coast, Republic of Panama		
Premier	13:00	"Dans le sel, nos racines" (In salt, our roots) - A documentary film by Sabali Expeditions	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	

		Session chair: Rafael Araujo		
Code	Hour	Keynote Address	Room	Theme
14:00		Juan Camilo Cardenas - Understanding the human logic in the local coastal commons: Lessons from experiments in the field	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	
		Session 13A - Chair: Jaime H. Polanía		
13.1A	14:45	Virginie Tsilibaris - ROM: a mobile App designed for mangrove managers	Rhizophora forest (Flexible and Hemiciclo rooms)	V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
13.2A	15:00	Ricardo Climent - Mangrove.World video-game: A transformative medium to engage the public in sustainability		
13.3A	15:15	Rafael J. Araújo - Mangrove city: using virtual reality to demystify and normalize mangroves as critical parts of our coastal landscape		VI. Changing human relationships with mangrove wetlands
13.4A	15:30	Layla Olefs - Ecological Influencers - What people know and think about mangroves on social media.		

Code	Hour	Session 13B - Chair: Edward Castaneda	Room	Theme
13.1B	14:45	Armando Soares dos Reis-Neto - Historical Ecology of Brazilian mangroves: past, present and future	Avicennia forest (Auditorio and Magistral rooms)	VI. Changing human relationships with mangrove wetlands
13.2B	15:00	Nicole Chabaneix - The Climate-Smart Mangrove Decision-Support Tool: helping mangrove practitioners climate-smart mangrove conservation and restoration		IV. Unlocking climate action and implementing mangrove-based solutions to climate change
13.3B	15:15	Janwar Moreno - Estimating the Value of Mangrove Assets Applying the System of Environmental Economic Accounting in the Cienaga Grande of Santa Marta		VI. Changing human relationships with mangrove wetlands
13.4B	15:30	Barend van Maanen - Mangroves and Mud: investigating the impacts of human activities on estuarine landscape development		

FRIDAY 28th

		Session chair: Norman Duke		
Code	Hour	Keynote Address	Additional room	Theme
8:00		Andre Rovai - Drivers of change and uncertainties on blue carbon dynamics across the world's mangroves: A walk through spatial and temporal scales	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	
		Session 16A - Chair: Véronique Helfer		
16.1A	9:00	Marc Simard - A New Global Map of Mangrove Canopy Height		

16.2A	9:15	Cristian Camilo Montes-Chaura - Use of semi-automated remote sensing techniques for the quantification of mangrove cover in colombia: input for territorial ecosystem management.	Rhizophora forest (Flexible and Hemiciclo rooms)	V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
16.3A	9:30	David Lagomasino - Quantifying the human footprint of mangrove change		
16.4A	9:45	Juan Carlos Mejía-Rentería - Assessing Mangrove Ecological Condition based on Canopy Roughness using Drone-Based Digital Surface Models: examples from the Caribbean and Pacific Coasts		
16.5A	10:00	Nathan Thomas - All of our Mangrove maps are right!		
16.6A	10:15	Rachel Collin - Application of Open Access Data for National and Sub-National Scale Mapping of Mangrove Cover		
16.7A	10:30	Paulo J. Murillo-Sandoval - Global trends of greening and browning in mangrove ecosystems		

Code	Hour	Session 16B - Chair: Martha Palacios	Additional room	Theme
16.1B	9:00	Laurel Wood Gutenberg - Remote Sensing of Belowground Carbon in Mangrove Forests- Case Study of Pohnpei, Federated States of Micronesia	Avicennia forest (Auditorio and Magistral rooms)	I. Protecting and restoring mangrove forests and their biodiversity
16.2B	9:15	Lourdes Celeste Ortega Trasviña - Mangrove conservation and restoration in collaboration with community women groups in the Northwest of Mexico		III. Achieving sustainable socio-economic development and equity
16.3B	9:30	Melva Treviño - Thinking Outside the Blue Economy Box: Achieving Equity in Mangrove Management		
16.4B	9:45	Mark Spalding - Mapping Mangrove Wealth: collaborative efforts to determine global values		
16.5B	10:00	Hector Arsenio Tavera Escobar - Structural Characteristics of the Tallest Mangrove Forests of the American Continent: A Comparison of Ground-Based, Drone and Radar Measurement		
16.6B	10:15	To Be Announced	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	
16.7B	10:30			

Code	Hour	Session 17 - Chair: Paula Sierra	Additional room	Theme
17.1	10:45	Cheuk Yiu Cheung - True Mangrove species in global marine databases: a critical appraisal	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
17.2	11:00	Lola Fatoyinbo - New system to map mangrove degradation in the Caribbean and Gulf of Mexico		
17.3	11:15	Alison K.S. Wee - Environmental DNA (eDNA) metabarcoding of ichthyofauna in Asian mangrove ecosystems revealed spatial challenges in community-level analysis		
17.4	11:30	Tadashi Kajita - Challenges to Understand Global Mangrove Biodiversity by eDNA Metabarcoding		
17.5	11:45	Gustavo A. Castellanos-Galindo - The role of mangrove typology and biogeography in structuring mangrove fish assemblages in the American continent		
17.6	12:00	Stefan Sorge - Identifying most influential factors and related innovation development patterns in mangrove governance innovations in Colombia		IV. Unlocking climate action and implementing mangrove-based solutions to climate change
17.7	12:15	Tom Van Der Stocken-Future changes in seawater properties across mangroves globally and implications for dispersal		

Code	Hour	Session 18 - Chair: TBA	Additional room	Theme
18.1	14:00	Ilka Feller - Mangroves and the Mangrove Finch in the Galapagos:	Rhizophora & Avicennia forest (Flexible, Hemiciclo, Auditorio and Magistral rooms)	I. Protecting and restoring mangrove forests and their biodiversity
18.2	14:15	Farid Dahdouh-Guebas and ca. 200 collaborators - Everything you always wanted to know about mangroves* (*but were afraid to ask)		V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
18.3	14:30	To Be Announced		
18.4	14:45			
18.5	15:00	Concluding remarks		
18.6	15:15	Awards and recognitions		
18.7	16:00	Announcement of MMM7 host country		

VENUE : Universidad de Cartagena, Claustro San Agustìn

Monday 24th

Lightning talks

Code	Session 4	Room	Theme
P 4.1	André Guilherme Madeira - The role of oceanic currents in the dispersal and connectivity of the mangrove Rhizophora mangle on the Southwest Atlantic region	Paraninfo	I. Protecting and restoring mangrove forests and their biodiversity
P 4.2	Steven W. J. Canty - Do protected areas provide co-benefits to mangroves and coastal communities?		
P 4.3	Anna R. Armitage - Black mangrove (Avicennia germinans) regrowth and reproductive output following hurricane and freeze disturbances		
P 4.4	Andrew From - Establishing structural and surface elevation change targets for a mangrove forest undergoing hydrological restoration on Marco Island, Florida, USA		
P 4.5	Rod M Connolly - Fish use of restored mangroves is unrelated to habitat maturity		
P 4.6	Cai Ladd - Identifying suitable sites for mangrove restoration using the low-cost, self-assembled, and open-source 'Mini Buoy' hydrology sensor		
P 4.7	Marina Paixão Gil - Changes in forest structure and aboveground carbon stocks in preserved and impacted mangroves in southeastern Brazil		
P 4.8	Staquet Adrien - Natural establishment of mangroves: Lessons from the muddy open coast of French Guiana		
P 4.9	Michael Kyei Agyekum - Spatio-temporal patterns of mangrove canopy gaps in South Africa: An in-depth analysis		
P 4.10	Jeff Kelleway - Mangrove responses following black summer bushfire impact		
P 4.11	Camila Frances P. Naputo - Assessment of Fish Biodiversity in Two Biogeographic Regions (Sorsogon and Oriental Mindoro) using eDNA metabarcoding: An Emerging Tool in the Philippines		
P 4.12	Melissa Abud - Rehabilitation of the eastern Pacific endemic mangrove, Mora oleifera, in the southern Colombian Pacific		
P 4.13	Kristin Wilson Grimes - Growing Research, Restoration, Outreach, and Education (GRROE) of U.S. Virgin Islands Mangroves		
P 4.14	Lindy Knowles - A Bahamian mangrove creek restored: a decade of the Bonefish Pond Mangrove Restoration Project		

Poster

Code	Session 5	Room	Theme
P 5.16	Marília Cunha Lignon - Mangrove Forest Dynamics: long-term monitoring using permanent plots in the southeastern Brazilian coast		
P 5.17	Marília Cunha Lignon - Current conservation status of mangrove forests at UNESCO and Ramsar sites in southeastern and southern Brazil		
P 5.18	Marília Cunha Lignon - An estimate of the efficiency in the filtration capacity of mangrove oyster (crassostrea brasiliana) in southeastern brazil		
P 5.19	Marília Cunha Lignon - Evaluation of seedlings and saplings growth of mangrove species in different sediments		
P 5.20	Alejandra G Vovides - Mangrove sestoration trajectories seen through macrozoobenthic community assemblages – a tool for local managers		
P 5.21	Jhon Alexander osorio - A biotic perspective of mangroves health in South Africa		
P 5.22	Hannah Morrissette - Rapid mangrove monitoring and blue carbon assessments to support Mesoamerican Reef restoration efforts		
P 5.23	Heather A. Stewart - Using mangrove monitoring to inform and guide restoration efforts		
P 5.24	Nicole Cormier - Challenges and opportunities for the management of hydrologically restored wetlands		
P 5.25	Heather A. Stewart - Coexisting mangrove-coral habitat use by reef fishes in the Caribbean		
P 5.26	Anoop Raj Singh - A decadal change on the mangrove colonization on the new intertidal habitats of Andaman and Nicobar archipelago – a post tsunami and subsidence scenario		
P 5.27	Lorae T. Simpson - Do global change variables alter mangrove decomposition? A systematic review		
P 5.28	Phoebe Stewart-Sinclair - Benefits of mangrove restoration in different geomorphic settings		
P 5.29	Bailey Ross - Visual surveys reveal coral growth in mangrove fringes in a subtropical metropolis		
P 5.30	Kerry E. Grimm - Follow the money: Understanding the Latin America and Caribbean mangrove restoration funding landscape to assist organizations and funders in improved social-ecological outcomes		
P 5.31	Eunice Lois D. Gianan - Impacts of varying salinity and inundation on the structural complexity of mangrove stands in the Philippines: an individual-based modeling study		
P 5.32	Alexandra Rodriguez - A conceptual model to support decisions in mangrove restoration based on techniques, knowledge, and experiences in colombia		
P 5.33	Jack Hill - Adult mangrove roots facilitate juvenile establishment		
P 5.34	Agustin de Jesus Basañez Muñoz - Comparison of mangrove structural values in different conditions of ecological degradation		
P 5.35	Amina Juma Hamza - Changes in Mangrove Cover and Exposure to Coastal Hazards in Kenya		
P 5.36	Angela Inés Guzmán - Project "Research on ecosystem services derived from mangrove forests in the Colombian Pacific". Alliance Universidad Nacional de Colombia - Universidad del Valle		
P 5.37	Zoya E.A. Buckmire - Understanding Grenada's mangroves: zonation, plasticity, and the potential for restoration		
P 5.38	Agustín de Jesús Basáñez Muñoz - Comparison of mangrove structural values in different conditions of ecological degradation		
P 5.39	Zixiao Guo - The biogeography of multiple mangrove species in the Indo-West Pacific region		
P 5.40	Alex Pearse - Baseline assessment of carbon stocks before hydrological restoration for a pilot blue carbon project		
P 5.41	A. Aldrie Amir - Tropical vs. subtropical mangrove canopy gaps: Characteristics and their regeneration dynamics		
P 5.42	Maria Camila Guevara Torres - Trophic flow modeling of a mangrove in the colombian pacific coast		
P 5.43	Diana Medina Contreras - Combining approaches for modelling trophic pathways supporting a species of fishery importance in a tropical mangrove		
P 5.44	Celio Helder Resende de Sousa - The potential of West and Central African coastal protected areas for Blue Carbon projects and mangrove restoration		
P 5.45	Li Yulong - Genome of mangrove without specialized phenotypes reveals common requirements of adaptation to intertidal environments		

P 5.46	Ranran Zhu - High-quality genome of a pioneer mangrove Laguncularia racemosa corroborates its utility in reforestation efforts	Paraninfo	I. Protecting and restoring mangrove forests and their biodiversity
P 5.47	Citra Gilang Qur'ani - Carbon dynamics in various mangroves climate zones and habitat characteristics in Asia and the Pacific		
P 5.48	Nico Koedam - A near-century old baseline unexpectedly suggests limited change in part of Bangka island's mangroves (Indonesia)		
P 5.49	Maria Elisa B. Gerona-Daga - Variations in chlorophyll fluorescence-derived photosynthetic parameters imply stressed seedlings under different mangrove conditions		
P 5.50	Julián Esteban Díaz Triana - Approaching forest landscape restoration in mangrove forests in latin america and the caribbean		
P 5.51	Rafael J. Araújo - SEAHIVE: A Shoreline Protection System that Supports Mangrove Ecosystems Restoration and Creation		
P 5.52	Martin Zimmer - Mangrove species-specific herbivore communities, potential drivers of their occurrence, and effects of their activity		
P 5.53	Laura Ebeler - Development of social-ecological mangrove typologies		
P 5.54	Yamian Zhang - Biotic homogenization increases with human intervention: implications for mangrove wetland restoration		
P 5.55	Luz Ángela López de Mesa - ABC stories from south American mangroves: Biomass/Abundance comparison of macro-invertebrates from Colombian mangroves in the Pacific and Caribbean coasts suggest moderate disturbance		
P 5.56	Dina Rasquinha - Spatio-temporal changes in mangrove forest biomass levels of Bhitarkanika Wildlife Sanctuary		
P 5.57	Emma Rossouw - Biodiversity and connectivity of mangrove-seagrass ecosystems in South Africa using a metabarcoding approach		
P 5.58	Lydia Slobodian - Around the world with mangrove laws: a global snapshot of national legal frameworks for mangrove conservation and sustainable use		
P 5.59	Stephania Alvarez - What is a mangrove forest? Importance of legal definitions in mangrove governance		
P 5.60	Lila Uzzell - Natural Recovery for a Mangrove-Coral Community in Hurricane Hole, St. John, USVI		
P 5.61	Luis Felipe Santos Becerra - Deterioration of mangroves and its impact on eutrophication increase: evidence in a tropical estuarine lagoon complex		
P 5.62	Santiago Millán Cortés - Application of GIS-based landscape metrics for monitoring mangrove restoration and natural regeneration: A local scale approach		
P 5.63	Brigitte Gavio - Intertidal algae as occasional refuge for insects in mangrove forests, Pacific Colombia		
P 5.64	Kevin Novelo - The importance of partnership expansion and its success for mangrove research, conservation, and management		
P 5.65	Anoop Raj Singh - A decadal change on the mangrove colonization on the new intertidal habitats of Andaman and Nicobar archipelago – a post tsunami and subsidence scenario		
P 5.66	Tobias Poprick - Population genetics of mangroves among the Galápagos archipelago		
P 5.67	Myriam Arias de López - Evaluation of the damage caused by Coccotrypes rhizophorae in Rhizophora propagules along the Ecuadorian coast.		
P 5.68	Nelson Miranda - A cooperative ecological and social survey in Inhambane Bay, Mozambique: bio-indicators, livelihoods, and conservation		
P 5.69	Carlos Andres Sisquiarco Torreglosa - Community structure of macroinvertebrates associated with submerged roots of red mangrove in the Rionegro Cove (Necoclí - Antioquia)		
P 5.70	Quentin Gusmai - Mangrove typology using Very High-Resolution satellite images, Bombetoka Bay, Madagascar		
P 5.71	Loo Yan Ping - Mangrove sediments support a diverse and abundant microphytobenthos		
P 5.72	Wah Wah Min - Crab species-specific excavation and architecture of burrows in restored mangrove habitat		
P 5.73	Bailey Ross - Mangroves as Fish Habitat: A review of field studies published since 2006		
P 5.74	Abigail Barenblitt - If a Mangrove is "Protected", is it? Using satellite-borne LiDAR to understand efficacy of protection status in West African mangroves		
P 5.75	Lisa Macera - Evaluate the Good Ecological Status of mangroves thanks to a Rapid Assessment Method		
P 5.76	Adriana Santos-Martínez - Post hurricane response and restoration protocol of mangrove forests on san andrés island		
P 5.77	Arida Fauziyah - Reassessment of mud crabs Scylla spp. taxonomic identity in Segara Anakan Lagoon, Cilacap, Indonesia.		
P 5.78	Angela Inés Guzmán Alvis - Crab burrowing in Colombian Pacific mangroves affects mangrove forest soil organic carbon		
P 5.79	Fernando J. Parra-Velandia - Changes in plant and benthic community structure in urban mangroves		
P 5.80	Micah Marie G. Bernales - Stand structure and composition of planted mangrove forest seven years post establishment: The case of Mangrove and Beach Forest and Development Project, Philippines		
P 5.81	B. Satyanarayana - Mangrove propagules are viable five times longer than previously thought		
P 5.82	Benoit Thibodeau - Feeding specialisation and partitioning of nitrogen sources in a subtropical mangrove highlighted by isotope of amino acids		
P 5.83	Diana Jacqueline Cisneros de la Cruz - Strengthening local capacities, a pillar in mangrove ecological restoration		
P 5.84	Shaohua Xu - Gene loss facilitates gene regulatory network stability and adaptive trait evolution in mangroves invading unstable intertidal zones		
P 5.85	Weihong Wu - Nypa fruticans genome reveals its origin and long-term adaptation to the intertidal zones		
P 5.86	Jiayan Wang - Genomic evolution underlying propagule dispersal via seawater: A case of Heritiera mangrove species		
P 5.87	Krishna Ray - Testing a site-specific approach for ecological restoration of degraded mangrove ecosystems, species communities and ecosystem services: Case study from Indian Sundarbans		
P 5.88	Severino G. Salmo III - Optimizing "Blue Carbon" Information as a Complementary Strategy to Mangrove Conservation and Restoration: A Meta-Analysis on Carbon Stocks in Philippine Mangroves		
P 5.89	Genea Nichole Cortez - We can't protect what we do not know: Floral diversity assessment of Del Carmen Mangrove Forest in Siargao Island, Philippines		
P 5.90	Jalyssa Britt Fermo - Inferences on the role of different mangrove stands in mollusk biodiversity and assemblages in Philippine mangroves		
P 5.91	Juan Felipe Blanco - Trophic niches of estuarine fish and evidence of mangrove-fishery causal links in the Southern Caribbean (Colombia)		
P 5.92	Juan F. Blanco-Libreros - Tea time in racoon city: (composing) music from decomposing litter to communicate the ecosystem effects of mangrove die-off		V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
P 5.93	Juan F. Blanco-Libreros - Translating land-cover data into music to promote mangrove conservation awareness		
P 5.94	John Dorado Roncancio - Bulk density along the colombian coast and its relationship with mangrove forest attributes		
P 5.95	Maria José Pacheco Tuberquia - Local perception of the state of mangroves in rural and peri-urban areas (Coincidences and mismatches) in the Urabá Gulf, Colombian Caribbean.		VI. Changing human relationships with mangrove wetlands
P 5.96	Farid Dahdouh-Guebas - Also species-poor mangrove forests provide rich ecosystem goods and services		

P 5.97	Enrique Peña - Plastic pollution in mangrove forests in the colombian pacific coast: a case study in buenaventura bay		II. Understanding and solving marine pollution in mangrove wetlands
P 5.98	José Ernesto Mancera-Pineda - Challenges of the Colombian Network of Estuaries and Mangroves for the implementation of the recent law (2243) aimed at protecting mangroves country-wide.		VI. Changing human relationships with mangrove wetlands
P 5.99	Olga Lucia Ruiz Morales - NATURE-BASED SOLUTIONS: Restoration of the systems of canals, marshes, mangroves and corks as a mechanism to address the effects of the salt wedge, rising sea levels and coastal erosion in the Sanctuary of Flora and Fauna El Corchal "El Mono Hernández"		I. Protecting and restoring mangrove forests and their biodiversity

VENUE : Universidad de Cartagena, Claustro San Agustìn

Tuesday 25th

Lightning talks

Code	Session 9	Room	Theme
P 9.1	Luis Eduardo Servín Garcidueñas - Diversity of bacterial and archaeal communities in mangrove sediments of the Pacific Coast of Mexico	Paraninfo	I. Protecting and restoring mangrove forests and their biodiversity
P 9.2	Uday Pimple - Spatio-temporal dynamics of mangrove forest diversity in Eastern Thailand?		
P 9.3	Brosse - Realized ecological niche of a species of interest: Terebralia palustris (Linnaeus, 1767), in the mangroves of the island of Mayotte (France, Indian Ocean).		II. Understanding and solving marine pollution in mangrove wetlands
P 9.4	Jocelyn Bravo - Additive effects of nutrient enrichment on marsh species composition and mangrove encroachment		
P 9.5	Laura Michie - Microplastic Accumulation in Southeast Asian Mangroves		
P 9.6	Kerry E. Grimm - Community member perceptions of mangrove conditions, management, and community engagement in Belize.		
P 9.7	Zoë I. Shribman - Landscape-scale biophysical controls on mangrove blue carbon distribution in Singapore		
P 9.8	Elizabeth Francis - Enabling Blue Carbon Policy Conditions		
P 9.9	Stijn Temmerman - Nature-based flood risk mitigation in a river delta context: evaluating impacts of mangrove conservation versus human conversion		
P 9.10	Verginia Wortel - Tree growth and dynamics in Mangrove forests in the coast of Suriname		
P 9.11	Mondane Fouqueray - Societal acceptance of mangrove (re-)establishment: perspectives from Barú, Colombia, and Setiu Wetlands, Malaysia		
P 9.12	Raymond Ward - Mangroves of the Amazon estuary: a hotspot for global carbon sequestration		
P 9.13	Natalia Zapata Delgado - Permeable structures for climate adaptation in the Colombian Pacific Coast		
P 9.14	Theresa-Marie Fett - Labile or stable? Assessing organic matter recalcitrance - case study on Malaysian mangrove sediments		IV. Unlocking climate action and implementing mangrove-based solutions to climate change
P 9.15	Chaitanya Katharoyan - Drivers of mangrove macrofauna and range shifts in South Africa		

Poster

Code	Session 10	Room	Theme
P 9.16	Jonas Vollhüter - The mangrove-saltmarsh ecotone: Explaining observed vegetation patterns with a mechanistic modelling approach considering plant-soil-water-feedback		I. Protecting and restoring mangrove forests and their biodiversity
P 9.17	Trialaksita Sari Priska Ardhani - On contrasting mangrove forests and aquaculture in facing sea level rise		
P 9.18	Clare Duncan - Reconstructing pre-Anthropocene mangrove ecosystem distributions		
P 9.19	Myra Knowles - The Ecological Impacts of Mangrove Patch Size on Fringe Prop Root-Dependent Communities		
P 9.20	Cesar Padilla-Mendoza - Influence of wave dissipation on erosion-accretion dynamics in mangroves of the Colombian Pacific		
P 9.21	Jennifer Rowntree - Global patterns of Mangrove genetic diversity		
P 9.22	Andres Molina - Importance of mangrove for fish communities in a highly impacted tropical estuary		
P 9.23	Carolina Rubiano Labrador - Cartagena mangroves: reservoir of bacteria with biotechnological potential		
P 9.24	María A. Camargo - A multi-criteria modelling approach to prioritize mangrove restoration areas: The case study of Hondita bay - La Guajira, Colombia.		
P 9.25	Juan Camilo Rodríguez Atará - Assessment of temporal changes in the mangrove forest structure following hydrologic rehabilitation actions in the Ciénaga Grande de Santa Marta, Caleta del Tambor sector		
P 9.26	Sebastian Herrera - Hydric rehabilitation in salt flat areas and its effect on interstitial salinity in Cispata bay´s mangroves, colombian Caribbean		
P 9.27	Tania carolina Hoyos Ruiz - Comparison of blue carbon techniques for measure in mangrove forests		
P 9.28	Wilmar Sarmiento Serge - Foliar phenotypic plasticity of Rhizophora mangle and Avicennia germinans as potential bioindicators of environmental stress		
P 9.29	Ana Laura Lara Domínguez - The Ramsar Site 1602 Tuxpan Mangroves and Wetlands as a biodiversity refuge.		
P 9.30	Damir Creecy - The potential vertical range of Avicennia germinans in the marsh-mangrove ecotone		
P 9.31	Susan Kotikot - Mangrove cover mapping for ecosystem monitoring using Sentinel-2 in Google Earth Engine		
P 9.32	Natalia Molina Moreira - First record of insects in mangroves of gender rhizophora in ecuadorian cost		
P 9.33	Natalia Molina Moreira - Research program: sustainable biodiversity from mangrove to coral reefs		
P 9.34	Myriam Arias de López/William Galvis - Araneofauna diversity in ecuador´s mangroves		
P 9.35	Juan Carlos Aguirre Pabon - Genetic status of two mangrove species (Avicenia germinans and Rhizophora mangle) in the Colombian Caribbean: what does DNA tell us about mangrove conservation?		
P 9.36	Nicole Spanier - Effects of crab bioturbation on wetland vegetation productivity at a mangrove-marsh ecotone		
P 9.37	Itchika Sivaipram - Assessment of Fish Diversity in Mangrove Ecosystem of Thailand using eDNA metabarcoding		
P 9.38	Amna Almansoori - A review of the literature and data sources on mangroves of the Southern Arabian Gulf		
P 9.39	Dan Peng - Acquisitive functional traits driving the tree invasion in mangrove-Spartina ecotone in southern China		
P 9.40	Keila Guillen - Preferences for Mangrove Restoration in The Colombian Caribbean		
P 9.41	Ana Sofía Gil-Ramírez - The mangrove fern Acrostichum aureum (Pteridaceae): literature review and field data of a poorly-known, opportunistic species in the Southwestern Caribbean		
P 9.42	Sergio Andrés Restrepo Moreno - The mangrove swamp as classroom-laboratory space for addressing climate and environmental change: Innovative educational-research approaches in marginal rural communities of the Pacific (Golfo de Tribugá) and Caribbean (Isla Fuerte) coasts of Colombia		
P 9.43	Elissa Pelsmaekers - Assessment of Macro- and Microplastics in the Mangrove Bay of Gazi (Kenya): Identity, Quantity, Distribution and Sources		
P 9.44	A. Rajkaran - Assessing the utility of crabs and snails as indicators of microplastic pollution in mangrove dominated estuaries: A South African case study		

P 9.45	Christelle Not - Microplastics in Hong Kong mangroves: Spatial and temporal patterns	Paraninfo	II. Understanding and solving marine pollution in mangrove wetlands
P 9.46	Ziying He - Additional N input may alter the species-specific blue carbon cycling differently in mangroves		
P 9.47	Morgan Mack - Exploring the Vulnerability of Coastal Wetlands to Nutrient Pollution at the Marsh-Mangrove Ecotone		
P 9.48	Allie Durdall - Debris in the trees: a comparison of U.S. Virgin Islands mangrove and beach clean-up data collected by citizen scientists		
P 9.49	Paola Echeverry Hernández - Coastline dynamics in different mangrove forests of the Colombian Caribbean Sea and Pacific Ocean . Analysis based on remote sensing and field study		
P 9.50	Luisa Fernanda Espinosa-Díaz - Impacts of marine litter pollution on the Ciénaga Grande de Santa Marta mangrove ecosystem, Colombian Caribbean		
P 9.51	Maria Alejandra Ariza Gallego - Invertebrates consuming microplastics in mangroves of the colombian pacific: are feeding behaviors determinant for its abundance?		
P 9.52	Véronique Helfer - Spatio-temporal patterns of trace metal concentrations and their potential ecotoxicological effects in mangrove sediments: a global review over 32 years (1988-2019)		
P 9.53	Sarah Louise Robin - Leaf litter degradation in an urban semi-arid mangrove forest (New Caledonia)		
P 9.54	Guillermo Duque - Concentration of nutrients in soils related to mangrove forests exposed to different degrees of anthropic intervention in the Colombian Pacific		
P 9.55	Andrés Molina - Accumulation of microplastics in sediments associated with the state of development of mangrove forests in colombian pacific bays		
P 9.56	Luisa Fernanda Gómez García - Forest structure and organic carbon in sediments of Colombian Pacific mangroves		
P 9.57	Laura Daniela Garcia Melendez - Polycyclic aromatic hydrocarbons (pah) in seston and sediments in mangrove areas of the central caribbean region of colombia		
P 9.58	Lina G. Melo-Flórez - Towards sustainable mangrove management using Ostrom's framework		
P 9.59	Mayara de Oliveira - Factors influencing governance of coastal wetland protection and restoration: A case study in Brazil		III. Achieving sustainable socio-economic development and equity
P 9.60	Jessica Archibald - International, regional, and national policy influences on collaborative mangrove governance opportunities in the Mesoamerican Reef Ecoregion		
P 9.61	Mihyun Seol - Carbon farming for resilient livelihoods and landscapes in Mt. Batur, Bali, Indonesia		
P 9.62	Allison Holevoet - Can recycled crushed glass be used as a mangrove nursery substrate?		
P 9.63	B. Satyanarayana - History revisited: the regime shifts in the world's longest managed mangrove for charcoal and timber production		
P 9.64	Mwita Marwa Mangora - The socio-economic role of mangroves and their conservation framework in the Western Indian Ocean region		
P 9.65	María José Rodríguez García - Closure period for Anadara tuberculosa y Anadara similis: participatory management experience in the mangroves of Bahía Golfito, Puntarenas, Costa Rica		
P 9.66	Marlenë Beca & Yegor Tarelkin - "Dans le sel, nos racines"		
P 9.67	Marie Christine Cormier Salem- Promote the mangrove as a nourishing biome, an opportunity for co-benefits between people and nature.		
P 9.68	Angelo Bernardino - Flow of ecosystem services in Brazilian Amazon mangroves		
P 9.69	Marcela Franco - Nature-based tourism: livelihood and conservation strategy for the communities of the cienaga grande de santa marta		
P 9.70	Natalia Peña Gonzlez - Mangrove restoration: perspectives from local communities in the CGSM		
P 9.71	María Alejandra Ocampo Rojas - Assessing ecosystem services of mangroves at country scale (Colombia) based on expert opinion		
P 9.72	Jin Liang - Can the Ecological Redline Policy meet the demand of management on blue carbon sequestration in mangrove? A case study in Guangdong, Southern China		
P 9.73	Catherine Lovelock - Trends in sediment surface elevation of tropical mangroves vary among geomorphic settings		IV. Unlocking climate action and implementing mangrove-based solutions to climate change
P 9.74	Alexandra Rodriguez - Structured decision-making process to prioritize mangrove restoration: a proposal for the cienaga grande de santa marta (colombia)		
P 9.75	Kyaw Myo Lwin - Forest Structure and Site-specific Allometric Models of the Dominant Mangrove Species in Letkhokkon Area, Myanmar		
P 9.76	Mohammad Abdul Quader - Disaster risk reduction through mangrove management: A case study of Sundarbans and surroundings		
P 9.77	Therese Adgie - Climate change-induced shift in mangrove ranges drives above and belowground changes to salt marsh habitat		
P 9.78	Wei-Jen Lin - Mangrove carbon budgets suggest the estimation of net production and carbon burial by quantifying litterfall		
P 9.79	Chiao-Wen Lin - Greenhouse gas emissions from subtropical and tropical mangroves during the tidal cycles		
P 9.80	Priscille Raynaud - Ecosystem Restoration Standard: a new approach to certify mangrove-based projects in the Voluntary Carbon Market		
P 9.81	Elizabeth Francis - Modular Guidance for Blue Carbon Projects		
P 9.82	Alice Twomey - Effect of tree geometry and spatial zonation on sediment accretion in mangrove forests		
P 9.83	Yudhishthra Nathan - Accommodation space provided by paleochannels in late-Holocene mangrove environments of Singapore		
P 9.84	Martin Zimmer - sea4soCiety - searching for solutions for Carbon sequestration in coastal ecosystems		
P 9.85	Mirco Wölfelschneider - The fate of mangrove-derived organic matter in the land-coast-sea continuum: a pledge for finding answers to pressing questions		
P 9.86	Kayleigh Svensson - Opening Access to the Measurement, Reporting, and Verification (MRV) of Mangrove Forest Growth and Carbon Storage With Blockchain Technology		
P 9.87	Andrea Dueñas Lagos - Fauna Associated With Submerged Roots Of Rhizophora Mangle In The Colombian Caribbean: An Updated Checklist		
P 9.88	Ansmarie Soetosenojo- Ngu Chin Tjon - Soil Organic Carbon Stocks in the Mangrove Forest along the coast of Suriname		
P 9.89	Paula Andrea Casas Cortes - Evaluating the potential of mangroves to climate adaptation and mitigation: a metanalytic approach		
P 9.90	Elizabeth Bogan - Wave Attenuation Through a Mangrove Forest Using LiDAR Representation		
P 9.91	Tania carolina Hoyos Ruiz - Mangrove blue carbon in islands vs mainland located in the Caribbean and Pacific coasts of Colombia		
P 9.92	Alejandra Robles Sánchez - Salinity and bulk density influence on the morphoanatomy and carbon content in underground roots of the main neotropical mangrove species		
P 9.93	Carla Frechiani O. Pacheco - Aboveground biomass loss: can a SE Brazilian mangrove forest recover from a massive mortality?		
P 9.94	Carla Frechiani O. Pacheco - The difference in the greenhouse gas emissions from the soil of dead and live mangrove forests in Brazil		
P 9.95	Amanda Selene Rojas Aguirre - Root dynamics and effect of logging in a delta estuarine mangrove of the colombian Caribbean		
P 9.96	Karen Patricia Ibarra Gutierrez - Trends of carbon accumulation in mangrove sediments in Cispata bay as a strategy for blue carbon management		
P 9.97	Vilma Machava António - Massive mangrove dieback in Maputo River Estuary, Southern Mozambique		
P 9.98	Nádia Gilma Beserra de Lima - Consequences of the accumulation of natural and anthropogenic impacts on mangrove forests		

P 9.99	Valerie Kwan - Estimating carbon capture in coastal wetlands restoration with a process-based model		
P 9.100	Johann Delgado - Hydrodynamics of Open Channels in Mangrove Forests		VI. Changing human relationships with mangrove wetlands

VENUE : Universidad de Cartagena, Claustro San Agustìn

Thursday 27th

Lightning talks

Code	Session 14	Room	Theme
P 14.1	Leyla Roy - Use of terrestrial laser scanner to determine allometric equations and carbon stocks in aboveground biomass of mangrove forests in semi-arid region (New Caledonia)	Paraninfo	V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
P 14.2	Elodie Blanchard - MangMap: a new platform for mangrove mapping and monitoring using Earth Observation data		
P 14.3	Angelo Bernardino - Increased mangrove plant biomass and tree density in the Amazon Delta		
P 14.4	Zhiliang Zhu - Tracking loss and recovery of mangrove forests from repeat hurricanes using Landsat		
P 14.5	Karla Ramírez-Ruiz - Assessing Potential Interactive Impacts of Urbanization and ENSO on Mangrove Greenness in the Colombian Caribbean		
P 14.6	Denise Poveda - Mangrove belowground biomass and necromass in Gulf of Nicoya, Costa Rica		
P 14.7	Muhammad Hadi Ikhsan - Visualizing Mangrove Regulating Services in the Form of a Virtual Reality Game		
P 14.8	Stuart Hamilton - A high-resolution annual time series database of global mangrove change from 2000 to 2020		
P 14.9	Ariel Quintanilla - Configuration of the socio-ecological system from the community management of the mangrove forest in the Estero de Jaltepeque, El Salvador.		VI. Changing human relationships with mangrove wetlands
P 14.10	Sana Lynch - Environmental Communication Through Visual Imagery: Using Wahoo Bay, a GrayGreen Installation in Pompano Beach, Florida, as an Educational Tool		
P 14.11	Anliati Ahmed Abdallah - Resilience trajectories of Mayotte mangrove social-ecological systems through the adaptive cycle heuristic		
P 14.12	John Benrich Zuniga - Strengthening Inter-sectoral Convergence in Ecological Mangrove Restoration of Abandoned Brackish-water Fishponds in the Philippines		
P 14.13	Regina Hershey N - Impact of human interferences on N2O fluxes from tropical fragmented mangrove ecosystems, India		
P 14.14	Guilherme M O Abuchahla - The effect of precipitation on sediment bacteria and leaf organic matter leaching along the mangrove-salt flat-continuum in the sine-saloum estuary, senegal		

Poster

Code	Session 15	Room	Theme
P 15.16	Sreelekshmi S - Estimation of carbon pools in the vegetation biomass and soil of major mangrove ecosystems of India		IV. Unlocking climate action and implementing mangrove-based solutions to climate change
P 15.17	K. Anggi Hapsari - Above- and belowground carbon stocks in Caribbean mangroves of the Magdalena River delta, Colombia		
P 15.18	Angélica Quintero - Salinity influence on the flows and accumulation of organic carbon in open waters karstic mangroves		
P 15.19	Daniela Vásquez - Accumulation and distribution of microplastics in sediments of mangrove forests in the bay of tumaco and buenaventura, colombian pacific		II. Understanding and solving marine pollution in mangrove wetlands
P 15.20	Chuan-Wen Ho - Enhancement of carbon sinks through mangrove afforestation in a tropical constructed wetland park		IV. Unlocking climate action and implementing mangrove-based solutions to climate change
P 15.21	Luisa Fernanda Mondragon Diaz - Variation in the concentration of nutrients in the soils of mangrove forests exposed to different degrees of anthropic intervention and its relationship with environmental variables, in the Colombian Pacific.		
P 15.22	Precious B. Jacob - Litter Dynamics of Naturally Revegetated Mangrove Forests in Abandoned Aquaculture Ponds in Southern Oriental Mindoro, Philippines		
P 15.23	Juan Pablo Caicedo Garcia - Carbon stocks in mangroves of Isla Fuerte (Colombian Caribbean): a first approximation		
P 15.24	Janis Beuve - The LIFE Adapt'Island project – Nature-based solutions for climate change adaptation in the Caribbean.		
P 15.25	Martin Zimmer - Combined effects of burrowing crabs and tides on carbon fluxes in sediments		
P 15.26	Laura Vanessa Vidal Torralba - Pollution by microplastics in surface waters of mangrove forests of the colombian pacific with different degrees of anthropic intervention.		
P 15.27	Tannia Frausto-Illescas - The WILDCOAST's blue carbon strategy for northwestern Mexico.		
P 15.28	Derrick Vaughn - Lateral Carbon Fluxes from the Florida Everglades		
P 15.29	Mackenzie Taggart - Applying Global Datasets to Recognize Mangrove Carbon Stocks Within the World Bank's Inventory of the Changing Wealth of Nations.		
P 15.30	Jairo Humberto Medina Calderón - Effect of interstitial salinity on growth and survival of individuals of Rhizophora mangle originating in environments with contrasting salinity		
P 15.31	Tania E. Romero G - Estimation of Blue Carbon for the Mangrove Community of La Playa Mermejo, Gulf of Montijo, Ramsar Site, Panama.		
P 15.32	Bora Lee - Studying the carbon uptake capacity of mangroves as a response to climate change		
P 15.33	Adriana Daza - Design and implementation of a blue carbon initiative and ecosystem-based adaptation measure (eba) on mangroves in bahía hondita (uribia), alta guajira		
P 15.34	Jaime Ricardo Cantera_Kintz - Mangrove productivity of the pacific coast of colombia: from leaves to fisheries		
P 15.35	Nathan Thomas - Reconstructing mangrove inundation dynamics with spaceborne data		
P 15.36	Henrique Bravo - Biodiversity survey of mangrove gastropods and crabs of Hong Kong by integrating DNA barcodes and morphology		
P 15.37	Pete Bunting - Global Mangrove Watch: Updated Global Mangrove Extent and Annual Change Mapping (GMW Version 4.0)		
P 15.38	Paulo Murillo-Sandoval - Mangroves Cover Change Trajectories 1984-2020: The Gradual Decrease of Mangroves in Colombia		

P 15.39	David F. Vasquez S. - Mangrove forest: cover and fragmentation in protected and unprotected areas in the Colombian pacific	Paraninfo	V. Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness
P 15.40	Juan C.Mejía-Rentería - High-resolution mapping of forest characteristics in Eastern Pacific mangroves using consumer-grade drones		
P 15.41	Jasper Feyen - Improving regional mangrove carbon estimations based on terrestrial lidar scanning in suriname		
P 15.42	Hector Arsenio Tavera Escobar - Structural Characteristics of the Tallest Mangrove Forests of the American Continent: A Comparison of Ground-Based, Drone and Radar Measurements		
P 15.43	Véronique Helfer - Functional traits of “true mangroves”: a pledge for a global initiative		
P 15.44	Suci Puspita Sari - Monitoring Mangrove Dynamics Using Sentinel-1 and Sentinel-2 Data Fusion: Mangrove affected by the tin mining operation on Teluk Kelabat Dalam, Belinyu, Bangka Island		
P 15.45	Mirco Wölfelschneider - Molecular fingerprinting sheds light on the biogeochemical cycling of mangrove-derived dissolved organic matter along the land-ocean continuum		
P 15.46	Lola Fatoyinbo - Change, Carbon stocks and associated emissions from 40 years of mangrove losses in Nigeria		
P 15.47	Filipe de Oliveira Chaves - Utilization of Terrestrial Laser Scanning to Determine Carbon Stock of Mangroves in Brazil		
P 15.48	Angela Marcela Barrera Bello - Mangrove vegetation characterization and stakeholder perception on community-based mangrove restoration (CBMR): A case study in Sucre, Colombia		
P 15.49	Florent Taureau - Mapping spatial dynamics of mangroves over seventy years: lessons learnt from French overseas territories		
P 15.50	Yulizar Ihrami Rahmila - Determination of ecosystem boundary, definitions, and parameters of ecosystem health		
P 15.51	Gathot Winarso - Mangrove Species Discrimination Using Spectrometry of Landsat 8 OLI Spectrum		
P 15.52	Jaime Ricardo Cantera Kintz - A country between two coasts: integral assessment of four ecosystem services in different types of mangrove forests on the colombian pacific and caribbean		
P 15.53	Kyle Cavanaugh - Dispersal limitation at the northern range limit of mangroves in Baja Mexico		
P 15.54	Paula Cristina Sierra-Correa - Environmental education for the management of blue carbon in mangroves in Latin America under the Ocean Teacher Global Academy strategy		
P 15.55	Joaquin Antonio Torres Duque - Blue carbon soils methodology applied in a conglomerate of the national forest inventory, on mangrove ecosystem		
P 15.56	Laura Lozano Arias - Estimating Living Biomass and Carbon Storage in Mangrove Forests through Remote Sensing and Machine Learning: A Case Study in Tumaco-Nariño		
P 15.57	Gabriel R. Navas - Structure and floristic composition of riparian vegetation in eleven channels of the urban area of Cartagena de Indias, Colombia		
P 15.58	Michael O. Vázquez Feliciano - Changes in mangrove coverage post-Hurricane María and their possible implications in the coastal management of Guayama, Puerto Rico (2017-2019)		
P 15.59	Fernanda Loayza Cabezas - Experiential learning: Environmental education experiences for mangrove conservation in Galapagos		
P 15.60	Ariel Quintanilla - Configuration of the socio-ecological system from the community management of the mangrove forest in the Estero de Jaltepeque, El Salvador.		VI. Changing human relationships with mangrove wetlands
P 15.61	Layla Olefs - Public perception and framing of #mangrove and #coral through qualitative image analysis on social media		
P 15.62	Meenakshi Poti - Shifted baselines: governance of coastal wetlands in a post-tsunami land subsidence context		
P 15.63	Marijem Djosetro - Including local knowledge in conservation planning: the case of the Western coastal protected areas in Suriname		
P 15.64	John Benrich Zuniga - Strengthening Inter-sectoral Convergence in Ecological Mangrove Restoration of Abandoned Brackish-water Fishponds in the Philippines		
P 15.65	Mariela Garcia Vega - Use and Management of Mangrove Ecosystems as a Response to Storm Events		
P 15.66	Maria Isabel Jiménez - Ostrom's framework and sustainable management of the Rincón del Mar Mangroves (Sucre, Colombia)		
P 15.67	B. Satyanarayana - From research to education through serious gaming and game-based learning from The Mangal Play		
P 15.68	Gustavo A. Castellanos-Galindo - Historical ecology of mangrove ecosystems around the Panama Canal area		
P 15.69	Guilherme M O Abuchahla - Origin of sediment organic matter along the mangrove forest-salt flat-atlantic forest continuum in northeastern brazil		
P 15.70	Longépée Esméralda - Mangroves require social-ecological systemic research		
P 15.71	Zoya E.A. Buckmire - Mangroves for Money: ecological and social impacts of recent development projects in the mangrove forests of Grenada, West Indies		
P 15.72	Amna Almansoori - Fish assemblages in mangrove creeks along the arid coastline of the southern Arabian Gulf		
P 15.73	Laura Palomino - Community Perceptions of Mangroves in the U.S Virgin Islands and Implications for Mangrove Restoration Efforts		
P 15.74	Lilian Nyaega - Exploring Gender-Inclusive Mangrove Conservation in Lamu, Kenya		
P 15.75	Juliana Bermúdez - Museographic device presenting the mangrove zones in the Botanical Garden of San Andres, Colombia		
P 15.76	Valentina Aristizábal - Evaluation of small-scale artisanal fisheries in different communities of the Pacific coast and the insular Caribbean of Colombia		

SEMANGLARES V: “A Policy Day in MMM6”

The Colombian Network of Estuaries and Mangroves "REDSEM" was created by a joint effort between Colombian Universities and research institutes in the country as a tool to promote the study, conservation and management of these socio-ecosystems through the exchange of knowledge and dialogue between actors from different social sectors. The network represents a national platform to develop key scientific and technical capacities for mangrove management. Every two years, REDSEM organizes the National Seminar on Mangrove Socio-Ecosystems (SEMANGLARES).

The V SEMANGLARES will be held within the framework of “the sixth Mangrove Macrobenthos and Management conference (MMM6), to be held in Cartagena de Indias between July 24 and 28, 2023 (mmm6.co). SEMANGLARES V aims to discuss experiences on public policy used in the management of mangrove forests at the international and national level, with a view to the collective construction of the strategic research plan for these socio-ecosystems in Colombia, which is mentioned in Law 2243 of 2022.

To meet the objective of SEMANGLARES V, this time it has the support of the Environmental, Natural Resources and Applied Economics Group (REES), based in the Faculty of Economics of the Universidad de los Andes, which is a node in Colombia for the international network Environment for Development Initiative (EfD). Together with CEMARIN and REDSEM, the following work agenda has been designed, which will have the participation of the different key actors: local communities, government, academia, research institutes, and others.

Day 1. Tuesday, July 25, 2023: The role of the actors in Law 2243 of 2022 for the Protection of the mangrove

Start time: 6 pm

Place: San Agustin – University of Cartagena

Hour	Activities
6:00 – 6:05	Introduction Ernesto Mancera – National University, REDSEM Jorge Higinio Maldonado – University of the Andes, REES – EfD
6:05 – 6:20	Presentation of Law 2243 of 2022 and vision of the Ministry of the Environment Dr. Sandra Vilardy Vice Minister of Public Policies
6:20 – 6:35	Experiences from the academy (REDSEM) Enrique Peña Salamanca – University of the Valle; REDSEM Scientific Coordinator
6:35 – 6:55	Experiences of Environmental Coastal Public Corporations: Pedronel Montoya Vice Director of Valle del Cauca Environmental Corporation(10 min) CARDIQUE (10 min)
6:55 – 7:15	Experiences of local communities Santiago Valencia Comunidad La Plata, Bahia Málaga. Pacific coast of Colombia Wilmer Gómez Comunidad Barú, Cartagena. Colombian Caribbean
7:15:7:25	Experiences of the Institute of Marine Sciences INVEMAR Colombia Paula Sierra
7:25 – 7:50	**Questions for panelists**
7:50 -8:00	Conclusions Jorge Higinio Maldonado – Universidad de los Andes, REES – EfD

Day 2. Thursday, July 27, 2023: International and national experiences regarding research needs in mangrove ecosystems
Start time: 6 pm
Place: San Agustín – University of Cartagena

Hour	Activities
6:00 – 6:05	Introduction Enrique Peña Salamanca – Universidad del Valle Scientific Coordinator REDSEM
6:05 – 6:35	Experiences in Ecuador: Natalia Molina Moreira – Universidad Espíritu Santo – Ecuador Mangrove use and custody agreements for ancestral users 1999-2023 (10 min). Experiences de local communities in Ecuador: Santiago Morales: Mancomunidad Puerto El Morro (5 min) Felipe Moreira: Comunidad Sabana Grande (% min) Fernando García Fondagua: Social relationships in Mangroves (10 min)
6:35 – 6:50	The role of Non-profit Organizations Luis Alonso Zapata – World Wildlife Foundation WWF
6:50 – 7:00	The role of local communities Santiago Valencia (Comunidad La Plata, Bahía Málaga) Wilmer Gómez (Comunidad Barú, Cartagena)
7.15 – 7:30	The scientific bases for the management of mangrove ecosystems Argiro Ramirez- Official of Ministry of Science Technology and Innovation Andrés Osorio-Director Corporation Marine Science Center of Excellence CEMARIN Juan Felipe Blanco - Universidad de Antioquia, REDSEM
7:30 – 7:50	**Questions for panelists**
7:50 – 8:00	Closing Ceremony Ernesto Mancera, Universidad Nacional de Colombia; General Coordinator REDSEM

Keynote Speakers

DR. DAN FRIESS
Tulane University

Short Bio

Dr. Friess is the Cochran Family Professor of Earth and Environmental Sciences at Tulane University in the United States. His research interests focus on blue carbon and ecosystem services, as a lens to understand the value of mangroves, the threats they face, and opportunities for their restoration and conservation. His research is conducted predominantly in Southeast Asia, and from 2009 to 2022 Dan was based at the National University of Singapore. Dan is a member of the IUCN Mangrove Specialist Group and the Blue Carbon Initiative.

For more information please visit www.themangrovelab.com.

Celebrating the diversity of the world's mangroves

The mangrove ecosystem is deceptively complex. We all define mangroves based on our location or research discipline, but mangroves are geographically diverse and made up of numerous components. Mangroves are shaped by environmental gradients from local-global scales, and are affected by gradients of human and natural stressors. We must holistically understand mangroves from multiple perspectives, or we risk misapplying scientific paradigms and management strategies, and excluding voices who can contribute to a richer understanding of mangroves. We can only achieve the UN Ocean Decade Challenges for mangroves if we embrace the diversity of this ecosystem and the people who live, manage and study them.

DR. SARA FRATINI
University of Florence

Short Bio

Dr. Fratini is an Assistant Professor of Zoology at the Department of Biology of the University of Florence in Italy, and a member of the IUCN SSC Mangrove Specialist Group. Since her Ph.D. in Animal Behavior at the University of Florence, she has been interested in studying ecology and behavior of intertidal and marine invertebrates, mainly focusing on mangrove crabs and mollusks. Her research includes also phylogenetic, phylogeographic and population genetics studies of intertidal invertebrates.

Currently, her research activities explore the application of metabarcoding and genomics to the study of biodiversity and environmental adaptations. Her overarching goal has been to devote her skills in genetics, genomics and ecology to the conservation of biodiversity.

Genetics and genomics approaches are powerful tools for conservation of mangrove biodiversity

Habitat degradation and climate change are among the main causes of the increasing global loss of biodiversity, and mangroves are no exception. Mangrove forests host a unique faunal community, dominated by brachyuran crabs and gastropods which strongly contribute to the functionality of the entire ecosystem. The global biodiversity crisis calls for information able to accurately describe and identify species, to define conservation units and to monitor how biodiversity responds to different environmental pressures over time. In this context, genetic and genomic data may offer a great contribution to inform efficient management and conservation plans.

DR. ANDRE ROVAI
Louisiana State University

Short Bio

Dr. Rovai is an Assistant Research Scientist at the Department of Oceanography and Coastal Sciences, Louisiana State University in the United States. He pursued a bachelor's degree in marine biology, and a masters and a PhD in Ecology in Brazil. His previous experiences in mangroves across the Americas include restoration projects and blue carbon inventories. His current research focuses on bottom-up biogeochemical and geomorphic controls on macroecological patterns of carbon dynamics across the world's mangroves.

Drivers of change and uncertainties on blue carbon dynamics across the world's mangroves: A walk through spatial and temporal scales

Mangroves thrive along nearly all the world's tropical and subtropical coastlines. This pantropical distribution spanning broad geographical gradients – climate, sea level rise, geomorphology – has shaped the diversity and plasticity of mangrove forests as we know today. Understanding how these drivers interact in time and space to control mangroves' physical environments and ecological feedbacks is fundamental to account for present and future carbon dynamics along ever-changing coastlines. Here, we review process-based concepts and map data available on carbon fluxes and stocks across the world's mangroves to ask: How far are we from really understanding mangroves' significance to the global climate system?

DR. JENNIFER HOWARD
Conservation International

Short Bio

Dr. Howard is the Vice President of the Blue Carbon Program at Conservation International (CI). Her work focuses on implementing scalable mechanisms to conserve coastal and marine ecosystems to protect threatened coastal communities, combat climate change, and conserve coastal biodiversity. In this role, she provides technical support to our teams on the ground all over the world and builds partnerships for largescale meaningful change. She helped to found the Global Mangrove Alliance and represents CI on its Steering Committee with the goal of halting loss, doubling protection, restoring half of mangrove ecosystems globally through meaningful collaboration across sectors and disciplines. She is also a technical expert with Blue Carbon Initiative, a global program on coastal carbon science and marine policy working to mitigate climate change through the restoration and sustainable use of coastal and marine ecosystems. She is a technical advisor to the Verra Blue Carbon Working Group where she is developing carbon crediting methodologies that work for large and small projects anywhere in the world. Jennifer also spends time working closely with partners to identify barriers to taking blue carbon to scale and coming up with innovative solutions to overcome those barriers.

Challenges to responsible scaling of mangrove protection and restoration

With coastal communities already facing the impacts of a changing climate, we urgently need to invest in conserving and restoring mangroves now as nature-based solutions to adapt to this changing planet. This includes setting a global target that aligns ambition, provides a systemic vision, and attracts public and private capital at the scale needed to turn the tide in mangrove conservation. Scaling is key but navigating the complexities of reaching scale in a responsible and science-based manor has hinders our ability. Much more capital and collaboration is needed to turn commitments into actions. Dr. Howard will speak to this challenge and the opportunities for radical collaboration.

DR. JUAN CÁRDENAS
Universidad de Los Andes

Short Bio

Dr. Cardenas is a Professor at the Economics Department, Universidad de Los Andes in Colombia. He uses tools from behavioral and experimental economics in the lab and the field, surveys and participatory tools to understand how humans can achieve cooperation within groups. He also explores the behavioral mechanisms associated with the drivers and barriers to have more diverse and honest organizations or communities. His research has been published in high-impact journals.

He has also been visiting fellow at the Workshop in Political Theory and Policy Analysis (Indiana University) under the mentorship of Elinor Ostrom, and visiting professor at University of Massachusetts Amherst, Harvard University, and the Santa Fe Institute.

Understanding the human logic in the local coastal commons: Lessons from experiments in the field

Over the last 25 years numerous economic experiments in field settings, including coastal ecosystems around the world, offer a wealth of human behavior data. The most frequently used paradigm is the common-pool resource game that resembles the essential collective action problem where individual incentives to over extract resources clash with the group incentives to preserve the capacity of the ecosystem to sustainably provide goods and services over time for the local users and beyond. In this lecture I plan to offer an overview of what we have learned and what we are still seeking in answers to the understanding how self-governed solutions can help manage coastal ecosystems.

Abstracts
Oral Presentations

Code: 6.2B. Brachyuran crabs as indicator species for microplastics pollution at Setiu Wetlands, Peninsular Malaysia

Abd Rahim, N.H.,[1] Satyanarayana, B.,[1,2,3*] Ibrahim, Y.S.,[4] Idris, I.,[1] Jani, J.M.,[4] Cannicci, S.,[3,5] Dahdouh-Guebas, F.[2,3,6,7]

[1]Mangrove Research Unit, Institute of Oceanography and Environment, Universiti Malaysia Terengganu, 21030, Kuala Nerus, Terengganu, Malaysia [2]Systems Ecology and Resource Management Research Unit, Université Libre de Bruxelles, B-1050 Brussels, Belgium [3]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), c/o Zoological Society of London, London, United Kingdom [4]Microplastic Research Interest Group (MRIG), Faculty of Science and Marine Environment, Universiti Malaysia Terengganu, 21030, Kuala Nerus, Terengganu, Malaysia [5]Department of Biology, University of Florence, Sesto Fiorentino, Italy [6]Ecology & Biodiversity Research Unit, Vrije Universiteit Brussel, B-1050 Brussels, Belgium [7]Interfaculty Institute of Social-Ecological Transitions—IITSE, Université Libre de Bruxelles—ULB, B-1050 Brussels, Belgium

Setiu Wetlands is a unique place on the east coast of Peninsular Malaysia where different ecosystems such as mangrove, lagoon, seagrass, estuary, beach, etc., are duly connected and influencing each other. In recent years, these wetlands have been threatened by the shifted river mouth causing severe hydrodynamic changes in the lagoon, especially in the core mangrove zone (i.e. largest patch with a species diversity). The present study tested microplastics (MPs) pollution in the mangroves through brachyuran crabs as indicator species. Three sampling sites namely, Pulau Layat (close to core mangroves), Kampung Pengkalan Gelap (between core mangrove and shifted river mouth), and Pulau Sutung (close to shifted river mouth) were chosen. The four abundant crab species *Parasesarma eumolpe*, *Metaplax elegans*, *Austruca annulipes,* and *Scylla olivacea* which display different feeding behaviours were collected from all sites covering the dry (Feb-Mar 2021) and the wet (Dec 2021-Jan 2022) seasonal periods. There were significant differences in the seasonal abundance of microplastics among sites as well as crab species (Kruskal-Wallis test, $p<0.05$). The highest accumulation of microplastics in the crab guts at Pulau Layat for the dry period could be linked to subdued water circulation and poor material dispersion. Besides the lower microplastics pollution in the wet period due to improved water exchange conditions, its significant presence in the guts of *S. olivacea* and *A. annulipes* indicates the role of their foraging environment at the waterfront and their feeding behaviour as a carnivore resp. deposit-feeder. In addition, the Fourier transform infrared spectroscopy (FT-IR) revealed the widespread occurrence of polymers such as rayon, polytetrafluoroethylene and polyester (of domestic waste, fishing gear and boat paint origin) in all species across the sites. Further studies are necessary to investigate the detrimental effects of the microplastics pollution on local community's health and to assure sustainable conservation/management of the Setiu Wetlands.

Theme 2: Understanding and solving marine pollution in mangrove wetlands

Code: 8.6A. Linking national-scale policy interventions to mangrove conservation outcomes

Andradi-Brown, D.A.,[1] Slobodian, L.,[2] Buelow, C.,[3] Turschwell, M.,[3] Alvarez, S.,[2] Baker, S.,[2] Bell-James, J.,[4] Bukoski, J.J.,[5] Vázquez Vela, A.C.,[6] Carrie, R.,[7] Golebie, E.,[8] Heck, N.,[9] Valdivia, A.,[1] Villarreal-Rosas, J.,[3] White, A.,[3] Wood, K.,[2] Brown, C.[3]

[1]Ocean Conservation, World Wildlife Fund, Washington, D.C., USA [2]Environmental Law and Policy Program, Georgetown University Law Center, Washington, D.C., US [3]Griffith University, Queensland, Australia [4]University of Queensland, Queensland, Australia [5]Conservation International, Virginia, USA [6]WWF-Mexico, Merida, Mexico [7]Sustainability Research Institute, University of Leeds, West Yorkshire, UK [8]University of Illinois Urbana-Champaign, Illinois, USA [9]East Carolina University, North Carolina, USA

Mangroves are under severe threat – undergoing dramatic declines in extent and health over recent decades. Global momentum is building behind several initiatives seeking to increase mangrove protection and restore them when lost. This has led to concerted efforts to implement national-scale policy interventions such as national protection laws, coordination mechanisms, and mangrove-specific recognition in development. Yet the effectiveness of national legal instruments for mangrove conservation is poorly understood. We reviewed national legal systems for 80 countries containing >99.5% of the world's mangroves. We assessed each nation for the presence/absence of (i) specific mangrove policies, (ii) national mangrove protection laws (and strength of protection), (iii) mangrove national coordination mechanisms, and legal requirements for mangrove-specific considerations in (iv) coastal planning and (v) environmental impact assessment processes. We used Global Mangrove Watch data to measure trends in mangrove extent through time and construct counterfactuals to estimate rates of mangrove change for each nation in the absence of national policy interventions. By comparing observed rates of change in mangrove extent to these counterfactuals we assess the global and national impacts of national-scale mangrove conservation policy interventions on global mangrove forest extent. We then integrated mangrove change within global protected areas into the analysis, allowing us to look at the interactions between national-scale legal systems and site-based protection for mangroves. This aids understanding of how national policy context may enable or hinder the ability of protected areas to conserve mangroves. Although the analysis is currently in process, preliminary results suggest that the involvement of communities in the governance of mangrove resources is an important predictor of mangrove conservation outcomes. Our results assess widely used large-scale but previously unevaluated conservation interventions, and so are highly actionable to inform the success of mangrove conservation programs going forward.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 8.7B. Did sea level rise cause the disappearance of South California´s mangroves during the Early Holocene?

Arenas, F.,[1] Medina-Contreras, D.,[1,3] Fugita, H.,[2] Sánchez, A.[1]

[1]Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, Av. Instituto Politécnico Nacional S/N Col. Playa Palo de Santa Rita, La Paz, B.C.S Código Postal 23096, México.
[2]Instituto Nacional de Antropología e Historia, Centro Baja California Sur, México.
[3] Departamento de Biología, Facultad de Ciencias Naturales y Exactas, Grupo de Investigación en Ecología de Estuarios y Manglares, Universidad del Valle, Calle 13 No. 100-00, Ciudad Universitaria Meléndez, Valle del Cauca, Cali, Colombia.

Global changes in climatic patterns throughout the Holocene have affected the relationship between human populations and ecosystems. With the objective of inferring the effect of rising sea level on mangrove habitats and their use by humans, radiocarbon dating and ecological indexes of shells belonging to archaeological sites of Punta Faro del Marquez in Baja California's Pacific coast were carried out. Our results indicate that the mangrove bivalves *Anadara tuberculosa* and *Anadara grandis* were the most abundant and frequent in the archaeological strata of the early Holocene, suggesting the importance of mangrove ecosystems for the subsistence of early coastal human communities. Subsequently, an abrupt absence of these species in the archaeological strata was identified *circa* 8000 BP extending to the present, suggesting the rapid disappearance of mangrove forests in the region. These results coincide with Mid-Holocene sea level rise, SST changes and fluctuating oceanographic conditions recorded for the Baja California Peninsula. Today mangrove forests of Baja California's Pacific coast are scarce, fragmented, and represent the northern latitudinal limit of such ecosystems in the Eastern pacific. However, their ecosystem services still endure, and face numerous challenges for their survival.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 12.2A. Can the botanical occurrence data of the GBIF enhance accuracy of mangrove mapping by remote sensing with open access satellites?

Andrieu J[1]., Crook O.J[1].

[1]French Institute of Pondicherry (CNRS – MEAE)

Since decades, most of the local remote sensing applications to mangrove forest mapping achieve a satisfactory accuracy but the overall capacity of a global monitoring can yet be enhanced. The transition between mangrove and various wooded and humid continental vegetation is amongst the major confusions. It is the object of this present communication aiming at discussing the possibilities offered by adding open-access botanical data (occurrence data from the Global Biodiversity Information facilities: GBIF) to open-access satellite data (Sentinel-2). First, all the occurrences of the mangrove species of the Word have been downloaded (around 99 000 occurrences of true mangrove species and around 65000 of back mangrove or associate). This dataset contains important issues of accuracy (taxonomy, coordinates). Then, six mangrove areas, (Australia, Benin, Brazil, Colombia, Malaysia, USA) have been selected according to the density of mangrove occurrence data and the proximity of other wooded humid vegetation. Recent Sentinel-2 images of these areas has been downloaded with all the botanical (non mangrove) occurrence data surrounding the mangroves (7000 to 22000 occurrences). Two remote sensing methods are compared between themselves, and to a double blind photo interpretation of Google Earth very high resolution images, used as a verification dataset. The first one is a Stacked Kmeans method (SKM). The second one is a K-Nearest Neighbor (KNN) with, as a training sample, the pixels surrounding the GBIF data defined by image segmentation. On all sites it has been observed, for land cover classes map, that the SKM (unsupervised) scored better than the GBIF trained KNN. None fully resolved the confusion between mangrove and other vegetation. On all sites, the SKM strongly enhanced the "user's" accuracy while KNN slightly enhanced the "producer's" accuracy of mangrove. The GBIF seems therefore promising but maybe not yet performant enough to be implemented in global applications to mangrove detection

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 13.3A. Mangrove city: using virtual reality to demystify and normalize mangroves as critical parts of our coastal landscape

Araújo, R.J.,[1*] Ron, R.,[2] Rende, K. "Ren".,[3] Grinfeder, K.,[4] and Rodriguez, Z.[4]

[1] University of Miami, Rosenstiel School of Marine, Atmospheric & Earth Science, Miami, Florida, USA. *Email: raraujo@miami.edu
[2] University of Miami, School of Architecture, Coral Gables, Florida, USA
[3] University of Nebraska at Omaha, College of Education, Health, and Human Sciences, Omaha, Nebraska, USA
[4] University of Miami, School of Communications, Interactive Media, Coral Gables, Florida, USA

"Mangrove City" is a virtual reality experience targeted at middle school students and aligned with the Next Generation Science Standards, a multistate effort to create educational materials led by government, teachers, and nonprofit organizations. Mangrove City is a virtual reality (VR) application that immerses participants in a mangrove forest. Created by an interdisciplinary group of students and faculty, each group brought their unique expertise to the effort. The goal of this project is to create a basic understanding of the importance of mangroves to students enrolled in 8th grade (approximately 13–14 years old) by providing assessable immersive educational content that can easily be incorporated into classroom learning. We chose this demographic because Middle School children can influence how parents feel about the environment. The simulation is a virtual paddling through a mangrove forest, allowing the participant to explore its many components. For example, participants learn to identify mangrove species, watch underwater 360º movies, and discover the relationship between mangrove roots and ocean waves to combat land erosion by interacting with a virtual wave simulator. The content is geared towards instruction in sustainability principles, threats from global climate change, and some inspirational design ideas on strengthening future urban coastal settlements with lessons learned from mangrove habitats. The experience visualizes a "city of the future" in which mangroves play a role in carbon sequestration, water filtration, and mitigation of soil resulting from sea level rise, alongside futuristic architecture that learns from these principles. We pair the experience with a one-day workshop available to teachers for free. The classroom materials will include a downloadable teacher guide, a lesson, student response forms, and a discussion guide created with middle school science teachers and learning experts.

Theme 6: Changing human relationships with mangrove wetlands

Code: 17.2. New system to map mangrove degradation in the Caribbean and Gulf of Mexico

Amaral, C., [1]Poulter, B.,[2] Fatoyinbo, L.,[2] Montibeller, B.,[3] Leite, I.,[3] Dutra, A.,[4] Barenblitt, A.,[2] Almeida, D.,[5] Resende, A.,[5] Lagomasino, D.,[6] Torres, C.,[7] Goncalves, F.,[3] Roman-Cuesta, R.[8]

[1]Cooperative Institute for Research in Environmental Sciences, Earth Lab, Boulder, CO 80303, United States
[2]NASA Goddard Space Flight Center, Biospheric Sciences Laboratory, Greenbelt, MD 20771, United States
[3]Canopy Remote Sensing Solutions, Florianópolis, SC 88032, Brazil [4]National Institute for Space Research (INPE), Remote Sensing Division, São José dos Campos, SP, 12227900, Brazil [5]Universidade de São Paulo (ESALQ/USP), Department of Forest Sciences, Piracicaba, SP, 13418-900, Brazil [6]East Carolina University, Department of Coastal Studies, Greenville, NC 27858-4353, United States [7]Universidade Federal de Viçosa, Department of Forest Engineering, Viçosa, MG 36570-900, Brazil [8]Wageningen University & Research, Laboratory of Geo-Information Science and Remote Sensing, 6708PB Wageningen, The Netherlands

Here, we present an open-source system to track and map mangrove degradation and state change in the Caribbean and Gulf of Mexico region using Earth Observation. The system comprises three steps: 1. Fraction images and the newly-developed Normalized Degradation Fractional Index for Wetlands (NDFIW) calculation using 30-m resolution images from Landsat-5, -8, and -9; 2. Change detection, where we detect the disturbances from 2000-present at the pixel level; and 3. Time series classification into Mangrove forest, Grassland, Soil, and Water. The outputs are the pixel-based fractions and NDFIW time series, dates of disturbance, the magnitude of disturbance, rate of recovery, post-disturbance land cover class, and annual maps of mangrove degradation and deforestation. We used 1,876 point samples collected from aerial photos of Florida and Puerto Rico mangroves, which were impacted by the 2017 season's hurricanes, for external validation of the system. With an NDFIW drop of about 44% after the hurricane impact, the degradation was detected in 69.2% of the disturbed mangrove sample points between 2017 (65.0% of the samples) and 2018 (4.2%). On the other hand, the non-disturbed mangrove sample points did not show a significant NDFIW drop after the impact and 93.3% remained classified as non-degraded mangrove from 2016 to 2019. Scientists and stakeholders can use the system to advance the understanding of the compound effects of extreme weather events such as hurricanes and droughts and of sea level rise on different mangrove species, and ecosystem shifts to salt marshes and mudflats. The system outputs may also aid the assessment of how mangrove degradation is affecting ecosystem services, such as coastal protection, habitat, and carbon storage. Additionally, they can support reconstruction funds allocation after mega-hurricane seasons and the remote monitoring of mangrove restoration initiatives.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 1.3. Decadal Scale Trends in Surface Elevation and Mangrove Tree Growth in Moreton Bay, Queensland, Australia.

Bennion, V.,[1] Dwyer, J., Lovelock, C.[1]

[1]University of Queensland, Australia

Coastal wetlands provide important ecosystem services including protection from coastal erosion, soil carbon sequestration and provide habitat to marine and terrestrial fauna. Their persistence with sea-level rise depends upon their capacity to increase their soil surface elevation at a rate comparable to the rate of sea-level rise. Both sediment and organic matter from plant growth contribute to gains in soil surface elevation, but the importance of these components varies among sites and with variation in climate over long time scales, for which monitoring is seldom available. Here we analyse variation in surface elevation, surface accretion and mangrove tree growth over 15-years in Moreton Bay, Queensland; a period that spans variation in the El Nino/La Nina (ENSO) cycle which strongly influences rainfall and sea level in the region. Piecewise structural equation models were used to assess the effects of biotic (tree growth and bioturbation by crabs) and environmental factors on annual surface elevation increments throughout this period. Our model identified that surface accretion and tree growth were both positively influenced by rainfall, but surface elevation was not, and thus high levels of compaction of the soil profile in high rainfall/high sea level years was inferred. Declines in surface elevation were influenced by the species composition of the mangrove, with higher levels of elevation loss in mangroves dominated by *Avicennia marina* compared to those with a higher proportion of *Rhizophora stylosa*. Decadal-scale variation in ENSO affects mangrove tree growth, but surface elevation trends were more strongly influenced by variation in environmental conditions than by tree growth, although effects of biotic factors (mangrove species composition and bioturbation) on surface elevation trends were observed. Further research into tipping points with extreme ENSO events will help clarify the future of mangroves within Moreton Bay.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 1.4. Mangrove responses to sea-level rise: projections of blue carbon and species composition from resilient and vulnerable ecosystems.

Buffington, K.J.,[1] Thorne, K.M.,[1] Krauss, K.W.,[2] Mackenzie, R.A.,[3] Carr, J.A.[4]

[1]US Geological Survey, Western Ecological Research Center, Davis, CA, USA
[2]US Geological Survey, Wetland and Aquatic Research Center, Lafayette, LA, USA
[3]US Forest Service, Pacific Island Forestry, Hilo, HI, USA
[4]US Geological Survey, Eastern Ecological Research Center, Laurel, MD, USA

Accelerating sea-level rise (SLR) is poised to reshape coastal environments over the coming decades, providing a challenge to land managers who require actionable information to guide decision making. Mangroves have an innate ability to keep up with some amount of SLR but may be at risk to drowning under the higher rates projected by the end of the century. Understanding local mangrove resilience to SLR requires data on historic and contemporary accretion rates, measures of productivity, and forest elevations relative to tidal inundation. We apply a new modeling approach (WARMER-Mangroves) for assessing future mangrove resilience to SLR, blue carbon storage, and changes to mangrove species composition. Results from two case studies will be presented: Ding Darling National Wildlife Refuge in southwest Florida, USA and Pohnpei, Federated States of Micronesia. These ecosystems are distinct in key physical and biological parameters, including available sediment for deposition, productivity, and mangrove diversity. We found that Florida mangroves are highly vulnerable, with projected losses in mangrove area starting in ~2060 under moderate SLR (+1.15 m by 2100). Mangroves across Pohnpei were projected to be relatively resilient under all except the highest SLR scenario, although shifts in species composition were projected under all but the lowest SLR scenario. Opportunity for transgression between our simulations made a difference to relative SLR vulnerability. We will review the most sensitive input parameters and SLR rate thresholds for each case study, as well as provide a framework for applying the model to new areas. Model application for blue carbon projects will also be discussed. Projections based upon local or regional datasets can facilitate the effective management of coastal systems by guiding conservation resources to the most vulnerable areas.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.6A. Shred waves, not carbon: Co-occurrence of surf breaks and mangrove conservation opportunities

Bukoski, J.J.[1]

[1]*Department of Forest Ecosystems and Society, Oregon State University*

Surf breaks are increasingly recognized as natural resources that coincide with conservation opportunities while also providing substantial direct benefits to local communities. For example, benefits to local communities in the Uluwatu surf area of Bali, Indonesia are estimated at 35 million USD annually. However, global surf resources and their surrounding environments are subject to threats such as sea level rise, coastal development, and pollution. Here, we examine the spatial co-occurrence of surf breaks and opportunities for expanded mangrove conservation, which would simultaneously help preserve community benefits from surf resources, conserve mangrove biodiversity, and mitigate climate change. Using spatial data on surf break locations, mangrove extent, mangrove carbon stocks, protected areas, and Key Biodiversity Areas, we identify a total of 8,433 km^2 of mangroves in coastal watersheds that host surf breaks. Approximately 57% of these mangroves are found outside of protected areas. Accounting for carbon held in biomass and the top meter of soil, we estimate 213 million Mg C to be held in these unprotected mangroves. Moreover, 19% of these unprotected mangroves (904 km^2) coincide with Key Biodiversity Areas, or ecosystems identified as global priorities for conservation. Our results suggest a strategic opportunity to expand protection of mangroves in proximity to surf breaks, which can simultaneously contribute to improved mangrove conservation, benefits to local communities, and climate change mitigation.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.7A. Advances and challenges in computer-based forest modelling to understand and predict mangroves responses to environmental changes

Berger, U.,[1] Peters, R.,[1] Vollhüter, J.,[2] Tietjen, B.,[2] Wimmler, M.C.,[1] Pimple, U.,[3], Vovides, A.G. [4]

[1]Faculty of Environmental Sciences, Department of Forest Sciences, Chair of Forest Biometrics and Systems Analysis, Technische Universität Dresden, Germany
[2]Institute of Biology, Professorship of Theoretical Ecology, Freie Universitaet Berlin, Germany
[3]The Joint Graduate School of Energy and Environment and Centre of Excellence on Energy Technology and Environment, King Mongkut's University of Technology Thonburi, Bangkok, Thailand
[4]School of Geographical & Earth Sciences, University of Glasgow, United Kingdom

Understanding the processes that shape mangrove forest functioning, structure, and diversity remains challenging, even though data is being collected at a rapid pace and at multiple scales. Agent-based models have a long history in addressing knowledge gaps in the scientific understanding of ecological processes in forested ecosystems. They simulate forest dynamics from local (e.g. succession, disturbance driven mortality, anthropogenic effects) to regional scales (e.g. terrestrial feedbacks in the climate system, carbon flux) in short to long term temporal dimensions and measure the consequences of management, disturbances or environmental change. During the last decade, new data sources have emerged rapidly (e.g. automated sap flow measurements, laser-based forest inventories, tower measurements, satellite/drone products) and are accompanied by powerful methods of machine learning providing data generation and analysis at a spatio-temporal resolution that were not available so far. Incorporating these approaches at every step of a modelling workflow, would allow us to continuously incorporate new data to reduce uncertainty in models, use them for new regions, and make them a powerful tool for scenario assessment. We review advances in agent-based modelling, monitoring, data science, and present a vision of "big" forest models that can take ecological application and forest science to a new level. We present the pyMANGA platform as a modelling environment for interested scientists to develop mangrove simulation models according to their needs and conduct and analyse simulation experiments for research questions which need to consider, individual traits of trees, plant-soil feedback, physiological adaptations, or neighbourhood interactions while crossing spatial scales from local to regional ones. We address fundamental and applied questions related to the combination of computer-based forest modelling with new data sources and methods to promote a deeper understanding of system dynamics over space and time in the context of environmental change.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.1A. Sap flow characteristics of root-grafted *Avicennia germinans* individuals

Bowen, J.H.,[1)] Vovides, A.G., [2)] J López-Portillo, J.,[3)] Alvarado Barrientos, S.,[3)] Aguirre Franco, L., [3)] Nadezhdina, N.[4)]

[1]Plant Ecology Program, Archbold Biological Station, Venus, FL, USA
[2]School of Geographical and Earth Sciences, University of Glasgow, Glasgow, UK [3]Functional Ecology Network, Instituto de Ecología A.C., Veracruz, Mexico
[4]Institute of Forest Botany, Dendrology and Geobiocenology, Mendel University in Brno, Brno, Czech Republic

Within trees, water moves following water potential gradients, typically flowing vertically through a soil plant-atmosphere continuum. But such gradients can change, i.e., when only a section of a tree's root system is exposed to dryer soil conditions or during rain events; these deviations from typical vertical sap flow patterns are forms of hydraulic redistribution (HR) that help maintain optimal plant water status. While data exists showing different mechanisms of HR, very little information is available for its potential implications for trees that are connected through functional root grafts (the morphological fusion of cambium and vascular tissue of two or more roots). Root grafts are common in black mangroves (*Avicennia germinans*) and might represent a cooperative trait that works to maintain favorable plant water status under high salinity stress. Here, we tested the hypothesis that sap flow exchange occurs between grafted roots of different trees. We measured sap flow in grafted roots and stems of three *A. germinans* trees using the Heat Field Deformation method and found higher xylem sap flow rates flowing from the larger (donor) to the smaller tree (recipient). Furthermore, we documented simultaneous bidirectional flow, where the sap of the donor's outer xylem flowed to the recipient tree, whilst the inner xylem's sap flowed toward the donor's canopy. On further experiments, 90% of the leaves were removed from one individual in a grafted pair of trees. Neither root nor stem sap flow records showed a response to mechanical defoliation, suggesting the hydraulic architecture of *A. germinans* could be interconnected. We propose the term "root graft-mediated water exchange" to describe this newly discovered form of HR between trees through functional root grafts. Root graft mediated water exchange might be a widespread cooperation-based water regulation mechanism in black mangrove forest stands, but requires further studies.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.5A. A new regional map of mangrove extent for Southeast Asia shows losses of 44% between the 1970's and 1996

Baltezar, P.,[1] Murillo-Sandoval, P.,[2] Cavanaugh, K.,[1] Doughty, C.,[3,4] Lagomasino, D.,[5] Tieng, T.,[6] Simard, M.,[7] Fatoyinbo, T.[3]

[1] Department of Geography, University of California, Los Angeles, CA, USA
[2] Facultad de Ciencias del Hábitat, Diseño e Infraestructura, University of Tolima, Ibagué, Tolima, COL.
[3] Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD, USA
[4] NASA Postdoctoral Program, Oak Ridge Associated Universities, Oak Ridge, TN, USA
[5] Integrated Coastal Programs, East Carolina University, Wanchese, NC, USA
[6] Institute for Sustainable Communities (ISC), Montpelier, VT 05602
[7]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

Earth observation (EO) in recent decades has made it clear that humans have had a negative impact on mangrove ecosystems across the world. However, there is still much uncertainty in the timing and magnitude of changes in mangrove cover over the past 50 years. While there are several regional to global maps of mangrove extent covering the past two decades, data prior to the mid-1990s is limited due to the scarcity of EO data of sufficient quality and historical limitations to public access. In this study, we present a new methodology for extracting analysis-ready historical satellite data from Landsat 1 and 2 from 1972-1977, and the resulting mangrove extent estimates for case study sites in three SEA countries: Myanmar, Thailand, and Cambodia. Mangrove extent land cover maps were generated using a Random Forest machine learning algorithm that effectively mapped a total of 15,420.51 km^2. We found a decline of 6,830 km^2 between the 1970s and 2020, showing that almost half (44.29%) of the mangrove area in these countries has been lost in the past 48 years. The majority of this loss occurred between the 1970s and 1996, with rates of deforestation declining dramatically after 1996. Our findings for the first time confirm the often used historical loss rate of '50% in the past 50 years' described by Primavera et al (1995) in the SEA region. Our methods and results open the door for further analysis of historical mangrove extent and the scientific and management implications that these data support.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.6A. Size does not matter: functional diversity indices help predict endangered mangrove forests around Hong Kong

Bravo, H.,[1,2] Y Cheng, C.L.,[1] Fratini, S.,[3] Jimenez, P.J.,[1] Cannicci, S.[1,3]

[1] The Swire Institute of Marine Science, The University of Hong Kong, Hong Kong, Hong Kong S.A.R., P.R.C.
[2] Groningen Institute for Evolutionary Life Sciences, University of Groningen, 9700 CC Groningen, The Netherlands
[3] Department of Biology, University of Florence, 50019 Sesto Fiorentino, Italy

Mangrove forests are naturally biodiverse systems that harbour a plethora of highly specialised species. The size of a mangrove forest can influence its biodiversity, but the relationship between these two characteristics is not always linear. In the present study, carried out in 40 different medium- to small-size mangrove patches across Hong Kong, we show that species composition, diversity and functional role of the associated fauna plays a more important role than size in the functioning of such ecosystems. We determined the size of the mangrove forests, its tree diversity, and the taxonomic and functional richness of crab and mollusc assemblages in the mangrove system to understand if certain areas were more at risk than others. The forests were located along a gradient of human impact, which also helped us understand if anthropogenic impact plays a role in the overall functionality of a forest. We identified five sites with critical low levels of functional diversity and/or redundancy which are possibly not able to sustain all ecosystem functions anymore; six sites that were at risk of losing some of their functionality. We also highlighted four sites that were doing particularly well and that could be used as reservoirs or supply sites for nearby threatened locations and that should be the focus of conservation efforts. These findings were independent of the level of human impact. We show here that using indices of functionality and redundancy at a small scale is effective in determining the endangerment of a site and help predict its functional continuity or collapse when size is not.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.6B. Failed adaptations to mangrove shoreline erosion: Implications for socio-economic vulnerability in the Sundarbans

Bhargava, R.,[1], Kenney-Lazar, M.,[1] Friess, D.,[2] Sen, A.[3]

[1] National University of Singapore, Singapore
[2] New Orleans, United States of America
[3] Humanities and Social Sciences, India

Erosion and accretion are natural processes along mangrove shorelines, though erosion is exacerbated by various natural and anthropogenic factors and is now a leading cause of mangrove loss in many regions. Mangrove shoreline erosion can cause severe flooding and land loss, leading to the loss of ecosystem services and the displacement of shoreline-dwelling communities. This study focuses on the loss of mangroves due to shoreline erosion in the Sundarbans, the world's largest contiguous mangrove forest, shared between India and Bangladesh. ~14 million people are at a threat of land loss due to mangrove shoreline erosion in the Sundarbans. Since the 1960s, concrete embankments have been constructed to minimize shoreline erosion, though they often collapse within a few years of construction. The focus of this study is to understand how embankments, as an adaptation to shoreline erosion, impact mangroves and shoreline-dwelling communities. We used geospatial analysis to identify spatial and temporal trends in mangrove shoreline erosion and conducted 83 community interviews across 16 villages in India and Bangladesh to understand the socio-economic impact of shoreline erosion and embankment failures in the Sundarbans. It was found that erosion is particularly significant in the Sundarbans, where ~137 km^2 of mangroves have been lost to erosion between 1985-2019. 99.7% of the respondents reported that embankments are the primary mitigation against erosion. 24.5% of the respondents reported losing land to erosion, while 75% reported losing land embankment failures. This study shows that the current design of the embankments in the Sundarbans fails to prevent shoreline erosion. As a result, the shoreline-dwelling community suffers socio-economic losses. Furthermore, embankment failures trigger a recursive loop which, in the presence of pre-existing socio-economic vulnerabilities, reduces the shoreline-dwelling community's resilience to manage future risks, leading to higher dependence on external protection from embankments. Additionally, it is shown that pre-existing socio-economic vulnerabilities, specifically lack of government support, livelihood opportunities, and economic resources, are essential dimensions leading to the construction and reconstruction of poorly designed embankments. The result of this study provides implications for adaptations to prevent mangrove shoreline erosion.

Theme 3: Achieving sustainable socio-economic development and equity

Code: 8.1A. Applying Ecological Mangrove Restoration Protocols Within a Structured Decision-Making Framework for Improved Outcomes

Ball, L

U.S. Geological Survey, United States of America

There is a global backlog of places where mangrove forests could be restored successfully. Ecological Mangrove Restoration (EMR) protocols (Lewis and Marshall 1997) offer a holistic foundation based on restoring both tree cover and ecological functions, but they remain underused, especially after natural disasters. One reason may be that EMR is not prescriptive and the variation in soils, species compositions, legacy land use, and local resources varies widely among projects, requiring sequential targeted decisions. Additionally, vague restoration targets and multiple stakeholders (e.g., ecologists, politicians, funders) with different understandings of wetland ecology contribute to the confusion and misperceptions about mangrove restoration. Applying EMR within a Structured Decision Making (SDM) framework could increase its use and improve mangrove restoration success. SDM is an approach to decision making which decomposes a decision into its elements for individual attention, stresses clarity, recognizes multiple stakeholder values, and deals explicitly with technical uncertainty. The SDM framework contains a clear problem statement, measurable restoration objectives (e.g., desired future conditions), and multiple restoration alternatives to choose among. Every restoration alternative (e.g., planting saplings) is evaluated transparently against every objective (e.g., increased resilience) using available wetland models. Afterwards, ecologists can evaluate restoration success by comparing desired to actual outcomes (objectives). Quantitative outcomes can be communicated between successive projects.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 8.4A. On the impacts of ENSO on mangrove sediment accretion and adaptability to sea level rise

Belliard, J.P.,[1] Suello, R.H.,[1] Dominguez-Granda, L.E.,[2], Rosado-Moncayo, A.M.,[2] Ramos-Veliz, J.A.,[2] Pelckmans, I.[1] Gourgue, O.,[1,3], Govers, G.,[4], and Temmerman, S.[1]

[1] University of Antwerp, Ecosphere research group, Antwerp, Belgium
[2] Escuela Superior Politecnica del Litoral (ESPOL), Centro del Agua y Desarrollo Sostenible, Guayaquil, Ecuador
[3] Royal Belgian Institute of Natural Sciences, Brussels, Belgium
[4] KU Leuven, Department of Earth and Environmental Sciences, Leuven, Belgium

Mangrove forests are valuable wetland ecosystems that are known to be threatened by sea level rise (SLR). In the Eastern Pacific, mangroves are additionally exposed to extreme sea levels (ESLs) caused by the El Niño-Southern Oscillation (ENSO). Certain climate models show a tendency for an ENSO intensification with climate change, manifested by an increase in the frequency and magnitude of the El Niño and La Niña phases, and associated ESLs. Previous studies that investigated mangroves adaptability to SLR neglected the influence of changing ENSO patterns with climate change. Here, we present an integrated field and modelling study that aims to quantify such influence. Our study is applied to the mangroves of the Guayas river delta (Ecuador), where El Niño has strong impacts on ESLs. First, using a combination of historical tide records and field measurements, we analyze the effects of past El Niño/La Niña events on changes in tidal inundation regime within the mangrove forests. We found that an El Niño similar to the 1997-1998 event would lead to a ~100% increase in tidal inundation depth and ~60% increase in inundation frequency within the mangroves; conversely, a strong La Niña event would entail a reduction of up to ~40% in tidal inundation depth and ~20% in inundation frequency. Second, a tidally-driven sediment accretion model is applied to investigate effects of various ENSO driven ESLs, reflecting future potential scenarios of El Niño/La Niña frequency and intensity, on sediment accretion rates in mangroves in response to 21st century SLR. Results show that ESLs driven by present-day ENSO patterns can increase the capacity of mangroves to adapt to SLR, but future varying ENSO patterns can lead to different evolutionary trajectories. Our study highlights the exposure of coastal wetlands to ENSO driven ESLs and the need for adaptation measures to better protect them.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 8.5A. Carbon Dynamics in Mangrove Ecosystems of Andaman Islands: A living laboratory for studying natural disturbance and ecological succession

Bhomia, R.K.,[1] Singh, A.R., Thirumurugan, V., Prabakaran, N., MacKenzie, R.

[1]CIFOR, India

The mangroves in Andaman and Nicobar Islands (ANI), India not only provides numerous ecosystem services, but the aboveground carbon (C) stocks are also high in ANI's mangroves. After 2004 Sumatra earthquake, coastal geomorphology of ANI changed drastically resulting in subsidence (~2.85 m) and uplift (~ 1.35 m) zones. The sudden change in elevation changed coastal tidal regime and vast stretches of mangroves were lost following this event. We have attempted to understand the ecological succession as old vegetation died and new trees colonized the affected areas through systematic sampling of mangroves across entire Andaman Island. We assessed mangrove vegetation characteristics and quantified C stocks (above and belowground) at 26 sites representing 3 zones – Uplifted, Subsided and Control. Comparison of vegetation and C across these zones will help understand fate of blue C when coastal ecosystems experience large scale disturbance. Our preliminary results from vegetation analysis showed clear patterns indicating vegetation difference as a response to habitat conditions. Inventorying 156 vegetation plots (60 uplifted, and 54 each in subsided and control sites) we encountered 17 species in tree cohorts. The survey measured 2531 trees, 218 saplings, and 1152 seedlings. Control mangrove sites had significantly high tree density per site in comparison to subsided & uplift zones. Andaman mangroves forests are dominated by *Rhizophora spp.* and *C. tagal*, yet both uplift and subsided sites showed high instance of less salt tolerant species — *E. agallocha, H. littoralis* and euryhaline mangrove - *A. marina, C. taga*l. *V*egetation C ranged from 75-100 MgC/Ha with no significant difference between three zones. Data from below ground C stocks (currently being analyzed) will shed light on C dynamics. The uplift and subsidence gradient across coastal zones in Andamans provide a unique living laboratory to study an evolving ecosystem to understand fate of coastal vegetation and C due to change in environmental factors.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 8.4B. Monetizing Carbon Storage: Progress and pitfalls in mangrove carbon project development

Beers, L.,[1] Glass, L.,[1] Lebrasse, M.C.,[1] Emmer, I.,[1] and Crooks, S.

[1]Silvestrum Climate Associates, United States of America

Mangrove protection and restoration are essential for maintaining numerous critical ecosystem services and the livelihoods and well-being of coastal communities. Their increased recognition as a natural climate solution has garnered them significant attention in country-level greenhouse gas emissions mitigation strategies and businesses with ambitious carbon initiatives and corporate social responsibilities. In addition to their carbon storage capacity, mangrove restoration and conservation can bolster local communities and maintain and improve biodiversity, and as such, mangroves are well suited and sought after for carbon project development. Currently, the global demand for mangrove carbon projects is substantially larger than the availability of projects. However, as the sector strives to scale to meet demand, it is essential that projects are backed by rigorous science and are quantifiable, verifiable, and resilient to future climate change impacts. Here, we review the key components of coastal wetland carbon project development, providing case studies from projects that are being implemented across the world. We also highlight the challenges and limitations associated with them, such as effects of sea-level rise; complications with measuring and monitoring soil organic carbon; setting baselines for conservation projects; national policies and credit ownership.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 11.7A. Global Mangrove Watch (GMW) Mangrove Alerts: Near Real-Time Alerts of Mangrove Loss

Bunting, P.,[1] Hilarides, L.,[2], Rosenqvist,A.,[3] and Lucas, R.[1]

[1]Aberystwyth University, United Kingdom
[2]Wetlands InternationaL, Netherlands
[3]soloEO, Japan

Mangroves constitute a critical ecosystem under significant pressure despite providing a host of local to global ecosystem services. Annual maps of mangrove extent and change are crucial for long-term monitoring and planning. However, due to their long (annual) production cycle, they can be of limited use for the day-to-day protection of our mangrove ecosystems. To complement the Global Mangrove Watch (GMW) annual global mangrove extent maps, the GMW has developed a new Near Real-Time Alerts system to provide monthly alerts of
mangrove losses. The GMW Mangrove Alert system has been implemented using Copernicus Sentinel-2 imagery available within the Microsoft Planetary Computer to enable fast and efficient processing in a scalable fashion. The alert system is not yet global but has been implemented for Africa, Mexico, Ecuador, French Guiana, Suriname, Guyana, Bangladesh, Myanmar, Fiji, and the islands of Borneo and Sulawesi. The Mangrove Alert system uses a 20m pixel resolution with alerts provided as points representing individual pixels. The search for change alerts is confined to mangrove areas defined under the GMW 2018 mangrove baseline mask, with alerts produced since January 2019. From January 2019 to November 2022, 420,728 alerts were identified, of which 72,389 were found in Africa, 117,384 within the countries processed in the Americas, 158,799 within Bangladesh and Myanmar and 71,814 in Borneo and Sulawesi. The overall accuracy was estimated at 92.1 %, with a 95th confidence ranging from 89.0 % to 95.7 %. For Africa, the change drivers have also been studied, indicating that the majority of mangrove losses in Guinea-Bissau and Guinea are due to agriculture development; in Nigeria, changes are mainly due to infrastructure; while in Madagascar and Mozambique, they are dominated by storm damage.

The GMW Near Real-Time Mangrove Alerts are available in the public domain and provided through the GMW Portal: https://www.globalmangrovewatch.org

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 11.3B. Combining loss-on-ignition with sedimentary and geomorphic settings to characterize mangrove soils: Part 1, Organic Carbon

Breithaupt, J.L., [1] Steinmuller, H.E., [2] Rovai, A.S., [3] Engelbert, K.M., [4] Smoak, JM., Chambers, L.G., [5] Radabaugh, K.R., [6] Moyer, R.P., [7] Chappel, A., Vaughn, D.R., [9] Bianchi, T.S., [8] Twilley, R.R., Pagliosa, P., Cifuentes-Jara, M., and Torres, D.

[1] Florida State University, United States of America
[2] Dauphin Island Sea Lab, United States of America
[3] Louisiana State University, United States of America
[4] FSU Coastal & Marine Lab
[5] University of Central Florida, United States of America
[6] Florida Fish and Wildlife Conservation Commission, United States of America
[7] TerraCarbon LLC, United States of America
[8] University of Florida, United States of America
[9] Yale University, United States of America

Using loss on ignition (LOI) measurements of soil organic matter (SOM) to estimate soil organic carbon (OC) content is an internationally-recognized and decades-old practice. In spite of well understood uncertainties, LOI continues to be necessary for many coastal wetlands researchers and conservation practitioners without access to an elemental analyzer. Multiple measurement, reporting, and verification (MRV) standards recognize the need (and uncertainty) for using this process. However, no framework exists to explain the substantial differences between equations used to calculate OC from SOM and consequently, equation selection can be a haphazard process leading to widely divergent and inaccurate estimates. To address this lack of clarity, we used a dataset of 1,246 soil samples from 17 mangrove regions in North, Central, and South America and calculated conversion equations for six unique types of coastal environmental setting. A framework is provided for understanding differences and selecting an equation based on a study region's SOM content and whether mineral sediments are primarily terrigenous or carbonate in origin. This approach identifies the positive dependence of conversion equation slopes on regional mean SOM content and indicates a distinction between carbonate settings with mean (± 1 S.E.) OC:SOM of 0.47(0.002) and terrigenous settings with mean OC:SOM of 0.32(0.018). This framework, focusing on unique coastal environmental settings, is a reminder of the global variability in mangrove soil OC content and encourages continued investigation of broadscale factors that contribute to soil formation and change in blue carbon settings.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 12.4B. Mangrove research framing has changed from crisis to ecosystem services: a text mining analysis

Balke, T.[1], Ladd, C.T.J.[1], Vovides A.G.[1], Huxham M.[2]

[1]School of Geographical and Earth Sciences, University of Glasgow, Glasgow, G128QQ, UK
[2]School of Applied Sciences, Edinburgh Napier University, Edinburgh, UK

Nature conservation emerged in the 1970s as a crisis discipline in response to evidence of biodiversity loss. Since the Millennium Ecosystem Assessment in the early 2000s societal benefits of nature have been increasingly used as an argument for nature conservation and restoration. Using text mining of scientific papers, we compare publications on mangrove habitats to other habitats such as coral reef, seagrass or tropical forests to investigate how the framing of our research on these habitats has changed over the past 60 years. We found clear differences between coastal wetland and, for example, coral reef publications in how much the ecosystem services narrative is adopted. The research narrative we adopt should be deliberate and we discuss what consequences this might have on conservation and restoration actions on the ground.

Theme 6: Changing human relationships with mangrove wetlands

Code: 12.6B. Mangroves and human health through a medical ecology framework

Blumenthal, K.,[1] Lagomasino, D.,[1] Richards, S. [2]

[1]Department of Coastal Studies, East Caroline University, USA
[2] Department of Health Education and Promotion, East Caroline University, USA

During these times of rapid climate change, global population growth, and expanding urbanization, understanding how human–environment interactions shape human health is more important than ever. The immediacy of some health issues such as infectious disease can garner significant attention when they expand to the global scale, especially once they affect wealthier countries. However, many human health issues are more localized problems that can go overlooked when they are tied to physical location and/or socioeconomics. Such disparity and inequity in human health is exemplified in the continuing existence of neglected tropical diseases. The paucity of mangrove-related human health research is likely due, in part, to the global concentration of mangroves in less affluent countries. Current mangrove and human health research is scattered across many disciplines and poorly linked together. Results tend to be discussed within a limited discipline focused with minimal to no integration of how the study connects environmental setting and human health outcomes. The relationship of wetland ecology to the medical subject of interest receives little attention. This overview of mangroves and physical human health works to complement other review articles on this topic by using a medical ecology framework to transcend studies. Here, we will review findings from mangrove studies but placed within the context of related medical and ecology field(s). Contextualizing the literature in a wider, interdisciplinary scope highlights specific avenues for further research that would otherwise go overlooked. This synthesis will focus on three key areas: (1) medicinal uses of mangroves; (2) environmental contaminants; and (3) mosquito-borne disease. A preliminary list of future research avenues and societal needs largely based on the themes of applied research, exploratory research, and risk assessment and management will be provided. These points will be inherently interdisciplinary in nature and call for collaborative efforts combining health, natural, and social sciences.

Theme 6: Changing human relationships with mangrove wetlands

Code: 1.2. Hurricane Irma effects on mangrove forest structure in the Florida everglades, USA

Castañeda-Moya, E.,[1] Lagomasino, D.,[2] Kominoski, J.,[1,3] Troxler, T.,[1,4] Sah, J.[1]

[1]Institute of Environment, Florida International University, Miami, FL, USA [2]Department of Coastal Studies, East Carolina University, Greenville, NC, USA [3]Department of Biological Sciences, Florida International University, Miami, FL, USA [4]Department of Earth and Environment, Florida International University, Miami, FL, USA

In neotropical northern latitudes such as south Florida, hurricanes are recurring high-energy disturbances that can significantly affect community structure and function of mangrove wetlands. Despite the destructive impacts of hurricanes, these highly productive forested wetlands can recover quickly from disturbance due to their adaptations and intrinsic resilient traits. Here, we evaluated changes in mangrove forest structural attributes and species-specific responses in response to Hurricane Irma impacts (September 2017) at mid and downstream sites along the Harney (WSC-8, 10) and Broad (WSC-12, 13) Rivers in southwestern Florida Everglades. During pre-Irma (2015), mean basal area (BA) ranged from 25-27 m^2 ha^{-1} across sites, but decreased by 8-51% during post-Irma (2020), with higher reduction at downstream sites where mangroves were severely damaged. *Avicennia germinans* showed the highest dominance (56%) at downstream sites during 2015, whereas at the upstream site WSC-8, *Rhizophora mangle* was the dominant species (53%). Species dominance changed drastically post-Irma, with dominance of *R. mangle* at all sites (68- 78%). Smaller trees (DBH: 2.5-5 cm) accounted for 22-29% of the total density at all sites during pre-Irma. In contrast, the density of smaller trees during 2020 ranged from 33-51% across sites, indicating an increase in young adults post-Irma. Aboveground biomass ranged from 101-114 Mg ha^{-1} during pre-Irma at all sites, but decreased to 54-95 Mg ha^{-1} during post-Irma. Our results indicate a reduction in structural attributes across our study sites during post-Irma, particularly at near-coast mangrove areas. However, the observed increase in BA and tree density of smaller trees post-Irma at all sites suggest rapid regeneration and recruitment of juvenile saplings into adult cohorts of mangrove species. The interaction between hurricane physical properties and pre-storm forest structural development, species composition, and recruitment will largely control the rate and timescales of recovery, as well as the change of mangrove ecological attributes following disturbance.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.3B. Mangroves in an industrialized setting: the impact of heavy metals on flora and fauna of mangrove forests in the Greater Bay Area, PR China

Cannicci, S.,[1, 2] Butler, R.J.,[2, 3] Vorsatz, L.D.,[4, 2, 3] Not, C.A.[2, 5]

[1]Department of Biology, University of Florence, Sesto Fiorentino, Italy
[2]The Swire Institute of Marine Science, Hong Kong, Hong Kong Special Administrative Region, PR China
[3]School of Biological Sciences, The University of Hong Kong, Hong Kong, Hong Kong Special Administrative Region, PR China
[4]Department of Biological Sciences, University of Cape Town, South Africa
[5] Department of Earth Sciences, The University of Hong Kong, Hong Kong, Hong Kong Special Administrative Region, PR China

Mangroves worldwide are exposed to multiple anthropogenic stressors exacerbated by unprecedented rates of pollution due to the urbanisation and industrialisation of coastlines. Mangroves in China are no exception, experiencing, among other pollutants, consistent heavy metal contamination, which are of serious concern due to their toxicity, persistence, and bioaccumulation potential. Once accumulated, heavy metals may also transfer throughout food webs and transcend ecosystems with unknown ramifications, but current research fails to consider their bioaccumulation and affects in local flora and fauna. By analysing the concentration of Al, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) in mangrove sediments, flora and fauna, we determined the spatial variation of heavy metal contamination and bioaccumulation in five mangrove stands across Hong Kong, Greater Bay Area, PR China. Our data indicate mangrove plants are tolerant of metal contamination with no spatial variation in bioaccumulation observed throughout sites. An analysis of the concentration of metals within different plant tissues of *Kandelia obovata*, illustrate the exclusion of contaminants at the root level, inhibiting translocation to aerial plant tissues. Contrastingly, we found high levels of heavy metals accumulations in some mangrove crabs. The exposure to metal pollution appeared to impact the physiology of crabs, via suppressing their oxygen consumption and reducing their thermal optimum, ultimately diminishing their resilience to climate change. Our research indicates that heavy metals can potentially influence mangroves at multiple levels of biological organisation: influencing the physiology of individuals, reducing the resilience of populations and transferring through communities, which may all influence the wider ecosystem. Such findings highlight the importance of considering the impacts of metal pollution to mangrove systems that may be missed in current assessments of mangrove health which focus on the loss and gain of forest area, considering quantity instead of quality.

Theme 2: Understanding and solving marine pollution in mangrove wetlands

Code: 7.1B. Quantifying the capacity of Australian mangrove wetlands to store below-ground carbon and maintain substrate elevation with sea-level rise

Conroy, B.,[1] Kelleway, J.,[1] Zawadzki, A.,[2] Rogers, K.[1]

[1] School of Earth, Atmospheric and Life Sciences, University of Wollongong, NSW, Australia
[2] Australian Nuclear Science and Technology Organization, Lucas Heights, NSW, Australia

A large proportion of carbon stored in mangrove ecosystem substrates is added via organic matter additions, contributing to blue carbon sequestration and adjustment to sea-level rise through vertical growth of substrates. To improve models of blue carbon sequestration and adaptation to sea-level rise, data of both the mass and volume of organic matter within substrates are required. In southeastern Australia, reliable records of surface elevation change, vertical accretion (~20 years), and sedimentation rates (~100 years) are available; however, there remains a lack of data on below-ground processes of root production and turnover. In this study, the root ingrowth technique was coupled with measurements of vertical accretion and surface elevation change, derived from surface elevation tables and marker horizons (SET-MH) in southeast Australian mangrove wetlands. This was paired with analyses of standing stock and radiometric dating (^{210}Pb) of sediment cores to characterise short- (~one year) to long-term (~100 years) below-ground productivity rates across the entire active root zone (to 1m depth). Relationships were established between root productivity, in terms of mass and volume, and tidal position, which was used as a proxy for the inundation regime. Analyses extended to 1m depth, a greater depth than previous studies; this corresponds to reporting depths for blue carbon measurements and allowed for quantification of deep root additions. Analyses indicate root additions occur below typical measurement depths for terrestrial settings of 30cm and has important implications for measuring and reporting carbon addition to substrates. Results will be used to parameterise models to accurately account for rates of substrate change via root additions, improving the capacity to project rates of carbon sequestration in mangrove ecosystems and model surface elevation adjustment with sea-level rise. These models will improve confidence in the capacity of nature-based solutions (e.g., coastal restoration and climate mitigation activities) to deliver ecosystems services in a changing climate.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 8.1B. Incorporating WETFEET project results into a new sea level rise model to estimate nutrient sinks in mangrove ecosystems

Chapman, S.,[1] Morris, J.,[2] Chambers, L.,[3] Langley, A.[4]

[1]Villanova University, United States of America
[2]University of South Carolina, United States of America
[3]University of Central Florida, United States of America
[4]Department of Biology and Center for Biodiversity and Ecosystem Stewardship, United States of America

Mangroves face both rising sea levels and nutrient loads in many parts of the world. Ecosystem entanglement has increased nutrient runoff as increased precipitation events allow ever more efficient delivery of these nutrients. Though we have a good understanding of the nutrient limitation of mangrove growth from fertilization experiments around the world, we don't yet know how excess nutrients alter mangroves' ability to keep pace with sea level rise. Further, mangroves serve as major nutrient sinks and subsidence of coastal wetlands can exacerbate estuary eutrophication. Land managers and other stakeholders at our sites are concerned about rapidly increasing estuary nitrogen loads. To address these knowledge gaps, we are examining ecosystem nitrogen dynamics at three sites in Florida by coupling nitrogen enrichment experiments with a sea level rise model (Coastal Wetland Equilibrium Model; CWEM). We aim to determine 1) the nitrogen sink capacity of ecosystems where mangroves are encroaching and, 2) the potential losses of nitrogen that can occur when mangroves subside due to rising seas. We have estimated that 1 cm of mangrove soil elevation gain demands 33 g m^{-2} of nitrogen at our sites. Our CWEM model results show that mature mangroves will rapidly lose elevation in 60 years under a 100-cm sea level rise (SLR) scenario and in 80 years at a 60 cm SLR scenario. These losses of elevation for the 50 km^2 of coastal wetlands in our study region can release over 50,000 metric tons of N, exacerbating recent trends of increased dissolved organic nitrogen in waterways. To constrain the fate of wetland nitrogen pools we are investigating storage mechanisms including mineral associated organic matter in sediments and root ingrowth. Our findings will help managers in this region assess the nitrogen storage capacity of their coastal wetlands and will help ecologists and managers parameterize mangrove nitrogen budgets and quantify this crucial, but often overlooked, ecosystem service.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 8.5B. MangRes: Mangrove restoration as a nature-based solution in biosphere reserves in Latin America and the Caribbean

Castro Hernández, J.C.,[1] and Preciado, H.[2] Sponsors: UNESCO MAB Programme; UNESCO-Flanders Fund-in-Trust for the support of UNESCO's activities in the field of Science (FUST)

[1]La Encrucijada Biosphere Reserve, México
[2] Noroeste Amotapes-Manglares Biosphere Reserve, Perú

The UNESCO Man and the Biosphere (MAB) Programme fosters a harmonious integration of people and nature in biosphere reserves, which serve as model sites for sustainable development.

In the context of the twin UN Decades for Ecosystem Restoration and Ocean Science for Sustainable Development (2021-2030), the MAB Programme and the Government of Flanders are leading a three-year project (2022-2025) to support 'Mangrove restoration as a nature-based solution in biosphere reserves in Latin America and the Caribbean' (MangRes). The MangRes project will take place between seven biosphere reserves, namely Seaflower (Colombia), Guanahacabibes (Cuba), Macizo del Cajas (Ecuador), La Encrucijada (Mexico), Noroeste Amotapes-Manglares (Peru), and Jiquilisco-Xirihualtique (El Salvador).

MangRes seeks to assess the current state of mangrove ecosystems and support community-driven restoration actions, based on scientific evidence, and Indigenous and local knowledge. MangRes activities will be advised by a scientific advisory group composed of specialists from the participating countries* and from Flanders (Belgium), ensuring the exchange of knowledge and experience, as well as North-South and South-South collaboration. In addition, the project will mentor early-career scientists in order to train the next generation of mangrove restoration experts.

By combining community practices and scientific advice, the project will lead a campaign to restore habitat for biodiversity and commercially important species, and enhance ecosystem services, most notably carbon storage and coastal protection. In parallel, the project will support regenerative livelihoods, such as sustainable aquaculture, and promote Education for Sustainable Development in partnership with schools and youth networks. Overall, the project will raise awareness about positive action for nature and share its best practices to be replicated in other biosphere reserves and beyond.

www.unesco.org/en/mab/mangres

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 13.2A. Mangrove.World video-game: A transformative medium to engage the public in sustainability

Climent, R.,[1] Rivera, C.,[2] Embury, S.,[3] Pagaran, J.A. and Ruiz, A.[1]

1Keep•It•Human, The University of Manchester, United Kingdom
[2]Oceanus Conservation, Philippines
[3]Computer Science, United Kingdom

This presentation explores how video games can become a new transformative medium to engage people in sustainability research. Our proof-of-concept video game 'Mangrove.World' provides novel and imaginative routes for younger people to regain the ownership of environmental challenges through videogaming. The project is a collaboration between the University of Manchester in the UK (Keep•It•Human | Imago Software) and Oceanus Conservation, an NGO in the Philippines focused on the restoration of Mangroves species and other maritime ecosystems. Our video game methodology combines interactive media practices with fieldwork research, including environmental audio-logs data (IoTs) in three mangrove areas in the Philippines: La Union, Makati and Bais (Negros Oriental) and interviews with community leaders embedded in game-play.
The project aims to create awareness about the importance of Mangrove Reforestation for preserving life and local livelihood. We ran several trials across University of Manchester campus collecting data from student players and staff. 94% of player respondents stated that playing and interacting in Mangrove World increased their awareness of the importance of mangrove forests for their local ecosystems. The collaboration also aims to highlight broader social and economic issues observed from an environmental sustainability perspective, to communicate sustainable research and its SDGs. Mangrove World was funded by the Faculty of Humanities Recovery Fund and Innovation Factory, both at the University of Manchester in England.

Links to videos:
Videogame website: https://www.mangrove.world/
Gameplay video: https://youtu.be/QZl9ZESBObY
Field trip in Mangrove reservoirs (Philippines): https://youtu.be/bGVoF_WeJnY
Video game demo: Although this proposal is for a talk presentation, due to the dual dimensionality of this submission, we are proposing a video-game demo for conference attendees to play Mangrove World and provide feedback through a questionnaire form. The technical needs for the video-game demo are small, as it can be run on a game-laptop with headphones (we provide) but ideally it should have a second video monitor as pictured below.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 13.2B. The Climate-Smart Mangrove Decision-Support Tool: helping mangrove practitioners climate smart mangrove conservation and restoration

Chabaneix, N.,[1] Andradi-Brown, D.,[2] Purandare, J.,[3] Lovelock,C.,[3] Snyder, R.,[4] Bartlett, R.[1]

[1]Climate Team, World Wildlife Fund, Washington, D.C., USA
[2]Ocean Conservation, World Wildlife Fund, Washington, D.C., USA
[3]School of Biological Sciences, Faculty of Science, University of Queensland
[4]Arizona State University

Mangroves are on the front lines of climate change as coastlines face increasing sea levels and extreme weather events. In recent decades, extreme climate events have become major driver of mangrove forest loss, yet current mangrove conservation efforts rarely account for current or future climate-related threats. While scientific literature on mangrove vulnerability to climate change is expanding rapidly, user-friendly guidance for conservation practitioners on how to address climate risks is limited. Here we present an introduction to the *Climate-Smart Mangrove Conservation Decision Support Tool*, developed to fill this gap, and share case studies of how the tool has altered conservation interventions to improved climate resilience. The tool provides a step-by-step process for assessing climate risk and selecting appropriate management interventions for new mangrove conservation and restoration projects/programs or the adaptive management of existing ones. The tool starts with a vulnerability assessment based on site specific characteristics and climate exposures, as well as social adaptive capacity, then aids users with identifying and prioritizing potential management actions to address these climate risks. This process draws from local knowledge, global datasets, and locally collected data as available. The tool was co-developed with and is currently in use by WWF staff in Colombia, Fiji, Madagascar, and Mexico, as part of the Mangroves for Climate and Communities project funded by the Bezos Earth Fund. We share examples of how using the tool has informed mangrove conservation and restoration work in these places. And evidence why climate-smart mangrove conservation is key to the long-term viability of mangrove conservation investments and the socio-economic benefits they provide to coastal communities. The tool has shown to provide an effective mechanism for field-based practitioners to identify priorities and aid decision-making in the face of a rapidly changing climate.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 16.6A. Application of open access data for national and sub-national scale mapping of mangrove cover

Collin, R.,[1] Viquez, Y.,[1] Kotikot, S.M.,[2] Baloukas, E.,[3] Canty, S.W.J.,[4] Cissell, J.R.,[5] Romero, T.E.,[1] Connette, G.[1]

[1]Smithsonian Tropical Research Institute
[2]Pennsylvania State University, United States of America
[3] SERC
[4] Smithsonian National Museum of Natural History, United States of America
[5] Samford University, United States of America

One of the most productive ecosystems, mangroves provide an array of ecosystem services, yet they are under threat from anthropogenic effects and climate change. Repeatable, open-source data and analyses of mangrove distributions are necessary to track changes in mangrove cover to assess national carbon stocks, document deforestation, and assess the success of management and restoration efforts. Here, we used Sentinel-2 satellite imagery and Google Earth Engine, to generate a 10 m resolution map of mangrove cover for Panama. In 2020 total mangrove cover in Panama was 1,717.6 km^2,with 92% cover found on the Pacific Coast and 8% on the Atlantic Coast. This approach recovered 11% more mangrove cover compared to a previous 30 m mapping effort. This increase could reflect the inclusion of small mangrove cays and fine mangrove fringe in the higher resolution analysis. We provide an open access workflow with which mangrove cover can be estimated in a repeatable way, consistent with other open-source maps in the region to assist in the monitoring and management of Panamanian mangroves. Locations for which carbon estimates are available in the Coastal Carbon Atlas are also illustrated.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 17.1. True Mangrove species in global marine databases: a critical appraisal

Cheung, C.Y.,[1] Helfer, V.[1]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany

In the context of climate change and the biodiversity crisis, being able to reliably document past and current species distribution is of paramount importance for deciphering the main drivers of species occurrence and range shift and forecasting those under climate or global change scenarios. For that purpose, species observation records are essential and, according to open data science and the FAIR data principles, should be shared with a broad community of researchers and other stakeholders. Various databases have been created to compile and centralize information about biodiversity in the recent years, among which the Ocean Biodiversity Information System (OBIS), dedicated to the marine realm, and the Global Biodiversity Information Facility (GBIF) are the most renowned ones. Here we evaluated how 38 selected "true mangrove" species are represented in those databases and assessed the quality of those observations, including verification of the taxonomy (based on the World Register of Marine Species) and the quality and reliability of the geolocation information. Further, we evaluated the usability of such observational data for species distribution modelling under current and future environmental conditions. While OBIS and GBIF are extremely valuable databases, they still contain erroneous information, highlighting the need for a closer communication among scientific experts and database managers or the implementation of automated validation processes (e.g. using ecosystem distribution maps) to improve the data curation and data quality assurance processes. This will become even more relevant when occurrences derived from eDNA biomonitoring will be integrated in those global marine biodiversity databases, a process currently in implementation. Lastly, while FAIR data should be common practice nowadays, too many valuable observations are still either hidden in publications or deposited in private repositories but not shared with the global community, a practice that we hope will change for the benefit of mangrove conservation and management.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 17.5. The role of mangrove typology and biogeography in structuring mangrove fish assemblages in the American continente

Castellanos-Galindo, G.A.,[1,2,3] Pérez-Botello, A.M., [4,5] Giarrizzo, T.,[6,7] Robertson, D.R.[1]

1. Smithsonian Tropical Research Institute, Box 0843-03092, Balboa, Republic of Panama 2. Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany 3. Freie Universität Berlin, Berlin, Germany
4. Posgrado en Ciencias Biológicas, Facultad de Ciencias, Universidad Nacional Autónoma de México (UNAM), Sisal, Mexico
5. Unidad Multidisciplinaria de Docencia e Investigación, Facultad de Ciencias, Universidad Nacional Autónoma de México (UNAM), Sisal, Mexico 6. Instituto de Ciências do Mar (LABOMAR), Universidade Federal do Ceará (UFC), Fortaleza, Ceará, Brasil 7. Núcleo de Ecologia Aquática e Pesca da Amazônia (NEAP), Universidade Federal do Pará (UFPA)

Almost 1/3 of world mangrove forests occur in the American continent. These ecosystems there are distributed in diverse settings ranging from micro- to macro-tidal regimes, near-freshwater to hypersaline, hyper-humid to arid climates and in diverse adjacent seascapes (mudflats, seagrasses, coral-rocky reefs). Recent studies highlight that differences in mangrove setting or typology determine to a great extent mangrove characteristics (e.g. carbon storage and accumulation rates). These differences can influence the biological communities inhabiting mangroves. Here, we present the largest compilation of mangrove fish studies performed in the American continent (498 sampling localities, 29 countries, from 141 studies written in three languages) and analyze the relative importance of (1) biogeographical subdivisions and (2) the diversity in environmental settings found in mangroves of the region in explaining community composition. Mangrove-associated fishes in the Americas comprise 1346 species grouped in 153 families. The Western Atlantic (WA) that includes the Greater Caribbean and Brazilian provinces, is by far the most studied and richest (No. species) area (85% of sampled localities and 896 spp.) with the Eastern Pacific (EP) representing the remaining 15% of all localities (467 spp.). The richest sub-provinces are the Panamic in the EP (354 spp.) and the Central American and offshore islands of the WA (318 species). The poorest sub-provinces are the Abrohlos Bank (65 spp.) in the WA and the Ocean Island (95 spp.) in the EP. Most sampled localities are in estuarine and open coast mangrove types (30% in each type) with lagoonal (26%) and deltaic systems (14%) the less studied types. Multivariate regression trees clearly reflect the strong influence of biogeographical subdivisions in the composition of mangrove fish faunas. But at the sub-province level mangrove typology and tidal regime played a role influencing species composition indicating the importance that local settings can have in shaping communities at this level.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 18.2. Everything you always wanted to know about mangroves* (*but were afraid to ask)

Dahdouh-Guebas, F.,[1,2,3,4,*,**] Diallo, K.,[1,**], Abd Rahim, N. H., Abessa, D., Acosta-Velázquez, J., Adame, M. F., Adams, J., Adyel, T., Agyekum, M. K., Alagappan, R.A., Alnuwairah, M., Andrade-Medina, R., Arnaud, M., Arumugam, M. , Asante, F., Avila-Flores, G., Aziz, I., Balke, T., Ball, L., Bandeira, S., Banzato, B.M., Barman, S. K., Benefo, S. K., Bhargava, R., Blanchard, E., Blanco-Libreros, J. F., Bordbar, F., Bowman, J., Bukoski, J. J., Caillaud, A., Cannicci, S., Cantera-Kintz, J.R., Canty, S.W.J., Carr, C. C., Castellanos-Galindo, G.A., Cavanaugh, K., ChakrabartI, S., Chapman, S. K., Chee, S. Y., Chen, L., Cifuentes-Jara, M., Collin, R., Connolly, R. M., Cormier, N., Cormier-Salem, M.-C., Corrales, L., Cunha-Lignon, M., Dabalà, A., Das, S., Das, B., De Oliveira Gomes, L.E., Debroy, P., Diele, K., Duncan, C., Dwyer, P.G., Elizabeth, Q., Enright, J., Fazlioglu, F., Feller, I. C., Flynn, L.L, Foong, S. Y., Fratini, S., Friess, D. A., Gbodja, G. T., Gevaña, D., Goh, H.C., Golléty, C., Gómez-Ruiz, P. A., Gunarathne, U. K., Ha, N.-T., Hendy, I. W., Herndon, K. E., Hickey, S. M., Hoque, K.A., Hosen, M. S., Hossain, M. M., Hudatwi, M., Hugé, J., Huxham, M., Ivanauskas, N.M., Jayasingam, T., Jennerjahn, T. C., Kennedy, J. P., Kiprono, A., Kipyegon, J. K., Koedam, N. E., Kominoski, J. S., Kulkarni, B., Lacerda, L.D., Lai, D.Y.F., Lee, S. Y., Leung, F., Lima, N.G.B.d., Lin, H.-J., Liu, J., Longépée, E., López portillo, J., Macamo, C.d.C.F., Mafaziya Nijamdeen, T.W.G.F., Mancera, J.E., Manurung, J., Masilamani, M. S., Meeder, J.F., Metri, R., Mfonden Poumie, M. M., Michie, L.A., Mishra, A. K., Mizinga, D., Mollick, A. S., Mong, K. T., Monnier, Olivier, Moraes De Oliveira Abuchahla, G., Mori, G. M., Mukherjee, N., Munga, C. N., Naomi, S., Ngeve, M. N., Nguyen, T. H., Nguyen, T.-H., Ochoa-Gómez, J., Ofori, S. A., Ogurcak, D., Okumu, J. O., Olefs, L., Ouyang, X., Patrick, M. M., Pinheiro, M. A.A., Polania, J., Porri, F., Poti, M., Pranchai, A., Quddus, M. A. Q., Quevedo, J.M.D., Rahman, Md. S., Rajendiren, N., Ramírez-Ruiz, K. C., Rasquinha, D., Rebolledo Monsalve, E., Ren, H., Riascos, J. M., Rogers, K., Rowntree, J. K., Rubiano-Labrador, C., S, Sreelekshmi, Sabrina, S. A., Saintilan, N., Salmo, S. III, Sanz Yus, D., Sari, S. P., Satyanarayana, B., Sharma, S., Sillanpää, M., Singh, A. R., Sloey, T., Sok, S., Stiepani, J., Syrbe, R.-U., Teimoory, H., Thet, A. K., Todd, S., Twomey, A.J., Uche, I.C., Van Der Stocken, T., Van Puyvelde, K., Wee, A.K.S., Winbaw, A., Wolswijk, G. , Wong, P. P., Worthington, T.A., Wouters, B., Ximenes, A., Yando, E.S., Yong, J. W. H., Zamora Tovar, C.

[1] Systems Ecology and Resource Management, Department of Organism Biology, Faculté des Sciences, Université Libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50, CPi 264/1, B-1050 Brussels, Belgium

[2] Ecology and Biodiversity, Department of Biology, Faculty of Sciences and Bio-Engineering Sciences, Vrije Universiteit Brussel (VUB), Pleinlaan 2, B-1050 Brussels, Belgium

[3] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), 1196 Gland, Switzerland

[4] Interfaculty Institute of Social-Ecological Transitions—IITSE, Université Libre de Bruxelles—ULB, B-1050 Brussels, Belgium

*Presenting author & correspondence: Farid.Dahdouh-Guebas@ulb.be

** Co-first authors

Note: Full list of authors will be updated in the final version.

Code: 18.2. Everything you always wanted to know about mangroves*
(*but were afraid to ask)

Dahdouh-Guebas, F.,[1,2,3,4] and ± 200 collaborators (see names, e-mails and affiliations in Excel file)

Mangrove scientists can come up with 101 different research questions in their academic offices, but these questions will not necessarily be those that forest managers or policy-makers ask. The present study is the first ever to gather local mangrove scientists, forest managers and policy-makers world-wide to identify the future scientific curiosity-driven and managerial need-driven questions to which science, management, and/or governance needs an answer. In order to steer science into research avenues that will have a needed application in the field *sensu lato*, our consortium set up a short questionnaire about the future priority questions for science and management to people with experience in science, management or policy-making related to mangrove ecosystems or coastal zones including mangroves (https://serm.ulb.be/mangrove-priority-questions/). We also asked where and on which time scale these need to be tackled according to the respondents, along with a few respondent-background questions and an informed consent. To reach as many relevant persons as possible we translated the questionnaire in 18 languages, corresponding to the official and/or *de facto* languages spoken in all countries with mangroves, hence reaching out to >120 countries and territories in the Americas, Africa, Middle-East, Asia and Oceania. We will present everything you always wanted to know about mangroves and now received the chance to ask as responses of >200 respondents analysed from different perspectives including thematic, geographic, diachronic, personal experience and profession. This is to be complemented with a similar survey from the viewpoint of local inhabitants and visitors to mangroves.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 2.7. Joining forces for the Red List of Mangrove Ecosystems

Di Nitto, D.,[1,2,3] Koedam, N.,[3,5] Van der Stocken, T.,[1] Hugé, J.,[1,3,4] Van Puyvelde, K.,[1,2] Kochzius, M.,[2] Vanschoenwinkel, B.,[1] Worthington, T., Ximénes, A., Satyanarayana, B., & Dahdouh-Guebas, F.[1,3,5]

[1] Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel - VUB, Brussels, Belgium.
[2] Marine Biology, Biology Department, Vrije Universiteit Brussel - VUB, Brussels, Belgium.
[3] Systems Ecology and Resource Management, Université libre de Bruxelles, ULB-VUB, Brussels, Belgium.
[4] Open University of the Netherlands, Heerlen, the Netherlands.
[5] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN)

Mangroves have seen a fearsome global decline over the past 35 years. Mangrove restoration efforts, when not backed up by science, often lead to very low success rates or failures, with major financial losses and erosion of public support. The Vrije Universiteit Brussels and Université Libre de Bruxelles (Belgium) have therefore set-up a consortium of Belgian and international partners to support the IUCN Red List of Ecosystems (RLE) for mangroves. Tools to assess whether a mangrove ecosystem is facing imminent risk of collapse, or whether it is vulnerable, endangered, or critically endangered, are crucial for understanding key mangrove ecological traits and drivers that are needed for truly successful mangrove conservation, restoration, and management. The IUCN has developed a new global evidence-based RLE tool in consultation with IUCN Species Survival Commission Mangrove Specialist Group (IUCN SSC MSG), IUCN Commission on Ecosystem Management and the Global Mangrove Alliance amongst others. Our consortium will mainly provide scientific coordination of possible RLE assessments (level 4, 5 and 6) in (yet not limited to) the WIO Region and Latin America at a local, national or regional scale. Scientific goals are to assess the risk of mangrove ecosystem collapse and biodiversity loss by facilitating the team framework for the RLE assessments and reviewing the ecosystem descriptions and the final risk assessment. By supporting the coordination of the IUCN RLE project for mangroves, more countries will be provided with a cost and time-effective tool for environmental monitoring and international reporting that is comparable over time. In addition to these specific goals, this consortium will also reinforce and expand international mangrove collaboration opportunities, both for research, education, capacity building and awareness raising. This 3-year International Coordination Action (ICA) started in January 2023 and welcomes all partners interested in joining forces for the Red List of Mangrove Ecosystems.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 3.4. Point of (no) return? Mangrove restoration practices set different trajectories for the (re)establishment of benthic diversity and ecosystem functionality

Diele, K.,[1] Djamaluddin, R.,[2] Daffonchio, D.,[3] Evans, D.,[3] Huxham, M.,[1] Marasco, R., O'Connell, D.P.,[4] Salzmann, U.,[5] Singleton, I.,[1] Tjoa, A.,[6] Trianto, A.,[7,] Fusi, M[8]

[1]Edinburgh Napier University, United Kingdom [2]UNSRAT, Indonesia [3]Newcastle University, United Kingdom [4]University College Dublin, Ireland [5]Northumbria University Newcastle, United Kingdom [6]Universitas Tadulako, Indonesia [7]Universitas Diponegoro: Beranda [8]Joint Nature Conservation Committee

Monitoring mangrove restoration outcomes is important to learn from failure/ success. It typically focusses on assessing the re-establishment of vegetation, whilst macrofaunal and microbial communities (MMC) are rarely considered, despite their roles in mangrove ecosystem functioning. We took an integrated approach evaluating restoration/rehabilitation actions aimed at bringing back diverse and functional mangroves at two sites in Sulawesi, Indonesia, 14 and 16 years after the implementation of different restoration practices. We assessed sediment biogeochemistry, vegetation, MMC composition, species interactions, and presence of indicators for selected ecosystem functions, comparing monoculture reforestation- (MoRe), mixed species regeneration- (MiRe) and adjacent stands unaffected by deforestation/restoration (REF). At both sites, taxonomic and functional diversity patterns were correlated with tree composition and sediment biogeochemical characteristics. MMC diversity was highest in REF and lowest in MoRe. The pattern of plant-animal interactions differed less between REF and MiRe than between REF and MoRe. Nitrogen fixation and ammonium oxidation, as indicators for ecosystem functionality (i.e. nitrogen nutrient cycling) were higher in REF compared to MiRe, whilst interestingly, in MoRe, levels were similar to REF despite lowest tree and MMC diversity. This is likely linked to similar or higher levels of bioturbation (i.e. number macrofaunal burrows,) known to increase the sediment redox level. At MiRe, the number of crab burrows was consistently lowest. Overall, our results suggest that differences in MMC composition and diversity between MoRe and MiRe were driven by differences in restoration practices applied, which seem to have set-on different 'recovery' trajectories, which may – or not – lead to the re-establishment of a similar MMC composition relative to REF over time. Where the aim was to restore diverse and multifunctional mangroves, factoring-in MMC is key when monitoring restoration success, since using conventional methods of assessing vegetation only does not reveal the ecological status of the ecosystem as a whole.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 11.5A. An updated global perspective on mangrove range limits: Using multiresolution mapping to address discrepancies in the spatial and bioclimatic limits of mangroves on the edge

Doughty, C., and Fatoyinbo, L.[1]

[1]Biospheric Sciences Laboratory
NASA Goddard Space Flight Center
Greenbelt, MD 20771, U.S.A.

Mangrove ecosystems across the world are responding to the impacts of climate change. At the geographic range limits of mangroves, where tropical meets temperate, mangroves are highly sensitive to changes in macroclimate drivers like temperature and precipitation, and a warming climate has led to recent poleward expansion of mangroves in some regions across the world. Yet, our global understanding of mangrove extents and changes in range limit regions are derived from a piecemeal combination of moderate-resolution, remotely-sensed maps and field observations, which has led to great uncertainty in the true latitudinal limits, coverage, and macroclimatic limitations of mangroves in regions across the world. To reduce the mapping uncertainty at range limits, we applied a globally-consistent approach to map mangrove range limits using multi-resolution satellite imagery (1.8 – 30m) that has demonstrated accuracy in detecting mangrove areas currently missing from global distribution maps. We applied our mapping approach in eight mangrove range limits across the world in order to 1) update 2020 mangrove baselines, and 2) reassess the limiting drivers at each range limit, as CO2 concentrations, temperature, sea level, cyclones, and climate oscillations are expected to have spatially variable, wide-ranging impacts to mangroves as climate change continues. In the range limit of eastern FL, USA, we detected almost 400 ha of mangroves over 1 km north of the previously mapped limit defined by the Global Mangrove Watch. Reducing such discrepancies in less well-mapped range limits can help uncover the true global extents and climatic thresholds of mangroves from which we can better predict future climate impacts to these ecologically and economically important ecosystems.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 13.1B. Historical Ecology of Brazilian mangroves: past, present and future

dos Reis-Neto, A.S.,[1] Schaeffer-Novelli, Y. [1,2]

[1]BiomaBrasil Institute, São Paulo, SP, Brazil
[2]Oceanographic Institute, University of São Paulo, SP, Brazil

Historical Ecology allows to explore evidence from long-term connection between coastal dwellers and mangroves. Brazilian mangroves appear as a reliable source for human livelihood that formed a typical mangrove culture, earlier evidenced from shell middens or *sambaquis*, dated about five thousand years ago. This situation has dramatically change after Portuguese explorers adopted Brazil, about five hundred years ago. Historical Ecology research promotes an interdisciplinary framework to validate the use of historical sources and ecological data. With an emphasis upon mangrove social ecological adaptations over the past half century, we present an overview of relevant historical facts and summarize how this approach generates a better understanding of human-mangrove interactions and its legacies as conservation lessons.
Brazilian mangroves' first description is authored by the Jesuit Priest Anchieta written in 1560. In the 17th century mangroves started to be explored not only by indigenous people, poor people, and slaves in an extractive economy, but also used in government-structured activities generating social conflicts. In the 18th century, the Portuguese Crown prohibited the cutting of red mangroves trees once the crown exported it. In the 19th century, the crown signed the Law appointing the coastal territory as public propriety. This law is still in force today. In the 20th century voices in defense of sustainable use of mangroves became more frequent, as well as the scientific research, bringing into light a myriad of knowledge about this complex ecosystem. The 21st century are markable for extend local problems to global as Climate Change with Sea Level changes. We won´t find a simple solution to our conflict between the mangrove-society relationship. But we can better decide our path to the future if we make a wise-use of the lessons learned to disrupt the historical failure of economic growth and choose an environmentally sustainable-based model of development.

Theme 6: Changing human relationships with mangrove wetlands

Code: 1.1. What is so special about the mangrove genus *Pelliciera* (Tetrameristaceae) in equatorial America?

Duke, N.C.[1]

[1]James Cook University, TropWATER Centre, Townsville Queensland 4811, Australia.
E: norman.duke@jcu.edu.au

The Central American mangrove genus *Pelliciera* is incredible and uniquely distinctive for multiple reasons including it's large attractive flowers, unusual foliage, large cryptoviviparous propagules, and its association with hummingbirds. But, its odd distributional patterns are arguably even more profound as they are possibly indicative of the recent evolution and diversification of the genus during the formation of the Central American Isthmus.
While the genus occurs exclusively within the Atlantic-East Pacific (AEP) region, its extant distribution is further restricted within Central and northern South America. My recent review of distributional records of the genus showed *Pelliciera* comprised at least two distinct, but closely-related species, described as *P. benthamii* and the redefined *P. rhizophorae*. These species had previously been combined under one combined generic description. The closeness of the species explains their prior taxonomic uncertainty. But while their dissimilarity was shown by few morphological and genetic differences, this was significantly manifest in the small number of indistinct and variable intermediate individuals.
In this presentation, I briefly review such evidence and provide modest speculation on possible reasons behind its odd and restricted distribution in the AEP region.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.7B. Carbon sequestration and storage in two mangrove forests in the Colombian pacific coast and its contribution to climate change

Escobar, L.M.,[1] Palacios Peñaranda, M.L.,[1] Perdomo Trujillo, L.V.,[2] Moncada, A.L.,[1] Gordillo, M., Peña Salamanca, E.J., Mancera Pineda, J.E. [2]

[1] Universidad autónoma de occidente, Colombia
[2] Universidad Nacional de Colombia

During the last decade, the importance of coastal marine ecosystems as carbon sinks has been recognized, as they store half of the carbon retained in the ocean floor. Despite this, studies on carbon stocks and their rate of accumulation are still scarce in the neotropics. Given the desirability of ecosystem-based climate change mitigation and adaptation, it is imperative to produce the necessary information to support this initiative in mangrove ecosystems. In the present work, was possible to quantify the carbon stocks stored in the mangrove forests of the Colombian Pacific. The areas selected for the study were the mangroves of San Pedro (SP) and Punta Soldado (PS) in the municipality of Buenaventura. In each sampling site 6 plots were established, 3 internal and 3 along the coast. In each plot, information was collected to calculate the carbon stocks in the ecosystem. Total ecosystem carbon stocks based on mangrove structure averaged 958.35 Mg C/ha in PS and 880.86 Mg C/ha in SP. In this case, stored below ground carbon represents the largest contribution to carbon stocks in these forests with 880.46 Mg C/ha (91.9%) in PS and 752.84 mg C/ha (85.47%) in SP. It is followed by aboveground biomass with 52.03 mg C/ha (5.53%) in PS and 88.77 mg C/ha (10.01%) in SP. Aboveground biomass and below ground carbon reserves represented the main carbon stocks in the study area, reaching over 80% of the total carbon stocks of the mangrove forest. These results are similar with values observed at other tropical mangrove areas, where the greatest carbon stocks were found in below ground biomass.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 7.2B. Carbon stocks in mangrove ecosystems with different sedimentary setting in the Colombian Caribbean

Estrada Galindo, I.J.,[1] Perdomo Trujillo, L. V.,[1] Medina Calderón J. H.,[1] Mancera Pineda J,E.,[1] Quintero Alvarado, A.P.,[1] Palacios Peñaranda M.L, Peña Salamanca, E.J., Cantera Kintz, J.R.

[1] Universidad Nacional de Colombia

Different values of carbon storage in mangroves have been reported worldwide, which states great variability in this service. This study aimed to determine and compare the organic carbon (OC) stock in mangrove ecosystems in the Colombian Caribbean with different sedimentary setting, in the Ciénaga Grande de Santa Marta (CGSM), a terrigenous, river dominated environment and San Andrés Island (SAI), a carbonate open water environment. The high input of organic matter could mean that OC storage would be higher in CGSM. At each study site two forests were fixed, and plots were established to determine the OC stored in the aboveground and belowground biomass, downed wood, and soil, as well as to determine soil physicochemical variables of interest. The total OC stored in CGSM was 636 ± 376 Mg C ha-1 and in SAI was 591 ± 33 Mg C ha-1. The largest carbon stock in the two study sites was soil, next to aboveground and belowground biomass; in CGSM they corresponded to 85,6%, 9% and 5%, respectively and in SAI to 79%, 16% and 4,7% of the total OC, in both sites downed wood represented less than 1% of the total stock. All forests had similar interstitial water temperature (29 °C) and pH (6.9) conditions, and the greatest variation in environmental conditions was reflected in salinity (8.4 UPS and 38.2 UPS) and soil depth (0.91 m and 3.65 m). The forest with the lowest salinity (CGSM-SEV) and highest soil depth had the highest carbon content. The results highlight the importance of considering the influence of coastal morphology on soil conditions and their relationship with OC storage in mangrove forests.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 8.3A. Where can new mangroves establish within a large tropical river delta?: Quantifying hydrodynamic and geomorphological thresholds for new mangrove establishment

Espinoza-Celi, M.E.,[1] Ramos-Veliz, J.A.,[2] Rosado-Moncayo, A.M.,[2] Pelckmans, I.,[1] Belliard, J.P.,[1] Gourgue, O.,[1,3] Dominguez-Granda, L.E.,[2] Temmerman, S.[1]

[1] University of Antwerp, Ecosphere research group, Antwerp, Belgium
[2] ESPOL Polytechnic University, Escuela Superior Politécnica del Litoral (Centro del Agua y Desarrollo Sostenible), Guayaquil, Ecuador
[3] Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Mangrove restoration programs are highly demanded among others for nature-based solutions for climate change. However, a main constraint for their success is little quantitative knowledge on environmental thresholds for new mangrove establishment. Our study addresses where new mangroves can establish, in relation to critical thresholds of intertidal surface elevations, tidal inundation and mudflat geomorphology. We use as case study the largest estuarine system in the western South Pacific coast (ca. 12 000 km²), the Gulf of Guayaquil and Guayas delta (Ecuador), with a large mangrove extension (ca. 1400 km²). Here, we studied five large intertidal mudflats (0.5–5 km²) where mangroves are naturally expanding seawards. We apply a remote sensing analysis using the so called waterline method to derive intertidal bathymetry (Sentinel-2 imagery) and identify mangrove patches (PlanetScope imagery), combined with field work to apply drone photogrammetry. Our results suggest that new mangroves (NDVI between 0.3-0.7) establish above a critical elevation threshold only a few centimeters above the local mean sea level (MSL) [0.04–1.03 m]. As the tidal range increases, young mangroves establish higher above the MSL. Yet, sites with higher tidal ranges located along the sheltered fringes of small mangrove channels might allow mangrove establishment a few centimeters below the MSL [> -0.3 m], as compared to more exposed sites along wider channels. Mangroves only established below a maximum tidal inundation duration threshold [12 hours/day]. Mudflats with convex slope profiles facilitate new mangrove establishment compared to bare concave mudflat profiles. Our study provides new insights on how new mangrove establishment is favored at the estuarine ecosystem-scale under specific hydrodynamic and geomorphological thresholds. Understanding the coupled interaction between these properties as compared to their isolated effect on mangrove establishment is fundamental. These results are key to support mangrove restoration efforts improving their chances of success at large spatial scales.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.5A. Unveiling a Hidden World: The Assemblage and Diversity of Epiphytic Lichens in Different Mangrove Habitats of Oriental Mindoro, Philippines

Fallaria A., J.,*, Dacones L. S., & Salmo S. G. III[1]

[1]*Institute of Biology, College of Science, University of the Philippines Diliman, 1101 Quezon City, Philippines*

Lichens are the mutualistic products between fungi and algae or cyanobacteria that are often seen as epiphytes on tree barks. The assemblage structure and diversity of these composite organisms are occasionally used as bioindicators of stand continuity and disturbances in landlocked forests. However, lichens are oftentimes overlooked and underappreciated in mangrove ecology. This study proposed that lichen assemblage structure and diversity vary along a mangrove forest zonation (e.g. landward, midward and seaward) and across habitat types (e.g. old-growth natural stands, recolonized fishponds and plantations). In two fieldworks conducted in Oriental Mindoro, western Philippines, epiphytic lichens were tallied and identified from the triplicate plots in ten different sites (2 natural stands; 6 recolonized fishponds; 2 plantations) on different seasons, from October 4 to 7, 2022 and from January 17 to 22, 2023. Thirty five lichen species were identified from 10 mangrove species found across all sites, with some exhibiting host specificity to *Sonneratia alba*, *Rhizophora apiculata*, *R. stylosa*, *Ceriops decandra*, *Avicennia marina* and *Lumnitzera littorea*. For instance, *Pyrenula* lichens are often observed associated with *S. alba*, whereas *Cresponea* is common among *R. stylosa* stands. Analysis of variance (ANOVA) revealed significant differences in lichen diversity across the sites. One of the two plantations revealed low Simpson's index lichen diversity, which coincided with the low diversity of mangroves relative to other more diverse recolonized and natural stands. Non-parametric multidimensional scaling (NMDS) showed differences in lichen assemblages across sites, suggesting heterogeneity, with similarities between nearby sites and similar zonations. These results provide insights on the long-term implications of monospecific planting for mangrove restoration to biodiversity. Furthermore, this study also illustrates how natural stands can serve as reference models to understand restoration progress in other sites, to inform conservation decisions, and to determine effectiveness or ineffectiveness of restoration design.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 11.4A. Using Gedi-based forest structural metrics, sentinel-1/2 data, and field inventory data to map mangrove aboveground biomass in Suriname

Feyen, J.,[1,2] Wortel, V.,[3] Crabbe, S.,[2] Doelatip, S.,[2] Hanoeman, N.,[3] VanCoillie, F.[1]

[1]*Department of Environment, Ghent University, Ghent, Belgium, jasper.feyen@ugent.be*
[2]*Foundation for Forest Management and Production Control, Paramaribo, Suriname*
[3]*Department of Forest Management, Centre for Agricultural Research in Suriname (CELOS), Paramaribo, Suriname*

Obtaining state-of-the-art data on the state of the mangroves is important to monitor possible responses to environmental changes such as land use change and mangrove ecosystem degradation caused by climate change. For Suriname, there is an increasing awareness of the importance of the mangrove ecosystem to adapt and mitigate climate change effects. As a part of the National Forest Monitoring System (NFMS), a mangrove biodiversity monitoring system was set up in 2019. In 2022 a second inventory took place, where existing plots were remeasured and new plots were established. In total 18 Sampling Units (SU) will be measured along the 350 km long coastal zone by the end of the project in 2023. Forest attributes such as aboveground biomass (AGB), carbon stocks, forest structure, and floral and faunal diversity were measured in these units. To retrieve country-wide estimations of mangrove AGB and carbon, the field-based measurements were scaled to a regional level by using Sentinel-1 and Sentinel-2 data fused with the vertical vegetation structure data derived from the Global Ecosystem Dynamics Investigation (GEDI). From the discrete GEDI shot data, canopy height and relative height (rh) metrics were first extrapolated regionally by optimizing three machine learning regressors; a Random Forest regressor, a Support Vector Regressor, and a XGBoost regressor. As input features the Sentinel-1 and Sentinel-2 bands were supplemented with derived vegetation indices and textural metrics calculated with multiple window sizes. All models were optimized and the most useful features were selected. Best model performances were retrieved with the XGBoost regressor and a window size of 7x7 (R^2 = 0.833 for the canopy height map), while the lowest relative height (rh = 0) reached an R^2 of 0.322. Finally, national mangrove AGB maps are retrieved by modeling the field-measured AGB data using the GEDI-derived structural maps and the Sentinel-1/2 image stacks.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 12.7B. Characterization of freshwater coastal wetlands in areas adjacent to the mangrove ecosystem in Tonosí, Pacific coast, Republic of Panama

Fraiz, A.,[1] Gastezzi, P.,[2] González, M.,[1] Della Sera, B.,[3] Espinosa, A.,[3] Araúz, E.,[3] Clemente, A.,[1] Braghtley, B.,[4] Domínguez, K.[5]

[1]Wetlands International
[2]Universidad Estatal a Distancia Costa Rica
[3]Universidad de Panamá
[4]Universidad Marítima Internacional de Panamá
[5]Ministerio del Ambiente Panamá

Among the coastal wetlands that border the mangroves we can find rivers, streams, lakes, wooded swamps and even peat bogs. On the Pacific coast of the townships of Cañas and Búcaro in the district of Tonosí, province of Los Santos, there are mangroves whose function is to protect the coastline and maintain freshwater wetlands. According to studies in 2019, the existence of peat bogs was determined in areas adjacent to the mangrove ecosystem. Peat bogs have gained worldwide relevance due to the importance of the ecosystem services they provide to society, and play key roles in water, soil and climate regulation, among others. The objective of this study was to analyze the composition of organic matter in the soil and the floristic composition for the characterization of coastal wetlands in areas adjacent to the mangrove swamp. Sampling was carried out during the dry season of 2023. A total of seven plots were delimited for sampling. The vegetation was identified in situ, and inventories were carried out through transects that covered four hectares in total. In total, 88 species represented in 44 families and 78 genera were identified. The families with the highest number of species were Cyperaceae (9 spp.), Poaceae (8 spp.) and Fabaceae (6 spp.). Soil samples were taken by means of a bore at different depths: 0-15; 15-30; 30-50 and 50-100 cm. A total of 298 samples were obtained and taken to the laboratory. The preliminary results showed that the soil contains a high content of clay, and organic matter in a state of decomposition. This study made it possible to characterize the freshwater coastal wetlands in areas adjacent to the mangrove swamp to document relevant information, allowing to reinforce mangrove and freshwater wetland conservation policies, in addition to identifying possible peat bog sites on the Pacific coast of Panama.

Theme 6: Changing human relationships with mangrove wetlands

Code: 18.1. Mangroves and the Mangrove Finch in the Galapagos

Feller, I.,[1] Cunninghame, F.,[2] Moity, N.[2]

[1]Smithsonian Institution, United States of America
[2]Charles Darwin Foundation, Ecuador

In the Galapagos, mangroves provide the foundation species for the endemic, critically endangered Mangrove Finch (MF), *Camarhynchus heliobates*, an obligate mangrove resident. The total MF population consists of c. 100 individuals in two mangrove stands along the arid coast of Isla Isabela at Playa Tortuga Negra and Caleta Black where they nest in tall *Avicennia germinans* and *Laguncularia racemosa* trees. These two landlocked stands are subterranean estuaries that fill with seawater at high tide through permeable volcanic substrate. Upwelling of nutrient-rich water from the Equatorial UnderCurrent (EUC) in the adjacent coastal lagoon supports extremely high marine productivity. However, no studies have investigated the impact of upwelling on intertidal mangrove ecosystems along this or any other volcanic coastline. Our objectives were to quantify differences between tall mangroves (+MF) and low stature mangroves (-MF) and to understand the environmental drivers of those differences. We measured plant traits, forest structure, carbon stocks and environmental factors in plots and transects along Isabela's west coast. Aboveground C stocks were greater in +MF plots; values were similar to high rainfall/riverine settings, and 4x greater than arid settings. We measured salinity and nutrients in groundwater to trace the source and flow of water. In +MF plots, ~50% by volume of groundwater was from freshwater of meteoric sources. Nutrient data indicated that tidal seawater was the primary source of nutrients. We hypothesize that upwelling and intrusion of nutrient-rich seawater from the coastal lagoon and meteoric freshwater along hydraulic gradients from the highlands combine in subterranean estuaries on Isabela where they provide low salinity/high nutrient groundwater that promotes growth of tall, vigorous mangroves and provides the optimal habitat in which the MF persists. These results contribute to the goals of the Mangrove Finch Project to reduce extinction risk to the MF and conserve its habitat.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 2.6. Costs of restoring global mangrove forests

Goto, G.M.,[1] Goñi, C.S.,[1] Teav, S.,[2] Friess, D.A.,[3] Worthington, T.A.,[4] Howard, J.,[5] Cifuentes-Jara, M.,[1] Braun, R.,[1] Klinger, D.H.,[1] Busch, J.[6]

[1] Conservation International, Center for Oceans, Arlington, VA, United States
[2] Conservation International, Conservation Finance Division, Arlington, VA, United States
[3] National University of Singapore, Department of Geography, Singapore
[4] University of Cambridge, Department of Zoology, Cambridge, United Kingdom
[5] Conservation International, Center for Natural Climate Solutions, Arlington, VA, United Sates
[6] Conservation International, Moore Center for Science, Arlington, VA, United States

Intact mangrove forests provide ecosystem services, enhance resilience to sea level rise and severe storm surge, and are increasingly being recognized as natural climate solutions. While area-based restoration targets have been lauded to improve damaged and degraded mangroves, the cost to achieve these ambitious targets are uncertain. Here, we model the costs of restoring mangroves across a variety of conditions and geographies based on 266 observed implementation costs from 62 global restoration projects. We combine costs with spatial variation in carbon accumulation to generate marginal abatement cost curves. We find an average global restoration cost of USD 40,092 (n = 266, SD = 85,077). However, cost varies with the initial condition of the restoration site (e.g., aquaculture ponds, deforested only, hydrologic alteration required, or highly eroded) and associated cost-driving activities. Highly eroded sites generally had the highest per hectare costs at USD 95,656 (n = 34, SD = 131,018). By region, Asia had the lowest overall per ha restoration costs at USD 6,804 (n = 91, SD = 21,162), while the United States had the highest costs at USD 102,608 (n = 85, SD = 126,338). GDP had a significant influence on project costs (b = 0.0000471, t = 10.9). Globally, we find that a carbon price of USD 20 tCO_2^{-1} would exceed implementation costs of restoration for 0.55 Pg CO_2 of carbon sequestration. At this carbon price, the restoration of aquaculture ponds represents the initial site condition scenario with the greatest carbon sequestration potential. By country, Indonesia has the largest mangrove carbon abatement potential followed by Myanmar, Mexico, and Brazil. A large proportion of mangrove restoration potential is in Asia, where the per tCO_2 costs are lower than those found in higher GDP countries. Our findings suggest that achieving global restoration targets could be cheaper than previously anticipated.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 12.1A. The Mangrove Restoration Tracker Tool: meeting local practitioner needs and tracking progress of global targets

Gatt, Y.M.,[1] Walton, R.W.,[2] Andradi-Brown, D.A.,[3] Hilarides, L.,[4] Spalding, M.D.,[2,5] Veverka, L.,[3] Wodehouse, D.C.J.,[6] Worthington, T.A.,[2] + 57 co-authors

[1] Centre for Nature-based Climate Solutions, National University of Singapore, Science Drive 4, 117558 Singapore.

[2] Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge CB2 3QZ, UK.

[3] Ocean Conservation, World Wildlife Fund, 1250 24th St NW, Washington, D.C. 20037 USA. [4] Wetlands International, Ede, The Netherlands.

[5] The Nature Conservancy, Strada delle Tolfe 14, Siena, 53100, Italy.

[6] Mangrove Action Project, 1455 NW Leary Way, Suite 400, Seattle, WA 98107 USA

Understanding and tracking outcomes from mangrove restoration projects is essential to support future restoration works and to capture regional and global trends. However, conservation practitioners often struggle to know what information to record and where to store this data – leading to disparate data for evaluating mangrove restoration success. To address this need, the Global Mangrove Alliance, in collaboration with more than 100 conservation practitioners and scientists from over 25 countries has developed The Mangrove Restoration Tracker Tool (MRTT). Field trials and workshops in Mexico, Fiji and east Africa bought field scientists together with the database design team to ensure coverage and utility. The MRTT supports conservationists: (i) with planning and monitoring critical restoration components, (ii) in sharing results with key decision-makers to support project adaptive management, and (iii) in gathering standardized data to facilitate analysis for cross-project learning to improve restoration success. The MRTT uses a flexible structure designed to capture field and desk-based data on mangrove restoration projects in a standardised format. The MRTT records information through the lifetime of a mangrove restoration project across three overarching stages: (i) a pre-restoration site baseline, (ii) the restoration interventions and project costs, and (iii) post-restoration monitoring (incorporating management effectiveness, socio-economic, and ecological aspects). The data entry portal and global restoration project database is hosted on Global Mangrove Watch, a geospatial data platform which gives universal access to near real-time information on what and where changes are happening to mangroves across the world, with the MRTT launched on the platform in early 2023. The tool will aid the mangrove conservation community in quantifying how specific conservation actions lead to outcomes for biodiversity, mangrove resilience, management effectiveness, communities, and governance. In turn, this will help improve mangrove conservation implementation and build a community to support more effective mangrove restoration projects.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 16.1B. Remote Sensing of Belowground Carbon in Mangrove Forests- Case Study of Pohnpei, Federated States of Micronesia

Gutenberg, L.,[1] MacKenzie, R.,[1] Rovai, A.,[2] Johnson, N.[1]

[1]US Forest Service, United States of America
[2]Louisiana State University, United States of America

Mangroves provide many benefits to the people who live near them and they also provide benefits to the world, including carbon uptake and storage from the atmosphere into the soil. Quantifying this carbon is important for understanding where climate change mitigation efforts would be most useful, for participating in carbon markets, and focusing reforestation and protection in certain areas. This study uses satellite remote sensing, which has the advantage of wide spatial coverage and frequent re-visiting, to study and monitor belowground carbon storage though the accumulation of sediment in mangrove forests in Pohnpei, Federated States of Micronesia. This is accomplished using ground data to calibrate the remote sensing model. Turbidity data from a nearshore sensor and corresponding multispectral WorldView images were used to determine the relationship between turbidity levels and reflectance in various bands and band ratio values. This turbidity equation was then applied to sites with known sedimentation rates from previous study. For each site, a turbidity sampling area was selected in the nearby water and all applicable WorldView images were assembled. The turbidity equation was then used to derive an average turbidity for each site over time. Combined with elevation data, this measure of relative turbidity showed a strong correlation with sedimentation rate across the sites. This measurement could therefore help with modeling sedimentation rates around the island and estimating belowground carbon storage. Given the success of this case study, we are in the process of replicating the procedure in mangroves in different geomorphological settings in Costa Rica and Vietnam, as well as Palau in the near future. The results of these studies will help local communities be involved in the conservation and restoration of their mangroves, help land managers understand sedimentation rates across different conditions and areas, and focus efforts where most needed or more effective.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 2.5. Global drivers of mangrove loss in protected areas vary across governance and IUCN categories

Heck, N.,[1] Goldberg, L.,[2] Andradi-Brown, D.A.,[3] Narayan, S.,[1] Lagomasino, D.,[1] Ahmadia, G.N. [3]

[1] East Carolina University, United States of America
[2] Standford University, United States of America
[3] World Wildlife Fund, United States of America

Despite increasing recognition of the benefits of mangrove forests, mangrove cover continues to decline globally. Protected areas(PAs) are a long-established conservation tool that can help protect mangroves and reduce further mangrove loss. Yet, to what extent protected areas are effective in achieving desired conservation outcomes and the role of governance and PA management in this process is not well understood. We combine remote sensing data with protected area information to identify differences in mangrove loss and its drivers across protected areas at the global scale across distinct governance types and protected area management categories developed by the International Union of Conservation (IUCN). Our results show that human-driven loss is highest in protected areas governed by national management agencies. Mangrove loss in protected areas governed by local communities and indigenous people is mainly caused by natural drivers. At the same time, we detect spatial differences in the effectiveness of governance models and management approaches.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 3.5. Tracing the legacy of environmental change and human impact in mangroves of North Sulawesi, Indonesia

Holmes, R.,[1] Salzmann, U.,[2] Djamaluddin, R.,[3] Berrio, J.C.,[1] Hocking, E.,[2] Williams, M.,[1] Siregar, I.,[4] Trianto, A.,[5] Tjoa, B.A.,[6] Fusi, M.,[7,8] Diele, K.[8,9]

[1]School of Geography, Geology and the Environment University of Leicester, UK
[2]Department of Geography and Environmental Sciences, Northumbria University, Newcastle upon Tyne, UK
[3]Faculty of Fisheries and Marine Science, Sam Ratulangi University, Manado, Indonesia
[4]Department of Silviculture, Faculty of Forestry and Environment, IPB University, Bogor, Indonesia
[5]Faculty of Fisheries and Marine Sciences, Diponegoro University, Jawa Tengah, Indonesia
[6]Faculty of Agriculture, Tadulako University, Sulawesi Tengah, Indonesia
[7]The Joint Nature Conservation Committee (JNCC), Peterborough, UK
[8]Center for Conservation and Restoration Science, Edinburgh Napier University, UK
[9]School of Applied Sciences, Edinburgh Napier University, UK

Sulawesi`s mangroves are some of the most floristically diverse globally and have been subject to widespread deforestation and degradation, which has intensified over the last 40 years. Governmental and community-based projects have conducted mangrove restoration and rehabilitation activities in Sulawesi, but project outcomes are rarely assessed, and long term monitoring data are largely missing. Palaeoecological archives provide a unique opportunity to extend the period of record of observed data, and provide information on centennial to millennial scale responses to long-term drivers of ecosystem change. Palaeoecology can significantly improve restoration and conservation success by providing pre-human impact vegetation baselines. Here we present palaeoecological data (palynology, diatoms, charcoal and spheroidal carbonaceous particles (SCPs)) from three ^{14}C and ^{210}Pb dated cores from two areas in North Sulawesi: 1) a nearly 8,000 year old record from a mangrove lagoon on Mantehage Island, Bunaken National Park; and 2) two Late Holocene high-resolution records from estuarine mangrove stands in Likupang, one taken from a site restored mid 2000 CE following the establishment of aquaculture ponds in the 1980s and the other, with no recent history of deforestation, serving as a reference. Combined, the records document substantial changes in mangrove composition in response to long term Holocene climate and sea level changes, and human impact. Abrupt late Holocene hydrological and vegetation change in the Mantehage record enables us to assess mangrove recovery following large-scale disturbance. By identifying anthropogenic and natural drivers of vegetation change at the natural and restored mangrove stands of Likupang we will discuss the potential of Palaeecology to inform mangrove restoration and management.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 3.6. Drivers of global mangrove loss and gain in social-ecological systems

Hagger, V.,[1] Worthington, T.A.,[2] Lovelock, C.E.,[1] Adame, M.F.,[3] Amano, T.,[1] Brown, B.M.,[4] Friess, D.A.,[5,6] Landis, E.,[7], Mumby, P.J.,[1] Morrison, T.H.,[8] O'Brien, K.R.,[9]. Wilson, K.A.,[10] Zganjar, C.,[7] Saunders, M.I.[11]

1 School of Biological Sciences, The University of Queensland, Brisbane, QLD, Australia
2 Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge, UK
3 Australian Rivers Institute, Centre for Marine and Coastal Research, Griffith University, QLD, Australia
4 Research Institute for Environment & Livelihoods, Charles Darwin University, Darwin, WA, Australia
5 Department of Geography, National University of Singapore, Singapore
6 Centre for Nature-based Climate Solutions, National University of Singapore, Singapore
7 The Nature Conservancy, Arlington, VA, United States
8 Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, QLD, Australia
9 School of Chemical Engineering, The University of Queensland, Brisbane, QLD, Australia
10 Queensland University of Technology, Brisbane, QLD, Australia
11 Coasts and Ocean Research Program, Oceans and Atmosphere, Commonwealth Scientific and Industrial Research Organisation, St Lucia, QLD, Australia

Mangrove forests store high amounts of carbon, protect communities from storms, and support fisheries. Human activities in coastal areas have driven widespread mangrove declines, although in some areas, mangrove expansion has been reported. Mangroves exist in complex social-ecological systems, hence identifying socioeconomic conditions associated with decreasing losses and increasing gains remains challenging albeit important. The impact of national governance and conservation policies on mangrove conservation at the landscape-scale has not been assessed to date, nor have the interactions with local economic pressures and biophysical drivers. Here, we assess the relationship between socioeconomic and biophysical variables and mangrove change across coastal geomorphic units worldwide. Globally, we find that drivers of loss can also be drivers of gain, and that drivers have changed over 20 years. The association with economic growth appears to have reversed, shifting from negatively impacting mangroves in the first decade to enabling mangrove expansion in the second decade. Importantly, we find that community forestry is promoting mangrove expansion. An analysis of outliers revealed areas with high loss associated with conversion to agriculture and aquaculture often occurring in protected areas. Sustainable development, community forestry, and co-management of protected areas are promising strategies to reverse mangrove losses, increasing the capacity of mangroves to support human-livelihoods and combat climate change.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.2A. Mangrove sediment metagenomics – delving into the still largely unknown microbial functional diversity

Helfer, V.,[1] Mancera Pineda, J.E.,[2] Hassenrück, C.[1,3]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany [2] Departamento de Biología, Facultad de Ciencias - Sede Bogotá, Universidad Nacional de Colombia, Bogotá, Colombia
[3] Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Warnemünde-Rostock, Germany

Microbial communities play an important role in organic matter decomposition and element cycling, thereby, strongly influencing, in interaction with geomorphological settings and physico-chemical properties of the sediments, organic matter and blue carbon dynamics in mangrove ecosystems. We investigated three intertidal sites in a mangrove forest on San Andrés Island (Colombia), characterized by different mangrove species compositions and tidal regimes due to elevation. After having investigated microbial community composition and diversity derived from metabarcoding data, we here delve into microbial functional diversity by applying a newly developed automated workflow to analyze paired-end metagenomic sequencing data, providing taxonomic and functional composition information at the level of short reads, assembled contigs in the form of a gene catalogue, and metagenome-assembled genomes (only prokaryotes). Dominant metagenome-assembled genomes belonged to so far uncharacterized novel prokaryotic clades revealing the still greatly unknown microbial diversity harbored in mangrove ecosystems. Furthermore, we observed a strong difference in functional diversity across the three mangrove stands, at a very local spatial scale. Our results confirm the importance of including both local and global scales when investigating taxonomic and functional diversity variation across space and highlight the need for further research to fully understand the functional role of microbial communities in mangrove ecosystems.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 11.7B. Climate change vulnerability, risks and adaptation strategies for the management of mangrove ecosystems in Colombia

Herrera Carmona, J.C.,[1] Prüssmann, J.,[1] Abud, M.,[1] Zapata, L.A.[1]
[1]WWF Colombia. Cra. 10a #69 A - 44, Bogotá

Mangroves provide multiple ecosystem services and benefits against extreme events and against climate change. However, they are exposed to threats such as sea level rise, coastal erosion, increase in the frequency and intensity of extreme events, socioeconomic pressures, among others. Here we present a vulnerability and risk analysis carried out for mangroves in the Pacific and Caribbean coasts of Colombia. Based on the results of this analysis, adaptation measures were identified. The vulnerability and risk analysis, was carried out for 46 municipalities of the two coasts of Colombia with mangrove cover. Twenty-two threat indicators were used, seven of sensitivity and 16 of adaptive capacity, and through a multivariate numerical analysis the indices were generated. Vulnerability and risk, was higher for mangroves located in the Caribbean municipalities.
The municipalities that presented the highest risk in the Caribbean were located in the central part of that coast, while in the Pacific these high risk areas were located in the southern coast. To prioritize adaptation strategies, spaces for inter-institutional and community participation were developed, and criteria associated with benefits, costs, risks and opportunities were considered. The prioritized adaptation measures were: ecological restoration and natural infrastructure, new protected areas and complementary conservation strategies, strengthening of territorial ordering processes, development of early warning systems, housing and community infrastructure adapted to climate change, and monitoring and research around information gaps for management. These measures are an input for climate management of mangroves in Colombia and arrangements will be made for them to be included in the territorial climate change adaptation plans, and in the National Mangrove Program.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 7.3B. The "true" 'Blue Carbon' storage in mangrove sediments: autochthonous vs. allochthonous contributions, labile vs. stable organic matter

Jennerjahn, T.C.,[1,2] Goldmann, C.,[3] Ghodrati Shojaei, M.,[4] Sharma, S.,[5] MacKenzie, R.[6]

[1] Leibniz Centre for Tropical Marine Research, Bremen, Germany
[2] Faculty of Geosciences, University of Bremen, Germany
[3] École Normale Supérieure, Université PSL, Paris, France
[4] Department of Marine Biology, Tarbiat Modares University, Noor, Iran
[5] Department of Natural Resources and Environmental Management, University of Hawaii at Manoa, Honolulu, USA
[6] Institute of Pacific Islands Forestry, USDA Forest Service, Hilo, Hawaii, USA

Intensive research on the quantification of carbon sequestration in 'Blue Carbon Ecosystems' (BCE) in the past decade revealed their potential to serve as nature-based solutions in the global effort of mitigating climate change. Quantitatively most important in this context are the soils or sediments, which store the majority of the carbon on timescales of centuries to millennia. With regard to assessing the effectiveness of the BCE sink in removing CO_2 from the atmosphere, it is also important to analyze the portions of autochthonous vs. allochthonous and of labile vs. stable soil/sedimentary organic matter (OM). While autochthonous OM results from recent CO_2 fixation in the respective BCE, allochthonous OM results from CO_2 fixation somewhere else and does not necessarily contribute to the recent climate change mitigation function of BCEs. The distinction between autochthonous and allochthonous portions is therefore relevant for both the compliance and the voluntary carbon markets as demonstrated in the IPCC guidelines for calculating NDCs or, e.g., the Verra Standard. However, as yet the uncertainties are large because of a lack of data. Therefore, we analyzed mangrove sediment cores from Thailand, Palau, Cambodia, Vietnam, Indonesia and Iran for their C and N content, δ^{13}Corg, δ^{15}N and hydrolysable amino acids. We find large variability in the amount and composition of sedimentary OM between sites pointing to large differences in the autochthonous vs. allochthonous portions and reactivity of the OM. Labile OM contributes one quarter to half of the sedimentary nitrogen suggesting a large potential for decomposition and subsequent release of greenhouse gases. Our approach will allow to assess better the "true" 'Blue Carbon' storage in BCE soils/sediments and hence contribute to closing the knowledge gap which is relevant in terms of the science as well as for the societal challenge of carbon accounting and crediting in climate change mitigation.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 12.3B. Understanding local community perspectives of mangrove ecosystem disservices in kuala selangor, malaysia: a pilot study

Jamal, A.,[a] Aldrie Ahmad, A.,[a] Friess, D.A.[b]

[a]Institute for Environment and Development, Universiti Kebangsaan Malaysia, Bangi, Malaysia
[b]Department of Earth and Environmental Sciences, Tulane University: New Orleans, Louisiana, USA

Research on ecosystem services – the goods and benefits that nature provides to people - has proliferated since the Millennium Ecosystem Assessment in 2005. However, ecosystem disservices, a concept that reflects potential negative social ecological interactions, can strongly shape people's perceptions of nature, hence influencing the conservation agenda. The push to recognize the benefits of ecosystems in management has not seen a concomitant focus on ecosystem disservices, despite their importance for management in terms of public support and ecosystem use. Perceived and actual ecosystem disservices have historically been common for mangroves, which may have contributed to them being threatened by various anthropogenic threats. There is a need to recognize the ecosystem disservices of mangroves, which are strongly perceived by many, yet understudied. This paper explores the status, trends, typologies, and effects of mangrove ecosystem disservices perceived by a local community in the coastal district of Kuala Selangor, Malaysia. A mixed methodological framework was adopted, encompassing direct observations, key informant interviews (n=4), three focus group discussions, and house surveys (n=24). Qualitative data were analyzed using content analysis. Despite most community members discerning the existence of mangrove ecosystem disservices (such as danger and threats), their appreciation for mangrove ecosystem services and their altruism towards mangroves outweighed the influence of ecosystem disservices. Mangrove ecosystem disservices were perceived to increase and intensify as local development progressed over time. The community's most critical implications were notorious monkeys and public nuisance. Recognized critical drivers for ecosystem disservices of mangrove were urbanization and inadequate management. Perceptions of mangrove ecosystem disservices were closely associated with biodiversity loss. A full assessment of ecosystem services and disservices of mangroves under a common assessment framework allows a better understanding of balance and synergies between services and disservices, providing more balanced information for management.

Theme 6: Changing human relationships with mangrove wetlands

Code: 11.2B. Effects of mangrove crabs (*Ucides cordatus*) on carbon fluxes in mangrove sediments.

Katzer, N.D.,[1] Mancera Pineda, J.E.,[2] Zarza-González, E.,[3] Wölfelschneider, M.,[1] Helfer, V.,[1] Zimmer, M.[1]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Germany
[2] Universidad Nacional de Colombia
[3] Universidad del Sinú Seccional Cartagena, Colombia

Governments are searching for measures to mitigate, and adapt to, the devastating effects of climate change, pushing blue carbon ecosystems into focus. The potential of mangrove forests to sequester and store large amounts of carbon has been well documented. However, the effect of the macrobenthos thereon has not, and results are still inconclusive. Here we present a case study from Colombia on the mangrove crab *Ucides cordatus*, which are known to retain organic matter (OM) by storing material in their burrows, and modify OM through digestion. The aim of this research is to describe and quantify the individual and combined effects of crab burrows and their inhabitants on carbon fluxes in mangrove forests. We measured CO_2 respiration, characterised organic matter content and recalcitrance, quantified DOC content of the sediment porewater and examined the metabolic potential of microbial communities in the bulk sediment and in natural and artificial crab burrows. With this approach, we will be able to describe and differentiate between the physical effects of burrows and biological effects of crabs on carbon fluxes. We expect crabs, via their burrows, to increase the net export of carbon from the system due to aeration and desalination of the sediment, which in turn may shift microbial processes from anaerobic to aerobic and subsequently lead to the oxidation of OM. Furthermore, crab burrows constitute a collection point for DOC rich porewater, which may be exported from the ecosystem via the tidally driven hydraulic gradient. Ultimately, we expect mangrove forests to sequester and store large amounts of carbon despite the presence of crabs, rather than due to their abundance.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 11.6B. The millennial tale of mangrove peat sets hypotheses on coastal geomorphology and vegetation dynamics in Gazi (Kenya)

Koedam, N.,[1, 2, 3, 7, *] Cruz-Portorreal, Y.,[3, 4] Fonteyn, S.,[5,6] Blanckaert, J.,[5,6] Beeckman, H.,[5] Dahdouh-Guebas, F.,[1, 6, 7] & Van der Stocken, T.[6]

[1]Systems Ecology and Resource Management, Department of Organism Biology, Université libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50, CPi 264/1, B1050 Brussels, Belgium
[2] Marine Biology Research group, Universiteit Gent, Krijgslaan 281 – S8, B9000 Gent, Belgium
[3] Centre for Environmental Sciences (CMK), Universiteit Hasselt, Agoralaan z/n, B3590 Diepenbeek, Belgium
[4] Centro de Estudios Multidisciplinarios de Zonas Costeras, Universidad de Oriente, Patricio Lumumba s/n, Santiago de Cuba 90500, Cuba
[5]Laboratory of Wood Biology and Xylarium, Royal Museum for Central Africa (RMCA), B3080 Tervuren, Belgium
[6] Ecology & Biodiversity, Faculty of Sciences and Bio-engineering sciences, Vrije Universiteit Brussel, Pleinlaan 2, B1050 Brussel, Belgium
[7] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), 1196 Gland, Switzerland
*Presenting author & correspondence: Nico Koedam

Mangroves are usually described as 'dynamic systems'. This however can cover many aspects, with spatial, temporal and ecological (floristic and faunistic) dimensions. Land building, coastal protection, carbon sequestration are some processes often reported in this context. In the particular case of Gazi Bay (Western Indian Ocean, Kenya), an intensively studied mangrove bay system, coastal geomorphology suggests (amongst others) a land building of parallel dune or chenier ridges and creeks. Mangroves could function as one of the actors in the process, besides coastal sand mobility and siltation, which also leads to closure of mangroves from tidal access and burial of organic material. In the fine scale spatial complexity, it appears however that buried organic mangrove material, peat banks, are also exposed and eroded again. We sampled peat trunks lying in an exposed mudflat in a restricted area in Gazi Bay. These were anatomically identified as closely as possible to species level and radiocarbon-dated (C-14). The trunks (which allowed for radiocarbon dating) show an age of one to more than two millennia and were most plausibly and reliably identified as *Sonneratia alba* and *Avicennia marina*. Since both mangrove species occur at the very same site today, a parsimonious interpretation could be environmental stasis, contradicting land building and spatio-temporal and floristic dynamics. In this contribution we however discuss alternative interpretations of this remarkable find and put forward hypotheses to be tested. We also explore consequences of peat exposure for carbon sequestration and release.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 12.3A. Net ecosystem exchange of CO_2 in mangroves: estimation from leaf, tree, and stand water use characteristics

Krauss, K.W.,[1] Ward, E.J.,[1] Merino, S.,[1] Miller, H.,[2] Duberstein, J.A.,[2] & Conrad, J.R.[3]

[1] U.S. Geological Survey, Wetland and Aquatic Research Center, Lafayette, Louisiana, USA
[2] Clemson University, Baruch Institute of Coastal Ecology and Forest Science, Georgetown, South Carolina, USA
[3] U.S. Fish and Wildlife Service, Inventory and Monitoring Program, Sanibel, Florida, USA

Eddy covariance assessments to determine the net ecosystem exchange (NEE) of CO_2 among soil, stand, and atmosphere are limited to large spatial scales (multiple hectares). However, experimental manipulation has been critical in mangrove ecosystems to advance understanding of possible functional outcomes of environmental change (e.g., nutrient loading, altered flood regime, elevated CO_2). Measurements of stand water use using sap flow techniques that overlap experimental treatment offer a potential method for discerning what NEE response might be but at smaller spatial scales. Given that the exchange of carbon between plants and atmosphere is linked strongly to water use, we use leaf-scale water use efficiencies in mangroves to determine how much CO_2 would be taken up by trees given a specific amount of water used by stands. Site-specific sapflow measurements, stand water use modeling, and empirical assessment of soil and aerial root exchange of CO_2 are required, but all can be undertaken at small spatial scales (100 m^2) and converted to estimation of NEE relative to treatments applied at that same scale. As carbon cycle science advances within blue carbon wetlands, not only are large-scale assessments of carbon exchange important, but also linkages to process changes or environmental drivers that affect large-scale assessment need sorting. “Reverse modeling,” or bottom-up determinations, of NEE from stand water use estimation may provide a useful technique to link specific environmental drivers with CO_2 exchange, and test model predictions as climate variability increases.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 12.5A. In Indian Sundarbans xenogamous pollination is preferred in *Bruguiera gymnorrhiza* and *Avicennia* spp., the most successful ones used commonly for mangrove afforestation ventures

Kumar Basak, S.,[1‡*] Ray, K.,[2‡] Saha, S.[2]

[1]Sarat Centenary College, Dhaniakhali, Hooghly 712302, West Bengal, India
[2]Environmental Biotechnology Group, Department of Botany, West Bengal State University, Berunanpukuria, Malikapur, Barasat, Kolkata 700126, India

Mangroves propagate through sexual reproduction and study of reproduction in mangroves by quantifying effective fruit-set, is a pre-requisite of immense importance that mainly contributes to sustenance and development of a pristine mangrove forest. Success of sexual reproduction in mangroves is linked to flowering timings, pollinators' abundance, unhindered movement of pollinators and the failure of this dominantly entomophilous reproductive process to cope with environmental and climate changes is one of the fundamental reasons for species loss. Mangrove community has generalized pollination system in which generalist pollinators like honey bees, yellow wasps, lady-bird beetles, sweet bees, bats, snails, forage over a vast spectrum of mangrove flowers for their reward collection. These mangrove species are mostly reported to be self-incompatible and cross-pollinating, thus avoiding inbreeding depression, which causes low intra-population genetic diversity. We generated data on major reproductive ecological components of mangrove species of Indian Sundarbans viz. floral morphology, pollen viability, pollen load on stigma tip, in vivo pollen germination on stigmatic surface, success of artificial pollination (autogamous, geitenogamous and xenogamous modes), a comparative time-dependent histology of ovary after artificial pollination, using *Bruguiera gymnorrhiza* and *Avicennia* spp. (*A. officinalis*, *A. marina* and *A. alba*) as models. These are the most successful species in Indian Sundarbans, propagules of which are largely available and used here for large-scale afforestation. Differential transcriptomic data on expression profiles of genes related to post-pollination and post-fertilization ovule development, self-incompatibility, are demonstrated for *A. officinalis* flowers by isolation of total RNA, preparation of RNA library and then sequencing of RNA profile from female reproductive systems (gynoecia) at post-artificial pollination through autogamy, geitenogamy and xenogamy, set at mangrove populations of Indian Sundarbans. All data including RNA-seq results shed light largely on the post-pollination induced expressional changes that differ among and might lead to preferential fruit-set in xenogamy over autogamy or geitenogamy.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code.17.4. Challenges to Understand Global Mangrove Biodiversity by eDNA Metabarcoding

Kajita, T.,[1,2] Shan Wee, A.K.,[3] Basyuni, M.,[4] Salmo III, S.,[5] Fall, J.,[6] Sivaipram, I.,[7] Peer, N.,[8] Von Der Heyden, S.,[8] Leopardas, V.,[9] Sivakumar, K.,[10] Ranawana, K., [11] Nazre Saleh, M.,[12] Chen, L., [13] Ahsan Habib, K.,[14] Artigas Ramirez, M.A.,[15] Isowa, Y.,[15] and Suleiman, M.[2]

[1]Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyu [2]ITBC, Universiti Malaysia Sabah, MALAYSIA
[3]University of Nottingham, Malaysia, MALAYSIA [4]Universitas Sumatera Utara, INDONESIA
[5]University of the Philippines, PHILIPPINES [6]Cheikh Anta Diop University, SENEGAL [7] Chulalongkorn University, THAILAND [8] University of Stellenbosch, SOUTH AFRICA [9] Mindanao State University at Naawan, PHILIPPINES
[10] Annamalai University, INDIA [11] University of Peradeniya, SRI LANKA [12] Universiti Putra Malaysia, MALAYSIA
[13] College of the Environment and Ecology, CHINA [14] Sher-e-Bangla Agricultural University, BANGLADESH
[15] University of the Ryukyus, JAPAN

The revolutionary developments of environmental DNA (eDNA) metabarcoding have been changing our ways of the understanding ecosystem. EDNA metabarcoding using aquatic samples, in particular, enables us to assess the species diversity rapidly, effectively, and objectively by analyzing water samples and providing massive data with relatively less sampling time and effort. EDNA metabarcoding can be a breakthrough tool to understand the biodiversity across mangrove ecosystems worldwide, and international collaboration is essential because mangroves distribute across countries and continents. By obtaining support from JSPS Core to Core program for FY2020 – 2022, we established collaboration networks with members from ten countries in Asia and Africa. Our ultimate goal is to establish a research foundation for eDNA metabarcoding, expecting it to be a standard tool for studying global mangrove biodiversity. We believe that the biodiversity big data obtained in our studies will help us better understand and conservation of global mangroves in various ways. As the aims of JSPS Core-to-Core programs are (i) the formation of high-potential research hubs, (ii) the construction of sustainable collaborative relationships with overseas core institutions, with (iii) fostering young researchers, we held international workshops, seminars, and training courses involving younger researchers, and disseminated the ideas and methodologies of eDNA metabarcoding in mangroves. MiFish and its related methods are effective in mangroves, and we optimized the technical basis to apply these methods to mangroves. Developing a reference database is another essential factor, and we encourage members to start or perform their research projects in their countries. We are still on the way to integrating the data accumulated in member countries, and we expect that we can establish a global eDNA database for mangrove biodiversity.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 6.3A. The microphytobenthos drive key ecosystem processes in tropical mangroves

Loo, Y.P.,[1,2] Ouyang, X.,[1,3] Gao, X.,[1] Guo, F.,[1,4] Chiu-Leung, L.,[1] Ma, K.P.,[1] Lai, D.Y.F.,[2] & Lee, S.Y.[1,5]

[1]Simon F.S. Li Marine Science Laboratory, School of Life Sciences, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR, China. Email: joesylee@cuhk.edu.hk [2]Department of Geography and Resource Management, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR, China
[3] Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou), China [4] Guangdong University of Technology, Guangzhou, China
[5] Australian Rivers Institute, Griffith University Gold Coast, Qld 4222, Australia

The functional role of microphytobenthos (MPB) of tropical mangrove ecosystems have been largely ignored based on the assumption that low light availability of the mangrove floor reduces MPB abundance. The lack of effective ways of isolating MPB for chemical tracer and other analyses also contributed to the paucity of assessments of their functional significance. We used compound specific stable isotope analysis of amino acids (CSIA-AA) to assess the trophic significance of mangrove sediment MPB in estuarine food webs at three locations in Hong Kong. Most consumers seemed to depend predominantly on MPB either on the tidal flats or the mangrove sediment for food, contradicting the paradigm that mangrove detritus fuels food chains in tropical estuaries. Mesocosms experiments employing ^{13}C labels, however, showed that mangrove plants still played a critical role in supporting benthic secondary production through a tight coupling between mangrove and MPB production. ^{13}C labels applied to the leaves of mangrove seedlings were transferred effectively to MPB biomass, probably via dissolved inorganic carbon (DIC) released from root respiration, reducing sediment-atmospheric carbon emission. The MPB therefore are also a strong regulator of mangrove DIC dynamics. These findings have strong implications for the role of mangroves in global estuarine ecosystems, such as the relative importance of their roles in carbon storage and supporting secondary production. The functional significance of mangrove MPB needs to be further evaluated across various environmental gradients.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.7A. Enhancing sustainable mangrove restoration success through objective-based Global Mangrove Restoration Guidelines

Lovelock, C.,[1] Hagger, V.,[1] Cameron, C.,[1] Sippo, J.,[1] van Bijsterveldt, C.,[2] Howard, J.,[3] van Eijk, P. [2]

[1]School of Biological Sciences, University of Queensland
[2]Wetlands International, 3Conservation International

Efforts to restore mangrove ecosystems are growing worldwide due to the increasing recognition of the ecosystem services they provide and the growing availability of public and private sector finance to support restoration initiatives. With more than 80% of mangrove restoration initiatives failing, accessible guidance on implementing successful and sustainable mangrove restoration is urgently needed. Successful mangrove restoration requires biophysical assessments (ensuring conditions are suitable for mangrove growth) and the consideration of socioeconomic factors (e.g., securing land tenure, community engagement and consultation). While many mangrove restoration guidelines are available, they are often limited to specific geographies or applications, limiting their broad usability and creating confusion among the mangrove community. To improve the success of mangrove restoration initiatives, the Global Mangrove Restoration Guidelines were developed, drawing on the expertise available from published best practices and a global community of mangrove specialists. The guidelines provide the mangrove community with a unified resource linked to the best relevant thematic or geographic literature and guide readers through all the steps of the mangrove restoration process. Because many excellent restoration manuals exist, this guide means to 1) assist readers in aligning existing methods with specific objectives (e.g., blue carbon finance vs coastal protection) and 2) build on available expertise in a way that is additive, global, and owned by the entire mangrove community. These guidelines start with overarching considerations applicable to all mangrove restoration initiatives, followed by modules guiding objective-driven restoration (e.g., restoration seeking blue carbon finance). The first module related to blue carbon is available and will be complemented with further thematic modules (e.g., restoration for fisheries, coastal protection). These guidelines are intended to be a living reference, updated and maintained by a community of experts to form a restoration framework owned by the global mangrove community.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 11.2A. Long-term Monitoring of Hydrological Rehabilitation and Mangrove Restoration in Coastal Lagoon in the Gulf of Mexico

López-Portillo, J.,[1] Zaldivar-Jiménez, A.,[2] Lara-Domínguez, A.L.,[1]
Pérez-Ceballos, R.,[3] Aguirre-Franco, L. [1]

[1] Instituto de Ecología, A.C., Mexico
[2] Asesoría Técnica y Estudios Costeros S.C.P., Mexico
[3] Instituto de Ciencias del Mar y Limnología Estación El Carmen, UNAM, Mexico

There are many causes of massive mangrove forest death. Still, a common one is when the effect of tides is interrupted by blocking the hydrologic flow. In the mangrove forest of the Tampamachoco lagoon, Tuxpan, Mexico, the construction in 1987 of three levees perpendicular to the coastline interrupted water flow, causing forest “impairment” (death) by 2010 in about 30 ha and chronic tree damage (“transition”) in about 60 ha north of the levees. South of them is the well-preserved “reference” mangrove. Our objective was to monitor our ongoing restoration efforts from the start of the project in April 2011. In 300 ha, we installed seventy 1.5 m-deep PVC wells slotted every 5 cm to monitor salinity, pH, redox potential, and temperature in flood water, interstitial water, in the water table, and 1.4 m deep. In the first year, during the dry season, salinity was higher (up to 120 ups) in the impaired zone, contrasting with the reference zone to the south and even the transition zone to the north. After monitoring the area for one year, we opened five gaps along each levee to restore superficial water flow and widened them from two to 15 m in 2012, 2014, and 2015. Intersite differences in salinity and redox potential decreased but were still higher in the impaired zone. In 2019, we had the resources to excavate, with community participation, 1-m deep, 3-m wide, and 3000 m-long channels to connect the impaired mangrove to the lagoon, following the maximum slope suggested by a relief model. The hydroperiod and tidal dynamics improved, reducing salinity and ameliorating other water physicochemical attributes from the surface to -1.4 m. The excavated sediment was deposited at pre-disturbance ground elevations, and 750 islets, 5-m diameter and 40 cm high, were formed to facilitate colonization, with trees reaching up to three meters.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 16.3A. Quantifying the human footprint of mangrove change

Lagomasino, D.,[1] Blumenthal, K.,[1] Dail, J.,[1] Payton, A.,[1] Fatoyinbo, L.,[2] Simard, M.[3]

[1] East Carolina University
[2] NASA Goddard Space Flight Center
[3] NASA Goddard Space Flight Center

Over the past 30 years, mangrove forests have experienced significant loss and gain. Much of the loss has been associated with human activities, such as urbanization, aquaculture, and deforestation. Climate change is also contributing to the decline of mangrove forests, through sea-level rise, increased storm activity, and shifting weather patterns. These compound pressures are important to understand in order to implement effective management strategies that balance economic development and conservation. Knowing the location of mangrove loss and understanding the underlying causes of mangrove loss are two distinct, but closely related, aspects of mangrove forest monitoring and management. Earth satellite observations can provide accurate and timely information on mangrove extent and change, even in difficult-to-reach areas. These techniques have the ability to monitor the impacts of land use change, coastal development, and sea-level rise on mangrove forests. Understanding why mangrove loss occurs is important, as it provides insights into the underlying causes of mangrove forest change, such as human activities, natural events, or environmental factors. This information is critical for tracking trends in mangrove losses and for informing the decision-making processes around mangrove forest management. Here, we will present on the release of the Global Mangrove Change Drivers (GMCD) v2.0, that includes additional loss drivers and physical processes related to mangrove gains over a period from 1996 to 2020. The loss drivers have been updated to include the direct impacts from cyclones and the gains models include coastal expansion, landward transgression, and the reestablishment of mangroves. In this presentation we will discuss the methodology of GMCD and highlight the distribution and causes of mangrove change over the last 3 decades. By understanding the relative importance of these different causes of mangrove change, we can develop targeted management strategies that address the specific underlying drivers.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 6.2A. Landscapes of fear in mangrove ecosystems: conservation and restoration applications based in case studies.

Marín Zuluaga, D., and Polania Vorenberg, J.H.[1]

[1]Universidad Nacional de Colombia sede Medellín

The recent reintroduction of wolves to Yellowstone Park changed the behavioral patterns of its herbivores and thus became a typical example of a landscape of fear (LOF). Apart from generating restoration processes, which have been studied worldwide and have achieved some success, the term was coined to describe how an individual or a population of animals perceives spatial variation in predation risk and their behavioral responses. The emerging and growing scientific literature describes diverse LOFs in multiple terrestrial and aquatic worldwide ecosystems. Many cases have projected tangible applications, primarily focused on conserving and restoring both populations and ecosystems. Nevertheless, the growing popularity of LOFs has yet to generate studies in mangrove ecosystems -of fundamental importance as reservoirs of diversity and providers of ecosystem services vital for the survival of millions of people-. These ecosystems face significant anthropic pressures, a high rate of disappearance and an enormous risk in the face of climate change. Therefore this review includes five specific cases worldwide that could be categorized as LOFs and contribute to mangroves' management, conservation and restoration, their function, services and biodiversity. Two of them are in the Neotropics, with populations of curlews (*Numenius phaeopus*) and lemon sharks (*Negaprion brevirostris*); others in Japan (with *Apogon amboinensis*), Australia (with white-tailed stingrays *Himantura granulata*) and several systems which include crabs (Decapoda). Discussing these possible cases of LOFs in mangroves can shed light on understanding their ecology better and propose new approaches to preserve them.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.5B. 4 social methods, 14 districts with 24 stakeholder groups over 34 months study reveal that conservation through legal means is insufficient for successful mangrove co-management

Mafaziya Nijamdeen, T.W.G.F., [a, b] Hugé, J.,[a, c, d, e] Ratsimbazafy, H.A., [a,f] Sunanda Kodikara, K.A., [g] Peruzzo, S.,[a,c] Poti, M., [a,c] Olefs, L., [a,] Nijamdeen[h] Thajudeen Thahira, T.W.G.F.A.,[i,j] Dahdouh-Guebas, F. [a,c,k,l]

[a] Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, Brussels, 1050, Belgium [b] Department of Biological Sciences, Faculty of Applied Sciences, South Eastern University of Sri Lanka, Sri Lanka [c] Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, Brussels, 1050, Belgium [d] Department of Environmental Sciences, Open University of the Netherlands, Valkenburgerweg 177, Heerlen, 6419AT, the Netherlands [e] Centre for Environmental Science, Hasselt University, Hasselt, BE3500, Belgium [f] Institut Halieutiques et des Sciences Marines, Université de Toliara, Madagascar [g] Department of Botany, Faculty of Science, University of Ruhuna, Matara, Sri Lanka [h] Faculty of Agriculture, University of Bonn, Bonn, Germany [i] Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka [j] Department of Biosciences, COMSATS University, Islamabad, Park Road, Tarland Kalan, Islamabad, 45550, Pakistan [k] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN) Zoological Society of London, London, United Kingdom [l]Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, Brussels, 1050, Belgium

Understanding the extent and the nature of collaboration among stakeholders and their perspectives is crucial to support mangrove co-management. Despite the existence of robust mangrove conservation policies, the involvement of stakeholders in mangrove co-management remains largely unexplored in Sri Lanka. Our study aimed to identify the collaboration between mangrove management stakeholders and their perceptions regarding mangrove co-management in Sri Lanka using social network analysis (SNA), content analysis, ethnobiological surveys, and Q methodology. This study was conducted in all five coastal provinces of Sri Lanka from January 2020 to November 2022 involving 24 stakeholder groups. Stakeholders included were from government departments, non-governmental organizations, private institutes, and coastal communities. Our results from the SNA show that mangrove management differs between provinces specifically in the number of stakeholders involved and their degree of collaboration. Through the content analysis, the major challenges hampering effective mangrove management were identified. Those were inefficient communication, inconsistencies between policies, and lack of financial capacity of government stakeholders responsible for policy implementation. Through the ethnobiological surveys, it was apparent that the mangrove fringing communities still depend on mangrove-derived goods and services despite the government-led ban. According to the Q methodology, stakeholders' perceptions can be categorized into three clusters: (i) government-oriented management, (ii) community-oriented management, and (iii) synergy between government and communities. Stakeholders specifically encouraged collaboration, monitoring, and post-care of mangrove plantations, along with sufficient staffing and funding. Mangrove policies by the central government were not equally perceived by stakeholders of different provinces. Therefore, we suggest the establishment of a common platform to coordinate stakeholders and co-produce knowledge. We argue that "full conservation" only by legal means cannot be sufficient for successful mangrove management. Moreover, integrating different methods can give a better understanding and yield more complete evidence on mangrove management and cover any gaps and weaknesses of each method.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 6.8B. Belize Blue Carbon: Establishing a national carbon stock estimate for mangrove ecosystems

Morrissette, H.K.,[a] Baez, S.K.,[b] Beers, L.,[c] Bood, N.,[d] *Martinez, N.D.,[e] Novelo, K.,[e] Andrews, G.,[f] Balan, L.,[g] Scott Beers, C.,[c] Betancourt, S.A.,[g] Blanco, R.,[h] Bowden,E.,[i] Burns-Perez, V.,[j] Carcamo, M.,[g] Chevez, L.,[d], Crooks, S.,[c] Feller, I.C.,[k] Galvez,G.,[e] Garbutt, K.,[f] Gongora, R.,[e] Grijalva, E.,[g] Lefcheck,J.,[k] Mahung, A.,[e] Mattis, C.,[l] McKoy, T.,[g] Mclaughlin, D.,[e] Meza, J.,[m] Pott, E.,[g] Ramirez, G.,[i] Ramnarace, V.,[n] Rash, A.,[i] Rosado, S.,[f] Santos, H.,[h] Santoya, L.,[h] Sosa, W.,[m] Ugarte, G.,[e] Viamil, J.,[m] Young, A.,[f] Young, J.,[j] and Canty, S.W.J.[a,o]

[a]Smithsonian Marine Station, 701 Seaway Drive, Fort Pierce, FL 34949, USA [morrissetteh@si.edu], [b]The Pew Charitable Trusts, 901 E St. NW, Washington, DC 20004, USA, [c]Silvestrum Climate Associates LLC, 1 Lower Crescent Ave, Sausalito, CA 94965, USA, [d]World Wildlife Fund Mesoamerica (Belize Field Office), 1154 Sunrise Avenue, Belize City, Belize, [e]University of Belize Environmental Research Institute, Price Centre Road, Belmopan, Belize, [f]Coastal Zone Management Authority and Institute, Princess Margaret Drive, Belize City, Belize
[g]Belize Forest Department, Forest Drive, Belmopan, Belize, [h]Sarteneja Alliance for Conservation and Development, 329 Lagunita Street, Sarteneja Village, Corozal District, Belize, [i]Toledo Institute for Development and Environment, 1 Mile San Antonio Rd., Hopeville, Belize
[j]Turneffe Atoll Sustainability Association, 62 Bella Vista, Belize City, Belize, [k]Smithsonian Environmental Research Center, 647 Contees Wharf Road, Edgewater, MD 21037, USA, [l]National Climate Change Office, 7552 Hummingbird Highway, Belmopan, Beliz, [m]Corozal Sustainable Future Initiative, Chunox Sarteneja Road, Corozal, Belize, [n]Belize Fisheries Department, Princess Margaret Drive, Belize City, Belize, [o]Working Land and Seascapes, 1000 Jefferson Drive SW, Smithsonian Institution, Washington, DC 20560, USA.

The significance and preservation of Blue Carbon, the carbon storage in marine ecosystems, is a recommended nature-based mitigation measure against climate change. The Central American, developing nation of Belize has identified mangrove protection as one of their nationally determined contributions to the Paris Agreement due to their carbon sequestration capacity and potential. Some aboveground biomass carbon has previously been measured in-country, but this project expanded nationwide to also include sediment carbon. Values of carbon storage in the sediment of Belize's mangroves, as for many mangrove ecosystems around the world, have been based on regional or global estimates rather than ground-truthed metrics. Through an international and local collaboration among researchers, protected area managers, NGOs, and government agencies, Belize now has its first national carbon stock estimate of 25.7 Tg C, based on biomass and sediments to a depth of one meter. We determined the mean total ecosystem carbon stock (TECS) for the nation was 444.1 ± 21.0 Mg C ha-1, with 74.4 ± 6.2 Mg C ha-1in biomass stocks, and 369.7 ± 17.7 Mg C ha-1in sediment stocks. This varies from previous global estimates, which have both under and over estimated carbon, depending on the study. From this, Belize may be able to identify areas of greater storage potential or priority restoration areas, providing critical context when imminent coastal development threatens all mangrove forests nationally. This effort highlights the importance of countries conducting their own national carbon stock assessments and building local capacity to do so in order to achieve global climate targets.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 11.4B. Incorporating coastal blue carbon in the forest reference emissions level and market potentials

Murdiyarso, D.,[1,2] Sasmito, S.,[3] and Bhomia, R.[2]

[1] Department of Geophysics and Meteorology, IPB University, Bogor 16680, Indonesia
[2] Center for international Forestry Research, Jl. CIFOR Situgede, Bogor, 16115, Indonesia
[3] NUS Environmental Research Institute, National University of Singapore, Singapore

Forest reference emissions level (FREL) is one of the decisions adopted in the Conference of Parties to the United Nations Framework Convention on Climate Change to allow countries to attract payment based on the results of mitigation measures implemented at national or sub national level. Following the 2013 Supplement of 2006 IPCC Guidelines that assists countries to incorporate wetlands including peatlands and mangroves in greenhouse gas inventories, here we outline the technical challenges and policy processes to develop the FREL, and financial opportunities in incorporating mangroves blue carbon. Although the default values of emission factors are publicly available, project developers or host countries may prefer to use higher tiers in estimating the FREL, by which carbon benefits and incentives will be evaluated. The stock-difference approach is commonly adopted gain-loss approach is discussed, and soil carbon assets beyond standardized top meter are explored.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 12.6A. A first assessment of biomass and carbon estimation for Galapagos' mangrove forests

Moity, N.[1]

[1] CHARLES DARWIN FOUNDATION, Ecuador

Mangroves in the Galapagos Marine Reserve play a crucial role in carbon sequestration, coastal protection and support the livelihoods of local communities. Assessing the biomass and carbon stocks of these mangroves is important to understand the contribution of these ecosystems to the global carbon cycle and to develop effective conservation and management strategies. This study aimed to estimate aboveground and belowground biomass, soil carbon concentrations, mangrove forest structure and species composition within the Galapagos Marine Reserve. Field measurements were carried out at several mangrove sites to collect data on tree diameter, height, species composition and saplings density. Soil samples were collected and analyzed to determine soil carbon concentrations and below-ground biomass. The species composition of the mangrove forests was also assessed. The results showed that the mangroves in the Galapagos Marine Reserve have above-ground biomass ranging from scrub mangroves typical of arid coastlines around the world, to other well-developed forest patches comparable to more humid areas. Soil carbon concentrations varied from low levels to levels comparable to well-developed mangrove forests. Mangrove forest structure was found to be diverse, with a mixture of tall and short trees, and a higher abundance of *Rhizophora mangle* and *Laguncularia racemosa.* The mangroves of the Galapagos Marine Reserve are important carbon sinks, with significant above-ground biomass and diverse soil carbon concentrations. The results of this study highlight the need for effective conservation and management strategies to maintain and enhance the carbon sequestration potential of these important ecosystems. Further research is needed to understand the dynamics of carbon stocks in mangrove forests, particularly in the face of climate change and other pressures.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 13.3B. Estimating the Value of Mangrove Assets Applying the System of Environmental Economic Accounting in the Cienaga Grande of Santa Marta

Moreno, J.,[1] Gomez, C.,[1] Contreras, A.,[1] Sanchez, D.,[2] Arciniegas, N.,[1] Viloria, E.,[1] Guerrero, D.[3]

[1] Researcher at Institute of Marine and Coastal Research "José Benito Vives de Andreis" (INVEMAR)
[2] Professor at National University of Colombia
[3] Head of Economic Valuation at Institute of Marine and Coastal Research "José Benito Vives de Andreis" (INVEMAR)

We applied the System of Environmental and Economic Accounting for Ecosystem Assets (SEEA EA) developed by the United Nations (2021) to carry out the biophysical and monetary valuation of the natural capital of the Ciénaga Grande de Santa Marta. We obtained information from two (2) ecosystem services: carbon capture and small-scale wild fishing. To estimate the aboveground carbon stock in the aerial biomass of CGSM mangroves, we followed Yepes et al. (2016). We used allometric equations to estimate aereal biomass (Smith & Whelan 2006). To estimate the belowground carbon, we used reports from 4 stations of the CGSM basin. These reports evaluated the carbon content at a meter of depth. The carbon sequestration was accounted by interannual variations in the content of aerial biomass. As a carbon price, we used the Colombian tax rate declared in article 221 of Law No. 1819 of 2016 as a proxy. For 2017, this rate was USD 5 per ton of CO2 generated, annually adjuted to the national inflation. To estimate the value of the ecosystem service of wild fishing, we consulted the System of Fishing Information from Invemar. We obtained information on catches of fish, crustaceans and mollusks from 2015-2019; later, we used the market price of first sales in the CGSM to estimate its total value. We estimate a global value between 2015 and 2019. We calcute COP $68.244.426.985 in losses of ecosystem assets. Results of this research represent the first application of the ecosystem accounts methodology in a coastal marine ecosystem in Colombia. It is necessary to indicate that this pilot underestimates the total economic value of the ecosystem assets of the CGSM. There is need to continue filling the gaps of information; thus, continuing in process of recuperation of one of the most important and productive ecosystems of Colombia.

Theme 6: Changing human relationships with mangrove wetlands

Code: 16.2A. Use of semi-automated remote sensing techniques for the quantification of mangrove cover in Colombia: input for territorial ecosystem management.

Montes-Chaura, C.C.,[1] Vásquez-Prieto, L.P.,[1] Coy-Pertuz, M.M.,[1] Sierra-Correa, P.C.[1]

[1] Information Services Laboratory, Coordination of Research and Information for Marine and Coastal Management - GEZ, Institute of Marine and Coastal Research. "José Benito vives de Andréis" INVEMAR., Santa Marta D.T.C.H., Colombia

The importance of mangrove ecosystem services in Colombia has raised the need for monitoring, follow-up, and management actions to determine their spatiotemporal distribution and associated changes. Remote sensing together with data processing in the cloud has been fundamental for what is mentioned, given its temporal and spatial scopes. Altogether, the image processing, its operation in the cloud and the support of the institutions of the National Environmental System (SINA), allowed the Marine and Coastal Research Institute (INVEMAR), to generate the main input for the official mangrove coverage map 2020-2021 for Colombia, which in turn feeds the Information System for Mangrove Management (SIGMA). The overall mangrove map results from supervised classification with the random forest classifier for more than 450 Sentinel-1 and -2 images and the SRTM elevation model; the classifier is trained with field data and high-resolution imagery, finally, the result is refined by an expert. The final cartography reported about 280,000 ha of mangroves in the country, highlighting that the coverage in the islands of San Andres, Providencia and Santa Catalina was added with a scale of 1:5,000, product of the SeaFlower Plus 2021 and Strengthening mangrove restoration in Colombia: Techniques, knowledge, and experiences 2021 projects, the rest was generated at 1:25,000. Having a precise quantification mechanism for mangrove extension strengthens the evaluation and monitoring of policies and actions aimed at the preservation, recovery, rehabilitation, and restoration of these strategic ecosystems. In addition, this input becomes important for future estimates of GHG mitigation potential for blue carbon initiatives.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 16.4A. Assessing Mangrove Ecological Condition based on Canopy Roughness using Drone-Based Digital Surface Models: examples from the Caribbean and Pacific Coasts

Mejía-Rentería, J.C.,[1,2] Cantera-Kintz, J.R.,[1] Peña-Salamanca, J.E.,[3] Blanco-Libreros, J.F. [4]

[1] Ecomanglares, Instituto de Ciencias del Mar y Limnología, Department of Biology, Universidad del Valle, Cali, Colombia
[2] Centro de Excelencia en Ciencias del Mar – CEMARIN
[3] Grupo de Biología de Plantas y Microorganismos, Universidad del Valle, Cali, Colombia
[4] Universidad de Antioquia, Colombia, Medellín, Colombia

Mangrove forests play a crucial role in providing ecosystem services (ES) to coastal communities but assessing the ecosystem condition remains a costly and time-consuming task. The roughness of the canopy is associated with species composition, nutrient and water availability, and natural and human disturbances. To achieve effective management of this ecosystem, it is important to obtain baseline data and to undertake monitoring programs to understand the relationship between the structure of the canopy and drivers of change. The aim of this study is to link the roughness of the mangrove canopy with drivers of change in the insular Caribbean and Pacific regions of Colombia. To achieve this, practical mapping examples were carried out using Uncrewed Aerial Vehicles (UAVs) in various physiographic types of mangrove forests in several locations in these regions. We used consumer-drone products to generate digital surface models (DSMs) of the mangrove canopy, and analyzed the roughness of the canopies using Geographic Information Systems GIS. The results showed a correlation between roughness of the forest canopy and its ecological condition such as carbon capture and coastal line stability. These results suggest that the management and conservation of mangrove ecosystems in Colombia should consider the structure of the mangrove canopies and their impact on the ecosystem condition. This study highlights the potential of drone-based technology to provide valuable information about the structure of mangrove ecosystems and drivers of change.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 16.7A. Global trends of greening and browning in mangrove ecosystems

Murillo-Sandoval, P.J.,[1*] Perea-Ardila, M.A.,[2] and Younes-Cárdenas, N.[3-4]

[1*]Departamento de Topografía, Facultad de Ciencias del Habitat, Diseno e Infraestructura, Universidad del Tolima, Colombia. pjmurillos@ut.edu.co
[2] Facultad de Ingeniería Forestal, Universidad del Tolima, Colombia.
[3] Fenner School of Environment and Society, College of Science, The Australian National University, ACT, Australia.
[4] Centre for Tropical Environmental and Sustainability Science, James Cook University, QLD, Australia.

Greening and browning trends are terms used to describe ecosystem responses to changes in climate and human activity. Global trends analysis has been performed using coarse remote sensing data and often focus on inland forests of the northern hemisphere. Greening and browning trends for mangrove ecosystems remain unexplored, and are relevant to monitor mangrove degradation as well as restoration and conservation efforts at different spatial and temporal scales. Here, we present the first global analysis of mangrove greening and browning trends, and showing gradual changes, providing information about significant hotspots of greening and browning trends. We used Landsat imagery between 1997-2020 (23 years), THE LandTrendr, and Moran's Index to track the magnitude and the timing of greening and browning change. Over 61% of the worlds mangroves show an overall browning trend over the study period, while only 9% show a greening trend, and only 30% has remained stable. Using Moran's index we were able to identify significant hotspots of homogeneity in gradual change (greening or browning) in West Africa, Southeast Asia and the Caribbean islands. By highlighting areas where significant mangrove greening and browning has occurred, and where these clusters can be found, we contribute to targeted and more effective conservation efforts across the globe. We also provide a publicly available dataset that can be used to monitor mangroves at local scales, assist in restoration campaigns and track gradual changes. Importantly, this dataset can be expanded and easily updated for future events and to aid in conservation and restoration efforts. Our analysis contributes to assessing common drivers of change but also the underlying mechanisms that drive mangrove transformation.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 7.7B. The spatial and temporal distribution of mangrove coastal protection benefits against storms

Narayan, S.,[1] Thomas, C.,[2] Nzerem, K.,[2] Beck, M.W. [3]

[1]Department of Coastal Studies, East Carolina University, Greenville, NC
[2] Risk Management Solutions, London, U.K.
[3]Coastal Resilience Lab, Institute of Marine Sciences, University of California Santa Cruz

Mangroves are known to protect coastlines and communities from storm damage by acting as natural barriers to oncoming storm surge flooding. The damage reduction benefits of mangroves depend on several factors including storm characteristics, mangrove extents and the extent of mangrove-adjacent assets that are exposed to storm damage. Yet, little is known about the variability in these benefits, particularly the spatial distribution of damage reduction benefits or the distribution of these benefits across different storm frequencies. In this paper, we combine hydrodynamic models of storm surge flooding with datasets of economic exposure to investigate mangrove effects on flood damages in Florida for two scenarios: mangroves present, and mangroves absent. We apply these models to 100 events in south-west Florida, and to a single event across the entire state to understand spatial and temporal variations in mangrove benefits. We find that mangrove effects, while mostly positive, can have negative effects in some locations. We also find that mangroves tend to offer the greatest benefits for certain storm frequencies.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 11.1B. Effects of burrowing mud lobsters (*Thalassina anomala*) on carbon fluxes in mangrove sediments at Setiu Wetland, Terengganu, Malaysia

Nusser, M.,[1] Zimmer, M.,[1] Wölfelschneider, M.,[1] Katzer, N.,[1] Nie Lee, J. [2]

[1]Leibniz-Centre for Tropical Marine Research, Germany
[2]Universiti Malaysia Terengganu, Malaysia

Studies on effects of the burrowing macrofauna on carbon fluxes often focus on only a single flux pathway, e.g., the vertical efflux of gaseous carbon dioxide into the atmosphere, or the horizontal efflux of dissolved organic (DOC) and inorganic carbon (DIC) into tidal creeks. Improving the understanding of multiple pathways simultaneously can help to understand carbon dynamics in mangrove forests and therefore lead to more accurate estimates of carbon budgets. This study aims to provide a multifaceted insight of the effects of mud lobster burrows on vertical and horizontal fluxes of inorganic and organic carbon. Mud lobsters (*Thalassina anomala*) in the Indo-West Pacific dig burrows of several meters in depth and create mounds of filtered mud at the sediment surface that can substantially change the topography of the mangrove forest floor. We hypothesize: 1) *T. anomala* changes organic matter by digestion and redistributes it from deeper layers to the surface. 2) Bioturbation by *T. anomala* leads to deeper penetration of oxygen into the sediment, creating a change in microbial communities from anaerobic to aerobic and generates an efflux of carbon dioxide to the atmosphere via aerobic respiration. 3) Dissolved organic and inorganic carbon that has accumulated in water inside the burrow gets washed out into the ocean by the tidal pump of the porewater. To differentiate physical from biological effects of the burrows, we conducted an exclusion experiment with artificial burrows and compared those with natural burrows and bulk sediment. To test our hypotheses, we measured the content and recalcitrance of organic matter in the burrow wall sediment, analysed the microbial community metabolism, quantified CO_2 effluxes from the burrows, and measured the DOC and DIC concentrations in the sediment pore water across tidal cycles.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 7.7B. The spatial and temporal distribution of mangrove coastal protection benefits against storms

Narayan, S.,[1] Thomas, C.,[2] Nzerem, K.,[2] Beck, M.W. [3]

[1]Department of Coastal Studies, East Carolina University, Greenville, NC
[2] Risk Management Solutions, London, U.K.
[3]Coastal Resilience Lab, Institute of Marine Sciences, University of California Santa Cruz

Mangroves are known to protect coastlines and communities from storm damage by acting as natural barriers to oncoming storm surge flooding. The damage reduction benefits of mangroves depend on several factors including storm characteristics, mangrove extents and the extent of mangrove-adjacent assets that are exposed to storm damage. Yet, little is known about the variability in these benefits, particularly the spatial distribution of damage reduction benefits or the distribution of these benefits across different storm frequencies. In this paper, we combine hydrodynamic models of storm surge flooding with datasets of economic exposure to investigate mangrove effects on flood damages in Florida for two scenarios: mangroves present, and mangroves absent. We apply these models to 100 events in south-west Florida, and to a single event across the entire state to understand spatial and temporal variations in mangrove benefits. We find that mangrove effects, while mostly positive, can have negative effects in some locations. We also find that mangroves tend to offer the greatest benefits for certain storm frequencies.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Communicating Science to Policymakers: Blue Carbon Policy

Navarrete, A.,[1] Scheelk, B.[1]

[1]The Ocean Foundation

In this talk, entitled: "Communicating Science to Policymakers: Blue Carbon Policy" we will explore how The Ocean Foundation is reducing climate change vulnerability and impacts through restoration and nature-based solutions (NbS) in coastal-marine ecosystems including a review of case studies in Mexico and activities being carried out to implement NbS from a regional and national perspective in Mexico. Activities discussed include the maintenance and restoration of mangrove ecosystems, learning about the collection of consistent quantitative and qualitative data on the effectiveness of NbS, and sharing experiences on how mangroves, coral reefs, and seagrasses provide important ecosystem services for climate change adaptation and mitigation. Partners The Ocean Foundation, Fundación Mexicana para el Océáno AC, UNEP's Caribbean Environment Programme, the Mexican Carbon Program, UNAM ENES, CINVESTAV, and the government of Mexico, represented by the Ministry of Environment and Natural Resources, through the Commission of Natural Protected Areas (CONANP), have worked towards identifying the main challenges for implementing blue carbon ecosystem restoration as a NbS, which has been proven to recover ecosystem services and associated livelihoods. All of this has been shown to legislators and policy makers and has been the basis for open discussions on blue carbon policy and legislation in Mexico.

Code: 7.3A. Using causal modeling to understand resilience of mangrove ecosystems to hurricane impact

Ogurcak, D.E.,[1,2] Shribman, Z.I.,[1,3] Colon-Lozada, K.,[1,2] Schmid, J.,[1,2] Pabon, A.,[4] Krauss, K.W.,[5] Dieppa, A.,[4] Munoz, M.,[4] Carter, J.,[2] Figueroa, M.,[1,2], Black, J.,[2], Ramirez-Jimenez, A.,[1] and Guarin, A.[1]

[1]Florida International University, Miami, FL
[2]Rookery Bay National Estuarine Research Reserve, Naples, FL
[3]Tulane University, New Orleans, LA
[4]Jobos Bay National Estuarine Research Reserve, Naples, FL
[5]U.S. Geological Survey, Wetland and Aquatic Research Center, Lafayette, LA

Mangrove ecosystems located within the Greater Caribbean region are frequently impacted by tropical cyclones. Recovery following disturbance is highly spatially variable and dependent on numerous factors, including proximity to hurricane landfall, local storm effects, geomorphic characteristics, and the legacy of prior disturbances. Mangroves in this region provide substantial ecosystem services to nearby coastal communities. Here, the resilience of the human-natural ecosystem is being challenged by the cumulative effects of climate change, urbanization, and regional water management. In 2017, impacts from Hurricanes Maria and Irma resulted in extensive damage to two mangrove-dominated estuaries within the National Estuarine Research Reserve (NERR) system: Jobos Bay NERR (Salinas, Puerto Rico) and Rookery Bay NERR (Naples, Florida). In an effort to understand the relationships between drivers of hurricane impact and recovery in these reserves, the Mangrove Coast Collaborative (MCC) project was initiated in 2020. The project has engaged a diverse group of stakeholders to provide localized expertise on impacts to these mangrove ecosystems. During workshops held in 2021, a conceptual model of the relationships between drivers, antecedent conditions, and recovery from Hurricanes Maria and Irma was developed; this model serves as the hypothesis for subsequent analysis of the data using structural equation modeling (SEM). In 2022 and 2023, 64 and 70 100m^2 plots were sampled in JBNERR and RBNERR respectively, with the majority of locations selected via a random sampling design stratified by geographic location and dominant species composition. Metrics sampled at each site included forest composition, stem diameter, canopy closure, regeneration (seedling / sapling counts), average canopy height, and stem mortality/damage. Areas of low recovery (as measured by the extent of regeneration) have been identified and are frequently associated with either natural or anthropogenic barriers resulting in tidal restriction. Further work to assess the hydrologic regime at sites of continued low recovery is recommended.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 12.5B. Difference in the use of mangrove forest and its relationship with resource availability and change of ancestral practices in Afro-descendant and Embera-indigenous communities.

Ortiz, A.M., [1] Aristizábal, V., [1] Burgos, A.,[2] Ocampo-Rojas M.A.,[3] Zorrilla M. X., Cantera Kintz J. R. [1]

[1] Universidad del Valle, Colombia
[2] Muséum National d'Histoire Naturelle
[3] Departamento de Biología, Grupo de investigación en Ecología de estuarios y manglares.

Human populations in coastal regions have a tight bond with marine, estuaries, and nearby freshwater ecosystems including mangrove forests. Anthropogenic impacts on mangroves threaten the availability of provisioning and cultural services while also generating changes in ancestral cultural practices. We conducted 140 semi-structured interviews in six locations in the Colombian Pacific. We found that Afro-descendants primarily use mangrove fishing resources for commercial purposes while Embera-indigenous use them for subsistence, but both cases influence household income. Both groups reported a decrease in resources, which had a direct impact on their diets, economies, and ancestral cultural practices such as the transition from piangua (mangrove clam) extraction to fishing by afro-descendant women, and a transition from riverine fishing to fishing in estuaries and the sea by Embera-indigenous. The main reported causes for the decrease in resources included increased population, pollution, and unsustainable fishing. Nowadays, given the scarce resources, artisanal fishermen require more and more effort for benefits del 15% to 20% compared to those reported 20 years ago. Therefore, Afro descendant communities reportedly prefer that future generations focus on other livelihood activities rather than ancestral interactions with the mangrove ecosystem. Communities and their cultures are complex ecological actors, determined by the use and perception of resources. As such, to manage effective conservation and restoration strategies for coastal marine ecosystems, it is necessary to understand how resource availability is influenced by humans and how those changes affect cultural practices and ecological interactions of different groups of stakeholders withholding different traditions and practices in a shared space.

Theme 6: Changing human relationships with mangrove wetlands

Code: 13.4A. Ecological Influencers - What people know and think about mangroves on social media.

Olefs, L.,[1,2] Simpson, M.,[3] Hugé, J.,[1,4,5] Friess, D.A.,[6] Dahdouh-Guebas, F.[1,5,7,8]

[1]Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium
[2]White Green Blue – Sustainable You. Baal, Belgium
[3]Project Osiris Cic, United Kingdom
[4]Department of Environmental Sciences, Open University of the Netherlands. Valkenburgerweg 177, Heerlen 6419AT, the Netherlands
[5]Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, 1050, Brussels, Belgium
[6]Department of Earth and Environmental Sciences, Tulane University. 6823 St Charles Ave, New Orleans, Louisiana 70118, USA
[7]Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, 1050, Brussels, Belgium
[8]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN)

Online social platforms like Twitter are growing larger each day. These platforms are central to information exchange between individuals, organisations, NGOs, governments and research institutions. Previous research has shown that the way we communicate has a large impact on conservation awareness and project success, alongside the integration of a multi-stakeholder approach. Mangrove forests are one of those ecosystems that has benefited from social media to spread awareness of their role as socio-ecological systems. Here, we discuss current awareness and perceived value of mangroves by Twitter users from 2010-2022 from a text-mining perspective in which we searched for the terms: 'mangrove', 'mangroves', '#mangrove', or '#mangroves'. A comparative search was done for adjacent ecosystems. R was used to harvest the tweet texts and Python to clean the data (i.e. removing stop words and links) and to analyse bigrams (collectives of 2 words that most frequently appear together in the tweet text). The top 100 bigrams were collected and analysed. The number of annual tweets on mangroves has increased from 2010-2020 with its all-time high in 2020. Much of this communication has been in the framework of mangrove restoration by reporting on tree planting activities. Recurring bigrams displayed the highlights of mangrove news and awareness for each year. We also found that mangroves are used as ecological influencers for other connected but lesser-known ecosystems such as seagrass meadows and salt marshes. We concluded that the last decade of mangrove communication on Twitter has helped to push mangroves towards the forefront of climate action, nature conservation and nature restoration activities.

Theme 6: Changing human relationships with mangrove wetlands

Code: 16.2B. Mangrove conservation and restoration in collaboration with community women groups in the Northwest of Mexico.

Ortega Trasviña, L.C.,[1] Martínez Vázquez, F.C.,[1] Franco Ortiz, M.,[1] Frausto-Illescas, T.C.

[1]COSTASALVAJE, A.C., Mexico

Mangrove conservation is a natural solution against climate change. Although mangroves are protected by Mexican law, in the last 40 years, Mexico has lost 9% of its mangrove forests. The environmental impact of mangrove losses and the effects of climate change tend to be greater for women due to systemic gender discrimination and social expectations of gender roles. This project's objective is to conserve and restore 62.5 hectares of mangroves in two locations in Baja California Sur, Mexico, in collaboration with two community women's groups: Guardianas del Conchalito and Mujeres Unidas del Dátil. El Conchalito, a 40.5 hectares urban mangrove forest in La Paz, is threatened by growing urbanization and unregulated recreational use. The Guardianas del Conchalito carry out conservation work that includes monitoring, environmental education, clean-up campaigns, and visitor management. In El Dátil, the mangroves support local fishing. The Mujeres Unidas del Dátil have planted 80,000 red mangrove (*Rhizophora mangle*) seeds across 40 hectares of degraded mangrove forest. A workshop was held in October 2022 which brought together both groups to learn from each other's successes and lessons.. Six community groups attended the workshop which initiated a partnership which will allow them to continue sharing achievements, challenges, and progress. Community participation in mangrove conservation and restoration projects is essential to achieve short and medium term positive outcomes and contribute to the restoration of this vital ecosystem. Supporting and collaborating with community groups of women advances their goal of economic independence since these projects generate jobs. The project not only restores ecosystems, but also restores the women and their social environment.

Theme 3: Achieving sustainable socio-economic development and equity

Code: 2.2. Finding the window of feasibility for restoration in the face of biophysical, socioeconomic, and governance constraints

[1,2]Piccolo, R.L., [2]Saunders, M.I., [3]Brown, B.M., [1]Buelow, C., [4]Friess, D.A., [5]Lovelock, C.E., [1]Brown, C.J.

[1]Coastal and Marine Research Centre, Australian Rivers Institute, School of Environment and Science, Griffith University, Gold Coast, QLD 4222, Australia

[2]CSIRO Environment, St Lucia, Brisbane 4067, Australia

[3]Research Institute for Environment and Livelihoods (RIEL), Casuarina Campus, Charles Darwin University, Darwin, Northern Territory 0810, Australia

[4]Department of Earth and Environmental Sciences, Tulane University, New Orleans, Louisiana 70118, USA [5]The University of Queensland, School of Biological Sciences, St. Lucia, Queensland 4072, Australia;

Adequate planning is necessary to ensure restoration success. The likelihood of success (i.e., feasibility) of restoration may be qualitatively considered when making decisions around restoration, but quantitative frameworks have not been developed. There are several different feasibility factors, including biophysical, social, governance, resources, and logistical aspects that may co-vary across space. Therefore, it is important that qualitative and quantitative assessments of feasibility are integrated into spatial planning for restoration. We developed a framework for quantifying feasibility for spatial planning of restoration. Then, using mangrove ecosystems as a case-study, we identified windows of feasibility where multiple factors correspond spatially to mean restoration has the greatest chance of success. Finally, we determined what management interventions could jointly improve multiple types of feasibility. We found that considering multiple feasibility factors can geographically restrict restoration. However, feasibility could increase with management interventions including legislation, ecosystem service payments, and education. Understanding the influence of multiple factors during site selection is necessary to inform spatial planning for restoration and to improve success rates of restoration actions.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 2.4. Drivers and impacts of brachyuran distribution in South African mangroves

Peer, N.,[1] Miranda, N.A.F.,[2] Rajkaran, A.,[3] Rishworth, G.[4]

[1]Stellenbosch University, South Africa
[2]Argonaut Science, South Africa
[3]University of the Western Cape, South Africa
[4]Nelson Mandela University, South Africa

Mangroves, and their associated biota, exist within tropical, subtropical and warm temperate intertidal zones where they play a key role in shoreline protection, nutrient recycling, filtration of run off, and resource provision. In South Africa, mangroves are situated in estuarine habitats along the east coast where they occur at a southern latitudinal limit and are displaying a poleward shift, often encroaching significantly on saltmarsh habitat. Associated brachyurans seem to be experiencing a similar shift. Using field surveys and species distribution models, we investigated the drivers of mangrove crab distribution. We found that biotic factors must be considered alongside abiotic factors when modelling current and potential distribution and that latitude is not a strong driver of presence or abundance within South African mangroves. Specifically, the diversity of mangrove macrofauna, plant morphology, and the presence of certain mangrove species all influence mangrove brachyuran presence and abundance. We outline current research efforts including the use of barcoding and metabarcoding approaches to monitor mangrove brachyuran distribution, the impacts of mangrove-associated brachyurans on newly invaded ecosystems, and the response of key species to global change impacts.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 3.2. The impact of species- and site-specific hydraulic plant parameters on the forest structure – what do we (need to) know?

Peters, R.,[1] Wimmler, M.C.,[1] Vollhüter, J.[2]

[1]TU Dresden, Germany
[2]FU Berlin, Germany

As mangrove trees cope with extremely low osmotic soil water potentials of -3MPa at sea water salinity down to below -6MPa at hypersaline sites, water availability is one of the main factors influencing their growth and survival and the subsequent forest composition and structure. The hydraulic architecture is a key element for the growth of a single tree. Parameters essentially controlling the water uptake are (i) xylem conductivity k_s and (ii) root hydraulic conductivity L_P. Wider vessels increase xylem conductivity at the price of hydraulic safety and the risk of embolisms. Studies on xylem conductivity and vessel diameter distribution indicate typical species-specific characteristics and site (i.e. salinity) dependent plasticity. Moreover, laboratory experiments generating vulnerability curves describing the loss of conductivity by hydraulic failure in relation to extremely low water potential. Root hydraulic conductivity is lower than for terrestrial plants as salt ions have to be prevented from entering the tree's hydraulic system. For mangroves, information on that parameter is extremely scarce, but there is evidence of adaptation to porewater salinity, too. Utilising our individual-based mechanistic mangrove model BETTINA, we present the impact of plasticity and adaptation of these two parameters to the water availability of the tree, and consequences on the forest scale due to the feedback with the soil water and salt balance. We put a light on the implication of species-specific vessel distributions on tree transpiration and hydraulic safety and highlight possible benefits of more systematic knowledge on species-specific relations between prevailing water potentials, vessel diameter distributions, xylem conductivity, and risk of hydraulic failure. This may lead to a better understanding of functional differences between species and a better predictability of species occurrence.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.4B. Microplastics in mangrove ecosystem sediments, Pacific Coast of Colombia

Palacios Peñaranda, M.L.,[1] Castañeda Quintero, P.A.,[1] Gordillo, M., Peña Salamanca, E.J.[1]

[1]Universidad Autónoma de Occidente, Cali, Colombia.

Microplastic contamination is a worldwide concern due to its abundance, distribution and negative impacts on coastal marine ecosystems. These particles enter ecosystems through wastewater discharge and improper disposal of solid waste. The objective of this project was to determine the abundance, distribution and physical characteristics of microplastics in mangrove sediments at different depths in the Colombian Pacific. Sampling was conducted in the mangroves of San Pedro (SP) and Punta Soldado (PS) during the dry and rainy season, both during low tide break. Six square plots (100 m^2) were established in each location, with a distribution of three replicates in outer mangrove (EXT) and three replicates in inner mangrove (INT) with respect to the coastline, sediment samples were extracted at different depths between 0 and 300 cm. The samples were digested and filtered, and then observed under a microscope where they were quantified and measured with LAS software. In dry season, microplastics were identified in 100% of the samples and a total of 1,344 particles, the most abundant form was fiber (95%) in both locations, the estimated size was between 0.1 and 5 mm, being the blue and translucent colors the most representative in the particles. The EXT replicates in SP had a higher abundance of particles than the INF replicates, while in PS the INT replicates had a higher abundance.

Theme 2: Understanding and solving marine pollution in mangrove wetlands

Code: 11.1A. Loss of mangroves due to hard freeze leads to coastal erosion

Pennings, S.C., and Armitage, A.R.

It is widely assumed that mangroves stabilize sediments and protect shorelines from erosion. It is rare, however, for these benefits of mangroves to be documented with rigorous, ground-based measurements. We manipulated mangrove cover from 0 to 100% in ten 1,008 m-2 plots in Texas, USA. At this location, black mangroves are stunted, reaching maximum heights of ca. 2.5 m at the water's edge and ca. 0.5 m in the interior of the forest. In the experiment, we documented higher rates of erosion in the plots with the lowest mangrove cover. A major hurricane (Hurricane Harvey, August 2017) that passed directly over the plots did not dramatically affect erosion because it did not kill mangroves. In contrast, a hard freeze in February 2021 killed almost all the mangroves in the plots. Following the freeze, we documented sharply increased rates of erosion in all ten plots. The combination of the manipulative experiment and the natural experiment (the freeze) provide rigorous documentation that even the dwarf mangroves typical of Texas mangrove forests provide important shoreline stabilization services.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 11.3A. A Method for Long Term Monitoring of Mangrove Forest Change Dynamics Using Multisource Remote Sensing: The Ciénaga Grande de Santa Marta, Colombia

Parra, A.,[1] Murillo, P.,[2], Thomas, N.,[3] Fatoyinbo, L.,[4] Simard, M.[5]

[1]Jet Propulsion Laboratory, California Institute of Technology, United States, Adriana.s.parra@jpl.nasa.gov
[2]Universidad del Tolima, Colombia
[3]University of Maryland/NASA Goddard Space Flight Center, United States
[4]NASA Goddard Space Flight Center, United States
[5]Jet Propulsion Laboratory, California Institute of Technology, United States

The mangrove forest of the Ciénaga Grande de Santa Marta (CGSM) has experienced severe alterations in extent and structure for the past 60 years, mainly due to human-induced modifications of the hydrological fluxes of this lagoon complex. Large die-off events in the 1980's, followed by mangrove restoration projects starting in the 1990's, resulted in a current mangrove extent estimated to be approximately 66% of the original area. In recent years, the dynamic of mangrove cover loss and gain in the CGSM has been heavily influenced by climatic events which indicates this system's vulnerability to future climate change. We propose and evaluate a multisource remote sensing data method for monitoring long term changes, particularly considering NASA's spaceborne LiDAR and Synthetic Aperture Radar (SAR) missions that include the Global Ecosystems Dynamics Investigation (GEDI), the Ice, Cloud, and Land Elevation Satellite (ICESat-2) and the future NASA ISRO SAR (NISAR) mission. In this study, we evaluated the benefits of using multisource remote sensing data for land cover and structural change detection in the CGSM, with the main objective of identifying areas of mangrove degradation, regeneration, loss, or gain. We combined SAR imagery from Sentinel-1 and ALOS/PALSAR, optical imagery from Sentinel 2, and spaceborne LiDAR data from GEDI and ICESat-2. SAR backscatter was used to detect changes in mangrove cover, optical imagery provided information on vegetation health and productivity, and LiDAR data provided information on vertical mangrove structure. Our study includes a multitemporal analysis of mangrove cover change from 2015 to 2022. In order to improve the time-series analysis, the proposed methodology uses spatial objects (i.e., segments) instead of single pixels to track historical trends of homogeneous stands of mangrove forest. This method was particularly helpful for denoising SAR and optical images, and retrieve mangrove stand level statistics on 3D structure from LiDAR data.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 12.1B. Understanding the post-tsunami mangrove socio-ecological system recovery in the Nicobar archipelago drawing on the adaptive cycle heuristic

Poti, M.,[a,b,c] Prabakaran, N.,[d] Hugé, J.,[a,b,e,f] Koedam, N.,[b] Shanker, K.,[c,g] Dahdouh-Guebas, F.[a,b,h,i]

[a]. Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles – ULB, 50 Av. F.D. Roosevelt, CPi 264/1, 1050, Brussels, Belgium, [b]. Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel – VUB, 2 Pleinlaan, VUB-APNA-WE, 1050, Brussels, Belgium, [c]. Dakshin Foundation, 2203 D Block, 8th Main, 16th D Cross, Sahakar Nagar, Bangalore, 560092, India, [d]. Wildlife Institute of India, 18 Chandrabani, Dehradun, 248001, India, [e]. Department of Environmental Sciences, Open University of the Netherlands, 177 Valkenburgerweg, 6419AT, Heerlen, the Netherlands, [f]. Centre for Environmental Sciences, Hasselt University, 42 Martelarenlaan, 3500 Hasselt, Belgium [g]. Centre for Ecological Sciences, Indian Institute of Science, Bengaluru 560012, Karnataka, India [h]. Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), c/o Zoological Society or London (ZSL), London, United Kingdom, [i]. Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles – ULB, 50 Av. F.D. Roosevelt, 1050, Brussels, Belgium

Understanding how ecosystems and people respond to disturbances and how they reorganise following the disturbance is a crucial aspect of disaster recovery research and management. The 2004 Sumatra-Andaman earthquake and tsunami caused immense destruction of coastal biodiversity and livelihoods in the Nicobar archipelago of India. The coupled impacts of high intensity tsunami waves and the coastal subsidence of 1.1 – 3 m caused a socio-ecological crisis, as the archipelago lost 97% of its mangroves which played a major role in the livelihood of the indigenous Nicobarese community. This study aims to understand how the Nicobar mangrove social-ecological system (SES) react(ed) to the coastal subsidence induced sea level rise and tsunami, and how they shape mangrove dynamics. We use the adaptive cycle as a heuristic to conceptualise the changes, between its phases (release-Ω, reorganisation-α, growth-r and conservation-K) in relation to the capital (natural, built, human and social), connectedness and resilience of the mangrove SES. In addition, we exemplify how we can use the adaptive cycle to understand and predict cycles of renewal in the mangrove SES. The tsunami was a major release (Ω) event and triggered changes in all accumulated resources in the mangrove SES, resulting in almost complete loss of natural and built capitals. Although social and human capital declined drastically, resources were retained in the form of knowledge and skills. Results suggest that the mangrove SES is currently either in early or mid growth (r) phase. As the post-tsunami mangrove recovery in the Nicobar archipelago is confronted with shifted coastlines, ensuring the propagule availability of the right species in the new intertidal habitats (previously terrestrial areas) through management interventions will be crucial to overcome the poverty trap. This will facilitate faster mangrove recovery (r-phase), which is otherwise experiencing the challenges of shifted baselines for ecological restoration.

Theme 6: Changing human relationships with mangrove wetlands

Code: 2.3. Despite Being Smaller in Area, Urbanized Mangroves Provide Important Functions Along the Atlantic Coast of Florida

Reyes, G.J.,[1,2] Smyth, A.R.,[1,2] Reynolds, L.K.,[2] and Simpson, L.T.[3]

[1]University of Florida, Soil, Water, and Ecosystem Sciences Department, Tropical Research and Education Center, Homestead, Florida
[2]University of Florida, Soil, Water, and Ecosystem Sciences Department, Gainesville, Florida
[3]Florida Oceanographic Society, Stuart, Florida

Mangrove forests are rapidly declining in number and size, especially in urban areas. Our mapping found that urban mangroves are small in area, but it is unclear how the physical structure and function of these mangroves compare to larger non-urbanized mangrove areas. Our goal was to compare mangrove stand characteristics, carbon storage potential, and removal of contaminants along a gradient of urbanization. This information will help us quantify the ecosystem services these mangroves provide to cities to support their conservation. We expected that the degree of urban pressure affects mangrove stand size, species composition, sediment chemistry, and biogeochemical processes related to nitrogen and carbon cycling. We sampled mangrove stands throughout Miami-Dade County, Florida, USA, which contains one of the largest cities in Florida and large estuarine preserves. We used impervious surface cover and population density to categorize urbanization throughout the county. We measured mangrove species biomass (composition, stand size and diversity) and sediment characteristics (sediment carbon, nitrogen, organic matter, and metal concentrations) to characterize forest structure and function at 14 sites. Results indicate that mangrove diversity is higher in more urbanized stands. Heavy metal concentrations increase with urban intensity, while sediment organic matter and nitrogen content decrease. These changes in mangrove physical and chemical structure may have further implications on the provisioning of important ecosystem functions. Additionally, we measured denitrification and decomposition rates. Preliminary results suggest denitrification rates increase with increasing urban intensity. Decomposition rates varied along the gradient. Despite human influence on their physical and chemical structure, highly urbanized mangroves store metals, remove nitrogen, and are more diverse than less urban mangroves. Our data provide evidence that, while smaller in area, urban mangroves may contribute to key ecosystem functions that are valuable to coastal communities and should remain a feature in the urban landscape.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 6.4A. Assessing the health and biodiversity of mangrove forests across a disturbance gradient in South Africa to prioritise actions for restoration

Rajkaran, A.,[1] Badrodien, Y.,[1] Boatwright, S.,[1] Engelbrecht, A.,[1] Govender, J.,[2] Johnson, J.,[1] MacDonald, A.,[2] Ramdhani, S.,[2] Theron, W.,[1] Zide, A.,[1] Sershen[1]

[1] Department of Biodiversity and Conservation Biology, University of the Western Cape, Robert Sobukwe Way, Bellville, Cape Town, South Africa, 7530.
[2]School of Life Sciences, University of KwaZulu-Natal, Durban 4000, South Africa Email Address: arajkaran@uwc.ac.za

The ability of mangroves to maintain their position in coastal zones and ecological functionality in a changing climate depends on the geomorphology of the natural settings available in the intertidal area, changes in hydrology (both freshwater and marine) and anthropogenic activities. This study is aimed at (1) improving our knowledge of how disturbances have affected South African mangrove ecology and diversity; (2) characterizing bacterial and fungal communities using genomic tools and (3) and quantifying the tree population changes (before and after 2018) in forests across the eastern coast of South Africa. The results show that disturbance types and levels differ greatly between estuaries and forests. The resulting pollution retention (microplastics and metals) has reduced the ability of mangroves to provide high quality nursery habitats for different biota with all study sites recording microplastics in the water, sediment and keystone animal species. Metal concentrations were detected, in descending order, in sediments >below-ground roots >above-ground roots >leaves >porewater >surface water. For the first time in South Africa the microbial and fungal diversity was estimated using 16S and ITS2 primers and compared within and amongst sites. Despite disparities in diversity amongst bacterial and fungal assemblages, inter-site differences were consistent with levels of perturbation. Variable rates of mangrove seedling and sapling survival was recorded across mangrove forests with *Avicennia marina* dominating most forests but not all. Reproductive outputs have remained similar at most sites and tree diseases have been quantified. The small, marginal mangroves of SA are threatened by a myriad of anthropogenic disturbances and our current responses are limited by variable governmental capacity, decaying infrastructure and unchanging human behavior. Further loss of biodiversity and ecosystem services could be mitigated but requires urgent attention and meaningful action by all stakeholders across the country.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 8.3B. International Collaboration to Enhance the Management and Carbon Accounting of Mangrove Ecosystems

Roldán, R.B.,[1] Cannizzo, Z.J.,[2] Crooks, S.[3]

1Silvestrum Climate Associates
[2]NOAA Office of National Marine Sanctuaries - National MPA Center [3]Silvestrum Climate Associates

Effective mangrove management, and inventories of associated greenhouse gas reduction benefits, are critical components of the Paris Climate Agreement Nationally Determined Contributions (NDC) of numerous countries in Latin America and around the world. However, many countries lack sufficient data, capacity, and expertise to achieve these objectives. The NOAA Blue Carbon Inventory (BCI) Project, part of the U.S. Transparency Accelerator for Greenhouse Gas Inventories, works with partner countries to advance the development of emissions mitigation, coastal resource management, and resilience strategies that reflect the societal and climate mitigation value of mangrove ecosystems. This multi-agency project engages partner countries by providing technical guidance and building local capacity to enhance the inclusion of mangroves and other wetlands into national greenhouse gas inventories, and advance the long-term sustainable management of mangrove ecosystems. NOAA, the U.S. EPA, the Smithsonian, and others work with government agencies and protected area managers in partner countries to identify needs, develop training, and provide technical assistance. These efforts ensure the capacity and expertise exist to effectively manage mangrove ecosystems for the multiple ecosystem services they provide while quantifying those benefits for inclusion in national greenhouse gas inventories, carbon markets, and other pay-for-service programs. The first implementation of the BCI occurred in partnership with Costa Rica in 2022, and the project is currently expanding to partners in Latin America, Africa, and Asia. In this presentation, the BCI will share the approach developed to address the key goals of enhanced mangrove management and emissions accounting. Sharing this approach will engage mangrove practitioners, scientists, and decision makers to advance the integration of mangrove science and management in Latin America and globally. Sharing these successes, lessons learned, and early outcomes can guide future science, management, and international collaboration around the management and documentation of mangroves and their climate benefits.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 12.4A. Development and validation of a model of the response of adjacent mangroves and saltmarshes to sea-level rise

Rogers, K.,[1] Mogensen, L.A.,[1] Repina, O.,[1] Saintilan, N.[2]

[1] School of Earth, Atmospheric and Life Sciences, University of Wollongong, NSW, 2522, Australia
[2] School of Natural Sciences, Macquarie University, Sydney, NSW, 2109, Australia

Models of the response of mangroves and saltmarshes to sea-level rise (SLR) are needed to inform coastal decision making. Zero-dimensional models that simulate the evolution of a point are foundational for developing spatially explicit landscape models projecting extents under future SLR scenarios. However, both zero-dimensional and landscape models have suffered from insufficient calibration, and inadequate validation. This study aims to develop, validate, and apply a zero-dimensional model framework using real data from four sub-sites in Westernport Bay, Australia that exhibit varying rates of mineral and organic matter addition and autocompaction. This model was calibrated to correspond to tidal parameters at each sub-site and validation was undertaken across timescales encompassing the: i) observational period over which measurements of surface elevation gain were determined using a network of surface elevation tables (~20 years); ii) period when higher resolution colour aerial photography was available (~35 years); and iii) period of landscape evolution occurring under relatively stable sea levels of the previous two millennia. The model performed well across timescales and comprehensive validation provided the necessary confidence for exploring scenarios and model development at the landscape scale. The model indicated substantial shoreline retreat by 2100 when sediment supply is low and SLR is at the higher end of projections. Shoreline retreat also occurs when sediment supply is high, implying that 'keeping pace with SLR' cannot be achieved in the foreseeable future without substantial interventions. Critically, where sediment supply is low, even high elevation saltmarshes are projected to be colonised with mangroves by ~2070, and saltmarshes will be restricted above the current tidal limit – a zone with many competing land covers and land uses. This study demonstrates the critical need for site-specific data, a crucial component that is undervalued, often insufficiently resourced to generate useful data, and commonly addressed by extrapolating parameters generated from elsewhere.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 12.2B. "**Mangroves and Coastal Resilience: Challenges for Reporting on Socio-Ecosystem Services across Latin America, Africa and Asia"**

Reingold, J.[1]

[1]coordinator of the 'Mangroots' cross-border research team.

'Mangroots' is a cross-border investigation project produced through a Coastal Resilience grant from the Earth Journalism Network. During 2022, the group of journalists visited endangered mangrove forests in five different countries to report on how coastal communities can achieve resilience through proper mangrove management. Methods: primary data was recollected in all the case-studies. El Salvador: in the lower basin of the Río Paz IUCN is carrying out a lighthouse regional coastal biodiversity project to increase eco-services provided by mangroves, such as beekeeping, crab fishing and sustainable tourism. Colombia: the island of San Andrés suffered Hurricane Iota 2020, and the collateral damage on the coral reef and the mangrove barrier is felt until today. Ghana: major Ramsar sites such as Keta Lagoon and others have been facing rapid degradation and in the next decade the country will lose its wetlands entirely to aggressive real-estate developments. Kenya: rising demand of wood products, real-estate and clearing for salt extraction has caused the loss in 40 years of about 20% of its mangrove cover. Along the Kenyan coastline efforts are happening to adopt the National Mangrove Management Plan. he Philippines: in Malampaya Sound -the country's fishbowl- aquaculture development, pollution, and climate change are imperiling the country's mangrove forest. Today, thanks to community partnerships and Indigenous belief systems, the importance of preserving mangroves is widely recognized and the area's coastal forests and fisheries are seeing a recovery. Results: These stories were published in Mongabay, Radiónica, The Standard, Citi Newsroom and Diálogo Chino (upcoming). Further details of each case-study will be shared during the presentation. This presentation will focus on the challenges involving mangrove journalism in the Global South , why news outlets should give more space to these issues and the key role of environmental communication in the climate and biodiversity crisis.

Theme 6: Changing human relationships with mangrove wetlands

Code: 1.5. Mangrove vegetation response to sea level decrease caused by coastal uplift in North Andaman Islands, India

Singh, A.R., [1,2] Vedagiri, T., [1,3] Prabakaran, N.[1]

[1]Post box No: 18, Wildlife Institute of India, Chandrabani, Dehradun 248001, India
[2]Gurukul Kangri (deemed to be) University, Haridwar 249404, India
[3]Department of Botany, Madras Christian College (Autonomous), Tambaram East, Chennai 600 059, India

The permanent retrieval of tidal water due to coastal uplift after the 2004 tsunami has caused massive degradation of mangroves in North Andaman (135 km^2). Meanwhile, the reef bed and the sea floor in the uplifted sites provided an opportunity for the seaward expansion of mangroves; while, the degraded mangrove vegetation provided an opportunity for the expansion of terrestrial forest. To understand the vegetation successional patterns, we studied three habitat categories, namely, New Terrestrial Forest (NTF) – terrestrial vegetation colonizing on the erstwhile mangroves; Old Mangrove Forest (OMF) – mangrove vegetation that undergone a change in tidal regime, however, remained as mangroves; and, New Mangrove Forest (NMF) – sea floor and reef beds with seaward mangrove expansion. A total of 243 plots (10 x 10 m^2) across nine sites, 81 plots/habitats category was established to study the tree diversity patterns. Species richness was highest in NTF sites (n=92 species, 88 terrestrial and 4 mangrove species), while NMF and OMF sites hold eight and 12 mangrove species respectively. The tree density/plot (100 m^2) was lowest in the NTF (3.84±0.62), followed by NMF (7.68±1), and was highest in OMF (8±0.75) sites. Contrarily, the basal area/plot was lowest in NMF (681.20±87.8 cm^2), followed by NTF (924.11±145.67 cm^2), and was highest in OMF (1802.07±260.10 cm^2). *Tetrameles nudiflora* (13%) was the most abundant species at NTF; while *Rhizophora mucronata* (36%) was the most abundant species at NMF sites and *Rhizophora apiculata* (44%) was the most abundant species at OMF. The species diversity and composition among the OMF and NMF have varied significantly ($p<0.001$). Our study has created a baseline on species diversity and community composition patterns in mangroves following a drop in sea level. Further, long-term monitoring of established plots would be critical in understanding competition and community dynamics in these unique successional forests.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 1.6. Biotic and abiotic influences on forest growth dynamics across different aged mangrove stands in west Papua, Indonesia

Sillanpää, M.,[1,2] Pandu Yudha, R.,[3] Krauss, K.W.,[4] Muhtarom, S.,[3] Heatubun, C.D.,[5,6] Xiang Teo, R.,[2] Wardle, D.,[7] Lupascu, M.,[1] and Friess, D.A.[8]

[1] National University of Singapore, Geography Department, Singapore
[2] Green Forest Product and Tech. Pte. Ltd., Singapore
[3] PT. Bintuni Utama Murni Wood Industries, Jakarta, Indonesia
[4] United States Geological Survey, Wetland and Aquatic Research Center, Lafayette, LA, USA
[5] Research and Development Agency of Provincial Government of West Papua (Balitbangda Papua Barat), Manokwari, Indonesia
[6] Universitas Papua, Forestry Department, Manokwari, Indonesia
[7] Umeå University, Department of Ecology and Environmental Science, SE-901 87 Umeå, Sweden [8] Tulane University, Earth and Environmental Sciences, New Orleans, LA, USA

The largest mangrove forest concession in the world (82 000 ha) is in Bintuni Bay, West Papua, Indonesia. The concession undergoes a selective logging regime over a 30-year logging period, following principles of sustainable forest management. This provides a unique opportunity to investigate ecological principles of forest growth across a managed mangrove landscape. In particular, understanding the biotic and abiotic processes that influence rates of tree growth and forest structure. Such knowledge is important to further understand the underlying ecology of mangrove forests, and what influences their ability to grow biomass and sequester blue carbon. We estimated individual tree and species-level growth in Bintuni Bay mangroves and the influence of biotic (forest structure), and abiotic (soil, tidal inundation, climate) on growth rates. Since 2018, over 370 dendrometers were installed and measured on trees from different canopy layers in forest plots at different stages of regeneration (5, 10, 15, 20, 25-year and unharvested plots). Forest structure (species, diameters, heights, density) at plot level and growth increment of each tree dendrometer band, was measured every 4 months and year, respectively. In 2022, soil conditions (C, N, P, K, Salinity, pH) and tidal inundation were measured in each plot. Rates of tree growth differed between canopy layers and forest stand ages. Tree diameter growth rates slow down with forest stand age, from 0.761±0.412 cm yr^{-1} at 5 years to 0.270±0.267cm yr^{-1} at 25 years. Tree located in lower height canopies (mean growth rate: 0.102±0.129 cm yr^{-1}) show reduced growth compared to the trees in the main canopy (mean growth rate: 0.597±0.305cm yr [1]). Effects of soil conditions, tidal inundation, and climate are currently being analysed. These results will provide a stronger understanding of the dominant factors influencing growth dynamics and can help maximise the ability of mangrove forests to sequester carbon at higher rates.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 2.1. Effects of climate variability and hydrologic rehabilitation measures on long-term mangrove trajectories: from reproduction to recruitment and landscape cover changes

Sanchez, D.A.,[1] Rodriguez-Rodriguez, J.A.,[2] Mancera, J.E.[3]

[1]Universidad Nacional de Colombia Sede de La Paz, Colombia
[2]Deakin University, INVEMAR, Australia
[3]Universidad Nacional de Colombia sede Bogotá, Colombia

We used long-term observations to assess the effects of El Niño Southern oscillation (ENSO) variability and hydrologic rehabilitation on propagule density, seedling/saplings growth rates, demography and landscape cover changes in basin and riverine mangroves of a Neotropical mangrove complex. The effects of hydrologic rehabilitation measures were nested into the effects of ENSO climate variability. Climate variability explained 63% of change in mangrove coverage rates and 61 and 60% of pore salinity in basin and riverine sites, respectively. Freshwater diversions that reconnect river flooding foster mangrove recovery, but in synergy with an episode of La Niña delayed recovery. Sediment dredging higher than 150.000 m 3 in the channel with greater discharge flow or upgraded management of the sediments dredged generated salinity drops and mangrove coverage recoveries beyond of the tendency driven by ENSO conditions during interventions. Salinity, rates of salinity change, and ENSO conditions explained (28—55%) the propagule density of Rhizophora mangle, Laguncularia racemosa and Avicennia germinans in reference basin and riverine sites. The rates of salinity change explained (36—59%) R. mangle and L. racemosa seedling growth rates in the basin site, while salinity explained (40—74%) seedling growth rates of the three species studied in the riverine site. High seedling/saplings diameter growth rates of L. racemosa and R. mangle (0.5—1.6 cm year -1) in rapid salinity drops triggered mangrove tree colonization during consecutive La Niña episodes, while a strong El Niño generated widespread tree mortality in the basin site. Besides salinity, rates of salinity change and climate variability should be considered in mangrove restoration planning and monitoring. Hydrologic rehabilitation designs must consider interactions between climate and hydrologic connectivity together with an adequate disposal of dredged sediments in maintenance operations and of excessive sediment loads from diversion channels.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 3.1. Evolution of coastal forests based on a full set of mangrove genomes

Shi, S.,[1] He, Z., Wu, C.I., Tracy, M.E.

[1]State Key Laboratory of Biocontrol, Guangdong Key Laboratory of Plant Resources, School of Life Sciences, Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-sen University, Guangzhou, China. Email: lssssh@mail.sysu.edu.cn

Genomic studies are now poised to explore whole communities of species. The ~70 species of woody plants that anchor the coastal ecosystems of the tropics, collectively referred to as mangroves, are particularly suited to this exploration. In this study, we de novo sequenced the whole genomes of 32 mangroves, which we combined with other sequences of 30 additional species, comprising almost all mangroves globally. These community-wide genomic data will be valuable for ecology, evolution and biodiversity research. While the data revealed 27 independent origins of mangroves, the total phylogeny shows only modest increases in species number, even in coastal areas of active speciation, suggesting that mangrove extinction is common. A possible explanation for common extinction is the frequent sea-level rises and falls (SLRs and SLFs) documented in the geological record. Indeed, near-extinctions of species with extremely small population size (*N*) often happened during periods of rapid SLR, as revealed by the genome-wide heterozygosity of almost all mangroves. Reduction in *N* has possibly been further compounded by population fragmentation and the subsequent accumulation of deleterious mutations, thus pushing mangroves even closer to extinction. Crucially, the impact of the next SLR will be exacerbated by human encroachment into these mangrove habitats, potentially altering the ecosystems of tropical coasts irreversibly.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.4A. Drones and Doves: Creating a more accurate national-scale mangrove inventory for The Bahamas

Schill, S.,[1] McNulty, V.,[1] Perez, D.,[1] Knowles, L.,[2] and Musgrove, M.[1]

1. The Nature Conservancy, Caribbean Division
2. Bahamas National Trust

Developing better techniques for classifying and monitoring mangroves is a growing need, especially when considering the growing demand for blue carbon markets. For small island archipelagos, global products typically do not resolve mangrove patches smaller than 60m in their smallest dimension. The lack of spatial detail results misclassification and many narrow, fringing, and sparse mangroves to be missed. We present a mapping method that used Planetscope Dove multispectral imagery and TanDEM-X radar data, coupled with extensive drone field work to create the first high resolution (4m) inventory of mangroves across The Bahamas. Using the field data, we identified critical thresholds in elevation to separate broadleaf coppice from mangrove and apply an object-based classification to identify the various categories of mangrove using vegetation and moisture indices, while integrating the radar data to define canopy height and structure. Our objective was to create a dataset that captured the wide variation of all mangrove habitat across The Bahamas. Results of the model were reviewed by a wide variety of local mangrove experts and refined using manual edits. This mangrove baseline provides critical information for determining above ground carbon storage and sequestration rates as well as a monitoring future change. The new mangrove layer has been integrated into a new online Blue Carbon Explorer application built using Google Earth Engine, that will provide government agencies and conservation partners a tool to evaluate and assess mangrove areas in terms of the extent, condition, and change using a variety of archived satellite datasets.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 7.5B. Spatiotemporal pattern of mangrove blue carbon in Southeast Asia as a nature-based solution

Syahid, L.N.,[1,2]. Ward, R.D.,[3,4] Sakti, AD., [1,2], Rosleine, D.,[5], Wikantika, K.[1,2]

[1] Center for Remote Sensing, Institut Teknologi Bandung, Bandung 40132, Indonesia
[2] Remote Sensing and Geographic Information Science Research Group, Faculty of Earth Science and Technology, Institut Teknologi Bandung, Bandung 40132, Indonesia.
[3] Centre for Aquatic Environments, University of Brighton, Lewes Road, Brighton BN2 4GJ, UK. [4] Department of Landscape Management, Estonian University of Life Sciences, Fr. R. Kreutzwaldi 1, 51014 Tartu, Estonia. [5] Ecology Research Group, School of Life Sciences and Technology, Institut Teknologi Bandung, Indonesia.

Mangroves are coastal plants that store more than five times the carbon of temperate, boreal and tropical terrestrial forests, equivalent to 2.5 times annual global CO_2 emissions. This means that mangroves are capable of playing a vital role in climate change mitigation, capturing, and conserving large amounts of carbon that can help reduce anthropogenic atmospheric CO_2 inputs using nature-based solutions. Southeast Asia has attracted a lot of international interest in mangrove research as it has the greatest mangrove area coverage and the greatest species diversity in the world. However, Southeast Asia has also experienced the greatest deforestation of mangroves, which has resulted in the loss of the carbon stored in mangrove forest biomass and soils. This loss has been exacerbated by climate change, which has resulted in the complete loss of mangroves in some areas of Southeast Asia. Better management of mangroves can reduce CO_2 emissions and increase the sequestration potential of disturbed forests. In this study, we demonstrate the spatial variation in blue carbon storage and sequestration in mangroves across Southeast Asia. This study integrates remotely sensed, modelling, and statistical data, with data from literature studies to determine the significance of mangroves in mitigating CO_2 emissions in Southeast Asia using several IPCC emission scenarios. The results of this study indicate that mangroves can play a significant role in reducing CO_2 emissions in Southeast Asia. Mangroves can capture more than a third of the total CO_2 emissions in Southeast Asia. Thus, mangroves can play an important role in achieving the target of reducing net CO_2 emissions committed by countries in Southeast Asia to help to achieve sustainable development goal targets. Thus, this research provides important information that can be used in policy making by presenting how significant a mangrove-based solution can be in mitigating climate change in the World.

Code: 8.7A. Functional analysis of benthic macrofauna in mangroves of the tropical Eastern Pacific (Colombian Pacific coast)

Sierra-Luna[1], V. A., Vásquez S, D. F.,[1] López de Mesa, L. Á.,[1] Ocampo-Rojas, M. A., & Cantera Kintz, J.R.

[1]Universidad del Valle, Colombia

Mangroves are crucial to the persistence of marine biodiversity and key for sustainability of fisheries. However, anthropogenic activities threaten mangroves' health and the goods and services they provide. Benthic macrofauna in mangroves are an ecologically important component of this ecosystem because they link primary producers to higher trophic levels. Estimating benthic macrofaunal functional diversity is crucial for understanding and predicting the response of mangroves to environmental fluctuations. We collected 66 species from seven localities of the Tropical Eastern Pacific (TEP), Colombia, which were classified into 34 functional entities (FEs). For each locality, we calculated the taxonomic distinctness (Δ+), functional richness (FRi), functional redundancy (FRe), and functional vulnerability (FVu) indeces to assess functional integrity. Bahía Buenaventura localities showed the lowest Δ+ and FRi, indicating a smaller occupied functional space and suggesting a decrease in ecosystem productivity. About 55% of the localities showed an average FRe < 2, demonstrating that the majority of FEs were unique species, suggesting that even a moderate loss of benthic macrofauna diversity could cause negative cascading effects for the mangroves of the TEP in Colombia. Our results add to the knowledge of mangrove ecosystem functionality, which is essential for the assessment of mangroves' vulnerability and the estimation of the goods and services mangroves provide, including fishing resources and carbon sequestration.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 11.6A. Exploring 3D Structural Signatures of Mangroves across the Planet

Stovall, A.E.L.,[1,2] Fatoyinbo, L.,[1] Thomas, N.M.,[1] Barenblitt, A.,[1,2] Xiong, L., Lagomasino, D.

[1] NASA Goddard Space Flight Center
[2] University of Maryland

Mangrove forests are vital components of coastal ecosystems, providing habitat for wildlife, protecting against coastal erosion and storms, and sequestering carbon. Despite the importance of mangroves for carbon storage and their widespread distribution, there are few studies that focus on detailed structural measurements of mangroves (e.g. branching architecture, leaf angle) and relatively little is known of the 3D structure of these forests - a key predictor of forest carbon and habitat quality. Accurately quantifying mangrove structure is crucial for assessing climate change mitigating strategies and for guiding conservation efforts in coastal systems. We are using cutting-edge 3D laser mapping from below and above the canopy to understand mangrove trees and forest structure in coastal environments around the world. As part of the Global Terrestrial Laser Scanning (GTLS) Database initiative, we are collecting ultra-high resolution terrestrial laser scanning data in mangrove forests. From the Florida Everglades to Pongara National Park, Gabon, we are capturing the 3D structure of these ecosystems in unprecedented detail. Now, we are leveraging this rich dataset to update allometric predictions of tree-level architecture and biomass, while improving our understanding of the major factors influencing tree structure in mangroves. With these data, we can even begin to understand and predict mangrove root architecture. To complement this work, we are looking at the forest canopy from above at a global scale with the NASA / UMD Global Ecosystem Dynamics Investigation (GEDI) to capture and investigate the vertical structural signatures of different mangroves across the planet. More comprehensive understanding of mangrove structure has direct implications for accurate carbon accounting and mangrove habitat conservation. Moving forward we will apply our newly developed 3D tree allometry to update biomass and structural characterizations of the mangrove forest with GEDI, while continuing to fill data gaps by collecting ground-based laser scanning data at new sites around the world.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 11.5B. Does mangrove conversion to oil palm and coconut plantations alter blue carbon at a similar degree to aquaculture?

Sasmito, S.D.,[1,2] Arriyadi, D.,[3] Bimantara, Y.,[4] Amelia, R.,[4], Saragi-Sasmito, M.F.,[2] Darusman, T.,[3] Basyuni, M.,[4,5] Maher, D.,[6] Hutley, L.B.,[7] Murdiyarso, D.[2,8]

[1]NUS Environmental Research Institute, National University of Singapore, Singapore [2]CIFOR-ICRAF, Bogor, Indonesia
[3]Katingan-Mentaya Project, Bogor, Indonesia
[4]Department of Forestry, Faculty of Forestry, Universitas Sumatera Utara, Medan, Indonesia [5]Center of Excellence for Mangrove, Universitas Sumatera Utara, Medan, Indonesia [6]School of Environment, Science and Engineering, Southern Cross University, Lismore, NSW, Australia
[7]Research Institute for Environment and Livelihoods, Charles Darwin University, Casuarina, NT, Australia
[8]Department of Geophysics and Meteorology, IPB University, Bogor, Indonesia

Impacts of land use and land-cover change (LULCC) on mangrove blue carbon dynamics have been globally studied, specifically those from converted mangroves for aquaculture and agriculture. Yet, there are currently several new frontiers of mangrove loss drivers, including mangrove conversion to oil palm and coconut plantations across coastal areas of Southeast Asia. While their rates of expansion area are increased, there is still limited study on how these expansions affect blue carbon storage. We assessed total ecosystem carbon stocks, spatiotemporal patterns of soil CO2 and CH4 effluxes and carbon burial across six land uses, namely mangroves converted to 15 yrs oil palm, 20 yrs coconut, as well as 20 yrs aquaculture (pond wall and water surface), newly logged mangrove, 10 yrs planted mangrove, and undisturbed mangrove forests reference in North Sumatra, Indonesia. We applied standard protocol for carbon stock assessment in mangrove forests and complementary with direct measurement of CO_2 and CH_4 effluxes by using a closed chamber system with an ultra-portable LGR gas analyser during low tide conditions. We found a dramatically decreased in carbon stocks between 40-90% depending on the carbon pool and time since land uses following mangrove conversion to these multiple land uses. Our preliminary results suggest that the variation in soil CO_2 and CH_4 in our study sites may be controlled by the duration of the disturbances, particularly we observed the highest CO_2 and CH_4 effluxes at newly (occurred in the same year with our measurement) constructed pond wall and logged mangrove locations compared to 15-20 years old of oil palm and coconut plantations. Overall, our findings and dataset provide new emission factors for mangrove conversion to oil palm and coconut plantations and thus it is essential for land-based national emissions reduction reporting.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 16.1A. A New Global Map of Mangrove Canopy Height

Simard, M.,[1] Fatoyinbo, L.,[2] Thomas, N.,[2] Stovall, A.,[3] Parra, A., Lagomasino, D.A., Cavanaugh, K., Murillo Sandoval, P.J., Lucas, R., Buntig, P., Hajnsek, I.

[1]NASA-JPL, United States of America
[2]NASA Goddard Space Flight Center, United States of America
[3]University of Maryland, United States of America

We present a new global map representing mangrove canopy height around the year ~2015. This map is based on the German Space Agency (DLR)'s TanDEM-X data that produced global digital surface models (DSM) with a spatial resolution of 12 meters. The method is similar to the map produced using the Shuttle Radar Topography Mission (SRTM), which represented global mangrove canopy height for year 2000 with a spatial resolution of 30 meters. The TanDEM-X derived map was calibrated and validated with global GEDI estimates of mangrove canopy height, with additional validation using airborne Lidar data. We compare the 2000 and 2015 maps, highlighting regions of spectacular mangrove growth or loss. For example, growth rates of ~1 meter per year were observed in the Guayas Estuary and other locations. The TanDEM-X fine spatial resolution and increased vertical accuracy—as compared to SRTM—enables observations of narrow fringes of mangrove along tidal channels and can resolve canopy domes. Finally, we revisit statistics of height distribution of the tallest mangroves in the World.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 16.4B. Mapping Mangrove Wealth: collaborative efforts to determine global values

Spalding, M.D.,[1,2] and Worthington, T.A.[1]
[1] The Nature Conservancy, Siena, Italy
[2] Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge, UK

We present a synthesis of the growing number of globally-focused maps and products describing mangroves – location and change, condition, carbon, fisheries and other values, conservation progress and restoration potential. These global efforts are highly dynamic, interlinked and collaborative. They all have room for improvement, there are data gaps, and there are limitations in their application for on-the-ground action. We describe some ongoing and proposed directions for research and data sharing and distribution. Finally, we consider the role of such work in guiding conservation and setting targets, focusing on the goals of the Global Mangrove Alliance – to halt loss, restore half and double protection. We consider how global maps have helped to define such goals and how and when they may be appropriate to drive practical action.

Code: 17.6. Identifying most influential factors and related innovation development patterns in mangrove governance innovations in Bahía de Cispatá and a forest-management approach in a mountainous area in Antioquia, Colombia

Sorge, S.[1]

[1]Researcher at Chair of Forest and Environmental Policy, University of Freiburg, Tennenbacherstr. 4, 79106 Freiburg, Germany, Tel: +49 761 203-3720, E-Mail: stefan.sorge@ifp.uni-freiburg.de, Website: https://www.forstpolitik-umweltpolitik.uni-freiburg.de/,

As governance innovations can be considered as "new rules and organizational arrangements resulting in novel forms of forest management that allow for a sustainable provision of FES, to improve income sources or to provide alternative benefit streams" (Mann et al, 2022). This includes establishing "new markets and payment schemes to generate value from FES as well as novel forms of collaborations, including means of communication, contracts and the inclusion of new users that foster improved value chains or bundles of provisioning, regulating, and cultural FES" (Mann et al., 2021; Mann et al.,2022). Little is known about the emergence and development of novel governance approaches for forest ecosystem services (FES) provision, what drives them, and how they can be fostered. Existing frameworks often deal with single aspects of resource management and thus fail to assess processes, multi-level influences, and interacting dimensions and factors in a system-based understanding. In this journal article, I present the empirical application of an adapted SES (Social-Ecological System) framework with additional elements that builds on the idea of complex and interlinked social ecological-technical-forestry-innovation systems (SETFIS) that allows for the identification of key factors for revealing FES dynamics to understand the emergence and development of such governance innovations in the European Union and Colombia. The development of the framework was based on six case studies in diverse biogeographical regions for knowledge co-creation: a voluntary carbon market payment scheme in Germany, a network approach for forest-pasture management in Italy, a cultural and educational FES approach in Sweden, a local value chain related FES for local economic development in Austria and a compensation scheme in combination with biodiversity restoration in Finland. Results out of its previous application served to further develop the framework development and its holistic applicability. The application of the SETFIS framework in two case studies in Colombia: a hybrid mode of governing mangrove conservation/reforestation/compensation scheme in Carribbean coast and a forest pasture management in Antioquia. Both cases combine market, hierarchy and network components to manage natural resources and overcome social dilemmas, tries to validate previous methodological and content-related results of its holistic applicability in two other biogeographical regions/governance context in order to further identify context specific and/or comparable factors of such governance innovations as well as its transferability. I will conduct 10-20 interviewsin total, 5-10 in each case study. The interviewees in Cisbata will include representatives of NGOs (Fundation Amacha, Conservation International Colombia), public sector (Minambiente, CVS Cordoba, CARSUCRE, INVEMAR, EU), private companies (Apple Inc.) and community members of the region as well as actors that are not directly involved in the local governance innovation (e.g. the NGO Asocaiman). The application of the framework shall reveal required adaptations to improve the innovation by systematically unpacking the system dimensions and identifying fostering and hindering factors and their interdependencies within this differing context. I highlight the output of a sound system-based information basis that allows for purposeful innovation conditioning by policy makers, practitioners, and other related actors.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 3.7. Coastal morphology explain global mangrove blue carbon

Twilley, R.R.,[1] and Rovai, A.[1]

[1]Department of Oceanography and Coastal Sciences, College of Coast and Environment, Louisiana State University, Baton Rouge, LA, USA

Coastal environmental settings have been used for decades to define patterns of mangrove ecology as subdivisions of geomorphologically defined habitats. The hypothesis of this review is that regional gradients in geomorphic processes of a coastal region together with local platform characteristics in hydrology and topography will result in distinct patterns of carbon sequestration. We used two different techniques to classify coastal characteristics into different typologies of coastal environmental settings. To test if mangrove carbon sequestration vary with coastal environmental settings, we compiled datasets for a variety of ecosystem attributes that combines published and unpublished data representing the diversity of coastal settings. Summing ΔSorgC with organic carbon fluxes from NPPW (corrected to organic carbon density) defines mangrove NEP. NEP can represent a significant net flux of carbon from the atmosphere that is stored in long-term reservoirs of wood and soil. The carbon sequestration component of NPPA is NPPW that represents a more permanent sink (decadal storage) and is estimated at 3.81 Mg C ha^{-1} yr^{-1} or 381 gC m^{-2} yr^{-1}. There are 155 observations of sediment accretion in mangroves and 231 observations of carbon sequestration used to estimate a global mean of 0.54 ± 0.08 cm/yr and 180 ± 13 gC m^{-2} yr^{-1}, respectively. The global mean NEP carbon sequestration rate is 599 gC m^{-2} yr^{-1} with similar values for AEP (559 gC m^{-2} yr^{-1}) and IWP (621 gC m^{-2} yr^{-1}). The total carbon sequestration of undisturbed mangroves is 60 and 80 TgC yr^{-1}, respectively. Mangroves in deltas and estuaries in both CES schemes demonstrate the highest total carbon sequestration potential, demonstrating the global significance of mangroves in terrigenous settings to carbon mitigation.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 8.6B. Nutrient enriched mangrove sediments show evidence of carbon loss and altered biogeochemical properties

Thomson, T.,[1] Prinz, N.,[1] Fusi, M.,[2] Cary, S.C.,[3] Pilditch, C.A., Ellis, J.I.

[1]University of Waikato, New Zealand
[2]JNCC, United Kingdom
[3]School of Science, New Zealand

Anthropogenic nutrient pollution is one of the largest threats to coastal ecosystems. Mangrove forests have been proposed as natural filters of land-derived nutrients, due to their potential to absorb them in living biomass and burry them in sediments. The effects of elevated nutrients on mangrove tress has been well studied, however, there is still considerable uncertainty regarding changes to the sediment microbial community and the impacts on biogeochemical cycling including carbon storage. To investigate the effects of elevated nutrients on the microbial community and the carbon dynamics in mangrove sediments, a 4-month in-situ enrichment study was set up in an *Avicennia marina* stand in the North Island of Aotearoa, New Zealand. Bacterial 16S rRNA gene sequencing was used to assess changes in the bacterial community composition. We quantified carbon concentrations in the sediment and the porewater as well as the fluxes of carbon and nitrogen species between the sediment and the water column (high tide) and the atmosphere (low tide) in light and dark conditions. The microbial community composition showed only minor changes in response to the nutrient enrichment. However, elevated concentrations of total alkalinity and dissolved inorganic carbon in the nutrient enriched porewater indicated an increase of microbial respiration processes and therefore an accelerated breakdown of sediment organic carbon. Nutrient enrichment also influenced the carbon flux between the sediment and the overlying water column with the sediments becoming a source of dissolved organic carbon in dark conditions and a sink for total alkalinity in light conditions. These results suggest a sediment microbial community that is resilient to eutrophication that responds through a higher rate of organic matter remineralisation. Mangrove forests that are exposed to high nutrient pollution may therefore be less efficient at retaining carbon in their sediments with implications for long-term sequestration.

Theme 2: Understanding and solving marine pollution in mangrove wetlands

Code: 13.1A. ROM: a mobile App designed for mangrove managers

Tsilibaris, V., & Caillaud, A.[1]

[1]French Tropical Wetlands Network

The ROM mobile application has been developed over the past few years by the French Mangrove Monitoring Network (Réseau d'Observation des Mangroves or ROM in French), in close collaboration with mangrove managers from French overseas territories in the Caribbean, French Guiana, Indian Ocean (Mayotte and Europa) and the Pacific region (New Caledonia and Wallis + French Polynesia). This digital tool intends to help mangrove managers and custodians and more generally, any stakeholder to: - learn to recognize mangrove tree species, thanks to ID cards with an identification key - identify associated fauna species (birds, crabs, mollusks, fish, insects, and mammals) - be alerted or alert about detected disturbances in mangroves (such as illegal waste disposal, diseases, tree or fish mortality, oil spills etc.) - signal associated fauna sightings. The App is a result of several years of discussions and consultation with mangrove managers in very different contexts, from insular mangroves of the French Antilles to introduced mangroves in French Polynesia, so that it best responds to managers' needs. It geolocates automatically and may be used anywhere in the world; the App also includes a Forum section. In this forum, and through other means, various mangrove managers around the world have expressed an interest in our App, and have asked whether it might be translated in English. Seeing the interest the app is generating in other countries, we envisage creating an Open source back office which would enable any mangrove manager to develop their own tailored app, with options to add their own mangrove and associated fauna species ID cards. The App's various features will be presented, and possibilities of adapting it to other contexts will be discussed.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 16.5A. All of our Mangrove maps are right!

Thomas, N.,[1,2*] Barenblitt, A.,[1,2] Fatoyinbo, L.,[2] Lagomasino, D.,[3] Goldberg, L.,[1] Stovall, A.,[1,2] Bunting, P.,[4] Simard, M.,[5], Parra, A.[5]

[1] Earth system Science Interdisciplinary Center, University of Maryland, College Park, MD, USA
[2] NASA Goddard Space Flight Center, Greenbelt, MD, USA
[3] School of Coastal Studies, Carolina East University, Wanchese, NC, USA
[4] Aberystwyth University, Aberystwyth, Wales, UK
[5] CalTech/NASA Jet Propulsion Laboratory, Pasadena, CA USA
*Corresponding Author

At MMM5 we presented our initiative "All of our maps are wrong"; a lighthearted label for our critique of all the available and most commonly used datasets for mapping mangrove extent, change, biomass and carbon. We determine that depending on the baseline dataset used, wide variation is found between the results from studies that rely on these datasets, as a direct consequence of the dataset chosen. These discrepancies are caused by the inconsistency between resolution, study-period and methodology across the available global products. We show that global maps of mangrove properties are highly variable and highlight large discrepancies and disagreement in metrics at both the national and global scale, undermining the confidence that the community can place in these data and the evaluation of ecosystem services that they are predicted to provide. We determine that the multiple available datasets for each metric causes confusion in what dataset is most appropriate to use for a given application and that there is little guidance available to guide best-use practices. As a means of solving this, we provide a framework through which the mangrove research and applications community can determine the most appropriate datasets to use based on their study methods, research objectives and desired application criteria. This is openly provided in the form of Google Earth Engine interactive applications, ensuring access and the promotion of best practices to the whole mangrove community. Furthermore, we also evaluate a suite of new recently published maps and highlight the improvements in predicted extent, change drivers, biomass and carbon estimations that they make. We provide the community with transparency on these new datasets and offer a framework through which these data can be used most appropriately and accurately. This will improve the quality and effectiveness of the research and applications conducted by the mangrove community as a whole and transition the future of "all of our maps are wrong" to "all of our maps are right".

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 16.3B. Thinking Outside the Blue Economy Box: Achieving Equity in Mangrove Management

Treviño, M.[1]

[1] University of Rhode Island, College of the Environment and Life Sciences, Department of Fisheries, Animal, and Veterinary Sciences

The Blue Economy framework emerged as a toolkit for a sustainable, diversified, and resilient global economy fueled by "blue" ocean and marine resources. While this framework may be able to help generate economically and environmentally sound management decisions, it may not holistically capture the value of complex ecosystems like mangrove forests. Blue economic assessments cannot fully grasp the value of ecosystem services that provide non monetary benefits. For example, due to their intangibility and incommensurability, certain categories of cultural ecosystem services (CES) are often undervalued, misappraised, or disregarded in ecosystem valuation studies. CES from marine and coastal ecosystems are particularly poorly understood. In this talk, I present findings from field data collected in northern Ecuador, where I investigated how mangrove forests support local well-being. I took an ethnographic approach to develop an inventory of mangrove CES documented through 40 in depth interviews with multigenerational mangrove users. I found that while all mangrove users hold profound cultural importance and personal attachments to the mangrove ecosystem, different groups within a seemingly homogenous community may utilize and appreciate mangrove forests differently. Gender largely informs how mangrove users perceive and value mangrove forests. Women are socially, culturally, and emotionally more connected to the mangroves. Women also have a higher appreciation of mangrove resources and feel a stronger commitment to conserving these ecosystems. While qualitative studies cannot replace ecosystem assessments based on economic valuation schemes, this research shows they can be complementary. Understanding nature's value from non-monetary perspectives can help researchers and resource managers identify a plurality of ways in which ecosystems benefit diverse groups. Such findings can inform coastal development planning, particularly strategies aiming to achieve equity in mangrove management to minimize unintended consequences from development interventions such as those that have historically impacted communities who rely on mangrove ecosystems for their livelihoods and cultural survival.

Theme 3: Achieving sustainable socio-economic development and equity

Code: 16.5B. Structural Characteristics of the Tallest Mangrove Forests of the American Continent: A Comparison of Ground-Based, Drone and Radar Measurements

Tavera, H.,[1,2] Zapata Padilla, L.A.,[2] Simard, M.,[3] Casella, E.,[4] Castellanos-Galindo, G.A.[2,5]

1. Ministerio de Ambiente y Desarrollo Sostenible, Bogotá, Colombia
2. WWF Colombia, Cali, Colombia
3. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States
4. Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany
5. Smithsonian Tropical Research Institute (STRI), Panama City, Panama

The Panama Bight eco-region along the Pacific coast of central and South America is considered to have one of the best-preserved mangrove ecosystems in the American continent. The regional climate, with rainfall easily reaching 5–8 m every year and weak wind conditions, contribute to the exceptionally tall mangroves along the southern Colombian and northern Ecuadorian Pacific coasts. Here we evaluate the use of different methods (ground-based measurements, drone imagery and radar data [Shuttle Radar Topography mission-SRTM and TanDEM-X]) to characterize the structure of the tallest of these forests. In 2019, three mangrove sites with canopy heights between 50 and 60 m, previously identified with SRTM data, were sampled close to the town of Guapi, Colombia. In addition to *in situ* field measurements of trees, we conducted airborne drone surveys in order to generate georeferenced orthomosaics and digital surface models (DSMs). We found that the extensive mangrove forests in this area of the Colombian Pacific are almost entirely composed of *Rhizophora* spp. trees. The tallest mangrove tree measured in the three plots was 57 m. With ca. 900 drone photographs, three orthomosaics (2 cm pixel^{-1} resolution) and digital surface models (3.5 cm pixel^{-1}) with average area of 4,0 ha were generated. The field-measured canopy heights were used to validate the drone-derived and radar-derived data, confirming these mangrove forests as the tallest in the Americas. The orthomosaics showed significant patches of the Golden Leather Fern, *Acrostichum aureum*, an opportunistic species that can be associated to mangrove degradation, indicating that the mangrove forests investigated here may be threatened by selective logging requiring improvements and effective implementation of the current mangrove management plans in Colombia. On-going community-based mangrove restoration work around these areas seek to contribute to the preservation of these iconic mangrove forests.

Code: 7.4B. Importance of mangrove plantations for blue carbon sequestration and climate change mitigation in Bangladesh

Uddin, M.,[1] Lovelock, C.E.[1]

[1]School of Biological Sciences, The University of Queensland, QLD 4072, Australia

Mangroves have been identified as an important ecosystem that are natural carbon sinks, which have been called blue carbon ecosystems. In Bangladesh, the protection of the globally important natural mangrove (Sundarbans) is essential to preserving their carbon stocks and reducing CO_2 emissions. In addition, the establishment of mangrove plantations may be an additional sustainable pathway to enhance carbon sequestration, which can help Bangladesh meet its greenhouse gas emission reduction targets as well as contributing to climate change adaptation. As a part of its Nationally Determined Contribution (NDC) under the Paris Agreement 2016, Bangladesh is committed to limit the GHG emissions by continuation of coastal mangrove plantations. In response, the expansion of mangrove plantations was highlighted in the Bangladesh NDC, but the level of carbon emissions reduction that could occur though growth of mangrove plantations has not yet been estimated. Using remote sensing and plot-based inventory of the plantations, our preliminary estimate of the ecosystem mean carbon stock of the established 28,000 ha of mangrove plantations is 190.1 (± 30.3) Mg C ha^{-1}, with 60.3 (± 5.6) Mg C ha^{-1} in biomass and 129.8 (± 24.8) Mg C ha^{-1} in the top meter of soils. These accumulated carbon stocks equate to approximately 0.28 $MtCO_2e$ per year sequestration in biomass and 0.13 $MtCO_2e$ per year sequestration in soils since 1966. Ecosystem carbon density in plantations was lower than the Sundarbans natural mangroves (reference site) and global mean estimates. We estimated that plantations contributed 19.9 $MtCO_2e$ sequestration over 50 years. Higher levels of investment in mangrove plantations and higher plantation establishment success could contribute up to 7.7 $MtCO_2e$ to blue carbon sequestration and climate change mitigation in Bangladesh by 2030, or 8.6% of NDC commitment.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 3.3. Identifying establishment thresholds of mangrove pioneer species – Implications for restoration

Vovides, A.G.,[*1] Amelia, R.,[2] Bimantara, Y.,[2] Balke, T.,[1], Basyuni, M.[2]

[*1] School of Geographical and Earth Sciences, University of Glasgow, UK
[2] Center of Excellence for Mangrove, Universitas Sumatera Utara, Indonesia

Despite mangrove restoration practices have increased globally over the last decade, we still face low restoration success rates, with an overall failure rate 80%. Some reasons identified for this have been, in short words "planting the wrong species in the wrong places". Considering hydrology as a corner stone to coastal wetland ecosystem health, great progress has been achieved through including hydrological restoration to our practices. However, there is still a gap of knowledge in understanding environmental thresholds to seedling establishment in bare mudflats. We specifically lack information on optimal environmental conditions required by seedlings to successfully establish. In this study we investigate the hydrological thresholds to early establishment of two mangrove pioneer species of the eastern coast of Sumatra, Indonesia (*Avicennia alba* and *Avicennia marina*), with particular focus on the time period without flooding that propagules require to produce roots and withstand flooding events (hereafter referred as Window of opportunity, WoO). Through daily monitoring of seedling establishment at low and high salinity (10 and 30 psu, respectively) across different WoO treatments we identified a minimum WoO of 3 days for success on both species, with earlier establishment in low salinity treatments as compared to high salinity. However, *A. alba* showed higher vulnerability to salinity and prolonged dehydration, with decreasing establishment success at 30 psu (practical salinity units) and WoO >5. We discuss differential biomass allocation into roots (frequency and length) between salinity treatments and across different WoO, a plastic trait that can contribute to establishment success. We also compare the mesocosm results with field establishment observations, suggesting a link between natural hydrological cycles and pioneer species phenology. This study provides a baseline to inform the design of restoration programs that can be complemented with site hydrological monitoring to better identify Nature-based solutions and restoration opportunities within mangrove ecosystems.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 8.2A. Social feasibility and ecological suitability are key for identifying mangrove restoration priorities, even under tight decision-making deadlines

[1]Villarreal-Rosas, J., [1]Brown, C. J.,[2]Andradi-Brown, D., [3]Domínguez, R., [3]Jacobo, P., [3]Martínez, A., [3]Mascote, C., [3]Najera, E., [4]Paiz, Y., [1]Piccolo, R., [5]Vázquez M., Víctor Hugo, [3]Villarreal, J., [1]Adame, M. F.

[1]Griffith University, [2]World Wildlife Fund, US, [3]World Wildlife Fund, México, [4]The Nature Conservancy, México, [5]Comisión Nacional de Áreas Naturales Protegidas

Investment in mangrove restoration is expected to increase driven by the UN Decade on Restoration and international funding initiatives like The Mangrove Breakthrough. In the past, numerous mangrove restoration efforts have failed due to the lack of consideration of the ecological and social appropriateness of potential restoration sites, usually a consequence of short delivery time frames imposed by funding agencies. Therefore, we immediately need to improve site-selection processes for mangrove restoration. Using decision analysis, we developed an approach for identifying sites with the highest likelihood of mangrove restoration success considering ecological suitability and social feasibility metrics. We applied our approach in the biosphere reserve Marismas Nacionales Nayarit, Mexico, an area that recently received funding for implementing mangrove restoration actions. We found that selecting sites based on ecological suitability or social feasibility objectives alone incurred in significant trade offs that decreased the overall likelihood of mangrove restoration success, but incorporating both objectives as part of the decision process helped balance trade-offs. We also characterized community dynamics of priority sites to understand the social context influencing restoration interventions, this information is key to develop appropriate long-term strategies for building trust within the community and increasing engagement. Our approach was developed under strict delivery timelines as part of a collaboration between NGOs, the local government, and academics, demonstrating that systematic decision-making processes that integrate social and ecological considerations are achievable and necessary even under short delivery deadlines. Our approach can be adapted for making mangrove restoration site selection decisions elsewhere, to aid this we list best-practice restoration metrics that can be used in other contexts where tight deadlines and poor data are limiting factors.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 13.4B. Mangroves and Mud: investigating the impacts of human activities on estuarine landscape development

van Maanen, B.,[1] Xie, D.,[2] Schwarz, C.,[3,4] Kleinhans, M.G.,[5] Bryan, K.R.,[6] Coco, G.,[7] Hunt, S.[8]

[1]Department of Geography, University of Exeter, Exeter, UK [2]Department of Earth and Environment, Boston University, Boston, USA [3]Hydraulics and Geotechnics, Department of Civil Engineering, KU Leuven, Belgium [4]Department of Earth and Environmental Sciences, KU Leuven, Belgium [5]Department of Physical Geography, Utrecht University, Utrecht, the Netherlands [6]School of Science, University of Waikato, Hamilton, Aotearoa, New Zealand [7]School of Environment, University of Auckland, Auckland, New Zealand [8]Waikato Regional Council, Hamilton, New Zealand

While global mangrove loss has received much attention in recent years, mangrove expansion has been observed in many places around the world. This is partly because of changes in upstream land use, which have significantly transformed downstream coastal ecosystems by increasing sediment supplies to the coast. Accelerated mud-infilling of estuarine systems can drive new habitat development for mangroves. Although mangrove forests provide important ecosystem services, their rapid expansion also has negative impacts on navigation, recreational activities, and amenity values. The transformation of coastal habitats and mangrove expansion also happen at the expense of other valuable species. In this study, we focus on estuarine systems in New Zealand, which have experienced drastic changes following European settlement. Substantial conversions of forestland to agriculture or pastures resulted in rapid and widespread soil erosion in the hinterland, which in turn increased sediment yields to the coast. Widespread accumulation of intertidal mud then caused rapid increases in mangrove occurrence. As mangroves are expected to reduce tidal currents and trap sediment, mangrove removal has been applied in an effort to limit ongoing mud accumulation in New Zealand estuaries. Here we use a bio-morphodynamic model to study the effects of changes in sediment inputs and mangrove removal on estuarine morphology. Our model simulations show that mangrove removal initiatives cannot reduce estuarine mud-infilling and restore antecedent landscapes. The removal of mangrove vegetation in fact enhances estuary sediment trapping due to changes in landscape-scale flow and sedimentation patterns. Deceleration of mud accumulations only happens when upstream sediment supply is reduced. Our study demonstrates that bio morphodynamic feedbacks can have contrasting effects at local and estuary scales, and unexpected behaviours in landscape development can be initiated by human interventions. This highlights the need for more holistic management approaches.

Theme 6: Changing human relationships with mangrove wetlands

Code: 17.7. Future changes in seawater properties across mangroves globally and implications for dispersal

Van der Stocken,T., [1,2] Vanschoenwinkel, B.,[1] Carroll, D.,[2,3]. Cavanaugh, K.C.,[4] and Koedam, N.[1]

[1]Department of Biology, Vrije Universiteit Brussel, Brussels, Belgium. [2]Earth Science Section, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA. [3]Moss Landing Marine Laboratories, San José State University, Moss Landing, CA, USA. [4]Department of Geography, University of California, Los Angeles, CA, USA. ✉e-mail: Tom.Van.Der.Stocken@vub.be

The degree to which the distribution of mangrove forests will be impacted by climate change depends on the dispersal and establishment of sea-faring propagules, which drive forest rejuvenation, gene flow and range expansion. Climate change affects sea surface density via changes in temperature and salinity. However, these changes have not been mapped and it remains unclear how these factors may impact mangrove propagule dispersal. Here, we provide evidence for strong warming of coastal mangrove waters and elevated geographic variability in surface ocean density under representative concentration pathway RCP 8.5 by 2100. The largest changes will occur in the Indo West Pacific region, the primary hotspot of mangrove diversity. By comparing propagule densities to predicted sea surface density, we assessed potential effects on mangrove propagule dispersal. In the future, a warmer and fresher ocean is likely to alter dispersal trajectories of mangrove propagules and increase rates of sinking in unsuitable offshore locations.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 6.1A. Are root grafts cooperative traits for mangroves to cope with water stress?

Wimmler, M.C.,[1] Vovides, A.G.,[2] Bowen, H.J.,[3] López-Portillo, J.,[4] Nadezhdina, N.,[5] Berger, U.[1]

[1] Faculty of Environmental Sciences, Department of Forest Sciences, Chair of Forest Biometrics and Systems Analysis, Technische Universität Dresden, Germany
[2] School of Geographical and Earth Sciences, University of Glasgow, Glasgow, UK [3] Plant Ecology Program, Archbold Biological Station, Venus, FL, USA
[4] Functional Ecology Network, Instituto de Ecología A.C., Xalapa, Veracruz, Mexico
[5] Institute of Forest Botany, Dendrology and Geobiocenology, Mendel University in Brno, Brno, Czech Republic

Mangrove trees form intraspecific root grafts, and resources can be exchanged between trees if the tissues are fully fused. Connections can exist between two or more trees, forming groups with diverse structures. In black mangroves (*Avicennia germinans*), such group structures vary with increasing porewater salinity. Under benign conditions (low salinity and stand density), the groups had more members spread over a larger area. With increasing salinity, the frequency of groups increased, but they consisted of fewer members. These findings suggest there is a mechanism controlling group size, which could be associated with the physiological drought caused by porewater salinity. Here, we hypothesize that root grafting is a cooperative trait that can contribute to mitigating water stress, where the benefits outweigh the costs of cooperation for each individual. Costs arise, for example, during graft formation and resource donation. To better understand the implications of water exchange through grafts, we used a mechanistic individual-based model to investigate the physical limits of water exchange. We examined the factors determining the direction and the potential amount of water exchanged between grafted individuals. Furthermore, we measured black mangroves' *in vivo* radial sap profiles using the heat field deformation method. Identifying direct signals of water exchange proved challenging, and we observed unexpected flow patterns. For example, some trees had simultaneous bidirectional flow, suggesting a sectorial sapwood structure and that a complex hydraulic compensation mechanism might contribute to water balance. This topic should be further explored to understand sap movement patterns within and between trees, predict forest function in response to environmental change, and better inform climate change adaptation management policies.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code: 12.7A. How does forest management impact soil carbon in mangroves? A (10 m) deep study in the Matang Mangrove Forest Reserve, Malaysia

Wolswijk, G.,[1,2*] Behara, S.,[1,2,3] , Abd Rahim, N.H.,[2] Che Abdullah, M.K.A.,[2] Ali Ahmad, N.,[2] Wolswijk, L.,[4] Hami Hamzah M.K.,[2] Dahdouh-Guebas, F.[1,3,5,6]

[1] Systems Ecology and Resource Management, Department of Organism Biology, Faculté des Sciences, Université Libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50, CPi 264/1, B-1050 Brussels, Belgium
[2]Mangrove Research Unit (MARU), Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu (UMT), Kuala Nerus 21030, Terengganu, Malaysia
[3]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), 1196 Gland, Switzerland
[4]INO-CNR BEC Center and Dipartimento di Fisica, Università di Trento, 38123 Povo, Italy
[5]Laboratory of General Botany and Nature Management, Department of Biology, Faculty of Sciences and Bio-Engineering Sciences, Vrije Universiteit Brussel (VUB), VUB-APNA-WE Pleinlaan 2, B-1050 Brussels, Belgium
[6] Interfaculty Institute of Social-Ecological Transitions—IITSE, Université Libre de Bruxelles—ULB, B-1050 Brussels, Belgium
*Presenting author & correspondence: giovannawolswijk@gmail.com

The Matang Mangrove Forest Reserve (MMFR) in Peninsular Malaysia is well known for its silvicultural management for the production of poles and charcoal based on a thirty-year rotation cycle. Although the management includes measures to aim for sustainability, it still has an impact on the forest as carbon is lost both from the vegetation and the soil. In this study we analyzed carbon content in the soil at different forest stands at the MMFR. Guidelines for carbon studies suggest
focusing on soil depths of one meter, however, considering soil depth, the study of deeper layers is extremely relevant. Hence, we collected 10 m deep soil cores from 7 managed stands of different age as well as an unmanaged stand and conducted total carbon analysis on subsamples at 20 cm interval for the first two meters and at 1 m interval for the next meters. The results indicate that
most of the carbon is stored in the first 3-4 meters, which corresponds also with the abundance of peat in the soil. Importantly older forest stands and especially the unmanaged site had generally a deeper peat layer and higher carbon concentration in the soil (reaching more than 3000 Mg C ha-1).Clear-felling and thinning activities both had an impact on the soil carbon especially in the top two
meters of soil with an overall loss of 456.7 Mg C ha-1 and 284.8 Mg C ha-1 respectively. However, the replanting activities and the growth of the forest over time allow for a recovery of the carbon. These findings highlight the importance of preserving mangroves for their carbon storage capacity and indicate that studies on soil carbon should consider soil depth carefully to obtain more accurate estimations.

Theme 1: Protecting and restoring mangrove forests and their biodiversity

Code. 17.3. Environmental DNA (eDNA) metabarcoding of ichthyofauna in Asian mangrove ecosystems revealed spatial challenges in community-level analysis

Wee, A.K.S.,[1] Isowa, Y.,[2] Yee, L.F.,[1] Chu, C.,[1] Tan, A.Y.-H.,[3] Susilowati, A.,[4] Basyuni, M.,[4] Kajita, T.[2]

[1] School of Environmental and Geographical Sciences, University of Nottingham Malaysia Campus, Jalan Broga, Semenyih, 43500 Selangor, Malaysia.
[2] Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, Uehara, Yaeyama, Taketomi, Okinawa, 907-1541 Japan
[3] Institute of Biological Sciences, Faculty of Science, Universiti Malaya 50603 Kuala Lumpur, Malaysia.
[4] Center of Excellence for Mangrove, Universitas Sumatera Utara, Medan 20155, Indonesia.

Environmental DNA (eDNA) is an innovative molecular tool that can vastly improve biomonitoring in mangrove ecosystems. Compared to traditional surveys that are taxa-specific and time-consuming, eDNA metabarcoding offers a rapid, non-invasive, multi-taxa method to detect species and characterize distribution patterns. However, taxon detection could depend on environmental factors such as tidal condition, monsoons, salinity gradient, and the stratification of the water column. Furthermore, the dynamic spatiotemporal heterogeneity in faunal distribution poses a problem of scale in terms of delineating the sampling boundaries for different ecological and ecosystem applications. In this study, we collected eDNA water samples from mangroves in Malaysia, Indonesia and Japan across micro- (forest stand/estuary), meso- (coastline) and macro-scales (transboundary) to examine the spatial and temporal heterogeneity in ichthyofauna utilisation of mangroves. Specifically, we analysed how species detection and distribution vary (1) with tidal fluctuation, (2) between monsoonal seasons, and (3) across marine ecoregions. Our data showed that stationary sampling detected low overlap in community composition across temporal points, indicating the dynamic distribution of fish species and the transient nature of eDNA in tropical waters. Between monsoonal seasons, we detected only an overlap of ~15% of fish species, highlighting the need for seasonal sampling to better estimate the asymptotic number of species present. Comparison between different coastlines revealed the influence of adjacent habitats, with mangrove fish community comprising of more marine and reef-associated fish species in east coast than in west coast Malay Peninsula. Finally, fish communities have higher similarities within as compared to among marine ecoregions, indicating the importance of bioregionalization in designing global studies. Taken together, our results highlighted key spatiotemporal considerations for eDNA research in mangroves to ensure rigorous community-level analysis. Consensus in sampling protocols is necessary to facilitate comparison across mangroves and to realize the potential of eDNA as a reliable biomonitoring tool.

Theme 5: Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness

Code: 8.2B. Carbon dynamics across the mangrove-tidal flat ecotone in a tropical seascape

Yando, E.S.,[1,2,3]. Alemu I, J.B.,[2,4] Kiah Eng, L.,[2,5,8] Sloey, T.M.,[1,5] van Breugel, M.,[2,5,7] Bhatia, N.,[6] Friess, D.A.[2,8,9]

[1]Department of Biological Sciences, Old Dominion University, Norfolk, Virginia, USA [2]Department of Geography, National University of Singapore, Singapore [3]Campus for Research Excellence and Technological Enterprise, Singapore [4]Marine Science Center, Northeastern University, Nahant, Massachusetts, USA
[5]Yale-NUS College, Singapore [6]Asian School of the Environment, Nanyang Technological University, Singapore
[7]Smithsonian Tropical Research Institute, Panama [8]Centre for Nature-based Climate Solutions, National University of Singapore, Singapore [9]Department of Earth and Environmental Sciences, Tulane University, New Orleans, Louisiana, USA

Mangroves and other blue carbon ecosystems are important for climate through the storage and sequestration of carbon. Most research estimates carbon dynamics by subsampling central portions of the ecosystem and are then upscales using habitat maps to patch, landscape, or regional levels. However, heterogeneity is rarely accounted for – particularly at edges. Further, adjacent tidal flat ecosystems have only recently been considered for carbon storage, but may be undervalued if areas where they transition with vegetated systems are not accounted for. To address the lack of information at coastal ecotones, we examined both soil carbon storage and carbon dioxide flux across the coastal seascape (mangrove-tidal flat) and compared values to aboveground mangrove cover metrics in Singapore. We established six transects across two sites, extending from vegetated mangrove patches out into adjacent unvegetated tidal flats. Plots were established at end points within each ecosystem, at the aboveground transition, and then at increasing intervals (1-8 m) from the transition into both ecosystems. Our results highlight large disparities between discrete aboveground vegetation transitions and gradual belowground transitions for soil carbon storage. Further, soil carbon dioxide flux values show an edge effect where values are on average 2-6 times greater than within either ecosystem. We used regression-based techniques to scale up transect based measurements to the landscape level and account for the distance from the aboveground transition between vegetated and unvegetated ecosystems. We found mangrove soil carbon storage was overestimated by 4-9% and tidal flat soil carbon storage showed a 4-14% disparity. By gaining a better understanding of carbon dynamics across the coastal seascape we can provide more accurate carbon estimates, detect patterns and processes only seen with spatial analysis, and highlight the importance of a seascape perspective for ecological studies, ecosystem service assessments, and management.

Theme 4: Unlocking climate action and implementing mangrove-based solutions to climate change

Code: 6.6B. Effects of the benthic macrofauna on organic matter fluxes in mangrove sediments

Zimmer, M.,[1] et al.

[1]Leibniz Centre for Tropical Marine Research, Germany

Dissolved organic matter (DOM) contributes significantly to the pollution of mangrove forests, e.g., through sewage from settlements or wastewater from aquaculture. Three major classes of organic compounds are proteins, carbohydrates, and aromates ("phenolics"). They exhibit distinct chemical characteristics. In a laboratory study under controlled environmental conditions, we tested our hypothesis that the benthic macrofauna of mangrove forests affects the retention of DOM of the porewater in the sediment body. Thus, *Faunus ater* (Gastropoda) and *Manarma moeshi* (Decapoda) were hosted individually in experimental containers with artificial organic matter-free sediment and a micro-tidal regime. Different organic model substances were applied over one tidal cycle, and their concentrations were determined in the inflowing water body and the outflowing porewater. While the artificial sediment exhibited a moderate retention of dissolved organic matter, crab burrows and mucus trails of snails (after removing the animals from the containers) drastically increased the retention time and rate. These effects, however, were remarkably species- and compound-specific. Considering the sometimes high densities of snails and crabs in mangrove forests, our findings might affect our understanding of DOM and its dynamics and fluxes in the porewater of mangrove sediments.

Theme 2: Understanding and solving marine pollution in mangrove wetlands

Abstracts
Poster presentations

Code: P 14.14. The effect of precipitation on sediment bacteria and leaf organic matter leaching along the mangrove forest–salt flat–savannah continuum in the Sine-Saloum Estuary, Senegal

Abuchahla, G.M.O.,[1] Diouf M.,[2] Laso-Pérez, R.,[3] Zimmer, M.[1,4]

[1]Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany [2]Institut Universitaire de Pêche et d'Aquaculture, Université Cheikh Anta Diop, Dakar, Senegal [3]Museo Nacional de Ciencias Naturales, Madrid, Spain [4]Faculty 2 Biology/Chemistry, University of Bremen, Bremen, Germany

A thirty-day experiment was conducted with three different sediment mixes (mangrove forest, salt flat, and savannah) extracted from a transect that crossed the continuum of the respective ecosystems. Grass rachises and *Avicennia marina* leaves were placed on the different types of sediment, either having their surfaces sterilized (70% ethanol) or not. Half of the leaves received the equivalent to the local average precipitation rate divided by area and days once a day. The results from 16S analyses clearly show the transition character of the salt flat, with the vast dominance of Cyanobacteria. Mangrove and savannah sediments were similar in the sense that there was not only one dominating taxon among. In common, they showed higher occurrence of Anaerolineae and Gammaproteobacteria. Cyanobacteria were under-represented in the savannah sediment but abundant in the mangrove sediment. Notably, the savannah sediment showed much higher incidences of Bacilli, Clostridia, and Halanaerobia than the others. The analysis of bacteria on the treated leaves showed less pronounced differences. Nevertheless, further studies of longer duration could clarify other aspects of precipitation patterns on mangroves and the importance to their conservation and management.

Code: P 15.69. Origin of sediment organic matter along the mangrove forest–salt flat–Atlantic Forest continuum in northeastern Brazil

Abuchahla, G.M.O.,[1] Ferreira, B.P.,[2] Hatje, V.,[3] & Zimmer, M.[1,4]

[1]Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany [2]Departamento de Oceanografia, Universidade Federal de Pernambuco [3]Departamento de Química Analítica, Universidade Federal da Bahia [4]Faculty 2 Biology/Chemistry, University of Bremen, Bremen, Germany

While the terrestrial-most edge of mangrove forests is often neglected in connectivity research, the interface with the terrestrial realm demands special attention due to easiness of occupation by humans and their economic activities. This research explored six different transects, three in the state of Bahia, three in the state of Pernambuco. All six transects had in common the occurrence of salt flats between the mangrove forest and the adjacent Atlantic Forest. Samples of leaves of the most abundant plant species, superficial sediment (up to 2 cm depth), and megafaunal feces were analyzed through py-GC/MS for visualizing environmental metabolomics fingerprints as proxy for the origin of organic matter. The results show the contribution of different plant species and the megafaunal feeding habits to the spatial distribution of organic matter of different origins. Acknowledging such results may be of great relevance in the design of public policies or a management plan for the coastal landscape, ensuring the ecosystem health and their consequent provision of ecosystem services.

Code: P 4.12. Rehabilitation of the eastern Pacific endemic mangrove, *Mora oleifera,* in the southern Colombian Pacific

Abud-Hoyos, M.,[1] López, F.,[1] Jiménez, P.A., [1] Graciela-Serna, V.,[1] Tavera, H.A.,[2] G-Castellanos-Galindo, G.A.,[1] & Zapata, L.A.[1]

1. Wildlife World Fund Colombia. Cra. 10a #69 A - 44, Bogotá.
2. Ministerio de Medio Ambiente y Desarrollo Sostenible

Contacto: mabud@wwf.org.co

Mora oleifera, regionally known as Nato or Alcornoque, is an endemic mangrove species from the eastern Pacific with a restricted distribution (Costa Rica to Ecuador) and categorized as Vulnerable by the IUCN. *M. oleifera* can be a dominant species in the high intertidal areas of the Colombian Pacific coast in the transition between mangrove and Guandal forests. As with other mangrove forests, those of *M. oleifera* are strategic for the provision of ecosystem services serving as barriers against extreme weather events (natural solutions) and climate change impacts, and being fundamental in carbon storage in these lowlands. Despite its importance, the species has been historically affected by deforestation. Dedicated rehabilitation efforts of its populations are urgently needed in the whole Colombian Pacific coast to improve the integrity and resilience of these ecosystems. Here we present results of a community-based rehabilitation project of Nato populations in two areas of the Nariño department (Iscuandé and Sanquianga) in the southern Colombian Pacific coast. The process involved the participation of National Natural Park authorities and the local communities and followed the guidelines of SER. The rehabilitation was based on the reference ecosystem information and required the control of the Golden fern, *Acrostichum aureum* (a highly opportunistic species), the establishment of two nurseries, the collection of propagules, propagation, planting, and monitoring. The methodology considered climatic criteria to guide results under climate change scenarios, such as the identification of climatic threats, sensitivity and local adaptation capacity. Sea level rise and extreme rainfall variability were the main climatic threats found. As a result of the whole process, the integrity of the mangrove and guandal ecosystems was increased, helping to enhance ecosystem and local community resilience in both areas. The lessons learned here could be used to replicate rehabilitation efforts in Colombia and the region for this vulnerable species.

Code: P 9.77. Climate change-induced shift in mangrove ranges drives above and belowground changes to salt marsh habitat

Adgie, T.,[1] Langley, A.,[1] Canas, G., Fell, C.,[2] Geoghegan, E.,[3] Feller, I., Dix, N., Chapman, S.[1]

[1] Villanova University, United States of America [2] University of Louisville, United States of America [3] Cornell University, United States of America

Coastal wetland plant community structure is shifting globally as mangroves expand into salt marshes. Though causes of mangrove range expansion are varied, at the poleward limit in Florida, USA, we have previously shown that experimental warming can accelerate increases in mangrove dominance in coastal wetlands, and that mangrove growth differs across latitude. However, the impact of warming and increased mangrove dominance on marsh plant communities remains unclear. Continued mangrove infill of salt marshes changes the foundational plant community structure and increases competition, which may have cascading effects on ecosystem services like carbon storage, elevation maintenance, and resistance to freeze events. Using a warming experiment at three sites along the salt marsh-mangrove ecotone at Guana Tolomato Matanzas Research Reserve, we investigated the effects of warming, mangrove presence and size, and latitude on marsh plant biomass and soil characteristics. We found that *Spartina alterniflora* growth is tightly linked with latitude; in the south where we have measured more mangrove growth and mangroves are most established, *Spartina* is 33.6% taller and 76.4% less dense compared to *Spartina* in the north where mangroves are shortest and least established. Further, we found that soil carbon in the south is 66.1% greater compared to the north. Though we found no effect of warming on marsh plant biomass or soil characteristics, the variation we found across latitude corresponds to our previous findings and indicates that these changes in marsh habitat are intrinsically associated with mangrove encroachment. Our results suggest that as climate-driven mangrove range expansion continues, we can expect increased C storage despite loss of marsh habitat. Further, we suggest that the diverse matrix of plant species across the salt marsh-mangrove ecotone can provide the range of ecosystem benefits found in each separate ecosystem, and potentially bolster resiliency to both sea level rise and freeze damage.

Code: P 9.35. Genetic status of two mangrove species (*Avicenia germinans* and *Rhizophora mangle*) in the Colombian Caribbean: what does DNA tell us about mangrove conservation?

Aguirre, J.C.,[1] Caicedo, G.,[1] Atencia, M.,[1] Lea, E.,[1] Narváez, J.C.[1]

[1]Center for Genetics and Molecular Biology, University of Magdalena, Santa Marta, Colombia, Address 32 # 22-08, San Pedro Alejandrino.

Mangrove ecosystems are essential reservoirs of faunal diversity and valuable resources and perform critical ecological functions and environmental services. In the country, its coverage has been changing due to different anthropogenic activities; to mitigate this process, monitoring and restoration strategies have been proposed. However, some previous results show that restoration processes need timely technical guidelines to achieve successful results. For example, it has been found that using genetically related or different specimens can generate a loss of diversity due to inbreeding or adaptive loss due to exogamy, respectively. Therefore, this proposal aims to evaluate the genetic status of *Avicennia germinans* and *Rhizophora mangle* in the Colombian Caribbean. Samples of around 20 specimens were collected at the sites of Santuario de Fauna y Flora los Flamencos, VIPIS Park, Tayrona Park, Ciénaga Grande de Santa Marta Park, Mayorquín, Galerazamba, Cartagena, Cispatá and Necoclí in the Gulf of Urabá. Preliminary results using ten specific microsatellite markers for each species showed moderate to low genetic diversity (Ho = 0.3 – 0.5), moderate differentiation (Fst = 0.46), and the apparent existence of several genetic management units. It is hoped that this information will serve as a basis for improving the restoration and conservation programs that are being carried out in the country with mangrove forests.

Code: P 4.9. Spatio-temporal patterns of mangrove canopy gaps in South Africa: An in-depth analysis

Agyekum, M.K.,[1, 2] Zimmer, M.,[1, 2, 3] MacKay, F.,[4,5] Weerts, S.,[6,7] & Helfer, V.[1]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany
[2] Faculty of Biology/Chemistry (FB2), University of Bremen, Bremen, Germany
[3] IUCN SSC Mangrove Specialist Group
[4] Oceanographic Research Institute (ORI), SAAMBR, Durban, South Africa
[5] School of Life Sciences, University of KwaZulu-Natal, Durban, South Africa
[6] Council for Scientific and Industrial Research, Durban, South Africa
[7] Department of Zoology, University of Zululand, KwaDlangezwa, South Africa

Mangrove forests, like other forests, are susceptible to disturbances that can lead to the formation of canopy gaps. The occurrence of circular canopy gaps in mangrove ecosystems are well documented from over 35 countries at the global scale, but gap temporal and spatial dynamics are poorly investigated. Thus, we used spatial pattern analysis techniques and medium-resolution satellite imagery to investigate the spatio-temporal patterns of gap dynamics at the local scale, focusing on two sites (uMhlathuze and Beachwood) located in the KwaZulu-Natal Province on the East Coast of South Africa. The mangrove forests located in uMhlathuze are the largest in South Africa, comprising over 80% of the total mangrove coverage in the country. The study revealed considerable clusters of gaps at uMhlathuze, while the gaps at Beachwood exhibited a regular spatial distribution. Interestingly, we could identify a concentration of gaps in areas of high canopy height at the local scale, which supports the hypothesis of gap formation via lightning strikes, the highest trees being more susceptible to strikes. Regarding the temporal dynamics, gap formation rates varied over time at both sites. Importantly, gaps at uMhlathuze remained open for extended periods (at least 13 years) while, at the time of our analysis, none of the canopy gaps at Beachwood had closed since their initial formation (at least 20 years). These findings have strong implications for the management of mangrove ecosystems in South Africa, suggesting a need for human intervention to re-forest canopy gaps in systems where natural regeneration appears to be very slow. Also considering that gap cover can reach up to 0.35% and 1.5% of forest area for Beachwood and uMhlathuze mangroves, respectively. Further studies in other world regions are needed to evaluate the similarity of spatio-temporal patterns of canopy gap formation in mangrove forests, and their effects on forest dynamics.

Code: P 14.11. Resilience trajectories of Mayotte mangrove social-ecological systems through the adaptive cycle heuristic

Ahmed-Abdallah, A.,[1,2] Longepee, E.,[1,3] Jeanson, M.,[1,3] Bertrand, F.,[2] & Gollety, C.[1,4]

[1] Centre Universitaire de Mayotte (CUFR), 97660 Dembéni, Mayotte, France [2] PRODIG, CNRS, Univ Paris 1 Panthéon Sorbonne, AgroParisTech, Paris Sorbonne Université, IRD, Univ Paris, Paris, France [3] ESPACE-DEV, Univ Montpellier, IRD, CUFR de Mayotte, Univ Guyane, Univ Réunion, Montpellier, France [4] MARBEC, Univ Montpellier, CNRS, IFREMER, IRD, Montpellier, France Theme: Changing human relationships with mangrove wetlands

Mangroves are increasingly described as socio-ecological systems (SES), which represent a system composed of a society and an ecosystem linked by reciprocal connections and feedbacks. Interactions between the components of the SES can modify the functioning and/or structure of the SES, thus changing its trajectory over time. The theoretical framework of social ecological resilience provides heuristic tools such as the adaptive cycle (AC) to analyse the trajectories of SES. The AC represents the temporal trajectory of an SES passing through four phases: exploitation, conservation, release, and reorganisation. However, this approach has rarely been applied to mangrove SES. This study sought to understand the evolution of the resilience trajectories of two mangrove SES of Mayotte Island, the Vasière des Badamiers and Dapani. The methodology combined 42 semi-structured interviews, analysis of the surface evolution of the mangroves and sedimentary dynamics, and documentary research in the grey and scientific literature. Analyses identify contrasting current phases for each site: Vasière des Badamiers is in the conservation phase while Dapani is in a reorganisation phase since the early 2000s. Such contrasting situations over a small territory like Mayotte reveal different factors influencing the trajectory of these systems. After being cut by humans, the mangrove of the Vasière des Badamiers has rapidly re-established itself when conditions became favourable again (topography, availability of fine sediments and ecological connectivity between the lagoon and the sea). For Dapani, there has been a regime shift from a mangrove dominated system to a now beach dominated system as hydro-sedimentary conditions have caused a loss of mangrove trees, habitat for fauna, and a modification of morpho-sedimentary processes on the coastline. Further reconstruction of the past trajectory of mangrove SES is useful to better anticipate their future trajectory.

Code: P 9.38. A review of the literature and data sources on mangroves of the Southern Arabian Gulf

Almansoori, A.,[1] McGowan, P.,[1] & Fitzsimmons, C.[1]

[1]*School of Natural and Environmental Sciences, Ridley Building, Newcastle University, United Kingdom.*

Mangroves in the Southern Arabian Gulf form critical habitats, yet remain understudied and poorly represented in the global literature. They are vulnerable ecosystems at the interface of extreme local conditions and human activities. This review used a systematic approach to compile literature on mangroves in the Southern Arabian Gulf that we then compare with the literature on mangroves elsewhere. The search found 62 records and identified topics that fell into three themes: (1) spatial distribution of mangroves, (2) biophysical and forest characteristics; and (3) conservation approaches. Mangroves in the Southern Arabian Gulf are shaped into physically stunted forms and limited to one species: the gray mangrove (*Avicennia marina*). They grow at their physiological limits, offering reduced productivity levels and growth rates, signifying that high salinity is the main influence. The majority of the regional mangroves are distributed along the eastern coastline of Abu Dhabi, United Arab Emirates. A growing interest in mangroves restoration has led to large-scale plantation programmes that have not been informed by research. The regional threats to mangroves are land-use changes that cause hydrological modification, particularly to groundwater availability. While the importance of mangrove conservation is recognized, the limited literature indicates a significant gap in ecologically-based evaluations and approaches. Recommended research includes: (1) evaluation of ecosystem services and wider biodiversity in natural and planted areas; (2) identification and mitigation of the direct and indirect threats to mangroves in the region; and (3) development of conservation and restoration approaches supported by scientific evidence. A more coherent approach to research will better inform management and, ultimately, the conservation of mangroves.

Code: P 15.72. Fish assemblages in mangrove creeks along the arid coastline of the southern Arabian Gulf

Almansoori, A.,[1] McGowan, P.,[1] & Fitzsimmons, C.[1]

[1]School of Natural and Environmental Sciences, Ridley Building, Newcastle University, United Kingdom

Mangroves are highly productive ecosystems and one of the most complex vegetative habitat along the hyper-arid coastline of the southern Arabian Gulf. Mangroves in the southern Arabian Gulf remain poorly studied and underrepresented in global mangrove literature. The coastline of Abu Dhabi Emirate has a humid and arid climate with large fluctuating sea-water temperatures, and only one dominant species are found: the gray mangrove (*Avicennia marina*). The total cover of mangroves is approximately 176 km^2. This study addresses mangroves function as nursery habitats to support locally important fish species in mangroves of Abu Dhabi. The aim was to describe the fish assemblage in mangrove creeks along two habitat types; (1) young and sparsely distributed mangrove stands, and (2) mature, dense and one of the oldest mangrove stands. The main objective was to assess if variations in the stands and season affected fish diversity and abundance, and to ultimately provide a baseline for arid mangroves role to support fish. Underwater visual census were used to sample fish assemblages during the winter, spring, and summer seasons at high tide during daytime between January 2022 and September 2022. Environmental parameters were recorded during the fish sampling for water depth, sea-water temperature, pH, and salinity. The sampling areas were continuously monitored using vegetation health maps and aerial photography due to nearby tourism operations, fishing, and coastal development. The study identified a total number of 1,137 individuals found in mangroves. A total of 14 species belonging to 11 families were recorded (Gerreidae: *Gerres oyena*; Lutjanidae; *Lutjanus ehrenbergii*, *Lutjanus argentimaculatus*, *Lutjanus fulviflamma*, Belonidae; *Strongylura leiura*, Serranidae; *Epinephelus coioides*, Lethrinidae; *Lethrinus lentjan*, *Lethrinus nebulosus*, Dasyatidae; *Maculabatis arabica*, Monodactylidae; *Monodactylus argenteus*, Sparidae; *Acanthopagrus arabicus*, Gobiidae; *Gobiidae**, Pomacanthidae; *Pomacanthus maculosus*, Sparidae; *Acanthopagrus berda*). The result of species diversity measures was higher in the mature and dense mangrove stand, as well as fish abundance. The mean length of fish was 7.9cm and the minimum was 3cm, suggesting species were mostly at early development stages. Most species preferred sea-water temperatures ranging between 27 to 31°C. Nine species were identified to have commercial or recreational fishing value in the region. The overall results suggest that arid mangroves provides a critical nursery function for several locally important fish species. Further research is recommended to better inform management and conservation of mangroves for fauna in arid regions.

Code: P 9.52. Spatio-temporal patterns of trace metal concentrations and their potential ecotoxicological effects in mangrove sediments: a global review over 32 years (1988-2019)

Alvarez-Covelli, C.,[1,2] Zimmer, M.,[1,3] & Helfer, V.[1]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany [2] Ghent University, Ghent, Belgium - International Master of Marine Biological Resources (IMBRSea) [3] Faculty 2 Biology/Chemistry, University of Bremen, Bremen, Germany

Anthropogenic activities have increased the input of trace metals (TM) into various ecosystems across the globe, with often negative consequences for both environmental and human health. Mangrove forests, at the interface between land and sea, are known to be nurseries for various fish species of economic interest for human consumption, and as habitat for various crustaceans (crabs and lobsters) and mollusks species (mussels, oysters, clams, snails) also used as food sources. Moreover, local communities also uses mangrove plants for consumption or medical applications. In this context, it is crucial to document spatial and temporal patterns of pollution to ensure food security. In this study, we reviewed spatiotemporal patterns of TM in mangrove sediments at global and regional scales, covering a time span from 1988 to 2019. After a bibliographic review on TM in mangrove sediments, we extracted and mapped spatiotemporal information. The derived maps display the distributions of lead, copper, zinc, nickel, and cadmium (most reported TM in mangrove sediments) and the related ecological risk indices TEC-PEC. Our results show an increase in TM in mangrove sediments over the past 30 years, with nickel and cadmium most frequently found at concentrations hazardous for biota. Most research dedicated to TM in mangrove ecosystems has concentrated on industrial and urban areas, while “pristine” regions are underrepresented. The same applies to countries that harbor large mangrove ecosystems, such as Indonesia and Mexico. Those results stress the need for further comparative TM research in mangrove ecosystems with different levels of human impact, aiming for broader geographical coverage. Along the same line, the lack of regional TM background concentrations makes it difficult the accurately discriminate between human and natural sources of TM. We call for more standardized approaches, ensuring comparability across studies, to properly monitor TM concentrations in mangrove ecosystems.

Code: P 5.59. What is a mangrove forest? Importance of legal definitions in mangrove governance

Alvarez, S.,[1] Andradi-Brown, D.A.,[2] Baker, S.,[1] Wood, K.,[1]; Bell-James, J.,[3] Brown, C.,[4] Buelow, C.,[4] Bukoski, J.,[5] Carrie, R.,[6] Turschwell, M.,[4] Calzada, A.,[7] Golebie, E.,[8] Heck, N.,[9] Villarreal-Rosas, J.,[4] & Slobodian, L.[10]

[1]Georgetown University Law Center, Washington, D.C., US [2]Ocean Conservation, World Wildlife Fund, Washington, D.C., US [3]University of Queensland, Australia [4]Griffith University, Australia [5]Conservation International, USA; [6]Sustainability Research Institute, University of Leeds, West Yorkshire, UK; [7]WWF- Mexico, Mexico; [8]University of Illinois Urbana-Champaign, USA; [9]East Carolina University, North Carolina, USA; [10]Environmental Law and Policy Program, Georgetown University Law Center, Washington, D.C., US.

In the legislation of many countries, mangroves are poorly defined. They are often governed by legal frameworks covering forests, wetlands or coastal zones, but in some cases, the definitions of these ecosystems may be vague so that it is unclear whether mangroves are included. In other cases, definitions of protected or regulated ecosystems may include some mangrove species but not others, or only forests with a certain percentage of trees above a certain height or trunk diameter. Even when mangrove forests are named directly in national laws, the term “mangrove forest” is rarely defined. This creates additional legal questions: what happens to the protections of a mangrove forest area if the trees are cleared? What percentage of mangrove species are required for an area to be considered a mangrove forest? What if mangrove species establish themselves in an area not defined as a “mangrove area”? We conducted a global assessment of mangrove laws and regulations from 73 countries — representing > 99.5% of global mangrove area — and analyzed the different legal definitions applying (or failing to apply) to mangrove conservation in different countries around the world. We found that 15 countries have national laws or policies explicitly and exclusively focused on mangroves, about half of the countries analyzed have laws explicitly prohibiting or restricting cutting, clearing or conversion of mangrove areas. Other countries have laws protecting forests or coastal ecosystems that could be interpreted to apply to mangroves, depending on the definition. We evaluated the extent to which these definitions create incentives for mangrove conservation or destruction, and discuss whether more specific definitions could contribute to improving mangrove governance. We concluded that for effective mangrove conservation, a piece of the puzzle is to have a clear definition of mangroves and associated ecosystems.

Code: P 5.41. Tropical vs. Subtropical mangrove canopy gaps: characteristics and their regeneration dynamics

Amir, A.A.[1]

[1]Universiti Kebangsaan Malaysia, Selangor, Malaysia

Canopy gaps in mangrove forests around the world vary in size but are distinctly characterised by their circular openings. They consist of a group of standing dead trees apparent especially in the beginning of their formation. These characteristics are unique to mangroves that differ from canopy gaps in other forested ecosystems. The continuous creation of gaps was determined to be the key driver in the natural regeneration of mangrove forest. This was proven from the analyses on gap dynamics using a series of historical to recent aerial photographs supported by assessments in the field. The estimated canopy turnover for a hectare of mangrove forest in Moreton Bay was 316.9 ± 115.67 years, while in Pulau Kecil in Matang, it was estimated at 25.5 ± 6.9 years. The comparison between Moreton Bay and Matang mangroves, as well as comparison among other study sites in Australia and Malaysia showed that average gap size, frequency of gaps and the rate of gap dynamics (gap creation to closure) determined the rate of forest turnover. These factors also subscribed to the frequency and density of disturbances that caused the creation of canopy gaps in these mangrove forests. In conclusion, the findings of this study on canopy turnover through the dynamics of gap creation and closure support the hypothesis that disturbance prevents mangrove forest from reaching more senescent stage. In other words, the creation of canopy gaps is determined to drive the natural regeneration in mangroves and maintain the ‘forever young’ condition of the forests.

CODE: P 5.51. SEAHIVE: A shoreline protection system that supports mangrove ecosystems restoration and creation

Araújo, R.J.,[1] Rhode-Barbarigos, L.,[2] Andiroglu, E.,[2] D'Alessandro, E.,[1] Evans, R.,[3] Fernandez, M.,[1] Folchs, R.,[1] Galli, L.,[2] Ghiasian, M.,[2] Gleason, A.,[3] Haus, B.,[1] Jalfon, D.,[4] Lynch, S.,[1] Mead, J.,[1] Nanni, A.,[2] Suraneni, P.,[2] & Tontai, A.[2]

[1] University of Miami, Rosenstiel School of Marine, Atmospheric & Earth Science, Miami, FL, USA
[2] University of Miami, College of Engineering, Coral Gables, FL, USA
[3] University of Miami, College of Arts & Sciences, Coral Gables, FL, USA
[4] University of Miami, School of Architecture, Coral Gables, FL, USA

SEAHIVE is a sustainable estuarine and marine protection system researched and developed at the University of Miami (UM) under the National Cooperative Highway Research Program (NCHRP) in collaboration with the Florida Department of Transportation (FDOT). The system was designed through a morphological investigation that related the shape of the system's elements to aspects such as material efficiency, stability, and ease of manufacture, and physical testing at the UM SUrge STructure Atmosphere INteraction (SUSTAIN) Facility. The hexagonal SEAHIVE elements can be clustered to reflect the beehive design and used as revetment, breakwater and seawall alternative providing protection from storm surge and wave action in marine and estuarine environments. Considering its adaptive features and potential for habitat creation, the system provides an efficient and cost-effective eco-engineering alternative for the protection of coastal communities that can be tuned for both low and high energy areas. Here we describe SEAHIVE and the role it might play in coastal resilience, habitat creation and restoration, as well as a living lab that can support environmental education and outreach. Used alone or in combination with other engineering solutions, SEAHIVE might be critical in the protection of mangroves, an important part of coastal tropical ecosystems. We hope it is viewed as a new tool in the resilience toolbox of managers, property owners of public and private lands.

Code: P 9.60. International, regional, and national policy influences on collaborative mangrove governance opportunities in the Mesoamerican Reef Ecoregion

Archibald, J.L.,[1] Grimm, K.E.,[1] Canty, S.W.J.,[2] & Bonilla, S.E.,[3]

[1]Northern Arizona University, United States of America [2]Smithsonian Institution, United States of America [3]University Park, Pennsylvania, United States of America

We aim to understand the multi-scale policy landscape for mangrove governance in the Mesoamerican Reef Ecoregion (MAR; extending along the Atlantic coasts of Mexico, Belize, Guatemala, and Honduras) and identify challenges and opportunities for collaborative mangrove governance. Increasingly, mangroves are recognized for social-ecological benefits they provide to coastal communities and the global commonwealth. While conservation initiatives are advancing, the policy landscape for mangrove governance is not well understood for many countries. Additionally, while policies may exist, gaps and challenges inhibit effective implementation. Collaborative governance can enhance capacity while supporting inclusivity and equitability and may bridge gaps for implementation. To better understand these trends we ask, "What are the policies and institutions related to MAR mangrove governance, and how do they influence collaborative governance across and within states?". We will conduct a policy analysis of international, regional, and national mangrove governance policies in the MAR. Specifically, we will examine the similarities and differences in policy and institutions within and across each country of the MAR and identify how policy characteristics influence thel implementation of collaborative mangrove governance practices. Furthermore, we will contextualize these results with findings from exploratory interviews with some key mangrove managers in the MAR in which they describe challenges, opportunities, and experiences with transboundary conservation. Research outcomes will detail convergences and divergences in mangrove policy characteristics and institutions across the MAR and implications for collaborative mangrove governance. Opportunities to utilize existing or future policies to enhance collaborative practices as a way to meet social-ecological needs in the region will be identified. Understanding the multi-scale policy landscape can elucidate opportunities for improved mangrove governance including collaborative practices. This research provides such an analysis in the MAR and can inform future mangrove policy development and implementation.

Code: P 15.76. Evaluation of small-scale artisanal fisheries in different communities of the Pacific coast and the insular Caribbean of Colombia

Aristizábal V.,[1] Ocampo M.A.,[1] Ortiz A.M.,[1] & Cantera-Kintz J.R.[1]

[1]Universidad del Valle, Colombia.

Marine resources represent the main source of subsistence for local communities in the coastal and insular area. In order to assess the fishing resource associated with the mangrove ecosystem in Colombia, 70 semi-structured interviews were conducted among small-scale artisanal fishermen in nine locations. In the Colombian Pacific, it was obtained that the most fished resources (taxonomic gender and Common name is presented) in Tumaco are Lutjanus-Snapper with 90%, Hyporthodus-Rooster hind 80% and Merluccius- Hake 63%; in Buenaventura bay is Scomberomorus-Sierra with 50%, in "Punta Soldado", 90% in "La Bocana", 90% in "San Pedro"; and Malaga bay "PNN Uramba - La Plata Archipelago" is Lutjanus-Snapper and Ariopsis-Catfish both with 45%. For the Caribbean the sampling was conducted in the Insular Region (San Andres Island), where three locations were sampled: El Cove, San Luis, and Fisherman Place in the city center; where the most abundant species were Thunnus-Tuna with 90% and Lutjanus-Snapper with 60%. Where Tuna catch was of great abundance and frequency, which allowed fishermen to use it as bait to obtain larger species such as Snapper and eventually Sierra. Fishing gears were also different, Pacific fishermen frequently use the gill nets, bottom longlines, and simple hand-lines, while insular Caribbean fishermen only use selective fishing gear as hand-line, hook and harpoon. The differences when using selective fishing gear were evident in catch sizes and price, making it more profitable. In both regions, there was a significant reduction in the last ten years of all the species that are normally fished, due to several causes such as population growth, pollution and unsustainable fishing practices. The state of the fishery has been greatly affected in recent years, greatly affecting the economy of the fisherman communities.

Code: P 9.51. Invertebrates consuming microplastics in mangroves of the Colombian Pacific: are feeding behaviors determinant for its abundance?

Ariza, M,A.,[1] Peña-Salamanca, E.J.,[1] Palacios-Peñaranda, M.L.,[2] Quesada-Mora, C.A.,[1,2] Cantera-Kintz, J.R.,[3]

[1]Universidad del Valle, Grupo de Biología de Plantas y Microorganismos [2]Universidad Autónoma de Occidente, Grupo de Estudios Ambientales para el Desarrollo Sostenible [3]Universidad del Valle, Grupo de Ecología de Estuarios y Manglares

In mangrove forests, microplastics (MPs), (<0.5 mm particles) penetrate deep into the sediments, causing negative effects on the species that inhabit them. The aim of this research was to confirm the presence of MPs in mangrove organisms of San Pedro and Punta Soldado in Buenaventura Bay, Colombia, to characterize them, and to estimate their effect on trophic groups. For this purpose, two species of cockles, *Anadara similis*, *Anadara tubercolosa*, and crab *Goniopsis pulchra* were captured. MPs were extracted, identified, and counted, their maximum length was measured and they were classified according to their shape and color. We found MPs in 100% of the organisms and, transparent fragments were the most abundant particles (56.40%), which differs from other studies where fibers were the predominant MPs. An average of 25.54 ± 23.8 particles/individual was found and with greater soft weight, there was a greater abundance of MPs. Regarding the number of particles/individual, no differences were found between the cockles, but between each of them in regard to *G. pulchra*, species in which fewer MPs were found. The different feeding behaviors could explain these differences, more generalist species would ingest a greater amount of particles. This is the first approximation to studying MPs inside invertebrate organisms in the Colombian Pacific. The high prevalence and variety of MPs found in this research could imply a wide range of sources of MPs and a risk to the food security of the communities that consume these species.

Code: P 4.3. Black mangrove (*Avicennia germinans*) regrowth and reproductive output following hurricane and freeze disturbances

Armitage, A.R.,[1*] Thompson, J.E.,[1] Palmer, M.,[1] Kominoski, J.S.,[2] Pennings, S.C.[3]

[1]Texas A&M University at Galveston
[2]Florida International University
[3]University of Houston

Mangrove resilience following extreme climatic events is linked to the continued provision of ecosystem services such as shoreline stabilization and habitat provision. Climate change forecasts predict increasing frequency and severity of disturbances like hurricanes and hard freeze events. However, trajectories of mangrove recovery following disturbances in marsh-mangrove ecotones are largely unknown. We focused on *Avicennia germinans* (black mangrove) regrowth and reproductive output following three disturbance events on the Texas Gulf Coast. After a major hurricane (2017), mangrove mortality was low, vegetative cover largely recovered within three years, and reproductive output approached pre-storm levels (>85% mature trees produced propagules) within one year. After a cold snap in 2018 (minimum temperature -7°C), mortality ranged from 28-75% in affected sites. Surviving trees recovered 60-100% of their canopy volume within three years, but reproductive output was suppressed, with less than 35% of mature trees producing flowers one year after the disturbance. A second, more severe cold snap in 2021 (minimum temperature < -9°C) caused extensive (>90%) mortality and canopy damage, with vegetative cover reduced almost to zero in many areas. One year later (2022), the surviving trees had surprisingly high reproductive output, with 72% of mature trees producing flowers. In general, surviving individual *A. germinans* had rapid leaf regrowth and some degree of reproductive output, though the patterns of recovery varied among disturbances. However, at the stand level, cold snaps caused much higher and more widespread mortality than the hurricane; suggesting that cold damage will likely have longer lasting effects on local mangrove populations and associated ecosystem functions within the mangrove-marsh ecotone.

Code: P 5.74. If a Mangrove is "Protected", is it? Using satellite-borne LiDAR to understand efficacy of protection status in West African mangroves

Barenblitt, A.,[1,2] Fatoyinbo, L.,[2] Celio-Sousa[2,3]

[1]Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD, United States
[2]Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD, United States
[3]University of Maryland, Baltimore County, Baltimore, MD, United States

Mangrove integrity in West Africa faces increasing threats from human activities, such as urbanization, oil exploration, and cutting. Protected Areas (PAs) have been purported as a solution to protecting remaining stands of intact mangroves, which are vital for coastline stabilization, carbon storage, and support of livelihoods and biodiversity. However, a recent global study indicated that mangrove PAs are ineffective at conserving biomass, which holds implications about how PA designation may support biodiversity conservation in mangroves. In order to understand the role of PAs for mangrove conservation, this study will use the Global Ecosystem Dynamics Investigation (GEDI) lidar instrument to measure the forest structure of mangroves along the West African coastline, as well as overall biodiversity within PAs. GEDI is a space-borne lidar instrument aboard the International Space Station that is capable of measuring the height and complexity of vegetation canopy. We will compare forest structure metrics like Foliage Height Diversity (FHD), Canopy Copy, and Top of Canopy (RH98), as measured by GEDI, between PAs and unprotected counterparts. We will then identify metrics useful for the creation of a degradation index to classify a range of PA degradation levels. Finally, we will describe how bird presence/ absence data and overall bird species richness correlate with GEDI structural metrics. We will highlight the utility of GEDI and satellite LiDAR for monitoring mangrove forest conditions and degradation status, as well as the opportunities and limitations of each dataset presented here.

Code: P 15.48. Mangrove vegetation characterization and stakeholder perception on community-based mangrove restoration (CBMR): A case study in Sucre, Colombia

Barrera-Bello, A.,[1] Rodriguez-Rodriguez, J.A.,[2] Polanía, J.,[3] Riascos, J.M., [4] Wodehouse, D., Huge, J., & Dahdouh-Guebas, F.

[1] Systems Ecology and Resource Management Research Unit – SERM, Belgium [2] Blue Carbon Lab - Deakin University, Australia [3] Universidad Nacional, Colombia [4]Universidad de Antioquia-Sede Ciencias del Mar, Colombia

Mangroves offer an array of ecosystem services and are a source of livelihood for communities. Mangrove restoration is an essential strategy to contribute to the recovery of their ecosystem functionality in sites where they have been degraded. One of the strategies for successful restoration is Community-Based Restoration and monitoring. Here we combine two evaluation approaches to investigate the progress of a community-based mangrove ecological restoration (CBMR) project in Sucre, Colombia. We use Q methodology to map the main stakeholders' shared perceptions of CBMR and double-check these perceptions through characterization of the vegetation in the field and remote sensing. The Q methodology results will identify the community's needs and perceptions regarding mangrove management and enable us to understand the current restoration management status and its potential continuity in the area. The analysis of vegetation indices from remotely sensed imagery and ground truth would enable the quantification and qualification of the effect of restoration efforts in terms of restored areas. The combination of social and vegetation assessment will provide a roadmap to identify success factors and constraints that slow down the ecological restoration process or may limit the benefits to the community, compromising its sustainability over time. The results of this research will be added to the knowledge related to mangrove restoration needed to inform policymaking.

Code: P 5.34. Comparison of mangrove structural values in different conditions of ecological degradation

Basañez-Muñoz, A.J.,[1], Serrano, A., Guillermo, A., & Garza, J.

[1]Universidad Veracruzana.

Changes in hydrology in mangroves translate into well-defined degradation gradients that mainly translate into a decrease in their structure. A good estimator of the structure of a forest is the Complexity Index, which relates density, basal area, height and the number of species present in 0.1 ha. A neotropical mangrove swamp located within Ramsar site No. 1602 was fragmented by the construction of three solid structures across the width of the forest. This eventually caused the degradation of the forest, with three scenarios, apparently undegraded sections, semi-degraded and complete mortality. The present work, based on two ecological index, seeks to find changes in the behavior of the tree structure and regeneration that show the degradation process. A reference site was established and four more transects were made covering the width of the mangrove and all degradation scenarios. Quadrants were made every 25 m, taking the indicators to process the Complexity Index and a Regeneration Index. The reference site presented the best regeneration value and the second best in tree structure in relation to the forest fragments. When comparing for the degradation condition, the reference site and the area that apparently is not degraded had close values, not the semi- degraded condition that presented values much lower, mainly attributed to its low density and height of its individuals. Compared to the reference site, the apparently non- degraded areas of the forest fragments have good structural development and regeneration, so a rehabilitation is feasible to solve the stress caused and begin its recovery, not so for the total mortality area, which requires active intervention to begin a slow process that leads to its integration into the other areas.

Code: P 9.66. "Dans le sel, nos racines" *(In salt, our roots)*. A documentary film by Sabali Expeditions

Beca, M. & Tarelkin, Y.[1]

[1]Sabali Expeditions, Belgium

Sabali Expeditions is a non-for-profit organization aiming to sail around the world to carry out research on mangroves whilst advocating for marine and coastal conservation through film. After a departure from Brussels (Belgium) in June 2022, our expedition sailboat has now reached the intertropical belt where it will sail for the upcoming years, acting as a floating laboratory allowing for both data collection and storytelling mangrove-related activities. Through a first campaign in Senegal and Gambia in the last quarter of 2022, we were able to document the work achieved by local communities and NGOs around mangrove conservation and restoration in the region. We interviewed a variety of actors such as community members directly impacted by the health of the mangrove ecosystem regarding their livelihoods, or scientists and NGOs staff involved in conservation and reforestation programming. At the occasion of the MMM6, we wish to present a documentary film retracing the adventure and these encounters, in order to initiate discussion on a variety of practices and beliefs determining development funding and socio-economic initiatives revolving around mangroves in West Africa. Ranging from reforestation initiatives to oyster culture projects, this film highlights the importance of community adhesion to mangrove protection efforts, both through economic development opportunities and implication in regulatory enforcement. It also portrays the benefits of protected marine areas regarding habitat and resource sustainability, whilst addressing the need to provide alternative income sources to populations when restrictive policies counter traditional practices. Through our journey, we hope to keep documenting mangrove conservation initiatives around the globe and spark reflections on good practices that can foster sustainable socio-economic development amongst populations relying directly on mangrove forests for their survival.

Code: P 15.75. Creación de un dispositivo museográfico para presentar las zonas manglares en el Jardín Botánico de San Andrés, Colombia

Bermudez-Valderrama, J.[1]

[1]Colombia

The guides commented on the mangrove ecosystems inside the Botanical Garden of San Andres (JBSAI) required the design of a museographic device that would facilitate, to school and university audiences, to learn the relationships that occur due to the presence and abundance of mangrove species and other plant-animal and human associations that take place in the Old Point Regional Park. By using this device, we seek to increase the public's knowledge of the multiple species that are generated, mutate and die in these ecosystems. It also seeks to popularize the vocabulary and other relationships with which the Raizales and Raizales have known and have been linked for generations with the mangroves and other beings that inhabit them. For the construction of the scientific, museological and museographic scripts, the visual references with which mangroves have been portrayed in audiovisual productions housed in the archives of Señal Memoria de Colombia, Radio Televisión de Colombia -RTVC- and the Fundación del Patrimonio Fílmico Colombiano (Colombian Film Heritage Foundation), as well as some commercial films, were consulted. Conversations and with inhabitants of San Andres and with experts who investigate these ecosystems and who have worked to show it in different spaces and formats. The final product is a museographic device consisting of a scale model of the ecosystem and online reference material such as video clips. The joint creation between the JBSAI team, academic and local experts allowed us to reflect on the historical perspective of how this ecosystem has been shown, the opportunities and risks that exist in the aesthetic and museological decisions of the ways of showing and the opportunities that the communities have to propose their ways of exhibiting.

Code: P 5.80. Stand structure and composition of planted mangrove forest seven years post establishment: The case of Mangrove and Beach Forest and Development Project, Philippines

Bernales, M.M.G.,[1,2,] Castillo, J.A.A.,[1] Reyes, M.L.,[1] Moreno, M.L.Q.,[1] Gestiada, A.S.,[1] Manahan, J.R.F.[1]

[1]Ecosystems Research and Development Bureau, Department of Environment and Natural Resources, College, Los Baños, Laguna 4031 Philippines
[2]Graduate Student, University of the Philippines, Open University, Los Baños, Laguna 4031 Philippines

Mangroves provide ecosystem goods and services to society but still, continuous mangrove deforestation is happening. Rehabilitation programs have been implemented in Southeast Asia to increase forest cover and restore habitat functionality. Unfortunately, monitoring activities are rarely undertaken to document the performance of these planting programs. Due to high level of investment, studies that evaluate the success (or failure) of mangrove rehabilitation programs remain a challenge for researchers and resource managers. In the Philippines, the Mangrove and Beach Forest Development Project was implemented in 2015 However, information is lacking on the current status of the mangrove stands, seven years after the program. This paper aims to examine the current status of two selected mangrove stands (Occidental Mindoro, and Leyte) conducted in 2022 and compare them to the baseline result of 2015 using the transect line-plot method. Both baseline sites were bare, and purely mudflats with an abandoned fishpond prior to the rehabilitation. The result showed that *Rhizophora mucronata* and *Rhizophora apiculata* dominate the area, with recruitments of *Sonneratia alba* and *Avicennia marina*. The plantation cover ranged from 59% to 82% and a survival rate of 75% to 86%. As of 2022, the mean DBH, height, and basal area were found to be 3.67 cm (± 1.45 SD), 2.66 m (± 0.63), and 0.12 m2 (± 0.01) in Mindoro and 3.35 cm (± 2.18), 1.95 m (± 0.81), and 0.67 m2 (± 0.04) in Leyte, respectively. Mindoro and Leyte had 1,681 and 1,883 mangrove trees per hectare. The average carbon density in Mindoro was 1.88 MgC ha-1 (± 0.83) while 16.78 (± 34.19) MgC ha-1. in Leyte. Our findings indicate some early evidence of restoration of habitat functionality and increase in forest cover. The paper concludes with some policy and management implications of the findings, recommendations for management action, and future studies.

Code: P 14.3. Increased mangrove plant biomass and tree density in the Amazon Delta

Bernardino, A.F.,[1] Souza, F.,[1] Mazzuco, A.C.A.,[1] Santos, T.,[1] Costa, R.,[2] Barreto, A.E.,[2] Massone, C.,[3] Sanders, C.,[4] Nobrega, G.,[5] Ferreira, T.O.,[2] & Kauffman, J.B.[6]

[1]Corresponding author: Departamento de Oceanografia, Universidade Federal do Espirito Santo, Vitória-ES, Brazil. [2]Universidade de São Paulo, ESALQ, Piracicaba, Brazil [3]PUC Rio, Rio de Janeiro, Brazil [4]Southern Cross University, Coffs Harbour, Australia [5]Universidade Federal do Ceará, Fortaleza, Brazil [6]Oregon State University, Corvallis, USA

The Amazon coast holds over 2/3 of the Brazilian mangrove extent with 700,000 ha of well developed forests. In this region, there is a major salinity gradient starting at the Amazon Delta due to the outflow of the Amazon River where freshwater mangroves have been recently discovered, to the eastern coast where typical high-saline mangroves occur. To the East, Amazon mangroves hold significant amounts of carbon as aboveground biomass (145 Mg C ha^{-1}), however regional changes in these stocks have not been tested despite significant environmental changes towards the Amazon Delta. In the Amazon Delta there is a larger tidal amplitude, a higher freshwater input from the Amazon River and the occurrence of mixed forests. Here we tested these regional changes in the mangrove aboveground carbon by comparing plant carbon pools from 156 plots from an east-west gradient along the Brazilian Amazon coast. We found the total plant C and tree density is significantly higher in the Amazon Delta (186.9 Mg C ha^{-1} and 6257 ind. ha^{-1}; respectively) when compared to saline mangrove plots to the east located > 200 km from the Delta (131.5 Mg C ha^{-1} and 1708.6 ind. ha^{-1}; respectively). We did not find a significant relationship between soil salinity and aboveground carbon on the mangroves sampled, although plant carbon was on average 23.9 % higher on the Amazon Delta. We suggest that higher tidal amplitudes and the higher freshwater input in the Amazon Delta increase regional plant C due to increased tree size and the presence of a unique and dense low stand vegetation that is not typical on the more saline Amazon mangroves. Our expanded regional data may significantly increase global models of mangrove forest biomass by recognizing the effects major freshwater gradients on the largest continuous mangrove belt in the World.

Code: P 15.24. The LIFE Adapt'Island project – Nature-based solutions for climate change adaptation in the Caribbean.

Beuve, J.,[1] & Dalle, M.[1]

[1] GPMG, France

The mangrove, interface between land and sea, is an ecosystem providing many ecosystem services such as the protection of the coastline against wind and waves. However, it is subject to many natural and anthropogenic pressures (deforestation, pollution, climatic hazards, urbanization). Guadeloupe, Caribbean archipelago, is hosting an important assessment and evaluation of local mangroves. This ecosystem is strongly impacted by increased urbanization. This phenomenon causes soil disturbance and possible contamination which alters the water circulation and inhibits the natural recolonization of mangroves by benefiting invasive alien species (IAS). The « Grand Port Maritime de la Guadeloupe » (GPMG), by its new status, is manager of natural environmental areas, including mangroves. The port operators have the will to rehabilitate and protect such natural spaces as it implements the environmental program « Càyoli ». In order to deepen this approach to sustainable development, the LIFE Adapt'Island project, co-financed by the European Union, is coordinated by the GPMG. This five-year project (2019- 2024) is built on nature-based solutions by implementing techniques to monitor and fight against the effects of climate change. The project focuses on three coastal ecosystems: coral reefs, seagrass beds and mangroves. The aim is to rehabilitate degraded mangrove areas, to apply corrective environmental measures, and to restore abiotic parameters suitable for mangrove development (clearing, management and management of IAS). For example, during the wet season, mangrove planting operations are carried out to boost natural regeneration. After planting, some seedlings will be integrated into ecological monitoring campaigns (growth, state of health). The port is committed to monitoring and maintaining the ecological status of its natural areas over the long term.

Code: P 14.2. MangMap: a new platform for mangrove mapping and monitoring using Earth Observation data

Blanchard, E.,[1,2] Catry, T.,[1] Delbar, V.,[2] Marlard, P.,[1] Sonko, P.N.,[1] Mouquet, P.,[1] Gusmai, Q.,[1] Delaître, E.,[1] & Faure, J.F.[1]

[1] UMR ESPACE-DEV, IRD, Université de Montpellier, Univerdité de Guyane, Université de La Réunion, Université des Antilles, Montpellier, France [2] La TeleScop, Castelnau-le-Lez, France

Mangroves represent a vital natural heritage and our capacity to ensure their preservation is a key issue for fighting against global warming, preserving biodiversity and ensuring the way of life and subsistence of the increasing human population concentrated along the coasts. Over the last half century, however, mangroves have suffered an alarming loss of global cover. In order to improve the understanding of the dynamics and functioning of mangroves, up to date and recurrent mangrove mapping and monitoring tools are crucial assets. MangMap, a new online platform based on Sentinel-2 time series starting in 2018, renewed every 5 days, offers a complementary approach to existing tools. The platform provides an interactive dashboard dedicated to the production of enduser driven products useful to mangrove monitoring at local scales. Each image transformed in reflectance levels (2A) is available for downloading along with 11 automatically processed spectral indexes characterising mangrove environments. An automated vector contour of mangrove spatial distribution is calculated every quarter. Temporal composites of all indexes are processed monthly, quarterly, semesterly and yearly. Endusers can browse and import all data sets with simple tools. They can set specific on-demand analysis inside their own areas of interested, uploaded to the platform or drawn over the products on screen, for a chosen period of time: indicator of mangroves spatial evolution; calculation of index differences; statistics on index evolutions. The platform gathers 16 pilot sites spread over South America, Africa, Asia and Oceania regions. MangMap was designed to sustain and document scientific studies as well as to help institutional actors and stakeholders invested in the preservation and management of mangroves. Further up-grades in preparation with first users will seek to enhance enduser experience and to offer new Earth Observation products and services based on very high spatial resolution imagery and radar data time series.

Code: P 5.92. Tea time in racoon city: (composing) music from decomposing litter to communicate the ecosystem effects of mangrove die-off

Blanco-Libreros, J.F.[1]

[1] Institute of Biology, Universidad de Antioquia, Colombia

Tea bag experiments are a novel standard to study decomposition of plant litter in worldwide ecosystems. However, there are a few examples from mangroves, particularly in the Western Hemisphere, and no study has been conducted in Colombia. I employed a simple green tea bag experiment to assess the ecosystem effects of mangrove die-off produced by the loss of hydrological connectivity in a location in the Central Caribbean coast of Colombia. This area is also home to numerous racoons leaving their footprints on the mud as they seek for fiddler crabs. A racoon city, not very different from that of the famous video game. A spatially nested design compared three areas along a drought gradient. Each area 25 m^2 contained four 1 m^2 blocks within a, and each block contained 15 tea bags nested into five replicates (four corners and the center). Tea bags were left to decompose during 90 days to assess remnant mass stabilization and therefore carbon sequestration. The first results of remnant mass in 180 tea bags after 90 days were sonificated using various approaches to compare nested spatial patterns. The average for each area marks a moment of the musical piece, the average for each the four blocks marks the compases, and averages of the replicates depict the fine-scale variation as a melody. The coding for areas, blocks, replicates, and seudoreplicates were used to filter data with composition purposes. The drought and tree die-off reduced average litter mass loss and spatial variability, that is therefore translated into a dull and monotonous part of the musical piece. In other words, the mangrove sediments lost their lively melody! Sonificated data can be useful to easily communicate the consequences of ecosystem degradation in Caribbean mangroves (racoon cities) to a wider audience.

Code: P 5.93. Translating land-cover data into music to promote mangrove conservation awareness

Blanco-Libreros, J.F.,[1] & Ramírez-Ruiz, K.[2]

[1] Instituto de Biología, Facultad de Ciencias Exactas y Naturales, University of Antioquia, Medellín, Colombia.
[2]Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Brussels, Belgium.

Public communication of scientific research is critical for ecosystem conservation, to inform policy making and to promote dialogue with diverse interest groups. Despite global awareness about the importance of mangroves is growing, communicating the complex linkages between mangrove degradation and anthropogenic modifications remains a challenge. Data sonification is an emerging tool to understand complex datasets and to support science communication. We used TwoTone Midiout online app to sonificate and musicalize the spatial variation in land cover across coastalscapes surrounding mangroves. One piece guides the listener along a South-North travel across 13 marine protected areas (MPA hereafter) following a South-North gradient starting in the border with Ecuador to Northern Colombia. The result is a 13-second-duration groovy musical, with the high pitch of a trumpet representing the abundance of wetlands and waterbodies, erratic marimbas (wooden xylophones) giving life to forest cover, and a deep bass representing anthropogenic land covers. The sonification is based on land cover composition calculated within a 5-km buffer around 13 marine protected areas (MPAs) with mangroves in Colombia. A second piece was constructed using land cover of ca. 100 coastalscapes around the occurrences of an endangered mangrove genus endemic to the Americas (Pelliciera spp.). The piece highlights the marked conservation contrast between the Pacific and Caribbean basins in the Americas. Land cover data sonification helped us to identify spatial patterns in the coastalscapes, particularly gradients and discontinuities. By adding musicalized data to visually-supported scientific narratives (graphs and maps), these examples show a way to improve science communication both to specialized and general public, thus supporting efforts to promote conservation awareness.

Code: P 9.90. Wave Attenuation Through a Mangrove Forest Using LiDAR Representation

Bogan, E.,[1] Twilley, R.,[2,3] Rovai, A.,[3] Chancia, R.,[4] Trindade, F.[5]

[1] Louisiana State University, Department of Civil & Environmental Engineering, Baton Rouge, United States, [2] Louisiana State University, Coastal Ecosystem Design Studio [3] Louisiana State University, Department of Oceanography & Coastal Sciences, Baton Rouge, United States [4]Rochester Institute of Technology, Chester F. Carlson Center for Imaging Science, Rochester, United States [5] Louisiana State University, Center for Coastal Resiliency, Baton Rouge, United States

Coastal flooding can cause severe damage to built infrastructure in neighboring communities. Mangrove forests have been proposed as a line of defense to mitigate flood damage by reducing waves and surge during flooding. Rhizophora mangle, red mangrove, has complex aboveground forest structures containing prop roots that create a drag force on water flow which reduces surge and wave height. The fringe forest, dominated by red mangroves in the Caribbean, can protect built infrastructure based on physical simulations in flumes by measuring reductions in wave height using artificial structures to estimate mangrove forest features. The projected area of the mangrove root system has been identified as a key feature of nature-based solutions to calculate the drag force and wave reduction. We report on a study to characterize actual forest structure using field measurements to determine the projected surface area across coastal typologies. While there are several excellent allometric relations to predict different dimensions of mangrove forest structure based on tree diameter and density, there does not exist such equations to determine appropriate scaling of structure and flood reduction functions to interpret flume studies. While these are important components of wave reduction models such as X-Beach, most research has ignored field-calibrated forest dimensions that predict projected root surface area. We measured individual trees with a portable terrestrial laser scanning (TLS) system to determine precise, three-dimensional information about the shape and surface of prop roots. A correlation was found between trunk diameter at breast height, DBH, and root volume, with DHB range from 5 to 35 cm.
$V_R = .00007D^3 - .0034D^2 + .054D - 0.1283$ This relationship can be applied to other estimates of red-mangrove forest basal area to estimate surge and wave reduction parameters. Improved estimates of mangrove performance in reduced annualized damage assessments in coastal communities will support ecosystem designs for long-range planning and land use redevelopment decisions.

Code: P 15.36. Biodiversity survey of mangrove gastropods and crabs of Hong Kong by integrating DNA barcodes and morphology

Bravo, H.,[1,2] Cheng, C.L.Y.,[1] Iannucci, A.,[3] Cannicci, S.,[1,3] & Fratini, S.[3]

[1] The Swire Institute of Marine Science, The University of Hong Kong, Hong Kong, Hong Kong S.A.R., P.R.C.
[2] Groningen Institute for Evolutionary Life Sciences, University of Groningen, 9700 CC Groningen, The Netherlands [3] Department of Biology, University of Florence, 50019 Sesto Fiorentino, Italy

Mangroves host a unique and biodiverse faunal community dominated by brachyuran crabs and gastropods. Nowadays there is strong evidence that a rich and functionally redundant fauna is the key to ensure full mangrove functionality. The reliable assessment of mangrove faunal diversity is, thus, a crucial step for efficient management and conservation plans. However taxonomic surveys and species identification have proved to be challenging for mangrove associated macrofauna, mainly due to the cryptic behaviour of many species, inaccessibility to some areas, and the presence of a high number of morphologically very similar, and phylogenetically related, species We developed a verified DNA barcode library for brachyuran crabs and gastropods of the mangroves of the Greater Bay Area, Southern China. We identified, on the basis of their morphology and with the help of renown experts, and sequenced 275 specimens. Barcode sequences were then used to delineate Molecular Operational Taxonomic Units (MOTUs) using different delimitation methods. By integrating DNA barcodes with morphology, we identified 44 gastropod species and 58 brachyuran species associated with Hong Kong mangroves, with five and seven new records, for gastropods and crabs, respectively, for the Greater Bay Area. The delineation of MOTUs based on barcode sequences revealed a strong congruence between morphological and molecular identification for both taxa, showing the high reliability of the barcode library. This is the first reference barcode library for mangrove-associated macrobenthic fauna in the Greater Bay Area and represents a reliable tool to management and conservation plans. Our molecular analyses resolved long lasting taxonomic misidentifications and inconsistencies, and updated the knowledge on the geographical distribution of Asian mangrove associated fauna, highlighting a level of biodiversity higher than previously thought for Southern China.

Code: P 9.4. Additive effects of nutrient enrichment on marsh species composition and mangrove encroachment

Bravo, J.,[1] Langley, A.,[1] Chapman, S.[1]

[1]Villanova University, United States of America

Wetlands face a variety of global change drivers, such as sea level rise and nutrient pollution, that threaten their ability to sequester carbon, provide habitat, and mitigate climate change. As a result of reduced freeze events, sediment changes, and sea level rise, mangrove species typically found in tropical and sub-tropical coastal ecosystem have expanded into temperate wetlands. Over the last two decades, *Avicennia germinans* and other mangrove species have established at Guana-Tolomato National Estuarine Research Reserve (GTMNERR) in northern Florida (USA), transitioning these ecosystems into a marsh-mangrove ecotone. As anthropogenic nitrogen (N) inputs increase and eutrophication events in adjacent waterways become more frequent, it remains unclear how nutrient enrichment may influence mangrove establishment and marsh plant community composition, and how those responses may depend on hydrological settings. Interior platform, unlike the creek edge, have shorter inundation periods and less tidal flushing due to greater creek distance and higher elevation. In March (2022), we fertilized ten plots along the creek edge and high marsh platform composed of *Batis maritima* and *Spartina alterniflora* with 93 g N $m^{-2}yr^{-1}$of urea. Interior enriched plots exhibited the strongest N effects on plant growth and belowground processes. Within the marsh interior, *B. maritima* and *S. alterniflora* had higher biomass in N-enriched plots (693 and 675 g/m^2) compared to unenriched plots (288 and 526 g/m^2). Interior N-enriched plots also showed 66% higher root productivity compared to other plots. Mangrove seedling height followed similar trends to marsh species biomass. Regardless of location, enriched plots had higher mangrove seedling density ($p = <0.001$). The strong N response of *B. maritima* growth and mangrove seedling density within the interior plots suggest these areas may be more N limited. Ongoing experimentation will help determine how abiotic stressors, hydrological position, and nutrient accessibility influence plant community composition and wetland integrity.

Code: P 9.3. Realized ecological niche of a species of interest: Terebralia palustris (Linnaeus, 1767), in the mangroves of the island of Mayotte (France, Indian Ocean).

Brosse, R.,*[1,2] Golléty, C.,[1,3] Mercky, Y.,[1] Schaal, G.[2]

[1]Centre Universitaire de Mayotte (CUFR), 97660 Dembéni, Mayotte, France. [2]LEMAR, UBO, CNRS, IRD, Brest, France. [3]MARBEC, Univ Montpellier, CNRS, IFREMER, IRD, Montpellier, France

The study of species distribution is a key component of ecology and biogeography. The realized ecological niche – the niche actually observed in nature – is determined by analyzing the species-environment relationship. Its study can be used to assess the impact of land use and climate change on species or to support conservation planning. The epigean gastropod Terebralia palustris is widely distributed in the mangroves of the Indo-Pacific. It is an engineering species that contributes to mangrove functioning and is used as a resource. Nevertheless, existing knowledge on its distribution remains quite contradictory and suggests highly context-dependent responses. It is thus found either only in the internal mangrove or in the whole mangrove depending on the location throughout its range. In Mayotte (France, Indian Ocean), we observed a very heterogeneous presence within the internal mangrove of 13 mangroves out of 29. We therefore aimed to distinguish the specificities of the realized niche in Mayotte from the one common to the rest of the distribution area and to evaluate what the natural environmental factors that constrain this niche are. To this end, we studied environmental conditions related to feeding, shading, soil quality, and moisture comparing sites of species presence and absence during both dry and wet seasons. Results indicate the importance of shade-related variables in explaining the presence of the species. They are found where the habitat is dominated by numerous Avicennia marina of medium size (3.70 ± 1.28 m). This improved definition of the realized niche of T. palustris makes it possible to understand which habitat must be preserved to ensure the persistence of this species. The species was not always found where these characteristics exist: further studies should explore the reasons for its absence, whether natural (competition/predation) or anthropogenic (pollution/overexploitation).

Code: P 5.37. Understanding Grenada's mangroves: zonation, plasticity, and the potential for restoration

Buckmire, Z.E.A.,[1] & Koper, N.

Grenada Fund for Conservation Inc., Grenada

White mangroves (*Laguncularia racemosa*) are widely distributed throughout both the Caribbean region and the mangrove ecosystems they inhabit, despite being considered restricted to the back mangal. In Grenada, I have observed white mangroves expressing phenotypic plasticity, including aerial root expression, prompting questions about the link between its plasticity and mangrove community zonation. I hypothesized that mangal zonation and white mangrove plasticity were influenced by both site-level (forest type) and plot-level factors (edaphology and hydrology), and that plasticity also contributed to the zonation observed through niche expansion. I conducted vegetation surveys at one basin forest and one fringe forest in Grenada in summer 2020–2021, collecting environmental (site characteristics and soil chemistry) and vegetation data (tree height and size, aerial root presence, leaf size and thickness). Overall, white mangroves were more structurally important than both red and black mangroves and were well-distributed in all zones except the fringe forest's seaward zone. White mangroves showed preference for higher-elevation habitat with a limited hydroperiod, including the seaward zone of the basin forest, revealing that their distribution is driven by elevation and not zone *per se*. The species exhibited trait plasticity in tree height, diameter, leaf size, and root form in response to salinity and elevation. The latter was most interesting, as white mangroves produced pneumatophores in shallow water and adventitious roots in deeper water, allowing the species to survive in varying water depths and defy expected zonation patterns. The link between these two concepts should be explored in other forest ecosystems to further understand the effects of intraspecific variation and plasticity on community structure and zonation. These findings can also help improve mangrove restoration planning by highlighting the versatility of white mangroves. Incorporating the species into a multi-species approach can improve the success rates, cost-effectiveness, and sustainability of restoration in the Caribbean.

Code: P 15.71. Mangroves for Money: ecological and social impacts of recent development projects in the mangrove forests of Grenada, West Indies

Buckmire, Z.E.A.,[1] Daniel, J.,[2] Constant, N.,[3] & Hanna, J.[4]

[1]Grenada Fund for Conservation Inc., Grenada [2]Gaea Conservation Network, Grenada [3]Grenada Land Actors, Grenada [4]Heritage Research Group Caribbean, Grenada

The productivity and value of mangrove ecosystems worldwide are well-documented, as are anthropogenic drivers of mangrove degradation and loss. These coastal forests are hotspots of biodiversity, providing complex structure with abundant microhabitats for associated species. In Small Island Developing States (SIDS) like Grenada, mangrove ecosystem services are all the more important because they are intricately linked to local livelihoods and climate resilience. Through recent monitoring in Grenada, we have begun to document the status and structure of mangrove forests and the diversity and abundance of fauna found therein, as well as the varied ecosystem services they provide. Research documenting prehistoric settlements in Grenada also substantiates the sociocultural importance of mangrove forests in prehistory, as well as their ongoing connection to Grenada's cultural heritage. However, development remains an ongoing threat as this island nation endeavours to catch up to its neighbours in the Global North. Development projects, especially for large-scale resorts, continue to be approved in the delicate coastal zone in and around mangroves, introducing sustained disturbance that will persist through both construction and subsequent resort operations. How will these ecosystems respond long-term? Several local conservation non-profits are working together to document Grenada's mangrove ecosystems and advocate for their importance to the broader public. In this article, we provide a summary of our work in these areas, describing current threats and the ecological, economic, and cultural significance of Grenadian mangroves.

Code: P 15.37. Global Mangrove Watch: Updated Global Mangrove Extent and Annual Change Mapping (GMW Version 4.0)

Bunting, P.,[1] Rosenqvist, A.,[2] Hilarides, L.,[3] & Lucas, R.[1]

[1]Aberystwyth University, United Kingdom [2]soloEO, Japan [3]Wetlands InternationaL, Netherlands

The mapping and monitoring of mangrove ecosystems is of critical importance for their protection and sustainable management. To this end, the Global Mangrove Watch (GMW) was established in 2011, and the first maps of global mangrove extent were made available in 2018 (Version 2.0; Bunting et al., 2018). A subsequent update to the 2010 global mangrove baseline (Version 2.5; Bunting et al., 2022a) and annual change maps were released in 2022 as the GMW v3.0 product (Bunting et al., 2022b). The update significantly improved the quality and spatial coverage of the mangrove extent mapping and change estimates, provided for eleven annual epochs between 1996 and 2020.
The next version of the GMW global extent and annual change products, version 4.0, is due for release in July 2023. The GMW v4.0 release will feature a new global mangrove baseline map for 2020. Based on Copernicus Sentinel-2 data, the new baseline will have a spatial resolution of 10 m. An improvement over the 25 m resolution of the earlier GMW products, making the map more relevant for local scale analysis. The most significant limitation of the GMW v3.0 maps was the geometric inconsistency of the annual change products caused by the version of the L-band SAR mosaics available to the GMW at the time. JAXA hassubsequently, during 2022, re-processed all the global L-band SAR mosaic products with significantly improved geometric accuracy. The forthcoming GMW v4.0 dataset will thus represent a significantly improved annual change product that allows independent gains and losses to be estimated (not recommended with the GMW v3.0 products due to their inherent geolocation uncertainty). Additionally, the time series will be extended from 2020 to include the years 2021 and 2022.

The GMW global extent and change maps are available through the GMW Portal (https://www.globalmangrovewatch.org)

Code: P 15.23. Carbon stocks in mangroves of Isla Fuerte (Colombian Caribbean): a first approximation

Caicedo-García, J.P.,[1] & Polanía, J.[1]

[1]Facultad de Ciencias Agrarias, Universidad Nacional de Colombia Sede Medellín

Carbon dioxide (CO_2) and other gases have generated a greenhouse effect and global warming. Mitigating this global warming is a public need. Natural, as well as political solutions are urgently sought. "Blue carbon" is an option related to CO_2 captured by marine-coastal ecosystems, such as mangroves, which have a more significant storage potential than their terrestrial counterparts. The social appropriation of this knowledge by communities can contribute to the solution of climate change. The mangrove forests of Isla Fuerte (Bolivar, Colombian Caribbean) consist of four species (*Rhizophora mangle, Conocarpus erectus, Laguncularia racemosa,* and *Avicennia germinans*) and cover 55 ha. The students applied the national and subnational biomass estimation protocol as part of a university course on mangroves. They evaluated the island's blue carbon stocks: four experimental plots were established to measure shrubs, grasses, and regeneration, dendrometric variables (*i.e.*, diameter and height), and detritus on the ground. Allometric equations from the literature were used to estimate biomass and carbon stocks. The storage potential of Isla Fuerte could be 2,744 - 7,818 MgC. Scientific communication is crucial in academic projects, and the university students invited the Isla Fuerte Educational Institution schoolchildren to participate actively in recognition of the ecosystem and the assembly of the plots. The schoolchildren learned about different aspects of the ecosystem and took ownership of its natural resources. It is expected that the generation of critical thinking about the capture of pollutant gases by the ecosystems will contribute to determining future actions for their conservation and restoration on the island and in other world mangroves.

Code: P 9.24. A multi-criteria modelling approach to prioritize mangrove restoration areas: The case study of Hondita bay - La Guajira, Colombia.

Camargo, M.A.,[1] Rojas, Y.,[1] Millán, S.,[1] Montes, C.,[1] Ana Sierra, A.,[1] & Rodríguez-Rodríguez, A.[1,2]

[1]Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis"- INVEMAR.
[2] Deakin University, School of Life and Environmental Sciences, Blue Carbon Lab, Burwood, VIC 3125, Australia.

The benefits of successfully restoring vegetative coverage and ecological functions of mangrove ecosystems have been widely reported, yet quite a few restoration attempts have failed due to, among other reasons, lack of planning or insufficient local context understanding. Even though several spatial tools have been recently developed to prioritize restoration areas at global and regional scales; restoration sites must be selected according to criteria assessed at a very local scale and considering specific goals stated by all parties involved. In order to suitably identify onsite mangrove restoration areas in Hondita bay – La Guajira, Colombia, a multi-criteria spatial model was built based on the evaluation and weighing of prioritization criteria defined through technical-scientific input and local communities needs and knowledge. Input sources included high-resolution satellite imagery (GeoEye-1 from 2009 and Pleiades-1b from 2022) and ground-truth verification, as well as a participatory mapping with local communities. A total of 17 variables were compiled, analyzed, and categorized within four thematic components (i.e. biotic, social, tensors and accessibility), from which four raster models were built, standardized and weighed according to their relevance. Lastly, the final model was obtained by summing up all raster models, where the highest and lowest values that a pixel could contained were 100 and zero, respectively; indicating the final restoration priority score categorized within four levels (i.e. very high, high, medium and low). This model allowed the selection of the most suitable sites for mangrove restoration in Hondita bay, by thoroughly analyzing and integrating a range of social-ecological and landscape level attributes of the system, and thus, provides a practical tool applicable to other regions with mangrove restoration potential.

Code: P 15.34. Mangrove productivity of the Pacific coast of Colombia: from leaves to fisheries

Cantera-Kintz, J.,[1] Mancera-Pineda, E.,[2] Peña-Salamanca, E.,[1] Palacios-Peñaranda, M.,[3] Guzmán, A., Sierra-Luna, V.A., Vásquez, S., López, L.A.; Ocampo-Rojas, M., Mejía, J.C., Ortiz A.M., Guevara, M.C., Medina-Contreras, D.

[1]Universidad del Valle, Colombia [2]Universidad Nacional, Colombia [3]Instituto de Estudios para la Sostenibilidad, Colombia

Understanding the trophic dynamics of estuaries and mangroves is fundamental to generate new strategies for sustainable use of coastal marine resources and fisheries. Although the concept of mangroves as exporters of carbon to adjacent food webs and as support for fisheries dominated the field of mangrove ecology for a long time, the use of other analytical techniques has allowed for a more precise understanding of the importance of mangroves in the world. The Colombian Pacific coast presents mangroves in a high degree of development and conservation with seven species of mangrove trees, which reach a high structural complexity with large trees and relatively high biodiversity of fauna associated with this ecosystem. This paper presents the results of several years of research on Mangrove food webs in the Colombian Pacific mangroves and their importance in coastal fishery productivity. Throughout the years of research, the taxonomy and ecology of the organisms associated with mangroves have been identified, the parameters and structure indices, photosynthetic rate and complexity of mangrove trees have been studied carbon in vegetation and soil, primary productivity and nutrient flow in the water, and the phytoplankton community have been measured. The energy flow pathways between the main components of the trophic webs (macrobenthos, fishes) of the mangrove, estuary and coastal system have also been studied using taxonomy, ecology, functional diversity, stable isotope analysis and mass balance models with Ecopath (Ecosim); to determine the importance (in biomass and productivity) of each trophic level within the ecosystem.

Code: P 15.52. A country between two coasts: integral assessment of four ecosystem services in different types of mangrove forests on the colombian Pacific and Caribbean

Cantera-Kintz, J.R.,[1] Peña-Salamanca, E.,[1] Mancera-Pineda, J.E.,[2] Palacios-Peñaranda M.,[3] Santos-Martínez, A.,[2] Gavio, B.,[2] Medina, J.H.,[2] Sánchez, D.A.,[2] Ocampo-Rojas, M.A., [1] Sierra-Luna, V.A.,[1] Vásquez, S.D.,[1] López de Mesa, L.A.[1] Mejía Juan, C.,[1] Ortiz. A,M.,[1] Aristizábal, V.,[1] Guevara, M.C.,[1] Quesada, C.,[1] Ariza, M.A.,[1] Reinosa, A.,[1] Estrada, I., Perdomo, L.,[2] Quintero, A.,[2] Echeverry, P.,[2] Cabrera, C.,[2] Escobar, L.,[3] Castañeda, P.,[3] Moncada, A.[3]

[1]Universidad del Valle, Departamento de Biología, Instituto en Ciencias del Mar y Limnología, INCIMAR
[2]Universidad Nacional de Colombia, [3]Universidad Autónoma de Occidente, Grupo de investigación GEADES

Mangrove forests are highly relevant regarding several ecosystem services: blue carbon, fisheries, and mitigation of climate change impacts, coastal erosion and plastic pollution. For an integral assessment of some paradigms related to the provision of a mangrove ecosystem service, four of the most important ecosystem services were quantified by a interinstitutional team of three Colombian Universities (i-Fisheries provision, ii-carbon sequestration, iii-coastal erosion and iv-plastic pollution mitigation), in different mangroves types in Colombia. Results show that mangrove roots structures are efficient plastic traps, and mangrove fauna is an important microplastics filter factor, where all surveyed macro-invertebrates in Pacific mangroves had microplastics inside their tissues, including species used for human consumption, such as the piangua *Anadara tuberculosa*. The carbon stocks quantified are very variable and some cases exceeded the values reported in the literature for other regions. Coastal erosion is mitigated by mangroves on both coasts, through the wave energy dissipation, and it is also concluded that in mangrove swamps on the Pacific coast, the sedimentary balance should be evaluated taking into account the estuarine system as a whole. The benthic organisms of mangrove ecosystems play an important role in the energy flow from the mangrove primary production to the fisheries provision resource. Interestingly, fishermen from the Pacific agreed on the close relationship between the fisheries resource and the state of development of mangrove forests, while, fishermen of the insular Caribbean were oblivious of the contribution of mangrove to fisheries, although they perform this activity in other ecosystems connected to mangroves, such as coral reefs and rock platforms. The results that are being obtained will be used by the Colombian Network of Estuaries and Mangroves for the design of the national mangrove research program required by Law 2243 of 2022.

Code: P 4.2. Do protected areas provide co-benefits to mangroves and coastal communities?

Canty, S.W.,[1] Nowakowski, A.J.,[1] Hamilton C.,[2] & Kotikot, S.M.[2]

[1]Smithsonian Environmental Research Center, United States of America
[2]Pennsylvania State University, United States of America

Conservation interventions are central strategies for reducing and preventing ecosystem losses and declines in biodiversity. Protected areas are viewed as a key management intervention and are being scaled up as countries move towards 30x30 commitments. However, there is debate on whether protected areas can promote synergies or produce tradeoffs between the protection of natural resources and human well-being. Here we aim to determine if protected areas provide co-benefits to mangroves and coastal communities.
Methods: we used a quasi-experimental approach to examine whether protected areas lead to tradeoffs or synergies between mangrove cover and measures of human well-being, using the Global Mangrove Watch and USAID demographic healthy survey data sets, for the period of 2000 – 2020.
Results: Preliminary data suggest protected areas have a positive effect in reducing but not eliminating mangrove cover losses at the global scale, with deforestation rates approximately half of unprotected areas of mangroves. On-going analyses are assessing regional and national deforestation rates and investigating the drivers of any variations observed. Assessments of human well-being indicators of coastal communities also currently being conducted.
Conclusions: Impact assessments are critical to understand the effectiveness and equity of protected areas. Understanding the enabling conditions for that create synergies between promoting mangrove ecosystem integrity and human well-being will be critical to facilitate the sustainability of protected areas and ensuring co-benefits to people and nature.

Code: P 9.89. Evaluating the potential of mangroves to climate adaptation and mitigation: a metanalytic approach.

Casas-Cortes, P.A.,[1] & Pires, A.P.F.[2]

[1] PhD student, PPGEE, Rio de Janeiro State University. [2]Professor, Rio de Janeiro State University [2]Coordinator, Brazilian Platform on Biodiversity and Ecosystem Services

Mangroves are forested wetlands distributed worldwide being found in the coastal zones of countries in the tropics and temperate regions. These ecosystems provide multiple benefits to local populations, including food, timber and several cultural services. Mangroves are also recognized by their importance to climate adaptation and mitigation, protecting coastal cities from sea level rising and coastal erosion. However, it is still unclear how such potential can be limited by the climatic risks these regions are prone and the conservation status of mangroves. Here, we performed a metanalysis to evaluate the global potential of mangroves to promote coastal adaptation and mitigation facing climate change. Our systematic review returned more than 1600 studies that evaluated the climate adaptation and mitigation of mangroves. We performed a set of mixed effect models to evaluate differences in effect sizes among three different levels of climatic risks and conservation status (high, medium and low). Our preliminary results indicated a great bias to approaches that focused on the mitigation potential of mangroves. Nonetheless, this potential did not depend on their climatic risk, conservation status, or the spatial scale the study was performed. We revealed that mitigation performance can be fourfold higher than the adaptation potential. Areas with an intermediated level of conservation status and with low or medium climate risk presented the greatest adaptation potential. We highlight that there is a limit to the potential of mangroves, questioning the myth of infinite adaptation. Our results reinforce that combined strategies that increase the conservation status of mangroves and promote climate mitigation considering non related actions will be key to increase the resilience of coastal cities. We reinforce the potential of mangroves in designing strategies to promote climate adaptation while ensuring climate mitigation, constituting a key nature-based solution to protecting coastal cities.

Code: P 15.68. Historical ecology of mangrove ecosystems around the Panama Canal area

Castellanos-Galindo, G.A.,[1,2,3] Romero, T.E.,[1] Morales-Saldaña, J.M.,[1,4] Díaz, T.,[5] Torchin, M.E.[1]

1. Smithsonian Tropical Research Institute, Box 0843-03092, Balboa, Republic of Panama 2. Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany 3. Freie Universität Berlin, Berlin, Germany 4. Department of Biology, McGill University, Montreal, Quebec H3A 1B1, Canada 5. Universidad Marítima Internacional de Panamá (UMIP), Panama City, Republic of Panama

Panama contains 11% of all mangroves in Central America with most of them distributed on the Pacific coast of the country. Major infrastructure developments dating back at least to the construction of the Panama Railroad and Canal > 150 years ago dramatically transformed Panama's landscapes along both the Pacific and the Caribbean coasts. Here, using archival sources (maps and documents) we aim at reconstructing the historical distribution of mangrove ecosystems around the Panama Canal area. Historical accounts and maps from both Caribbean and Pacific areas adjacent to the current canal indicate that mangrove was a dominant landscape that was transformed through time. On the Caribbean, the Manzanillo Island and the shores of the Limon Bay constituted significant mangrove area before 1850s. Now, Manzanillo Island is dominated by the port infrastructure of the city of Colon. Likewise, in the Pacific, the development of the railroad and Panama Canal resulted in dramatic transformation of the Grande River watershed. Maps and historical accounts indicate that the lower watershed of this river was covered predominantly by mangrove ecosystems and mudflats. Most of these areas are now the port facilities of Balboa and adjacent neighborhoods in Panama City. Reverting the current landscape is unrealistic, however, understanding the consequences that these changes brought to the region around the Panama Canal could help to improve existing and future infrastructure around Panamanian coastal cities. Recognizing and embracing the importance of mangroves will enable a sustainable path for coastal development.

Code: P 15.53. Dispersal limitation at the northern range limit of mangroves in Baja Mexico

Cavanaugh, K.,[1] Stocken, T.V., Carroll, D.

[1] University of California, Los Angeles, United States of America

Understanding the processes that limit the geographic ranges of species is one of the central goals of ecology and biogeography. This issue is particularly relevant for coastal wetlands given that climate change is expected to lead to a 'tropicalization' of temperate coastal and marine ecosystems. In coastal wetlands around the world, there have already been observations of mangroves expanding into salt marshes near the current poleward range limits of mangroves. However, there is still uncertainty regarding regional variability in the factors that control mangrove range limits.

In this study we examined the role of climatic factors and dispersal limitation in controlling the northern range limit of mangroves in Baja California, Mexico. We combined satellite-based mangrove and saltmarsh datasets with gridded climate data to model the potential distribution of mangroves in Baja and southern California based on climate and coastal morphology. We then used a high-resolution, eddy- and tide-resolving numerical ocean model to simulate mangrove proposal dispersal around the range limit.

We found evidence for suitable habitat for mangroves far north of the range limits on both the Pacific and Gulf of California coastlines. While temperatures in this region have increased in recent decades, there has not been a poleward expansion of mangroves. Ocean dispersal modeling indicated that northward dispersal from the range limit is limited, and propagules have a very low probability of reaching suitable habitat north of the current range limits. This dispersal limitation is due to prevailing currents in the region, landscape features such as large headlands, and large distances between patches of suitable habitat. Our results indicate that this range limit is not limited by climate, and so may be insensitive to future climate changes.

Code: P 5.17. Current conservation status of mangrove forests at UNESCO and Ramsar sites in southeastern and southern Brazil

Charlier-Sarubo, S.,[1] Noveleto-Chiqueto, L.,[2] Cordeiro, L.T.,[3] Cunha-Lignon, M.[2,3,4]

[1] Universidade Federal do Paraná (UFPR), Laboratório de Ecologia e Conservação (LEC), Brazil,
[2] Universidade Estadual Paulista (UNESP), Programa de Pós-Graduação em Biodiversidade de Ambientes Costeiros, Brazil,
[3] Universidade Estadual Paulista (UNESP), Faculdade de Ciências Agrárias do Vale do Ribeira, Brazil,
[4] The International Union for Conservation of Nature Mangrove Specialist Group (IUCN MSG)

Mangroves are critical coastal ecosystems that offer ecosystem services to humanity, such as mitigating the adverse effects of climate change. The current study aims to assess the state of conservation of the largest mangrove area in southeastern and southern Brazil (46,392 ha) which is located at the UNESCO Natural World Heritage Atlantic Forest South-East Reserves and three Ramsar sites. The estuarine complex of Iguape-Cananéia-Paranaguá and Guaratuba are located at São Paulo and Paraná states. To understand the health of the mangroves and their state of conservation, we monitored its morphological structures in 48 permanent plots, assessing the mangrove species, their "basal area", and the dominance of live and dead trunks. The forests in this coastal system are in a good state of conservation and well-developed mangrove forests are observed with the presence of young individuals, trees of intermediate "development", and adult ones. *Rhizophora mangle,* and *Laguncularia racemosa* dominate the area. The main anthropic changes in the monitored mangroves are hydrological changes (artificial canal) and the presence of the largest bulk port in Latin America. Natural events (storms and lightning) also occurred in the area, making it possible to assess natural regeneration. Our study evaluated the state of the art of mangrove ecosystem health in one of the largest and best-preserved domains of the Brazilian Atlantic Forest, and one of the most threatened biomes of the world. It was possible to verify differences and interactions between areas, some under the influence of natural events and anthropic impacts, resulting in mangrove forests with diverse characteristics.

Code: P 15.47. Utilization of Terrestrial Laser Scanning to Determine Carbon Stock of Mangroves in Brazil

Chaves, F.O.,[1] Silva, D.A.,[2] José, N.O.R.,[2] Matta, T.C.,[2] Oliveira, R.G., & Soares, M.G.S.

[1]Faculty of Oceanographyfof State University of Rio de Janeiro, Brazil
[2]NEMA/UERJ, Brazil

Mangroves are tropical ecosystems found along coastlines that have unique vegetation and features. It can be challenging to obtain structural parameters of these forests manually due to the difficulty of accessing them. One solution is to use terrestrial laser scanning (TLS), a method that involves emitting and detecting laser pulses to create three-dimensional point clouds of the forest. TLS has been used as a substitute or supplementary method to improve and optimize data collection. The aim of this study was to validate the use of TLS to quantify the carbon stock in the mangrove border of Rio de Janeiro, Brazil. Data was processed using the RECAP PRO software (Autodesk) to obtain information on tree species, diameter at breast height (DBH), height, number of trunks, and whether the tree was alive or dead. This data was then used in specific allometric equations to calculate biomass and carbon stock. The results showed that carbon stock values in the aerial biomass ranged from 100.5 tC.ha-1 to 133.7 tC.ha-1, depending on the point cloud coverage of the trees. These values were 4.9% lower and 26.8% higher, respectively, compared to values obtained manually, but still within the range of global values for edge forests. This study demonstrates that TLS is an effective and reliable method for obtaining parameters for mangrove forests and estimating carbon stock. This is the first study to use TLS in Brazilian mangroves and opens up possibilities for using this technology in mangroves in the future.

Code: P 9.63. History revisited: the regime shifts in the world's longest managed mangrove for charcoal and timber production

Chen, D.,[1,2] Satyanarayana, B.,[1,3,4] Wolswijk, G.,[1,3] Abd, N.H.,[3] Amir, A.A.,[4,5] Hugé, J.,[1,6] & Dahdouh-guebas, F.[1,2,4,7]

[1]Systems Ecology and Resource Management Research Unit (SERM), Université Libre de Bruxelles-ULB, 1050, Brussels, Belgium [2]Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel-VUB, 1050 Brussels, Belgium [3]Mangrove Research Unit (MARU), Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu (UMT), Kuala Nerus 21300, Malaysia [4]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), c/o Zoological Society of London, London, United Kingdom [5]Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia [6]Faculty of Science, Department of Environmental Sciences, Open University of the Netherlands, PO Box 2960, 6401 DL Heerlen, The Netherlands [7]Interfaculty Institute of Social-Ecological Transitions—IITSE, Université Libre de Bruxelles—ULB, B-1050 Brussels, Belgium

Matang Mangrove Forest Reserve (MMFR) in Peninsular Malaysia, with its 'management plans' traced back to 1904, is the longest-managed mangrove forest for pole and charcoal production through intermediate thinning and final felling (or clear-felling) operations. After revision for 115 years, the mangroves in the productive zones are now being harvested under a 30-year rotation cycle. The 10-year management plans released by the Forestry Department have been supporting efficient silviculture management. Despite the long management history, the mangrove biomass and quality were found to have decreased in recent years. Therefore, we analyzed all the available management plans between 1904 and 2019 to summarize both qualitative and quantitative data (i.e., silviculture policy/practice and trading) in search of their management regime shifts. A comparison with relevant literature on the MMFR was also made to evaluate the potential issues of scientific concern in the ongoing management. We found that the higher yield (per ha) of charcoal and poles in the past 20 years resulted from exploiting the restrictive productive zones (= forest that is environmentally sensitive and marginally productive). With a policy inclined greatly toward the financial outcomes of timber-based products, the current silviculture practice may turn out to be unsustainable if any impacts like extreme weather, tree die-off, sea-level rise, etc., affect mangroves in the future. We have discussed the dilemma between greenwood harvesting and ecosystem service protection values. This study unveiled the facts and figures of the age-old mangrove harvesting regime for the first time and can play a crucial role in future research and sustainable management of the MMFR.

Code: P 15.20. Enhancement of carbon sinks through mangrove afforestation in a tropical constructed wetland park

Chuan-Wen, H.,[1] Hsuan-Ying, C.,[1] Jung-Yi, L.,[2] Chiao-Wen, L.,[3] Wei-Jen, L.,[1] & Hsing-Juh, L.[1]

[1]Department of Life Sciences, National Chung Hsing University, Taiwan [2] Department of Landscape architecture, Fu Jen University, Taiwan [3]Department of Marine Environment and Engineering, National Sun Yat-sen University, Taiwan

Mangroves are important blue carbon sinks. There is great interest in mitigating greenhouse gas emissions through restoring mangroves. Zhongdu Wetland Park in Kaohsiung, Taiwan, which was once a natural mangrove habitat along a tidal river, was destroyed by the development of plywood factories. In 2011, the wetland park was established through the restoration of mangroves and expected to provide regulating and cultural ecosystem services. Therefore, this study aimed to investigate the carbon sink capacity of mangroves in Zhongdu Wetland Park. The mangrove species present in the wetland park are *Avicennia marina*, *Rhizophora stylosa*, *Lumnitzera racemosa* and *Kandelia obovata*. With the exception of poor-growing *K. obovata*, *A. marina* showed significantly higher net primary productivity (NPP) than *L. racemosa* and *R. stylosa* and the same pattern was also observed in soil carbon burial. Furthermore, the NPP and soil carbon burial of *A. marina* in the wetland park are higher than in natural mangroves habitat, according to the previous study. Since *A. marina* has the largest carbon sink capacity, it is considered the main contributor to the carbon sink in the Zhongdu Wetland Park. However, *A. marina* also showed the highest CO2 emissions, which may be due to a higher decomposition rate and the input of residential wastewater. In conclusion, the mangroves in Zhongdu Wetland Park serve as a carbon sink system, and the results suggest the strategy of restoring mangroves in constructed wetland parks for compensating for future greenhouse gas emissions.

Code: P 5.83. Strengthening local capacities, a pillar in mangrove ecological restoration

Cisneros, D.J.,[1] Hernández, C.T.,[2] & Herrera-Silveira, J.[3]

[1]Centro de Investigación y de Estudios Avanzados, Unidad Mérida, México
[2]Escuela Nacional de Estudios Superiores (ENES), Mérida, Universidad Nacional Autónoma de México (UNAM)
[3] Centro de Investigación y de Estudios Avanzados (CINVESTAV), Unidad Mérida, México

The mangrove ecological restoration is considered a nature-based solution that reduce climatic vulnerability of communities because its contribution on the recovery of ecosystem services such as refuge for species of commercial importance, carbon sequestration, protection against hurricanes and floods, among others. In the Yucatan Peninsula, Mexico, approximately 2,000 ha of mangroves have been restored through the implementation of more than 10 projects over 15 years. In these projects more than 150 of people of local communities have been involved through capacitation and temporal work for the restoration actions and community monitoring. The inclusion of community and the strengthening of its theoretical and practical capacities are essential for restoration successful, integrating their traditional knowledge and promoting a sense of belonging that contributes for permanence and continuity of restoration. The community monitoring considers the collaboration of local communities, organized groups, and brigades in the process of collecting and analyzing information, management, and management of ecosystems. To strengthen the local capacities of coastal communities for the restoration and monitoring of mangroves, workshops were implemented in nine coastal communities in the Yucatan Peninsula, Mexico. In the workshops, theoretical and practical modules were taught where techniques for the ecological monitoring of variables of the structure of the vegetation, physicochemical parameters of the water and soil characteristics were addressed. A total of 155 people were trained, who showed great interest in continuing community monitoring programs. As part of capacity building, the Guide for the ecological restoration of mangroves was published: lessons learned, the Manual for the ecological restoration of mangroves in the Mesoamerican Reef System and the Greater Caribbean, and the community booklet, Restoration, and monitoring of mangroves for our well-being. The strengthening of local capacities for mangrove restoration contributes to the climate resilience of the coastal communities of Mexico.

Code: P 4.5. Fish use of restored mangroves is unrelated to habitat maturity

Connolly, R.M.,[1] Kitchingman, M.E., [1] Sievers, M., [1] & Lopez-Marcano, S. [1]

[1]Global Wetlands Project, Coastal and Marine Research Centre, Griffith University, Gold Coast, Queensland, Australia

Mangrove loss and degradation have triggered global restoration efforts to support biodiversity and ecosystem services, including fish stock enhancement. As mangrove restoration accelerates, it is important to evaluate outcomes for species that play functional roles in ecosystems and support services, yet this remains a clear knowledge gap. There is remarkably little information, for example, about how fish use of mangroves varies as restored vegetation matures, limiting the theoretical links that can be made between restoration and fish stock enhancement. We used unbaited underwater cameras within two distinct zones of mangrove forests – fringe and interior – at five pairs of restored-natural mangrove sites in Queensland, Australia. We used deep learning to automatically extract data for the four commonest species: yellowfin bream (*Acanthopagrus australis*), sea mullet (*Mugil cephalus*), common toadfish (*Tetractenos hamiltoni*) and common silverbiddy (*Gerres subfasciatus*). These species represent four feeding groups, respectively: omnivore, detritivore, carnivore, and planktivore. The relative abundance of all species (i.e., restored relative to paired natural) varied among sites and zones. However, despite younger restored sites having much lower structural complexity, there was no trend of greater fish abundance at older sites. In fact, silverbiddy show the opposite with greater relative abundance at younger sites. Differences between fringe and interior were consistent at restored and natural sites, with more fish in the fringe, especially for yellowfin bream and sea mullet. Our paired, space-for-time design provides a powerful test of restoration outcomes for fish, highlighting that even newly restored sites with immature vegetation are readily utilised by key species. This finding helps to define the period over which fisheries enhancement should be incorporated into models of monetary valuations of restoration.

Code: P 9.69. Nature-based tourism: livelihood and conservation strategy for the communities of the Cienaga Grande de Santa Marta

Contreras, A.,[1] & Franco, M.[1]

[1]INVEMAR

Since 2017, the Institute of Marine and Coastal Research INVEMAR has been executing applied research projects aimed at the development of nature-based tourism in the Cienaga Grande de Santa Marta (CGSM) as a strategy for the conservation of ecosystems and the improvement of the quality of life of the populations settled in the lagoon complex. A total of three projects have been developed, one completed and two in progress, which include studies to strengthen the tourism sector, such as identification of attractions, tourist carrying capacity assessment, market research, and value chain analysis. So far, the CGSM had been extensively studied from the biophysical, economic, and political dimensions, but there was a lack of studies on its tourism potential. The studies' results have made it possible to build a baseline that will serve as a guide and support for the current and future interventions. They have also been developed in a participatory manner, providing the communities with a new perspective on the natural treasures of their territory. The projects have resulted in specific actions favoring local people in finding a complementary source of income to their traditional fishing activities. One of the projects' lines of action has been training in birdwatching, entrepreneurship, and sustainable business. During the first project, for example, 14 local guides were trained in birdwatching in one community; with the current projects, 30 people from 5 villages were already trained in birdwatching, and during the first quarter of 2023, 48 people will begin technical studies in tourism and national and international cuisine. The interventions have also led to the improvement of the tourism infrastructure and the provision of elements for the activity, such as the construction of the Amphibian Culture Interpretation Center, which gradually is consolidating a space for the dissemination of information on biodiversity and culture.

Code: P 5.36. Strengthening the population of the threatened mangrove *Pelliciera benthamii* through ex-situ and in-situ conservation strategies

Contreras, M.P.,[1] Rueda, C.,[2] & Madriñán, S.[1,2]

[1]Jardín Botánico de Cartagena "Guillermo Piñeres", Turbaco, Bolívar
[2]Universidad de los Andes, Bogotá DC

Although not evaluated by International Union for Conservation of Nature (IUCN), *Pelliciera benthamii* (Triana & Planch.) Cornejo, is likely the most threatened of the mangrove species present in the Colombian Caribbean region due to its limited distribution and severe threats to its ecosystem caused by expansion in construction and unsustainable economic activities. Conservation activities are needed at a broad front, including research, education, in-situ and ex-situ conservation and ecosystem protection. Piñuelo, *P. benthamii*, a segregated species from *Pelliciera rhizophorae* Triana & Planch, is a mangrove species restricted to small populations in the Panamanian Pacific and the Colombian Caribbean. *P. rhizophorae* was listed as vulnerable by the IUCN due to isolated populations, reduced range, and decline in habitat quality. We are re-assessing *P. benthamii*, and its conservation status will most likely change from vulnerable to endangered. The Cartagena Botanical Garden's science and horticulture teams have worked together to strengthen the population of *P. benthamii* in the Colombian Caribbean region. We strive to conserve, restore, and enrich the mangrove through long-lasting actions involving local communities. We identified three localities for seed collection near Cartagena, where we made phenological annotations and the recognition of potential planting areas. To accomplish mangrove conservation, we established propagation protocols and nursery line guides and submitted a new Red List assessment for *P. benthamii*. Additionally, we have propagated other mangrove species, as it may be beneficial that restoration initiatives focus on ecosystem restoration rather than planting individual species. In addition to *in-situ* initiatives, we will strengthen *ex-situ* through the establishment of a new living collection of mangrove species in the Cartagena Botanical Garden, and installation of educational displays to educate visitors about this important ecosystem. We aim to increase the information regarding propagation strategies and conservation actions to provide input for future restoration and protection initiatives.

Code: P 5.24. Challenges and opportunities for the management of hydrologically restored wetlands

Cormier, N.,[1] Davies, P.,[1] Rogers, K.,[2] & Saintilan, N.[1]

[1]School of Natural Sciences, Macquarie University, New South Wales, Australia;

[2]School of Earth, Atmospheric and Life Sciences, University of Wollongong, Wollongong, New South Wales, 2522, Australia

Wetlands are threatened worldwide by land-use change and are often impacted by coastal development and resource use; hydrologic restoration is one management strategy implemented to improve or restore conditions on impacted wetlands. Data exist on the ecological benefits of hydrologic restoration, but these data are not often integrated into targeted management actions or used to substantiate restoration success. This study explores the goals and drivers of restoration projects and the actual and perceived level of success for project outcomes, using evidence derived from 20 semi-structured interviews with scientists and land managers at mangrove and marsh restoration case study sites in Australia and the United States. This research 1) identifies factors used in the decision-making process of restoration projects, 2) determines how different organizations and jurisdictions set restoration goals, 3) reveals what factors define success and influence the management and planning of future wetland creation and restoration projects from the perspectives of those charged with the responsibility for managing wetlands, and 4) identifies emerging opportunities for managing changing environmental conditions in mangroves and other wetlands.. This talk profiles the strategic responses of wetland scientists and managers to the challenges of land management associated with restoration, including risk aversion and conservatism by management, unexpected third-party impacts, varying definitions of success, and inconsistent metrics for success. Comparing wetland degradation and restoration processes between different political and environmental settings may reveal overlying spatial, institutional, policy and governance patterns. Insights from these comparisons may suggest new directions for policy and legislation that may be applicable in a broader range of conditions. Emerging opportunities are identified for mitigating changing environmental conditions in wetlands, including managing wetland vulnerability to sea-level rise and other impacts of climate change.

Code: P 9.67. Promote the mangrove as a nourishing biome, an opportunity for co-benefits between people and nature.

Cormier, M.C.[1]

[1]IRD UMR PALOC (IRD/MNHN, Paris)

The three pillars of the CBD, namely conservation, sustainable use and equity, put forward in 1992, are still not simultaneously taken into account, which leads to negative trade-offs and frequent policy failures. Promoting biodiversity-rich food systems or « nourishing biomes », such as mangrove, is one way of addressing the nexus between these three pillars and achieving the challenge of co-benefits or positive synergies between them.

Based on fieldwork conducted in West Africa and Vietnam and litterature review, this presentation analyzes two opposing trajectories of the mangrove use, through the analysis of the mangrove-based products value chain.

On the one hand, the shrimp breeding ponds dominate the landscapes of the Mekong Delta. This single use for productivist purposes is the major cause of the retreat of mangrove areas. Increasingly criticized as "imported deforestation", this type of trajectory is beginning to be subject to control measures, notablly at the European level. Moreover, it is at the origin of unsustainable and unfair food supply chains, insofar as pelagic fish, often originating from poor countries in the South, are transformed into fish meal, and are now unaffordable for IPLC.

On the other hand, the multiple use systems along the Northern Rivers of West Africa, managed and controled by the IPLC, are a good illustration of fair and sustainable livelihoods, that improve food security, reduce poverty and boost economic resilience. Particular attention will be paid to the oyster value chain in the hands of women, actors whose knowledge and practices are often invisibilized.

In conclusion, this presentation argues mangroves are not simple carbon sequestration sinks or refuge areas for migratory birds, but complex nourishing biomes, whose conservation is critical for the IPLCs, notably the women. To address this complexity, innovative, systemic and inclusive approaches to co construction of biodiversity-based solutions are needed, firmly rooted in local contexts.

Code: P 5.89. *We can't protect what we do not know:* Floral diversity assessment of Del Carmen Mangrove Forest in Siargao Island, Philippines

Cortez, G.N.,[1,2,*] Ordas, J.A.,[2] Zamudio, S.G.,[2,4] Rubite, R.R.,[3] Tandang, D.N.,[5] & Moran, C.B.[1,2]

[1] The Graduate School and the Research Center for Natural and Applied Sciences, University of Santo Tomas, España blvd., 1015 Manila, Philippines [2] Department of Biological Sciences, College of Science, University of Santo Tomas, España Blvd., Manila, Philippines [3] Department of Biology, College of Arts and Sciences, University of the Philippines [4]Manila, Padre Faura St., Manila, Philippines [4] Department of Biology, De La Salle University, 2401 Taft Avenue, Malate, 1004, Manila, Philippines [5] Botany Division, National Museum of the Philippines, Metro Manila, Philippines * Corresponding author: ggcortez@ust.edu.ph

The Del Carmen Mangrove Forest in Siargao Island is perceived to be one of the largest contiguous mangrove stands in the Philippines. To date, there is very limited knowledge about the floral assemblages and communities in the area. Hence, we provide an extensive floristic assessment, achieved through species identification, floral composition, and diversity analyses. Fieldworks were conducted within 11 barangays from July to November 2019. Plant species were surveyed in five quadrats (10 m ×10 m) established along a 2 km transect. We report 164 species, distributed in 143 genera in 73 families. The most specious families belong to Rubiaceae, Asteraceae, Fabaceae, Orchidaceae, and Moraceae. Of these, 121 species are native, with 19 species that are endemic to the Philippines. The densest families include Rhizophoraceae (918), Rubiaceae (149), Acanthaceae (95), Primulaceae (54), and Fabaceae (43), whereas Rhizophora mucronata, R. apiculata, and Nypa fructicans as the most dominating species. Nine species are classified as threatened based on the IUCN. Shannon Diversity Index and five other univariate diversity indices were consistently highest in Del Carmen followed by Katipunan. Multivariate analyses identified Del Carmen and Katipunan to exhibit the most dissimilar floristic assemblage, highlighting the wetland region's uniqueness in terms of floral diversity and habitat complexity. Thematic maps showed patterns of consistently higher diversity in adjacent barangays – Del Carmen, Katipunan, and San Jose, within a contiguous patch of mangrove forest. Our findings emphasize the importance of performing floristic surveys to serve as baseline information in formulating effective conservation, international recognition, and Ramsar nomination of the Del Carmen Mangrove Forest.

Code: P 9.30. The potential vertical range of *Avicennia germinans* in the marsh-mangrove ecotone

Creecy, D.,[1] Vervaeke, W.,[2] Therese Adgie, T.,[1] Canas, G., [3] Langley, J.A.,[1] Chapman, S.[1]

[1] Villanova University, United States of America [2] National Park Service, United States of America [3] University of North Florida, United States of America

In the United States mangroves are moving poleward as climate change progresses. In NE Florida specifically, *Avicennia germinans* mangroves are colonizing wetlands that have not contained mangroves for decades. The current vertical range of mangroves in the ecotone is influenced by a combination of chance dispersal events and bio-physical variables associated with elevation. We used a combination of observational surveys and a mangrove planting experiment to explore how these variables interact to control the establishment of mangrove seedlings, and we used a model to extrapolate mangrove expansion to the rest of this area under multiple climate change scenarios. The planted mangrove seedlings survived for 2 years at a broader elevational range (over 10% survival from -0.1 to 0.8 m NAVD88) than the distribution of elevation at which mangroves occur (95% of mangroves occurred from 0.3 to 0.7 m NAVD88). Growth of mangroves was greatest at 0.12 m NAVD88 elevation, indicating that these may have the best chance for long-term survival. We surmise that the realized elevational range will expand in the ecotone as *Avicennia* becomes less limited by dispersal. Using maximum entropy modeling, we were also able to confirm that the climatic variable that most influences the global distribution of *A. germinans* is the lowest temperature of the coldest month. Using these findings, we created models that allow us to map out the locations of suitable growing areas for establishing mangroves. Our models determined that an elevation of 0.45, or a hydroperiod of around 19%, is ideal for establishing mangroves. These areas of suitable habitat can be viewed as places where it is likely to find establishing mangroves, as well as the best places to plan restoration projects.

Code: P 5.16. Mangrove Forest Dynamics: long-term monitoring using permanent plots in the southeastern Brazilian coast

Cunha-Lignon, M.,[1,2] Kampel, M.,[3] & Dahdouh-Guebas, F.[2,4,5]

[1] Universidade Estadual Paulista (UNESP), Brazil [2] The International Union for Conservation of Nature Mangrove Specialist Group (IUCN MSG) [3] Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, [4] Université Libre de Bruxelles (ULB), Belgium, [5] Vrije Universiteit Brussel (VUB), Belgium

Mangroves are highly resilient and flexible systems adapting to various environmental conditions. Structural and functional variability observed in mangrove ecosystems is determined by the plasticity of the species involved and by the capacity of self-adjustment to the biotic and abiotic factors. We analysed mangrove forest dynamics in a long-term monitoring study using permanent plots on the Cananeia-Iguape Coastal System (CICS) in southeastern Brazil. Its mangrove area covers 11,943ha, including three mangrove species *Rhizophora mangle*, *Laguncularia racemosa* and *Avicennia schaueriana*. We assessed the mangrove forest dynamics through the vegetation structure and interstitial salinity using 34 permanent plots over an uninterrupted period from 2001 to 2022. A database was implemented by the research group Integrated Mangrove Monitoring. Mangrove condition (dead or alive), mortality and growth rates, structure development, species dominance, and zonation pattern were considered in this assessment. Regression equations were calculated using the structural characteristics of mangrove trees. Natural impacts, such as erosional processes, wind gusts, and lightning, which occurred throughout the studied period, created gaps and provided succession processes. Natural forest recovery was carried out according to the state of environmental health. When a negative impact persists, regeneration does not occur, reducing and fragmenting the studied mangrove areas. We considered two types of impacts: chronic (continuous and human-induced drivers, such as hydrological changes) and acute (intense and natural effects, such as hail and lightning). The long-term monitoring of interstitial salinity indicates the critical influence of hydrological changes on the northern sector of CICS, varying from 0 to 5ppt. In contrast, in the southern sector, the salinity ranged from 24 to 30ppt. A proposed conceptual diagram highlights the direct and indirect natural and human-induced pressures and the mangrove forest dynamics. Our results can help to understand mangrove forest dynamics better and can be a baseline for better protection and restoration practices.

Code: P 15.67. From research to education through serious gaming and game-based learning from The Mangal Play

Dahdouh-Guebas, F.,[1,2,3,4] Mafaziya-Nijamdeen, T.W.G.F.,[1,5] Hugé, J.,[1,2,6,7] Dahdouh-Guebas, Y[8] Di Nitto, D.,[1,2] Hamza, A.J.,[9,10] Kodikara-Arachchilage, S.,[11] Koedam, N.,[2,3] Mancilla-García, M.,[12,4] Mohamed, M.O.S.,[13] Mostert, L.,[8] Munga, C.N.,[14] Poti, M.,[1,2] Satyanarayana, B.,[15,1,3] Stiers, I.,[16] Van-Puyvelde, K.,[17] Vanhove, M.P.M.,[7] Vande-Velde, K.,[1,2] & Ratsimbazafy, H.A.[1,18].

[1] Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium [2] Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, 1050, Brussels, Belgium [3] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN) [4] Interfaculty Institute of Social-Ecological Transitions - iiTSE, Université Libre de Bruxelles - ULB, Brussels, Belgium [5] Department of Biological Sciences, Faculty of Applied Sciences, South Eastern University of Sri Lanka, Sammanthurei, Sri Lanka [6] Department of Environmental Sciences, Open University of the Netherlands, Valkenburgerweg 177, 6419AT, Heerlen, the Netherlands [7] Hasselt University, Centre for Environmental Sciences, Research Group Zoology: Biodiversity & Toxicology, Agoralaan Gebouw D, BE3590, Diepenbeek, Belgium [8] Vrije Universiteit Brussel - VUB, Pleinlaan 2, 1050, Brussels, Belgium [9] Department of Life & Environmental Sciences, Faculty of Science & Technology, Bournemouth University, Fern Barrow, Poole BH12 5BB, UK [10] Oceanography and Hydrography Department, Kenya Marine and Fisheries Research Institute, P.O.Box 81651-80100, Mombasa, Kenya [11] Department of Botany, Faculty of Science, University of Ruhuna, Matara, Sri Lanka [12] SOcio-eNvironmental dYnamics research group (SONYA), Université Libre de Bruxelles - ULB, Brussels, Belgium [13] Marine and Coastal Research Centre, Wildlife Research and Training Institute, P.O. Box 82144 – 80100 Mombasa, Kenya [14] Department of Environment & Health Sciences, Marine & Fisheries Programme, Technical University of Mombasa, P.O. Box 90420 – 80100 Mombasa, Kenya [15] Mangrove Research Unit (MARU), Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu - UMT, 21030, Kuala Nerus, Terengganu, Malaysia [16] Multidisciplinary Institute for Teacher Education (MILO), Science & Technology, Vrije Universiteit Brussel, Pleinlaan 9, 1050 Brussels, Belgium [17] MSc Marine and Lacustrine Science and Management (Oceans & Lakes) , Biology Department, Vrije Universiteit Brussel VUB, Pleinlaan 2, Brussels, Belgium [18] Blue Ventures Madagascar, Villa Huguette, Lot II U 86, Cité Planton, Ampahibe, 101 Antananarivo, Madagascar

The objective of this contribution is to explain the functioning of a serious game to experience multi-stakeholder decision-making in complex mangrove social-ecological systems. We developed the Mangal Play, an experiential learning method to have participants adopt the role of a particular stakeholder in an imaginary mangrove forest social-ecological system (SES). The Mangal Play is a role-play aimed at promoting oral dialogues between 20 stakeholders involved in governance, fisheries, aquaculture, agriculture, forestry, tourism, transport, conservation and communication sectors. By providing tools to lecturers and scientists to execute it in a public or classroom setting, the Mangal Play stimulates a decision-making process while accepting compromise and distinguishing bottom-line issues from negotiable positions, and instructs about the behaviour of complex real-world systems in a safe learning environment. We exemplify how social network analysis can serve to visualise the outcome and further develop the Mangal Play. In this way we hope to help stakeholders achieve collaborative action in nature conservation and natural resources management, to understand and acknowledge other stakeholders' interests, values, world visions and objectives and to overcome the problem of irrational decision-making through innate opposition discourses.

Code: P 15.33. Design and implementation an ecosystem-based adaptation measure (eba) in mangroves blue carbon ecosystem of Bahía Hondita, Alta Guajira

Daza-Suarez, A.,[1] Guzmán-Vivas, M.R.,[1] Villamil-Echeverri, C.,[2] Julián Castro-Gomez, J.[2]

[1]CORPOGUAJIRA [2]GIZ

La Guajira located in the extreme north of Colombia is a very dry coastal zone and vulnerable to climate change effects. The environmental authority of La Guajira - CORPOGUAJIRA, and four Wayuu indigenous communities with the technical and operational support of the MIMAC* project implemented by GIZ, designed, and implemented an Ecosystem-based Adaptation measure (EbA) in the mangrove ecosystem of Bahia Hondita. This initiative focused on the rehabilitation of the water flow from the opening of channels (500 m), the production of mangrove plants, and the awareness of tourists for local planting, using traditional practices (Yanama). These actions reduce vulnerability to climate threats present in the area and reinforce additional benefits such as the management of blue carbon reservoirs, habitat to support livelihoods and marine-coastal biodiversity. Ethnic knowledge is central to the initiative; therefore, the activities were aimed to strengthen local governance. For instance, a local organization to conserve mangroves was created and the implementation of an agreement for mangrove areas conservation that includes ancestral knowledge regarding mangrove management. In addition, local training was implemented for mangrove monitoring and seed management, and an economic alternative in nature tourism "The Mangroves Route" and registration as one of the Blue Carbone initiatives in Colombia.
Currently, COPOGUAJIRA and MINAMBIENTE reinforce this process building agreements with the support of the Adapted management of ecosystems to prevent coastal erosion project implemented by KfW in the IKI initiative of the German Ministry of Environment (BMUV), those agreements promote conservation and use on mangroves to reduce pressure and temper climate change emissions. These results show that climate actions based on the management of marine and coastal biodiversity at the local level are more efficient if they are implemented following public policies, local participation, and other stakeholders. Moreover, the application of the indigenous and intergenerational approach allowed broad participation, contributed to social cohesion, promoted the mangroves conservation as a blue Carbon ecosystem, and generated new income alternatives.

Code: P 9.19. Hydrodynamics of Open Channels in Mangrove Forests

Delgado, J.K.,[1,2,3] Cowen, E.A.[1]

[1] DeFrees Hydraulics Lab, College of Engineering, Cornell University [2] Coastal Solutions Fellows Program, Cornell Lab of Ornithology, Cornell University [3] NGO Adaptation Latin America, Colombia

Conservation of mangrove forests is a promising approach to climate-change mitigation and adaptation in coastal areas. Mangroves are known as “champions” of sequestering soil carbon, ~50 times more effective than tropical forests (McLeod et al., 2011). Human actions, e.g. deforestation, can create new channels with relatively high-velocity flows due to a significant reduction in drag forces. Hence, these flows can enhance sediment transport and remove soil carbon from the channels. Paradoxically, the presence of these channels contribute to a reduction of flow velocities within the adjacent forest and potentially facilitating sedimentation. To study this process, we conducted laboratory experiments in a current-only flume (8 m x 0.61 m x 0.6 m). Still water level was 0.11 m. Incident velocity was fixed at U_∞= 0.23 m/s. Mangrove roots were represented by random and emerged cylinder arrays that partially fill the flume. Cylinders diameter was d = 0.0126 m, averaged spacing between cylinders, Sxy = 0.056 m, and solid fraction, φ = 0.04. Spatial superficial velocity records were acquired along the flume using Particle Imaging Velocimetry (PIV) techniques and Acoustic Doppler Velocimetry (ADV). Results show flow in the unvegetated region accelerates linearly and reaches mean stremwise velocities over two times U_∞. The lateral velocity is ‘relatively high’ (V/U_∞ = 12%) at the leading edge of the vegetation, but with a rapid decay within the vegetation. A strong mass and turbulent kinetic energy transfer from the vegetated area into the main channel was observed. Spatial data suggest the formation of a secondary flows in the main channel that contributed to the redistribution of momentum from the bottom and the vegetated region to the free surface. These experiments help to obtain a better understanding of channelization of mangrove forest and transport processes in this ecosystem.

Code: P 5.50. Approaching forest landscape restoration in mangrove forests in Latin America and the Caribbean

Díaz-Triana, J.E.[1]

[1]Grupo de Restauración Ecológica – Departamento de Biología, Universidad Nacional de Colombia. *Address*: Av. Cra. 30 #45-03 – 421 (Of. 106).

Mangrove destruction and degradation is a global problem that threatens the provision of essential ecosystem services for coastal populations. In Latin America and the Caribbean (LAC) the situation is alarming given the socio-ecological contexts, economic interests, social inequality and the weakness of legal protection frameworks, which added to the phenomena of global change, make mangroves highly vulnerable ecosystems. Although this problem has been addressed for more than three decades through the silvicultural approach, the results have not been entirely successful, leading to a reevaluation of approaches to mangrove ecological restoration. Global and regional restoration goals, under different initiatives (e.g. Bonn-Challenge), demand the attention of large areas, opening the opportunity for the generation and use of new tools and models that allow the fulfillment of mangrove restoration objectives within the framework of sustainable development. This review found that mangrove restoration in LAC has been approached from reforestation/afforestation, mangrove ecological restoration (MER), community-based restoration (CBMER), relocations and replacements, becoming increasingly necessary the landscape perspective. Despite the background and standards for mangrove restoration at the site level, the approach to forest landscape restoration (FLR) has been partial and has not yet been considered as a serious alternative. FLR approaches restoration under multiple ecological and socioeconomic objectives, organized planning with all stakeholders, integration of actions at multiple scales, and long-term adaptive management. The vision of “seascapes” may be a novel approach to bring mangrove restoration closer to the principles and guidelines of FLR aimed so far at terrestrial forests. Given its advantages, its application in the restoration of LAC mangrove forests is recommended and the development of experiences that ratify its suitability is invited, in the 2021-2030 decade agenda of restoration and marine sciences. Experiences are needed that simultaneously address experimental treatments, implementation in large mangrove areas, as well as monitoring and adaptive management.

Code: P 15.63. Including local knowledge in conservation planning: the case of the Western coastal protected areas in Suriname

Djosetro, M.,[1] & Behagel, J.[2]

[1]Anton de Kom University of Suriname, Suriname
[2]Wageningen University, Netherlands

There is increasing recognition of the importance of local knowledge in conservation governance and sustainable use of natural resources. This article uses a social-ecological system perspective to explore how local knowledge was recently included in the management planning of three Western coastal protected areas of Suriname - *Bigi Pan, Noord Coronie, and Noord Saramacca* - each one is designated as a Multiple Use Management Area (MUMA). The main focus of this article is how local knowledge and user perspectives may contribute to the management of a MUMA and to what extent local knowledge contributes to making decisions about biodiversity and natural resources in these protected areas through planning activities. We use an action research approach that includes qualitative case study methodology, participant observations, group and individual interviews. Our conceptual framework is based on the Social-Ecological System (SES) model from Ostrom (2009), to understand interactions between resources, users, and governance as mediated by local and other forms of knowledge. The results of our analysis show that local knowledge is key to sustainable nature conservation and that it is important to consider both the social and ecological environment in conservation planning. Moreover, considering that local knowledge results from the interactions between subsystems of SES, integrating such knowledge directly leads to the support of the local community for executing management plans. Action research was moreover found helpful as a strategy to recognize local knowledge and to promote social learning among stakeholders. This paper concludes that local knowledge has contributed to policy decisions that are connected to the use practices of local people and to overcome some major management challenges. Finally, we argue that including local knowledge in management planning is necessary to address the many interactions that take place in social-ecological systems, especially those that are subject to changing socio environmental pressures.

Code: P 5.94. Bulk density along the colombian coast and its relationship with mangrove forest attributes

Dorado-Roncancio, J.,[1] Mancera-Pineda, J.E.,[1] Sánchez, D., Echeverry, P.,[1] Fernanda, L.[1]

[1] Universidad Nacional de Colombia. Facultad de Ciencias, Departamento de Biología, Sede Bogotá. Grupo de Investigación de Modelación de Ecosistemas Costeros.

Sediment retention and shoreline stabilization are processes typical of mangrove forests but widely variable, which difficult the understanding of their drivers and mechanisms. This research presents the relationships found between Bulk Density (BD), Basal Area (BA) and Volumetric Density (VD) of the aerial root system in 12 *Rhizophora mangle* forests from the Colombian Pacific and Caribbean. The BD was estimated by extracting surface sediments; to determine the VD, the volume occupied by the roots in $1m^3$ was measured and the waves were quantified through pressure loggers. The relationship between roots VD and their exposure to waves was determined by Pearson's linear correlation coefficient ($p<0.05$). The results show that BD is higher in the Pacific ($\bar{X}$=1.46 $g.cm^{-3}$; SD=0.3) than in Caribbean mangroves ($\bar{X}$=0.87 $g.cm^{-3}$; SD=0.3). Probably the macrotidal system (±4 m) and high river sediment discharge in the Pacific, allows the continuous flow of sediment, favoring the establishment of soil. The BD of one of the Caribbean forests receiving contributions from the Sevilla River is similar to BD in the Pacific forests. On the Pacific, a direct relationship (r=0.56) was found between BD and BA, but an also significant inverse relationship (r=0.23) between BD and VD, which could be explained by a compensation for higher growth of trunk and foliage at the expense of less abundance of aerial roots. An inverse relationship (r= 0.16) was also found between BD and the degree of wave exposition. It is concluded that the BD varies according to the balance between allochthonous and autochthonous contributions of sediments and their retention capacity. The structural complexity of the forests contributes to the allochthonous contribution and to the retention of sediments, which is why anthropic factors can generate changes in the composition of the soil, losing sediments, affecting coastal stability. However, the magnitude of these impacts is site-specific.

Code: P 9.87. Fauna associated with submerged roots of *Rhizophora mangle* IN the Colombian caribbean: an updated checklist.

Dueñas-Lagos, A.,[1] Mancera-Pineda, J.E.,[1] Campos, N.H.,[1] Dueñas-Ramírez, P.R.

[1]Universidad Nacional de Colombia, Colombia,

Mangrove wetlands are recognized for different ecosystem services. Although being a support for biodiversity is one of the main ones, baseline studies are still lacking, of some taxonomic groups of transcendental importance in the transfer of trophic energy. The objective of this study was to integrate and update the taxonomic list of fauna associated with submerged roots of the red mangrove, *Rhizophora mangle*, to fill an existing gap for the characterization of mangroves in the Colombian Caribbean. The taxonomic list based on 24 bibliographic sources, includes the synonymies found in the World Register of Marine Species (WoRMS) database. The results show a total of 7 phyllum with 182 families, distributed in 315 genera and 353 species. The greatest species richness is contributed by the phyllum Crustacea with 115 species (32.58%), Mollusca with 95 species (26.91%) and Annelida with 78 species (22.10%). These results confirm that the roots of *R. mangle* in the Colombian Caribbean are important supports for biodiversity, which is the basis for the development of other ecosystem services such as fishing and the mitigation of coastal erosion.

Code: P 9.18. Reconstructing pre-Anthropocene mangrove ecosystem distributions

Duncan, C.,[1,2] Turvey, S.,[1] Worthington, T.,[3] Senior, N.,[4] &Hansford, J.[1]

[1]Institute of Zoology, Zoological Society of London, London, UK; [2]University of Exeter, Penryn, Cornwall, UK; [3]University of Cambridge, Cambridge, UK; 4: University College London, London, UK.

The UN 'Decade on Restoration' provides the policy platform for major global biodiversity conservation achievements, and particularly for mangrove ecosystems. Major research and policy focus now targets the rehabilitation and restoration of mangroves. Global mapping research has now having identified >800 thousand ha of recoverable mangroves lost since 1996 and the Global Mangrove Alliance now targets restoration of 50% of this by 2030. In many regions, however, most mangroves have been converted prior to this 1996 baseline, meaning that spatial restoration opportunities may be being overlooked. The talk will outline on-going research that aims to fill this knowledge gap by hind-casting pre-Anthropocene mangrove ecosystem distribution baselines using cloud-based computing and ecological niche modelling. It will present in-development spatial models of extant mangrove distributions including key ecological, anthropogenic and climatic drivers (incl. temperature, precipitation, exposure, tidal rage, elevation, anthropogenic land-use) and the use of palaeo-climatic data in model hindcasting to identify potential historical mangrove distributions. It will present early findings from our pilot case study in Madagascar, and discuss the further applications of the planned global mapping outputs to identifying mangrove restoration opportunities, changes in global carbon cycling and ecosystem services delivery, and historical ecosystem state shifts and collapse events.

Code: P 5.96. Also species-poor mangrove forests provide rich ecosystem goods and services

Dupont, R.,[1] Georis, S.,[2] Makosa, D.K.,[2] Polanía, J.,[3,4] & Dahdouh-Guebas, F.[1,2,4,5]

[1] *Systems Ecology and Resource Management, c/o Ecology & Biodiversity, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, 1050, Brussels, Belgium* [2] *Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium* [3] *Departamento de Ciencias Forestales, Universidad Nacional de Colombia, Sede Medellin, Carera 65 N° 59A-110, Medellín, Colombia* [4] *Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN)* [5] *Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, 1050, Brussels, Belgium*

Mangrove forests provide valuable goods and services to coastal communities around the world, many of which depend heavily on them. However, mangroves are under constant pressure from anthropogenic activities, jeopardizing the provision of goods and services. Senegal and Colombia, two countries belonging to the Atlantic East Pacific (AEP) floral kingdom, both host mangrove forests and share mangrove species on their territories. The present study evaluates the use of different mangrove resources (fuelwood, construction wood, and other non-timber forest products) for local communities in Senegal and Colombia. In addition, the versatility and (dis)similarities between the local utilization patterns is investigated. Semi-structured ethnobotanical questionnaires were carried out around the town of Sokone bordering the Sine-Saloum Delta in Senegal and around the Cispata lagoon system in Colombia. The results for Senegal show that Sokone inhabitants depend less on the mangrove for their livelihood than inhabitants of the periphery. In Colombia, this difference is based on the profession practiced. Although poor in mangrove species, both Senegalese and Colombian mangroves provide different goods and services, demonstrating the importance to local communities in both areas. Although both countries have mangrove regulation, further inclusion of local ecological knowledge is essential for the continued preservation of species-poor mangroves.

Code: P 9.54. Concentration of nutrients in soils related to mangrove forests exposed to different degrees of anthropic intervention in the Colombian Pacific

Duque, G.,[1] Mondragón-Díaz, L.F.,[2] Panesso-Guevara, M.,[3] & Molina, A.[2]

[1]Universidad Nacional de Colombia, Sede Palmira–Facultad de Ingeniería y Administración, Palmira, Colombia. [2]Grupo de investigación en Ecología y Contaminación Acuática, Universidad Nacional de Colombia, Sede Palmira, Palmira, Colombia. [3]Grupo de investigación en Ecología y Contaminación Acuática, Universidad Santiago de Cali, Cali, Colombia.

Mangroves are ecosystems with important ecological functions, but are threatened by anthropogenic and natural impacts. The objective of this research was to analyze the relation between nutrients with the structure of forests exposed to different degrees of impact, in two areas of the Colombian Pacific. Interstitial water and sediment samples were taken from forests with high intervention in Piangüita, and less in San Pedro in Buenaventura, and high in Rompido and less in Bocagrande in Tumaco. In Buenaventura was registered the greatest density of total trees (13.1 ± 8.47) and *Rhizophora mangle* (10.9 ± 8.04), while in Tumaco, were found the highest values of tree height (17.1±8.91 m) and DBH (22.0±1.99 cm). In Buenaventura, Piangüita had the highest density of trees, whereas in San Pedro, the height and DBH were higher. In Tumaco, Rompido presented the largest density of trees, whereas in Bocagrande, the height and the DBH were higher. In Buenaventura, in areas where there was a higher concentration of nitrates, a higher density of trees was recorded, but it was significantly related to lower height and DBH, the latter two characteristics occurred in areas with excess of ammonium. On the other hand, in Tumaco there were fewer trees at high concentrations of nitrites. In conclusion, even though, the forests of Buenaventura presented higher densities of trees, in Tumaco, the forest was more developed in spite of lower nutrients concentrations. Such relationships have been found in other studies, where substrates with a high concentration of nutrients promote biomass, but the excess of nutrients may affect mangrove growth.

Code: P 9.48. Debris in the trees: a comparison of U.S. Virgin Islands mangrove and beach clean-up data collected by citizen scientists

Durdall, A.,[1] Grimes, K.W.,[1] Roper, Z.,[2] & Edwards, K.[2]

[1]Center for Marine & Environmental Studies, University of the Virgin Islands [2]Virgin Islands Department of Planning & Natural Resources, Division of Coastal Zone Management Abstract

In the U.S. Virgin Islands, coastal marine debris cleanups with citizen-science data collection have occurred since 1988. These data inform debris management, education strategies, and debris-preventive legislative action. Yet, it was not until 2018 that data-collecting cleanups expanded beyond sandy beaches to mangrove shorelines, which may be more vulnerable to debris and are a data gap globally. Little is known about how these shoreline types aggregate debris differently. Averaged by event and adjusted for effort, preliminary results suggest marine debris in mangroves is more prevalent, heavier, and differs in composition compared to sandy beaches. The average volunteer removed more debris from mangroves compared to sandy beaches (52 kg vs 11.6 kg; 64 items vs. 38 items). Composition analysis found overlap in commonly-removed items, but prevalence rankings and volumes differed. On sandy beaches, smaller, lighter items featured more prominently; compared to mangrove habitats, there were 6 times more bottle caps, 8 times more cigarette butts, and 25 times more plastic straws. Larger debris dominated mangroves; compared to beaches, there were two times as many plastic beverage bottles, and 8 times more construction materials. Potential explanations for these differences include mangrove structure's propensity to trap debris, forest locations adjacent to debris sources (e.g., landfill, active marinas), and prolonged buildup of debris from chronic and acute processes (i.e. hurricanes) without routine cleanup. Sandy beach cleanups are more common; mangrove habitats are less accessible and have lower public concern; mangroves are smelly with harder to locate debris. However, this work suggests the two habitat types accumulate debris differently. As such, future territorial debris management, education, and legislation should consider and incorporate data from both shoreline types. The discrepancies found suggest a need for data collection efforts in alternative shorelines worldwide, and highlight the utility of citizen scientists to this effect.

Code: P 5.53. Development of social-ecological mangrove typologies

Ebeler, L.,[1] Renaud, F.,[1] Balke, T.,[2] Le, H.,[3] & Nguyen, T.[4]

[1] School of Interdisciplinary Studies, University of Glasgow, Dumfries, UK
[2] School of Geographical and Earth Sciences, University of Glasgow, Glasgow, UK [3] Central Institute for Natural Resources and Environmental Studies, Vietnam National University, Hanoi, Vietnam
[4] Faculty of Engineering, Technology, and Environment, An Giang University

Mangrove social-ecological systems (SES) are being lost or degraded globally. Many restoration and conservation efforts are underway but with regionally contrasting success rates. In many cases, restoration projects that were deemed successful initially have not produced healthy mangroves habitats in the long run. The key shortfall of many restoration and conservation initiatives is the lack of understanding of social-ecological complexities across appropriate strategies, biophysical site assessments, socio-economic contexts, stakeholder engagement, and policy environments. We aim to determine such integrative social-ecological typologies of mangrove restoration and conservation efforts in two large delta regions: the Mekong and Red River deltas in Vietnam. The key methodology includes a synthesis of meta-analysis and 30 key informant interviews as well as 20 focus group discussions that were held in both delta regions in 2022. Preliminary findings suggest that failures in mangrove restoration and conservation are rooted in underlying governance issues, such as insufficient clarification of responsibilities between government agencies, inconsistent mangrove policies, and an imbalance between economic development and conservation priorities. In addition, local communities need to be more involved in policy, project design and implementation, while the provision of alternative livelihoods could be a key factor mitigating the potential failure of previous achievements in mangrove conservation. The typologies of successes and failures of mangrove restoration and conservation measures can be used to inform best practice and to develop a tool for SES policy and management.

Code: P 9.49. Coastline dynamics in different mangrove forests of the Colombian Caribbean Sea and Pacific Ocean. Analysis based on remote sensing and field study

Echeverry, J.P.,[1] Mancera-Pineda, J.E.,[1] Sanchez, D.A.,[2] Dorado, J.H.,[1] Medina, J.H.,[3]

[1]Universidad Nacional de Colombia, Sede Bogotá, Departamento de Biología [2]Universidad Nacional de Colombia, Sede La Paz [3]Universidad Nacional de Colombia, Sede Caribe, Jardín Botánico

Colombia has an important diversity of mangrove forests distributed on coasts and islands of the Caribbean Sea and the Pacific Ocean. These two regions differ widely in oceanographic, environmental, and social aspects. Consequently, mangroves present marked structural and functional differences, as well as their state of conservation, which is reflected in the ecosystem services provided by these forests. To assess coastline dynamics in relation to mangrove structure during the last five decades, field studies and analysis of aerial photographs and satellite images from different years between 1969 and 2022 (depending on the sector) were carried out. The results show very different dynamics between the sectors analyzed. A generalized loss of large areas of mangroves was quantified along the entire coastline of Ciénaga Grande de. Santa Marta in the Caribbean (with an EPR or end point rate of -2.54 m/y) and Punta Soldado in the Pacific (EPR of - 2.58 m/y). Piangüita in the Pacific and Isla San Andrés in the Insular Caribbean presented positive EPR, with 0.85 and 0.21 m/y respectively. Finally, Tumaco in the Pacific, presented the highest cyclical variability between erosion/accretion rates with a net EPR of 3.95 m/a. The plant structures density that resist the movement of water (volumetric density of mangrove roots) is relatively high (5.46%) in Bahía Málaga, Pacific, where the coastline remained stable, and very low at Cienaga Grande de Santa Marta (0.063%) where the greatest erosion occurred. There is evidence of a bidirectional relationship between the physical conditions of the sea and the coastal geomorphology and the stability of the mangrove front line that is evidenced in the structure of the forest and the erosion/accretion rates.

Code: P 15.70. Mangroves require social-ecological systemic research

Esméralda, L.,[1,2] Julien, A.,[3] Anliati, A.A.,[4,2] Edward, A.,[5] Brosse Rémi, B.,[6,2] Ariadna, B.,[7] Stefano, C.,[8,9,12] Cormier-Salem, M.C.,[7] Dahdouh-Guebas, F.[10,11,12,13] Fratini, S.,[8,12], Friess, D.,[14] Hugé, J.,[15] Jeanson, M.,[1,2] Koedam, N.,[10,12,16] Mangora, M.M.,[17,18,12] Poti, M.,[10,11] Proisy, C.,[19] Thanne, W.,[10] Golléty, C.[20,2]

[1] ESPACE-DEV, Univ Montpellier, IRD, CUFR de Mayotte, Univ Guyane, Univ Réunion, Montpellier, France [2] Centre Universitaire de Mayotte (CUFR), 97660 Dembéni, Mayotte, France [3] French Institute of Pondicherry [4] PRODIG, CNRS, Univ Paris 1 Panthéon Sorbonne, AgroParisTech, Paris Sorbonne Université, IRD, Univ Paris, Paris, France [5] Aix Marseille U, CNRS, IRD, INRA, Coll France, CEREGE, Aix-en-Provence, France [6] Laboratoire des Sciences de l'Environnement Marin, UMR CNRS 6539, Institut Universitaire Européen de la Mer, Rue Dumont d'Urville, 29280 Plouzané, France [7] UMR PALOC, IRD, MNHN, Paris [8] Department of Biology, University of Florence, via Madonna del Piano 6, Sesto Fiorentino, Italy [9] The University of Hong Kong [10] Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium [11] Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, 1050, Brussels, Belgium [12] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN) [13] Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, 1050, Brussels, Belgium [14] Department of Earth and Environmental Sciences, Tulane University, New Orleans, Louisiana 70118, USA [15] Open University of the Netherlands, Vrije Universiteit Brussel & University of Hasselt, Heerlen & Brussels [16] Universiteit Gent - UGent (Marine Biology Research group Krijgslaan 281 – S8 B-9000 Gent) [17] Institute of Marine Sciences, University of Dar es Salaam, Zanzibar – Tanzania [18] Western Indian Ocean Mangrove Network, Zanzibar – Tanzania [19] AMAP, IRD, CIRAD, CNRS, INRAE, Univ. Montpellier, 34000 Montpellier, France - AMAP, Centre IRD de Cayenne, 97300 Cayenne, France [20] MARBEC, Univ Montpellier, CNRS, IFREMER, IRD, Montpellier, France

The focus on human-mangrove relationships would benefit from a systemic approach, provided by the 'social-ecological system' (SES) concept, which appeared in the mid-1990s. While the SES concept has quickly spread among studies dealing with many terrestrial or marine ecosystems, it only recently made its appearance in mangrove research. Yet, the complex dynamics of connections and feedbacks within and between societal and ecosystemic components would be better understood through this systemic approach. This review analyses how the SES concept has been integrated in mangrove research and the benefits that studies on human-mangrove interactions could draw from fully applying the SES concept. A systematic review of the literature was performed on Web of Science and Scopus with the key words 'soci* ecolog* system*' and 'mangrove*', providing 67 publications. Each publication was double-coded for: (i) descriptive information about the publication; (ii) SES information; (iii) concepts and frameworks other than SES; (iv) main methodologies and case studies; (v) main outputs. The first publication on mangroves mentioning the SES concept dates back to 2009. The number of publications increased from an average of 2 studies per year between 2009 and 2014 to 8 between 2015 and 2021. Most publications use the concept to place the studies on the society-mangrove relation topic. Instead, few actively use or apply SES frameworks. The few that are used lack a systemic approach. For instance, very few studies deal with links and feedbacks of the mangrove SES and/or try to determine the threshold of variables that have a paramount role in the resilience of the SES. Studying the dynamics of nested spatial-temporal scales would help identify and follow emergent properties of SES. One of the first steps for addressing these challenges is the co-building of integrated research designs in transdisciplinary research projects to produce more accurate data.

Code: P 9.50. Impacts of marine litter pollution on the Ciénaga Grande de Santa Marta mangrove ecosystem, Colombian Caribbean

Espinosa-Díaz, L.F.,[1] & Garcés-Ordóñez, O.[1,2]

[1]Instituto de Investigaciones Marinas y Costeras José Benito vives de Andréis – INVEMAR, Programa de Calidad Ambiental Marina. Calle 25 # 2-55 Rodadero, Santa Marta, Colombia. [2] Universitat de Barcelona, Facultad de Ciencias de la Tierra, Departamento de Dinámica de la Tierra y del Océano, Grupo de investigación Geociencias Marinas. E-08028 Barcelona, Spain.

Marine litter is a global problem, which is producing ecosystems degradation and losing their environmental services, as mangroves, which are coastal ecosystems where potentially the largest load of marine litter flows from the continent into the ocean. In the Colombian Caribbean, the Ciénaga Grande de Santa Marta (CGSM) has the largest mangrove coverage; in this place are also human settlements with high rates of poverty and unsatisfied basic needs, whose economic and food source depends on fishing and aquaculture, so the accumulation of marine litter represents a great environmental and economic threat. The objective of this study was to analyze the problem of marine litter in the CGSM mangroves, using the methodological framework of driving forces, pressures, states, impacts, and responses. To identify and assess the negative impacts of marine litter on the CGSM mangrove ecosystem, the socioeconomic characteristics of the inhabitants were documented and the abundance of litter and microplastics in soils was determined. The analyses showed that the inadequate disposal of domestic and industrial waste is the main pressure on the CGSM mangrove ecosystem. The marine litter abundance in mangroves close to populated centers was 540±137 item/ha and of microplastics was 2,863 item/kg; and the abundance of marine litter in mangroves far from populated centers was 31±23 item/ha, and of microplastics was 31 item/kg; 73–96% of marine litter was plastic. In the CGSM mangroves. 21 impacts (between severe and critical) of marine litter were identified, among these, are stand out the accumulation of microplastics, due to the potential danger, and the effects on natural regeneration, and on soil structure. To improve human well-being in vulnerable areas, the key responses for this problem management can be oriented to territorial planning, sustainable production, education/awareness, and research.

Code: P 15.46. Change, Carbon stocks and associated emissions from 40 years of mangrove losses in Nigeria

Fatoyinbo, L.,[1] Barenblitt, A.,[1] Stovall, A.,[1] Thomas, N.,[1] Souza, C.,[1] Lagomasino, D., Goldberg, L.,[2] & Nwobi, E.[3]

[1] NASA, United States of America [2] Stanford University, United States of America [3] University of Edinburgh

The Niger Delta region of Nigeria harbors the one of the largest mangrove forest system in the world. It is also one of the largest areas of oil and gas production globally, ever since the first oil reserve was discovered in the 1950's. The history of oil exploration and frequent spills have led to extensive environmental pollution that affects air quality, childhood survival rates, water quality, fish stocks and soil quality. Oil spills and pollution also severely threaten coastal ecosystems and the ecosystem services they provide worldwide. Past oil spills in coastal ecosystems such as mangroves, marshes and seagrass have led to widespread die-off of plants and associated fisheries, persistence of oil-based compounds in water and food webs, as well as other losses of ecosystem services. Although the oil spillage and subsequent pollution and die off are well documented in certain geographic locations of Nigeria, especially the eastern part of the Niger Delta, the full extent of mangrove loss, as well as the direct causes and timing of changes are still not well quantified. Furthermore, the compounding effects on Carbon sequestration and biodiversity caused by the degradation and encroachment of the invasive nypa palm from need to be incorporated into current estimates of mangrove ecosystem losses. In this paper, we report on the extent, timing and cause of mangrove die off and degradation in the Niger Delta region and the consequences in terms of carbon emission and losses of ecosystem services. We mapped mangrove losses in Nigeria from 1984 to present with Landsat data. By combining, field measurements, extent and change maps and 3D structure measurements from the several spaceborne datasets, including GEDI Lidar (Global Ecosystem Dynamics Investigation) data, we estimated Total Ecosystem Carbon Stocks, as well as past and future carbon emissions. We combined oil spill location data from the Nigerian Oil Spill Monitor and additional geospatial data on land cover, to attribute the main drivers of mangrove loss in Nigeria. We found that contrary to global trends, mangrove losses in Nigeria -which are primarily human driven- have increased since 2000. Our results also show that previously published global mangrove change numbers vastly underestimated the total extent of loss through oil spills or deforestation, and that the compounding encroachment of the invasive Nypa palm resulted in one of the largest per country mangrove loss rates recorded to date. We will present our results that show that over 70 thousand hectares of mangrove have been lost since 1995 in Nigeria, with an additional 60 thousand hectares of endemic mangrove species being replaced by Nypa palm with associated CO_2 and ecosystem service loss estimates

Code: P 5.77. Reassessment of mud crabs *Scylla* spp. taxonomic identity in Segara Anakan Lagoon, Cilacap, Indonesia.

Fauziyah, A.,[1] Kochzius, M.,[2] Ahmad, I.,[1] Dwiartama, A.,[3] & Sholihah, A.

[1] Insitut Teknologi Bandung, Indonesia
[2] Vrije Universiteit Brussels, Belgium
[3] School of Life Sciences and Technology, Indonesia

Due to high morphological similarity, taxonomic misidentification on the commercially important mud crabs genus *Scylla* is common. Studies from Segara Anakan Lagoon (SAL) Cilacap mostly recognized *Scylla serrata* as the only existing mud crabs species in the area. Misidentification of *Scylla* spp. derived from only using a morphological approach to identify the species. This study aimed to re-assess mud crabs *Scylla* spp. in SAL using morphometrical analysis, complemented with DNA barcoding. One hundred and seven specimens were collected from SAL in March-June 2021. Fourteen morphometric parameters were measured using a digital vernier caliper (0.01 mm). The DNA barcoding targeted mitochondrial cytochrome oxidase 1 (mtCO1) region, using mtd10 5'TTGATTTTTTGGTCATCCAGAAGT 3' and C/N 2769 5' TTAAGTCCTAGAAATGTTRGGGA 3' paired-end primer set. The Polymerase Chain Reaction (PCR) amplified the region with the protocol used by Rumisha et al. (2018). The Neighbor-Joining Tree (NJT), Non-Metric Multidimensional Scaling (NMDS), and Principal Component Analysis (PCA) showed no clusters of the morphometrical data. In contrast, the mtCO1 sequences revealed that the four species of *Scylla* spp. were present in SAL, remonstrating previous findings on Scylla spp. presence in the area. Sequences-based NJT clustered four distinct groups of the samples (Bootstrap value= 1000). Each group corresponded to different Barcode Identifier Number (BIN) codes derived from the Barcode of Life Data System (BOLD) during genetic identity verification. The genetic distance (Ds) values between species were higher compared to the within species (0.068-0.173>0.002 to 0.004), confirming there were no cryptic species found in the samples. This study proved that all four *Scylla* species i.e *Scylla serrata, S. olivacea, S. tranquebarica*, and *S. paramamosain* were present in SAL. Additional environmental data such as total organic matter (TOM), Biological Oxygen Demand (BOD), and heavy metal concentration are suggested to support the morphological plasticity assumption.

Code: P 5.90. Inferences on the role of different mangrove stands in mollusk biodiversity and assemblages in Philippine mangroves

Fermo, J.B.,[1] Batomalaque, G.A., & and Salmo, S.G.

[1]Institute of Biology, University of the Philippines – Diliman, Quezon City, Metro Manila, Philippines

Mollusks are one of the most dominant fauna in mangrove forests. They provide several ecosystem services to local communities and serve as bioindicators of mangrove health. This study explored and compared the biodiversity within the different types of mangroves in Oriental Mindoro, western Philippines. We tested the hypothesis that mollusk assemblages vary with different mangrove stands. Our results show that recolonized fishponds have 150-450% higher abundance than the planted and natural mangroves. However, the natural mangrove stands had the highest diversity overall (H' = 1.15 and H'= 1.75 for arboreal and epifaunal assemblages, respectively), whereas the recolonized fishponds had higher diversity (H' = 0.88 and H' = 1.51) than the planted mangroves (H' = 0.21 and H' = 1.42). The species *Littoraria scabra* was the most dominant arboreal species across all mangrove stands. *Cerithidea* was the most dominant epifaunal genus within recolonized mangrove stands and *Terebralia sulcata* had a larger presence in planted mangroves. *Drupa sp.* and bivalve species such as *Magallana bilineata* and *Barbatia sp.* were observed only in natural mangroves while *Cassidula sp.* was found only in colonized and planted sites. Furthermore, we observed an undescribed bubble snail (Opisthobranch gastropod) in the recolonized mangrove stands, thus highlighting the potential of recolonized mangrove stands to harbor unique species. These findings provide evidence that utilizing recolonized fishponds is a better alternative for mangrove rehabilitation, supporting faunal biodiversity comparable to natural mangrove stands and potentially providing more food sources for locals.

Code: P 9.14. Labile or stable? Assessing organic matter recalcitrance - case study on Malaysian mangrove sediments

Fett, T.M.,[1] Lucas, T.,[1] Wölfelschneider, M., Prugger, J., Lee, J.N., Amir, A.A., Zimmer, M. & Helfer, V.

[1]Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany

Mangrove forests and other coastal vegetated ecosystems sequester and store large amounts of organic carbon in their biomass and their sediments. In recent decades, their integrity and extent have been compromised and reduced by numerous human activities. As a result, the global capacity to mitigate climate change through blue carbon storage in coastal vegetated ecosystems has declined dramatically. For concrete actions to reverse this trend it is not only crucial to have better knowledge of the quantity but also stability of the stored organic matter (containing the organic carbon). The present research aims to enhance the understanding of sediment organic matter, notably by quantifying OM fractions of distinct stability. Here we present a case study from peninsular Malaysia, where we collected 50 cm-deep sediment cores in three different regions at the west and east coast. By applying a stepwise combustion method, we provide first insights into OM quality with regard to thermal stability as a proxy for recalcitrance against decay. We will present 1) regional organic matter characteristics, and 2) possible differences of OM recalcitrance levels across sediment depth. Novel insights into organic matter stability will deepen our understanding of long-term organic matter storage in mangrove ecosystems and thereby their potential as climate change-mitigators. This knowledge will further inform regional and global management of coastal vegetated ecosystems and potential carbon offset schemes.

Code: P 15.41. Improving regional mangrove carbon estimations based on terrestrial lidar scanning in suriname

Feyen, J.,[1,2] Wortel, V.,[3] Calders, K.,[1] Crabbe, S.,[2] Doelatip, S.,[2] Hanoeman, N.,[3] & VanCoillie, F.[1]

[1]Department of Environment, Ghent University, Ghent, Belgium [2]Foundation for Forest Management and Production Control, Paramaribo, Suriname
[3]Department of Forest Management, Centre for Agricultural Research in Suriname (CELOS), Paramaribo, Suriname

Monitoring mangrove ecosystems is crucial in tracking the impacts of environmental and anthropogenic factors on these ecosystems. Especially within the scope of climate change, the mangrove ecosystem is a key factor to adapt and mitigate to potential effects such as sea level rise and their capacity to store large amounts of carbon. As part of the National Forest Monitoring System (NFMS) of Suriname, the first mangrove biodiversity monitoring system was set up in 2019 and in 2022 a second inventory project started where the existing 11 sampling units (SUs) are remeasured and complemented with 7 new SU's. Key attributes such as biomass, carbon stocks, forest structure, and floral and faunal diversity were measured in these units. In 12 sampling units a Terrestrial Lidar Scanner (TLS) was used to capture 3D images of the various structural stages and types present in the mangrove ecosystem of Suriname. A total of 20 mangrove plots with an area of 20x50m were scanned based on 36 scan positions each. The scans were distributed over 15 plots dominated by A*vicennia germinans* (ranging from young to adult and decaying trees), 4 plots dominated by *Rhizopora mangle,* and 3 plots with a mixture of both species. Occasionally, *Laguncularia racemosa* trees were present as admixture. Using these 3D data, new allometric relations for both *Avicennia germinans* and *Rhizopora mangle* trees are generated to increase the accuracy of the total aboveground biomass (AGB) estimation and can act as ground-truth data for regional AGB maps retrieved by remotely sensed data like GEDI and Sentinel-1 and Sentinel-2. The terrestrial LiDAR scans will also be used for a better structural characterization of these forests in terms of tree and stand structure. Preliminary results will be presented at the MMM6-conference.

Code: P 9.11. Societal acceptance of mangrove (re-)establishment: perspectives from Barú, Colombia, and Setiu Wetlands, Malaysia

Fouqueray, M.,[1] Ratter, B.,[2] Fink, M.,[2] Mancera-Pineda, J.E.,[3] Zarza, E.,[4] Aziz, N.,[5] Lee, J.N.,[5] Amir, A.A.,[6] Zimmer, M.[1]

[1] Leibniz Centre for Tropical Marine Research, Germany [2] University of Hamburg, Germany [3] Universidad Nacional de Colombia [4] Universidad del Sinú sede Cartagena, Colombia [5] Universiti Malaysia Terengganu [6] Universiti Kebangsaan Malaysia

Large-scale expansion of mangrove areas can contribute to enlarging carbon sinks for climate change mitigation. Such actions will add to competing land-uses in these often densely populated coastal areas. Therefore, societal acceptance of such endeavours must be evaluated, to include local people in the project design and ensure long-lasting success. The present research looks into societal acceptance of mangrove (re-)establishment, in the context of sea4soCiety, a large-scale and long-term project on ocean based measures of carbon dioxide removal. Semi-structured qualitative interviews were conducted on the peninsula of Barú, Colombia, from April to June 2022, and in Setiu Wetland, Malaysia, from September to November 2022. The questions sought to grasp local people's perceptions of climate change, the benefits they derive from their local mangrove forests, and the main threats to these ecosystems. Participants were asked to share their thoughts on a potential (re-)establishment project, which criteria needed to be fulfilled to successfully involve their communities, and what structures currently existed to carry out such a project. While some parallels can be drawn between the two case studies, there are important differences in the main factors threatening existing mangroves, and their potential expansion. This study is a first step towards understanding these complex socio-ecological systems and reaffirms the value and importance of including local people in (re-)establishment efforts.

Code: P 9.8. Enabling Blue Carbon Policy Conditions

Francis, E.,[1] & Wilkman, A.[1]

[1]Fair Carbon , United States of America

Blue carbon projects are essential to combat climate change, support sustainable development, and protect biodiversity. Compared to forest carbon projects, there are relatively few accredited and operational blue carbon projects on the voluntary carbon market. Fair Carbon's goal is to facilitate the development of blue carbon projects by providing free, easy-to-access information, resources, and tools to navigate all components of the project development process. Fair Carbon is currently developing modular guidance for mangrove carbon projects, covering the entire project development cycle from pre feasibility to design to implementation and monitoring. Fair Carbon is writing the module content based on industry best practices, research, and lessons learned from prior coastal conservation and restoration projects. The modules contain original tools, templates, and information that is jargon-free and easy to follow. All module content emphasizes using scientifically rigorous methods while balancing the rights and needs of local stakeholders and supporting biodiversity

Code: P 9.81. Modular Guidance for Blue Carbon Projects

Francis, E.,[1] & Wilkman, A.[1]

[1]Fair Carbon , United States of America

Blue carbon projects are essential to combat climate change, support sustainable development, and protect biodiversity. Compared to forest carbon projects, there are relatively few accredited and operational blue carbon projects on the voluntary carbon market. Fair Carbon's goal is to facilitate the development of blue carbon projects by providing free, easy-to-access information, resources, and tools to navigate all components of the project development process. Fair Carbon is currently developing modular guidance for mangrove carbon projects, covering the entire project development cycle from pre feasibility to design to implementation and monitoring. Fair Carbon is writing the module content based on industry best practices, research, and lessons learned from prior coastal conservation and restoration projects. The modules contain original tools, templates, and information that is jargon-free and easy to follow. All module content emphasizes using scientifically rigorous methods while balancing the rights and needs of local stakeholders and supporting biodiver

Code: P 15.27. The WILDCOAST's blue carbon strategy for northwestern Mexico.

Frausto-Illescas, T.,[1] & Franco-Ortiz, M.[1]

[1]COSTASALVAJE, A.C., Mexico

WILDCOAST (WC) is an international team that conserves coastal and marine ecosystems and addresses climate change through natural solutions.
In 2016 WC established its Blue Carbon Strategy (BCS) aimed to conserve 32,689 ha of mangroves in the Gulf of California (GC).
The BCS has the following components: Legal Protection: Protected 3,421.48 ha of coastal ecosystem, including mangroves, through the legal tool Federal Conservation Concessions (FCC) in collaboration with the Mexican Government through the National Commission of Natural Protected Areas, (CONANP). This project resulted in the document: "Strategy for the administration and management of surfaces of the federal maritime land zone and maritime beaches destined to the service of the National Commission of Protected Natural Areas.
Co-management: In 2020, WC signed an MOU with the CONANP to co-management El Conchalito, a 40-ha urban mangrove forest in the city of La Paz, Mexico. The co-management activities are carried out in collaboration with the local group of women, "Las Guardianas del Conchalito".
Science: WC in collaboration with the PhD. Jonny Torres and according to Kauffman and Donato methodology (2012) estimated the stock of carbon in Laguna San Ignacio, Baja California Sur. The average of stock is 59.30 Mg/C/ha. Environmental Education: In alignment with the curricular of the Ministry of Education of Mexico, designed specialized environmental education materials on blue carbon ecosystems for children between 6 and 12 years of age. Restoration: Restoration of 62.5 ha of mangrove forest in the GC in collaboration with two local groups of women. Policy: WC is working to promote a blue carbon agenda for Mexico using the blue carbon policy framework proposed by UNFCCC. All of these activities contribute to avoiding the emission of 3,486,146.9 MgC by reducing the mangrove degradation and deforestation in the GC.

Code: P 4.4. Establishing structural and surface elevation change targets for a mangrove forest undergoing hydrological restoration on Marco Island, Florida, USA

From, A.S.,[a] Krauss, K.W.,[a] Demopoulos, A.W.J.,[b] McClain-Counts, J.P.,[b] Bourque, J.R.,[b] & Cormier, N.[c]

[a] U.S. Geological Survey, Wetland and Aquatic Research Center, 700 Cajundome BLVD, Lafayette, LA 70506, USA
[b] U.S. Geological Survey, Wetland and Aquatic Research Center, 7920 N.W. 71st Street, Gainesville, FL 32653, USA
[c] Macquarie University, School of Natural Sciences, Sydney, New South Wales, Australia

Hydrologic restoration can enhance mangrove ecosystem services on naturally tidal and managed lands globally. Here, we use a functional equivalency approach to assess the potential success of a hydrologic restoration project in southwest Florida. While losses to mangroves were initially low from the direct clearing for a road, the road itself restricted tidal flow into the wetland and over 60 years resulted in large die-off areas. The on-going restoration effort, which began in part in 2014 and earnestly in 2021, involves repairing channels and establishing culverts under the original road to rehabilitate tidal movement. We established five sites, four perpendicular to multiple impacted areas and include transects in closed canopy, transitional canopy, and open canopy sites to assume a space-for-time design to inform restoration targets, and a fifth reference area off-site. Open canopy sites represent dead, peat-collapsed mangrove forests, and are the primary target of hydrologic restoration, while closed-canopy and reference forests represent the target condition. Forest structural and surface elevation change were measured over 9 years, and trajectories of change were compared to determine the impact hydrologic restoration. Once restoration is complete, we expect upwards of 71-110 Mg C/ha of new carbon (C) storage in aboveground mangrove biomass, 3.6 Mg C/ha/year of new C storage in upper soil horizons, and an establishment of natural regeneration and an increase in root productivity to counter decomposition losses that led to the original peat collapse. Similar approaches are underway in other parts of Florida, Mexico, and the U.S. Virgin Islands, and with an appropriate restoration framework in place, should stimulate long-term success even if adaptive management processes are necessary because of natural stochastic events.

Code: P 9.57. Polycyclic aromatic hydrocarbons (pah) in seston and sediments in mangrove areas of the central Caribbean region of Colombia

García, L.D.,[1] Santos, N.,[2] Monroy, M.,[3] Mancera, N.J.,[1,] Vélez, A.J.L.,[2] Navarro, A.,[2] Almario, M.L.,[2] Campos, N.H.,[4] & Sanjuan-Muñoz, A.[2]

[1]Department of Forestry Sciences, Faculty of Agricultural Sciences, Universidad Nacional de Colombia, Medellín Branch, Carrera 65 No. 59A - 110, Block 14, postgraduate offices, 4th floor, Medellín, Colombia [2]Biological and Environmental Sciences Area, Faculty of Natural Sciences and Engineering, Universidad de Bogotá Jorge Tadeo Lozano, Santa Marta Campus. Carrera 2 # 11-68. Mundo Marino Building. El Rodadero. Santa Marta [3]Department of Biology, Faculty of Sciences, Universidad Nacional de Colombia, Bogotá Branch, Carrera 45 No. 26-85, Bogotá, 111321, Colombia. [4]Institute of Marine Science Studies (Cecimar), National University of Colombia, Caribbean Branch, Santa Marta.

Polycyclic aromatic hydrocarbons (PAH) are organic pollutants, with chains of benzene rings, differentiated into high (> 4 rings; HMW) and low (< 4 rings; LMW) molecular weight, also persistent and bioaccumulative that generate environmental problems, mainly in aquatic ecosystems. The objective of this study was to determine PAH levels in seston and sediments from two zones of the colombian Caribbean (area of influence of the Sinú and Magdalena rivers), each composed of 5 sampling localities in climatic periods of rain and drought. The samples were analyzed by gas and liquid chromatography. The presence of 12 types of PAHs was detected, mainly LMW, the threshold effect levels (TEL), or probable effect levels (PEL) were not exceeded, although some outliers were found. The average value of PAH concentrations in sediment in dry season was 1527.04 ng g^{-1}(SD: 4155.76 ng g^{-1}) and in rainy season 190.75 ng g^{-1}(SD: 158.96 ng g^{-1}). On the other hand, the average values in seston in dry season was 464.19 ng g^{-1}(SD: 316.15 ng g^{-1}) and in rainy season was 1847.86 ng g^{-1}(SD: 2162.94 ng g^{-1}). Differences between localities were determined, with higher levels of sediment in the dry season in the stations located near the discharge zone of the Sinú river, adjacent to the mangrove swamp, highlighting the locality Ciénaga de Caimanera, with a value of 22883.52 ng g^{-1}, mainly HMW structures. During the rainy season, seston values were higher in the Cispatá Bay area (7119.69 ng g^{-1}), mostly of low molecular weight, concentrations that may be influenced by transport of this type of pollutants from different sources. Therefore, monitoring or follow-up and research on the levels and effects of PAHs on the biota of marine ecosystems in the Colombian Caribbean is recommended

Code: P 15.65. Use and Management of Mangrove Ecosystems as a Response to Storm Events Abstract

Garcia-Vega, M.,[1] Heck, N.,[1] & Siddharth, N.[1]

[1]East Carolina University, United States of America

Coastal ecosystems such as mangroves provide diverse ecosystem products and services to coastal communities, including storm protection through wave energy dissipation. These services, however, can change as mangrove extent and health changes due to human use and management actions. Yet, not much is known about how humans change their use and management of mangroves in response to extreme events, such as storms, and how these changes might affect the flood risk benefits of mangroves. Thus, we conducted a systematic review of existing literature to 1) identify ecosystem services provided by mangroves, 2) how these are affected by storms, and 3) how use and management subsequently change and what this means for mangroves and communities. We find that mangroves provide diverse benefits to coastal communities including coastal protection. The main impacts of storms on mangroves include mass mortality of mangroves that shape the way people respond to storm events and subsequent changes in the mangrove ecosystem. Existing knowledge on changes in use and management after storm events though is very limited. We conclude that there is a need for more research to identify how mangroves and mangrove users respond to extreme events, such as storms, and how these responses influence the health of both the mangrove ecosystem and the coastal communities that depend on it for diverse ecosystem services.

Code: P 5.63. Intertidal algae as occasional refuge for insects in mangrove forests, Pacific Colombia

Gavio, B.,[1] Huber, J.T.,[2] Avendaño, J.M.,[3], Sarmiento, C.E.[4]

[1]Departamento de Biología, Universidad Nacional de Colombia, sede Bogotá, Bogotá, Colombia
[2]Canadian Forest Service, Natural Resources Canada, Ottawa, Canada
[3]Departamento de Entomología, Facultad de Recursos Naturales. Escuela Superior Politécnica de Chimborazo. Riobamba, Ecuador.
[4]Instituto de Ciencias Naturales, Universidad Nacional de Colombia, sede Bogotá, Bogotá, Colombia

Despite their enormous abundance and diversity, insects have failed to adapt and establish in marine waters, as no marine insects, as far as we know, remain submerged throughout their lives. They have reached intertidal and coastal environments, and in a few unusual cases, e.g., *Halobates* (Hemiptera, Gerridae) have successfully adapted to live their entire life cycle on the open ocean surface, kilometers away from land. Maybe for this reason, insects associated with intertidal environments have been relatively poorly studied. Their association with macroalgae in the intertidal region is reported just on seaweed wrack where seaweed flies may abound, e.g. *Playaspalangia* (Hymenoptera, Pteromalidae). Seaweeds as a refuge for insects have seldom been observed. Saccate macroalgae in the intertidal may retain water inside their thalli and be a refuge for several invertebrates, especially during low tide. Yet, the organisms hiding inside these algae are fully marine. In contrast, very few terrestrial species have been associated with macroalgae in marine waters. Here we report two individuals of an unidentified species of *Anaphes* (Hymenoptera, Mymaridae), a parasitoid fairyfly found in an insect egg inside the red alga *Catenella caespitosa* (Caulacanthaceae) growing on aerial roots of *Rhizophora mangle* (Rhizophoraceae). The two individual wasps were fully developed and ready to emerge from their host eggs. The insect host of this parasitoid is unknown. *Anaphes* is a speciose genus with 235 nominal species; they occur on all continents except Antarctica. They parasitize insect eggs, mainly of Coleoptera, Diptera and Hemiptera. Curculionidae and Chrysomelidae are common beetle hosts for *Anaphes* species and some species of these families have been reported in mangrove habitats. It will be a challenge to obtain more host eggs inside *Catenella* so as to identify both host and parasitoid.

Code: P 5.49. Variations in chlorophyll fluorescence-derived photosynthetic parameters imply stressed seedlings under different mangrove conditions

Gerona-Daga, M.E.B.,[1,2*] Naputo, C.F.,[1] MacKenzie, R.A.,[3] & Salmo, S.G.[1]

[1]Institute of Biology, College of Science, University of the Philippines Diliman, 1101 Quezon City, Philippines
[2] University of the Philippines Visayas Tacloban College, 6500 Tacloban City, Philippines
[3] USDA Forest Service, Koror, Palau, USA

Environmental stresses affect mangroves' health affecting biomass accumulation and growth. Measuring plant responses at physiological level is important to understand how mangroves respond to varied environmental conditions. Stresses can cause photodamage to plants, thereby affecting its overall health. While this view is highly supported under greenhouse and laboratory conditions, current knowledge on photosynthetic performance of mangroves under field conditions is limited. Mangroves in the Philippines are widely distributed with varied conditions (e.g. intact/natural, restored, colonized) and with different levels of exposure to stresses/disturbances. This variation in stand conditions provides an opportunity to assess the photosynthetic performance and health of mangrove seedlings. In this study, we investigated the photosynthetic performance of seedlings in intact, colonized (abandoned fishponds with natural regeneration), and restored (planted) mangrove stands in Ormoc Bay, eastern Philippines using an open-source, open-design plant phenotyping tool. Relative chlorophyll content and other photosynthetic parameters, such as photosynthetic efficiency of Photosystem II (Phi2), yield of non-regulatory energy dissipation (PhiNO), and yield of non-photochemical quenching (PhiNPQ) were determined. Relative chlorophyll content was relatively higher in restored (60.21± 0.68) compared to natural (55.08 ± 1.13) and colonized (55.54± 1.41) stands. Values for photochemical quenching parameters (i.e. Phi2, PhiNO, and PhiNPQ) were comparable across stands although the atural (0.53 ± 0.004) and colonized (0.55 ± 0.004) stands were relatively "healthier" compared to the restored (0.51 ± 0.004) stands. However, mangrove seedlings in colonized stands exhibited higher PhiNO values reflecting higher damage to its photosynthetic apparatus probably indicating long-term persistence of sediment damages from previous fishpond operations. This study provides the first physiological measurements of mangrove seedlings under field conditions in the Philippines, and highlights the importance of the impacts of photosynthetic regulation for seedling establishment and growth.

Code: P 5.31. Impacts of varying salinity and inundation on the structural complexity of mangrove stands in the Philippines: an individual-based modeling study

Gianan, E.L.D.,[1*] Salmo, S.G.,[2] Yñiguez, A.T.[1]

[1] Marine Science Institute, University of the Philippines Diliman, 1101 Quezon City, Philippines
[2]Institute of Biology, University of the Philippines Diliman, 1101 Quezon City, Philippines

Structural complexity (SC) has been commonly used to quantify stand structure to understand its development. However, there is limited information on the impact of stressors such as salinity and inundation on mangroves' structural complexity index (SCI) and stand characteristics. Understanding the effects of these different stressors is important to provide information and insight into if and how these mangroves will cope if subjected to changes. An individual-based model (IBM) was developed to investigate the long-term impact of these stressors on SC. Mangroves were modeled based on biomass, zone-of-influence, tree diameter, age, salinity threshold, and mortality rate. Field observations from three representative mangrove stand types from two sampling periods between 2016 and 2017 were used to parameterize and validate the model. The representative stand types were simulated to determine the effects of different scenarios of combined salinity and inundation on tree competition, growth, reproduction, and mortality for 500 years. Simulation results showed variations in the SCI due to its sensitivity to changes across stands, time, and scenarios. SCIs of each stand climax before the 100th and then fluctuated until their 500th year. The highest SCIs in each stand occurred earlier when the salinity and inundation levels were low. *Avicennia marina* stand had the highest SCI compared to multispecies stand, while planted *Rhizophora* spp. stand had the lowest SCI. The multispecies stand eventually turned into a two-species stand, regardless of the scenario. It was observed that stand characteristics in each stand are low when the salinity and inundation levels increased. The mean simulation and field observation SCI values of the study were comparable to each other and to other study sites frequently visited by periodic tropical disturbances. These findings imply that when mangroves are subjected to more extreme levels of salinity and inundation, they can survive, but with limited stand development.

Code: P 4.7. Changes in forest structure and aboveground carbon stocks in preserved and impacted mangroves in southeastern Brazil

Gil, M.P.,[1] Cunha-Lignon, M.,[2] & Rovai, A.S.[3]

[1]marina.paixao@unesp.br.
[1,2]São Paulo State University (UNESP), Campus of Registro – Brazil.
[3]Louisiana State University – USA.

The Cananeia-Iguape Coastal System (CICS), southeastern Brazil is home to some of the most preserved mangrove forests in the country but also has undergone hydrological changes that have altered mangroves' structure and function. A river diversion in the CICS northern sector has caused serious environmental and social impacts. Here, we assess the temporal variation of structural parameters and carbon stocks in mangrove aboveground bio- (AGB) and necromass (AGN) across preserved and impacted stands in the CICS. We used mangrove forest structure plot-level data from the 'Integrated Mangrove Monitoring' database (http://dgp.cnpq.br/dgp/espelhogrupo/7663628607577460). Our design included four sites (2 preserved stands and 2 impacted) with 3 permanent plots each, which were sampled in 2011 and 2020. We used DBH (diameter at breast high) to calculate basal area and AGB, which was estimated using species-specific allometric equations and biomass-to-carbon conversion factors. Between 2011 to 2020, there was and shift in live basal area from younger to older cohorts (DBH classes) in preserved stands indicating stand's succession into mature stages. Contrary, in hydrologically impacted stands, live basal area decreased over the period studied while dead basal area was more prominent among older cohorts. Accordingly, preserved stands had an increase in biomass (12% to 76%), whereas impacted stands had a decrease in biomass and a significant increase in necromass (374% and 301%, respectively) over time. On average, these changes represent a gain of 34 MgC ha^{-1} in preserved stands and carbon losses amounting to 25 MgC ha^{-1} in impacted stands over the studied period. Our results contribute to the assessment of forest dynamics and the generation of reference values on carbon gain and loss from hydrological changes in mangrove ecosystems.

Code: P 9.41. The mangrove fern *Acrostichum aureum* (Pteridaceae): literature review and field data of a poorly-known, opportunistic species in the Southwestern Caribbean

Gil-Ramírez, A.S.,[1] & Blanco-Libreros, J.F.[1]

[1]Instituto de Biología, Facultad de Ciencias Exactas y Naturales, Universidad de Antioquia, Medellín, Colombia.

Mangroves are coastal ecosystems where high levels of physiological stress are imposed on the vascular plants present. They are also under threat from selective logging and other anthropogenic pressures. This combination of factors facilitates colonization, growth and expansion of *Acrostichum aureum* (Pteridaceae), the mangrove fern. Even though this fern is a component of the mangrove flora, its opportunistic life-strategy has a strong impact on true-mangrove tree species in disturbed areas. It takes advantage of increased light input from the canopy clearings, resulting in larger leaf size and higher population density. It also stunts the growth of true-mangrove species, and changes the topography and hydrology of the ecosystem. This cascading process is known as cryptic ecological degradation (CED), but its extent and duration are unknown. To better understand the implications of CED, we conducted a systematic literature review of the available information about this species. We also analyzed field-data from a case study in Urabá Gulf (Southwestern Caribbean, Colombia), where the fern is prevalent, to investigate the extent of CED. Our analysis drew on data from GBIF, with 556 records for the genus *Acrostichum*. The global distribution of occurrences of *A. aureum* suggests that CED is a widespread process, however the scant information about different aspects of the ecology of the species also indicates that it is a silent threat to the ecosystem. The case study exhibits the prevalence of the fern after a linear clearing between 2013 and 2016. Our study also highlights its negative influence on other mangrove-tree species when the natural balance among them is anthropogenically disturbed. Our research provides scientific insights into the ecosystem-wide impact of this opportunistic species that will help to guide restoration projects and conservation efforts, and to inform policy decisions in areas where it has overtaken the understory.

Code: P 9.56. Forest structure and organic carbon in sediments of Colombian Pacific mangroves

Gómez-García, L.F.,[1] Mancera-Pineda, J.E.,[1] Perdomo-Trujillo, L.V.,[2] Quesada-Mora, C.A.,[3] Peña-Salamanca, E.J.[3]

1. Universidad Nacional de Colombia, Sede Bogotá, Facultad de Ciencias – Departamento de Biología 2. Universidad Nacional de Colombia, Sede Caribe, Instituto de Estudios en Ciencias del Mar – CECIMAR a. Universidad del Valle, Departamento de Biología, Grupo de Biología de Plantas y Microorganismos

Mangrove forests capture and store organic carbon (OC). The variability recorded in the OC contents is evident and some research suggests that the sediment OC content could be a function of the aerial structure, as well as of the quality and age of the forests. The objective of this study was to evaluate the OC content in sediments of Colombian Pacific mangrove forests, with different structural characteristics. It is based on the hypothesis that the greater structural complexity, the higher OC content in the sediments. The analysis considered the OC in the sediments up to 2 m deep of six mangrove forests of the Pacific coast with different structural complexity, with basal area (BA) between 43.8±46 and 6.4±1 m2/ha, the stations with higher BA, being the stations with the lowest number of individuals and greater diameters at breast height (DBH). Structurally, the six forests were dominated by *Rhizophora spp*. The basal area (BA) had statistically significant difference between the BA medians of the stations (*Kruskal-Wallis*; $P < 0.05$). The OC, in MgC/ha, in the forest sediments was between 851.4±110 and 295.8±259 with a statistically significant difference between the median OC of the stations (*Kruskal-Wallis*; $P < 0.05$). Correlations between BA and sediments OC were made for each site, in which for all there were weak relationships and without statistically significant differences. According to the results, the initial hypothesis was rejected, since, although one of the stations with the highest BA had the highest sediments OC, the other one station with the highest sediments OC were which with the lowest BA. This means that, in the stations there are other factors not studied that may have greater weight to explain the variance of the sediments OC content.

Code: P 5.30. Follow the money: Understanding the Latin America and Caribbean mangrove restoration funding landscape to assist organizations and funders in improved social-ecological outcomes

Grimm, K.E.,[1], Archibald, J.L.,[1], Axelsson, E.P.,[2] & Grady, K.C.[1]

[1]Ecoculture; Northern Arizona University, United States of America
[2]Swedish University of Agricultural Sciences, Sweden

Recent attention to mangroves' social-ecological benefits has increased funding for restoration projects. Despite such proliferation, little is known about the mangrove restoration funding landscape or equity of funding. We aimed to increase understanding of this landscape, as well as identify relationships between multiscale funding flows and restoration organizations/project characteristics. We administered an online survey to project leads/managers of mangrove restoration projects in the Caribbean and Latin American. We located projects using relevant search terms and emailed these groups and other suggested contacts. For this poster, we focus on responses about funding sources and organization/project characteristics (e.g., size, inclusion of community information). To analyze the data, we categorized funder types by scale and type (e.g., International NGO) and projects as supported by in-country, out-country, or both types of funders. Using cross-tabulation and chi square tests, we identified relationships between funder type/scale and organization/project characteristics, which we illustrated using Sankey diagrams. We received 182 fully completed surveys, or which 115 provided funder details and were analyzed. Most funders were from the Global North (n=165/275), primarily in the United States (n=65) or broadly at the international scale (n=59). However, Mexican funders were also prevalent (n=35). Projects were mostly funded by out-country (n=43), then both (n = 36), and in-country (n=26). While similarities existed among funder type/scale and organization/ project characteristic trends, notable exceptions existed (e.g., foreign government supported larger projects), which we detail and contextualize.
We conclude with recommendations for funders and organizations. Recommendations include ways funders can better support projects managed by smaller organizations and projects using best practices (e.g., community engagement), as well as ways organizations can better target funding for mangrove restoration based on their organization and project characteristics.

Code: P 9.6. Community member perceptions of mangrove conditions, management, and community engagement in Belize.

Grimm, K.E.,[1] Archibald, J.L.,[1] Bonilla-Anariba, S.E.,[2] Bood, N.,[3] & Canty, S.W.J.

[1]Ecoculture; Northern Arizona University, United States of America [2]Penn State University, United States of America [3]WWF, Belize

Increasing community engagement can lead to more effective mangrove management and protections. However, there exists little information on community perceptions of mangrove management and if and how different community members want to be involved in efforts. We aim to identify community perceptions of mangroves, management approaches, and community engagement in Belize, as well as identify differences between communities and demographic groups. We administered an online survey to residents who live or work along the coast of Belize through several methods (e.g., Facebook groups, emails, and on-the-ground connections). People were asked to share observations of mangrove changes, opinions of mangrove regulations and management, interactions/relationships with managers around marine resource management, preferred methods for receiving information, and perceptions of benefits of and threats to mangroves. Of the 208 individuals completing the survey, more than 180 fit the study parameters. Preliminary analyses identified trends in community perceptions of benefits (e.g., wildlife habitat), threats (e.g., development), and observations (e.g., decreased mangroves). Many respondents thought mangroves are poorly managed. Most respondents, believed their community's relationship with managers was neutral or negative, especially due to the levels of communication and community inclusion/input. Trends existed in major challenges and barriers to engagement (e.g., don't know how to get involved, managers interact with certain groups), as well as preferred methods of engagement (e.g., workshops) and ways to receive information (e.g., social media). Additional analyses will identify differences between demographic groups (e.g., community, gender, ethnicity, age). These findings indicate that there are many who would like to be more involved in mangrove management, and therefore managers in Belize should expand with whom they interact. Understanding community concerns and preferences can help managers better target outreach and engagement efforts, including to specific communities and groups.

Code: P 4.13. Growing Research, Restoration, Outreach, and Education (GRROE) of U.S. Virgin Islands Mangroves

Grimes, K.W.,[1] Durdall, A.,[1] Callwood, V.,[2] Edwards, K.,[3] Ewen, K.,[4] Forbes, H.,[5] Gwilliam, E.,[4] Halliday, K.,[6] Holevoet, A.,[6] Krauss, K.,[7] Palomino, L.,[6] Plotkin, J.,[6] Silva, J.,[6] Stewart, H.A.,[8] Stout, J.,[9] Toline, C.,[4] Toner, K.,[3] & Uzzell, L.[6]

[1]Center for Marine & Environmental Studies, University of the Virgin Islands, St. Thomas, VI 00802
[2]Charlotte Amalie High School, Virgin Islands Department of Education, St. Thomas, VI 00802
[3]Virgin Islands Department of Planning & Natural Resources, Division of Coastal Zone Management, St. Thomas, VI 00802 [4]United States National Park Service [5]Virgin Islands Marine Advisory Service, St. Thomas, VI 00802 [6]Master's of Marine & Environmental Studies, University of the Virgin Islands, St. Thomas, VI 00802
[7]United States Geological Survey, Wetland and Aquatic Research Center, Lafayette, LA 70506
[8]Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL 33701 [9]Virgin Islands Established Program to Stimulate Competitive Research, St. Thomas, VI 00802

Hurricanes are a major coastal hazard that impact mangrove systems, globally. In 2017, two category five storms made landfall in the U.S. Virgin Islands (USVI) within a two-week period. The storms caused massive damage to the territory and its mangrove forests. Since then, partners from the National Park Service, the U.S. Geological Survey, the Virgin Islands Department of Planning & Natural Resources, Virgin Islands Established Program to Stimulate Competitive Research (VI EPSCoR), Virgin Islands Marine Advisory Service, Virgin Islands Department of Education, Schmidt Ocean Coalition, and the University of the Virgin Islands, have partnered in various ways to document mangrove forest recovery (forest stand structure, above and below ground carbon stocks, natural regeneration), build a shared vision for mangrove restoration in the territory, and engage the community in mangrove conservation, restoration, and education. Preliminary analyses of 19 mangrove sites in St. Thomas, St. John, and St. Croix, reveal few forests with intact canopies of mature trees and limited natural regeneration of saplings and seedlings, though recovery is variable by site and species indicating complex dynamics. A community workshop used these ecological data along with other variables like land ownership, conservation status, accessibility, and other information about mangrove ecosystem co-benefits, to create an index to help prioritize future restoration sites and activities. A new mangrove nursery at the University of the Virgin Islands grows *Rhizophora mangle*, *Avicennia germinans*, and *Laguncularia racemosa,* for restoration and provides training for middle school, high school, undergraduate and graduate students and outreach opportunities for the public. Activities within local schools also increase mangrove education through in-class experiments and field trips to mangrove ecosystems. Together, these partners are providing a strong foundation for mangrove education, conservation, and restoration throughout the territory which may serve as a model for others in the Caribbean and beyond.

Code: P 5.42. Trophic flow modeling of a mangrove in the colombian Pacific coast

Guevara-Torres, M.C.,[1] Medina-Contreras, D.,[2,1] Zetina-Rejón, M.,[2] & Cantera, J.R.[1]

[1]Departamento de Biología, Facultad de Ciencias Naturales y Exactas, Grupo de Investigación en Ecología de Estuarios y Manglares, Universidad del Valle, Calle 13 No. 100-00, Ciudad Universitaria Meléndez, Valle del Cauca, Cali, Colombia.
[2]Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, Av. Instituto Politécnico Nacional S/N Col. Playa Palo de Santa Rita, La Paz, B.C.S Código Postal 23096, México.

Mangroves are ecosystems with high trophic complexity, providers of important resources and ecosystem services for the subsistence of human communities that inhabit their surroundings. Using the Ecopath approach, the trophic structure of a riverine mangrove in the Pichidó Isthmus, Colombian Pacific was modeled. The model included 26 functional groups, consisting of one group of birds, nine fish groups, ten invertebrate groups, one zooplankton group, one detritus group and four primary producers with the largest biomass being the mangrove. According to the Pedigree index (0.69), which ranges on a scale of 0 to 1, the quality of the input data can be considered of high quality. The resulting model was also consistent as indicated by the outputs. Results indicate that the trophic level of the consumers range from 2.0 to 4.0 with piscivorous fish in the highest position of the food web, but with dominance of juvenile fish stages, highlighting the function of this ecosystem as a nursery area. In contrast, when comparing our results to other mangrove models in the Eastern Pacific (e.g. Huizache Caimanero lagoon and Golfo Dulce) most production flowing from benthic sources (mangroves and microphytobenthos) and detritus is being incorporated into the food web mainly through microcrustaceans, polychaetes, shrimps and semi-terrestrial mangrove crabs that transfer energy from the first trophic level to consumers of higher trophic levels, including Lutjanidae ("pargos"), Centropomidae ("gualajos") and Ariidae ("canchimalas") that constitutes the artisanal subsistence fisheries that take place in mangroves of the study area.

Code: P 9.40. Preferences for Mangrove Restoration in The Colombian Caribbean

Guillen K.,[1] Ferrini, S.,[1] & Di-Maria, C.[1]

[1]University of East Anglia, United Kingdom

Through a choice experiment survey, this research aims to analyse individuals' preferences for mangrove restoration projects in the Colombian Caribbean, specifically, Cienaga Grande de Santa Marta (CGSM). Despite its ecological importance, this area has suffered a major degradation process, reducing more than 50% of the initial mangrove cover registered in the '50s. Different actions were implemented since 1996. Currently, new restoration actions have been planned for those areas in need. The choice experiment survey collected information from individuals living within a 50 km ratio from the geographical centre of mangrove areas. To describe the current situation and the changes in the restoration program to be implemented and how this change might impact the environmental quality of mangroves areas, we choose three ecological attributes: biodiversity, represented by the richness of bird species in this area, mangroves extension in hectares to be restored, and fisheries represented by the annual catch (ton) in this area. Finally, a fourth attribute was a contribution to support the improvement of the restoration program. This contribution was then presented as i) a monthly monetary contribution and ii) hours per week as a volunteer in restoration activities, considering the heterogeneity of the population in and around the mangroves (rural and urban areas). The mixed Logit model was used to analyse this sample's preferences and willingness to contribute. We observed that individual was keener to participate as volunteers in restoration activities than contribute with monetary payment. Especially if they were part of the communities living inside the mangrove areas. In general, people are willing to pay more per month and work more hours per week for better scenarios of mangrove cover and fish catch, however, the biodiversity attribute was not significant when choosing between restoration improvements and the current conditions of the mangrove restoration program. The fisheries attribute was the most valued, followed by mangrove cover.

Code: P 5.39. The biogeography of multiple mangrove species in the Indo-West Pacific region

Guo, Z.,[1] Wang, J., & Shi, S.

[1]State Key Laboratory of Biocontrol, School of Life Sciences, Sun Yat-Sen University, Guangzhou, Guangdong, China. E-mail: guozx8@mail.sysu.edu.cn

The Indo-West Pacific (IWP) region, specially the Indo-Malayan, is the hotspot of mangrove species diversity, with most of the mangrove species found there. A good understanding the biogeography of mangrove species provides valuable insights for the conservation of mangrove forests. By sampling populations of multiple mangrove species in the IWP region and sequencing ca. 80 nuclear genes, we investigated the levels and geographic patterns of genetic diversity. Our large-scale survey into six mangrove species (*Rhizophora apiculata*, *Avicennia marina*, *Xylocarpus granatum*, *Aegiceras corniculatum*, *Ceriops tagal*, and *Sonneratia alba*) in the IWP revealed extremely low genetic diversity in mangrove species, and the reduction of effective population size in the history relates with historic sea level changes. We found the historic land barrier of Sunda shelf and ocean current barrier in the Wallacea region have effectively isolated populations of *R. apiculata*, *X. granatum*, *A. marina* and *A. corniculatum* in the Indian Ocean and West Pacific Ocean. However, the populations of *X. moluccensis* were isolated only by the historic Sunda land. The *A. marina* populations have diverged into three subspecies, indicated by uneven levels of divergence across the genome, with only a small subset of the genome providing clear delineation of subspecies. In particular, the *A. corniculatum* populations in the southern South China Sea were substantially differentiated from those in the northern South China Sea. This divergence was attributed to bottleneck events driven by historic sea-level changes. Hence, the mangrove populations in the Indo Ocean, Australasia and Southeast Asia should be considered as different conservative units, with (such as *A. marina*) or without recognizable morphological difference. Special care is also called for A. corniculatum populations in the southern South China Sea.
Keywords: Biogeography, Genetic diversity, Indo-West Pacific, Mangrove, Population structure

Code: P 5.70. Mangrove typology using Very High-Resolution satellite images, Bombetoka Bay, Madagascar

Gusmai, Q.,[1] Catry, T.,[1] Blanchard, E.,[1,2] Faure, J.F.,[1] Delaître, E.,[1] Révillion, C.,[1] Pennober, G.[1]

[1]UMR ESPACE-DEV, Univ Montpellier, IRD, Univ Guyane, Univ Réunion, Univ Antilles, Montpellier, France – quentin.gusmai@ird.fr
[2]La TeleScop, Castelnau-le-Lez, France

Mangroves have adapted to challenging environmental conditions and perform unique ecological functions. However, the extent of mangroves continues to decline. Since 2000, there has been an increased awareness of ecosystem services rendered by mangroves, and remote sensing has proven to be essential to monitor and map mangrove ecosystems. While various mangrove distribution products are available, assessment of mangrove extent is not fully consensual, as shown by recent publications. This highlights the importance of precise mapping methods for the evaluation of mangrove surface, structure and dynamics. In this context, we propose a new methodological framework dedicated to the monitoring of mangrove dynamics based on remote sensing. On the pilot site of the Bombetoka bay, Madagascar, this study proposes to build a standardized approach for generic data processing combining: High Resolution Sentinel time series to produce up-to-date distribution maps of mangrove and Very High Resolution Pleiades images for the characterization of mangrove types. The use of Iota2 chain on Sentinel time series allows to map rigorously the mangrove extent of the bay, which is used as a mask to apply the FOTO (FOurier transform Textural Ordination) method of canopy texture analysis to Pleiades images. An unsupervised classification is then applied to extract mangrove classes based on textural information. FOTO indices are compared to variables obtained from remote sensing data (mangrove density, canopy height, water recurrence...) through a statistical analysis in order to assess the existing correlations between each class and these variables. The most relevant ones are used to build the High Resolution mangrove typology of the Bombetoka bay and update the initial land cover map. 3 classes of mangrove types are finally extracted based on texture, the maximum NDVI, mangrove density and water recurrence. This approach was replicated on other sites to test the reproducibility and genericity of the method.

Code: P 5.36. Project "Research on ecosystem services derived from mangrove forests in the Colombian Pacific". Alliance Universidad Nacional de Colombia - Universidad del Valle.

Guzmán, A.I.,[1] Cantera-Kintz, J.,[2] Mancera-Pineda, J.E.,[3] Peña- Salamanca, E.J.,[2] Selvaraj, J.J.,[1] Gavio, B.,[3] López, L.A.,[2] Molina-Sandoval, A.E.,[1] Martínez, A.,[1] Dorado, J.,[3] Gómez, L.F.,[3] Gallego, B.E.,[1] Portilla, C.,[1] Quesada, C.A.,[2] Vásquez, D.,[1] Vidal, L.V.,[1] Lozano, L.,[1] López, C.M.,[3], Chacón, D.F.,[1] Ocampo, M.A.,[2] Sierra, V.A.,[2] Vásquez, D.F.,[2] Padilla, C.D.,[4] Panesso, M.,[1] Martínez, C.A.,[1] González, A.,[1] Vargas, S.,[1] & Guzmán, K.[1]

[1] Universidad Nacional de Colombia - sede Palmira, Facultad de Ingeniería y Administración, Departamento de Ingeniería, Calle 32 # 12-00, Palmira, Valle del Cauca, Colombia.
[2] Universidad del Valle, Facultad de Ciencias Naturales y Exactas, Departamento de Biología, Calle 13 # 100-00, Cali, Valle del Cauca, Colombia.
[3] Universidad Nacional de Colombia- sede Bogotá, Facultad de Ciencias, Departamento de Biología, Av. Carrera 30 # 45-03, Bogotá D. C. Colombia.

The Colombian Pacific contains approximately 80% of the country's mangroves, where reside Afro-Colombians and indigenous communities that belong to the poorest population in the country, deriving part of their livelihood directly from the mangrove (food security and household economy). The degradation of these ecosystems and their ecosystem services makes them more vulnerable. The great structural development of the mangroves gives them a high potential for the implementation of strategies that represent economic incentives for the communities and that partially release the pressure of use on the mangroves. Therefore, the objective of the project is to generate technical information that allows the economic valuation of its ecosystem services, for which six research groups from two public universities carry out various investigations. These include quantification of the structure of the vegetal biomass of the mangroves and evaluation of the organic carbon captured, estimating the current reserves of carbon stored in the biomass and soil. Additionally, the change in mangrove cover in 10 years has been contrasted, using satellite images. On the other hand, the type of soil and human intervention are being analyzed, including contamination due to excess nutrients, macroplastics and microplastics. Finally, the contribution of the mangrove to the fishing resource of surrounding ecosystems is being estimated, characterizing the functional diversity that intervenes in trophic flows, estimating the contribution of functional groups to the subsistence fishing resource of human communities, building a model of the resources in the ecosystem and its interactions using trophic modeling (Ecopath).

Code: P 5.78. Crab burrowing in Colombian Pacific mangroves affects mangrove forest soil organic carbon.

Guzmán, A.I.,[1] Chacón, D.F.,[1] Cantera-Kintz, J.,[2] Vásquez, D.F.,[2] Martínez, A.,[1] Sierra, V.A.[2]

[1] Universidad Nacional de Colombia, sede Palmira, Departamento de Ingeniería, Facultad de Ingeniería y Administración, Grupo de Investigación Recursos Hidrobiológicos, Calle 32 # 12-00, Palmira, Valle del Cauca, Colombia. [2] Universidad del Valle, Departamento de Biología, Facultad de Ciencias Naturales y Exactas, Grupo de Investigación en Ecología de Estuarios y Manglares, Calle 13 No. 100- 00, Ciudad Universitaria Meléndez, Cali, Valle del Cauca, Colombia

Crab bioturbation (Ocypodidae, Panopeidae, Grapsidae) have important ecological effects on the mangrove ecosystem in the Pacific coast of Colombia, functioning as ecological engineers by altering the physical, chemical, and biological state of soils and associated benthic communities. It is assumed that the activity and diversity of bioturbating crabs affects the amount of soil organic carbon. This activity was indirectly measured in two mangroves of three areas (Bahia Malaga, Buenaventura and Tumaco) by the density of individuals in five 2 x 2 m quadrats, in two seasons of the year in riverine, bar and fringe forests. Conductivity and temperature of interstitial water, pH, texture, and soil organic carbon between 0-15, 15-30 and 30-50 cm depth are also measured. The non-metric multivariate analysis shown that lower crab densities and high crab biodiversity were related to higher soil organic carbon. The lowest crab density was found in a riverine forest dominated by *Avicennia germinans* individuals with a high density of pneumatophores. This mangrove is protected by Afro-descendant communities. The other mangrove with low densities of crabs was the sand bar forest influenced by seasonal hydrodynamic changes that affected crab density. In addition, high crab densities were related to lower soil organic carbon content. This relationship was observed in other riverine and fringe forests, where *Rhizophora mangle* and *Pelliciera rhizophorae* dominate, respectively. Crab activity affects the amount of carbon in the mangrove soil, and that the type of mangrove roots and their density, together with hydrodynamic processes modulate the activity of bioturbators.

Code: P 14.8. A high-resolution annual time series database of global mangrove change from 2000 to 2020

Hamilton, S.[1]

[1]Coastal Studies Institute, United States of America

The only high-resolution long-term annual mangrove monitoring global database ended in 2012, leaving a decadal hole in researchers' ability to construct analyses requiring long-term mangrove change forest rates. The global mangrove change database presented is designed to track the yearly rates of global mangrove change at high fidelity in a spatially explicit manner since 2000. This data descriptor provides a detailed accounting of the worldwide mangrove change database to ensure applicable usage by researchers outside the remote sensing community. The database systematically, at the pixel level, synthesizes numerous remotely sensed databases, including Mangrove Forests of the World, Global Mangrove Watch, and High-Resolution Global Maps of 21st-Century Forest Cover Change. The database provides a systematic mangrove change product for use in models and analyses requiring reliable annual mangrove change data at high resolutions. The data can be used at global, continental, national, sub-national, and even highly-localized scales. The data are provided in an open-source GIS format and housed at the Harvard Dataverse.

Code: P 5.35. Changes in Mangrove Cover and Exposure to Coastal Hazards in Kenya

Hamza, A.J.,[1,2] Esteves, L.S.,[2] & Cvitanovic, M.[2]

[1]Kenya Marine and Fisheries Research Institute, P.O Box 81651-80100, Mombasa, Kenya
[2]Department of Life & Environmental Sciences, Faculty of Science and Technology, Bournemouth University, Talbot Campus, Poole, Dorset, BH12 5BB, UK

Mangroves are effective carbon sinks, support coastal fisheries and provide wood and non-wood resources to coastal communities. They are threatened by natural and human-induced stresses including over-exploitation, conversion pressures, pollution and climate change. Understanding changes in this important ecosystem is essential to inform the sustainable management of mangroves and assess the implications related to the loss of ecosystem services. This study used global remote sensing mangrove forest data to quantify changes in mangrove cover in Kenya between 2010 and 2016 and applied the InVEST coastal vulnerability model to assess the implications concerning the provision of natural coastal protection services in Kenya. The results indicate that the annual rates of mangrove cover loss in Kenya were 0.15% between 2010 and 2016. Currently, 16% of the Kenyan coastline is at higher levels of exposure to coastal hazards but this could increase to 41% if coastal ecosystems (mangroves, corals and seagrasses) are lost. The study further identified that higher rates of mangrove loss are observed in areas at higher risk of exposure in the southern and northern counties of Kwale and Lamu, where monitoring and management efforts should be prioritized.

Code: P 15.17. Above- and belowground carbon stocks in Caribbean mangroves of the Magdalena River delta, Colombia

Hapsari, A.,[1] Maanen, B.,[1] Borrero, W.J.,[2] Rodriguez, A., Sibaja, D.,[3] Polania, J., Gomez, L.F., Restrepo, J.C., & Urrego, D.

[1]University of Exeter, United Kingdom [2]Universidad del Norte, Colombia [3]Deakin University, Australia

Mangroves are integral for the global carbon cycle as they can efficiently sequester and store carbon (C). An estimated 5.9 Gt C is stored in mangroves worldwide, almost five times the C stored in tropical terrestrial forests, despite occupying only less than 0.2% of world's land area. Globally, mangroves are disappearing at alarming rate, with the highest proportional loss is endured by mainland Caribbean mangroves. The Magdalena River Delta in Colombia harbors a significant share of Caribbean mangroves. However, they are currently under immense pressures of infrastructure development and urbanization, illegal logging, and expansions of aquaculture and agriculture. Several efforts to protect the remaining and restore the damaged mangroves of the Magdalena River Delta are already being conducted, with some leading to recovery in mangrove cover. Such changes in mangrove extent have led to variation in the balance between C gain and loss. Quantifying the changes in mangrove C balance is crucial to assess their contribution to climate change mitigation, for REDD+ initiative and to meet Paris Agreement goals. For this, detailed inventories of mangrove C stock are needed. Despite numerous mangrove related studies and research concentrated in the Colombian Caribbean, information on ecosystem C stock is limited. To improve our understanding on changes in mangrove C stocks in the Magdalena River Delta, we provide an estimation of C stock in mangroves of the Mallorquin and Cuatro Bocas lagoons. The two sites represent mangroves in different environmental state, with the former being highly degraded and the latter more pristine. This study shows how above- and belowground C stocks of mangroves vary across different environmental settings and environmental degradation degrees in the Magdalena River Delta.

Code: P 9.46. Additional N input may alter the species-specific blue carbon cycling differently in mangroves

He, Z.,[1,2] Zhao, L.,[1,3] Wu, M.,[1,3] Yu, X.,[1,3] Sun, H.,[1,3] Chen, Z.,[4] & Peng, Y.[1,3]

[1] School of Environmental Science and Engineering, Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-sen University, Guangzhou, China. [2] School of Marine Science, Guangdong Provincial Key Laboratory of Marine Resources and Coastal Engineering, Sun Yat-sen University, Guangzhou, China. [3] Guangdong Provincial Key Laboratory of Environmental Pollution Control and Remediation Technology, Sun Yat-sen University, Guangzhou, China. [4] South China Institute of Environmental Sciences, Ministry of Ecology and Environment, Guangzhou, China.

Aquaculture is one of the fastest-growing economic activities in the world that results in a high amount of nitrogen-rich wastewater discharge into mangroves and affects the plant tissue's decomposition. However, a comprehensive analysis of above- and below-ground litter affected by the nitrogen (N) input is rare. This study investigated the responses of above- and below-ground litter decomposition to the different levels of N input in decomposition rates, chemical components, and chemical compounds releasement. Exogenous N input had stimulating, retarding, or even no effect on plants' litter decomposition and nutrient release in mangroves. The above- and belowground litter decompositions had different responses to anthropogenic N addition and varied among different mangrove species. The mechanism of the impacts of anthropogenic nitrogen input varies depending on species identity, litter composition, and additional N level. These results show that N enrichment in mangroves can be beneficial and detrimental to ecosystem function. For the native mangrove species, *Kandelia obovata* and *Avicennia marina*, the belowground tissues that had a direct correlation with carbon accumulation were significantly influenced by the additional N input. The worldwide problem of offshore aquaculture effluent discharge is a potential risk to the ecological function of mangroves in carbon storage.

Code: P 15.43. Functional traits of "true mangroves": a pledge for a global initiative

Helfer, V.,[1] Cheung, C.Y.,[1] & Zimmer, M.[1,2]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany [2] Faculty 2 Biology/Chemistry, University of Bremen, Bremen, Germany

Although there is an increasing interest, across a wide range of taxa, in incorporating functional traits in climate change research, discussion and research about functional traits of "true mangroves" has only recently emerged, while strongly needed to improve our understanding of mangrove species distribution and ecosystem processes. The recently compiled dataset of plant traits of 55 "true mangrove" species notably supported new insights into mangrove productivity and blue carbon storage, suggesting that it is functional distinctiveness rather than diversity that drives those processes. Nonetheless, we are still lacking information on the geospatial distribution of those traits, both within species and across distinct life stages. Such information, in conjunction with a proper description of local biotic and abiotic conditions, would be pivotal to 1) decipher how those traits influence the response of mangroves to changing environmental conditions and 2) investigate how they affect mangrove ecosystem processes, such as organic matter turnover, across space and within stands of various ages. Recent experiments indeed suggest that leaves of distinct growth stages show distinct decay rates, thus impacting carbon storage capacity of the ecosystems. We therefore call for concerted efforts in collecting functional traits of true mangroves, together with essential ocean variables to document local environmental conditions, following standardized protocols that would be deployed in strategic locations around the world. We propose to build a joint initiative to support these efforts that should feed into an open database and result in a wealth of information essential to further our understanding of mangrove ecosystems and their responses to ongoing environmental change. Knowing the importance of "true mangroves" in shaping mangrove ecosystems and supporting ecosystems processes and services, understanding the drivers of species diversity, functional traits and blue carbon in mangrove forests could greatly contribute to better manage those ecosystems and their blue carbon.

Code: P 9.26. Hydric rehabilitation in salt flat areas and its effect on interstitial salinity in Cispata bay´s mangroves, Colombian Caribbean

Herrera-Fajardo, S.,[1] Rojas-Aguirre, S., Sierra-correa, P.C., Gómez-lópez, D.I., Alonso-Carvajal, D.

[1]Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis" – INVEMAR, Santa Marta, Colombia (diana.gomez@invemar.org.co, selene.rojas@invemar.org.co)

Cispata bay made up of several swamps and streams, relics of the old Sinu River delta in the colombian Caribbean, is home to an extensive mangrove area that has deteriorated due to the clogging of natural canals and the interruption of their water flows, which has led to the formation of salt flats. Hydric rehabilitation activities have proven to be an effective technique to mangrove recovery. This study evaluated the changes in interstitial water salinity in mangroves near two Cispata Bay´s salt flats after the maintenance of eight natural canals in September 2021. The assessment was carried out in 8 transects perpendicular to the canals, in three sampling phases: before, during and one year after the intervention in the canals. The salinities of the canals in the salt flats area and those adjacent to them were pooled for statistical analysis. The salinities in the salt flat area did not show significant differences between sampling phases (H: 0.58; p-value: 0.75). When comparing between the canals in the salt flats and the adjacent ones, significant differences were found in the before phase (H: 9.05; p-value: <0.05); while, in the one year later phase, no significant differences were found between the canals (H: 2.98; p-value: 0.08). The rehabilitation actions demonstrated their effectiveness in decreasing salinity from the before phase (35.8 ± 9.6 PSU) to the one year later phase (33.8 ± 8.2 PSU), as well as the decreasing maximum salinity values between the before and after phase (from 54.6 to 48.2 PSU), proving that the hydric rehabilitation activities contributed to improve the natural water flows of the mangroves near the salt flats.

Code: P 14.13. Impact of human interferences on N_2O fluxes from tropical fragmented mangrove ecosystems, India

Hershey, N.R.,[1] & Nandan, S.B.

[1]Dept. of Marine Biology, Microbiology and Biochemistry, School of Marine Sciences, Cochin University of Science and Technology, Cochin 682 016, India.

Even though mangroves are nitrogen-limiting environments they may offer favourable settings for the production of the most potent greenhouse gas N_2O on the readiness of nitrogen substrate. Fragmented mangroves close to large urban centres are prone to nitrogen enrichment. Therefore, there exists an increasing demand to assess the N_2O flux from fragmented mangroves. Here we report the nitrogen dynamics, their source signatures and N_2O water-to-air fluxes from seven selected fragmented tropical mangrove ecosystems found close to a large urban centre along the southwestern coast of India. The study found that total nitrogen and dissolved inorganic nitrogen concentrations varied significantly among different mangrove ecosystems based on the degree of existing anthropogenic pressures. $\delta^{15}N$ signatures revealed the cause for nitrogen enrichment in these mangrove ecosystems to be anthropogenic inputs chiefly due to fertilizer or sewage inputs. Moreover, the estuarine nitrogen inputs were also witnessed. The study established that the fragmented mangroves act as net atmospheric sources of N_2O with fluxes ranging between 1.6 to 93.6 μmol m^{-2} day^{-1}. The study confirms that tropical fragmented mangroves subject to high anthropogenic nitrogen inputs act as an important element of the total N_2O budget.

Code: P 5.33. Adult mangrove roots facilitate juvenile establishment

Hill, J.,[1] & Lovelock, C.E.[1]

[1]School of Biological Sciences, The University of Queensland, St Lucia, Qld, Australia

Mangrove forests provide important ecosystem services, but have been extensively cleared and converted globally. In these degraded ecosystems, restoration projects suffer low success rates due to fundamental knowledge gaps. Among these gaps are tests of the potential facilitative effects of adult mangroves, which are absent at many restoration sites, but which may be important for facilitating establishment of juvenile mangroves. I tested for evidence of facilitation of establishment by adult mangrove roots and surveyed juveniles of two species across three sites on the western coast of Minjerribah (North Stradbroke Island), Australia. At all sites, adult roots did facilitate establishment; juvenile mangroves were densest on the lee side of adult trees, where wave conditions were attenuated by the trunk and roots.
Juvenile densities were also greatest at the sheltered northern site, and declined towards the more exposed southern site. Patterns of establishment were also species-specific, as wind-wave conditions along the coast were variable between seasons and my focal species released their propagules in different seasons. *Avicennia marina* juveniles, where propagules abscise in winter, were densest to the north and northwest of adult trees, matching winter wind patterns; *Rhizophora stylosa* juveniles were densest to the southwest of adult trees, matching wind patterns in their summer propagule abscission season. My results provide evidence for facilitative interactions between adult trees and juvenile mangroves. Developing our understanding of these interactions is critical to understanding potential establishment, recruitment and forest growth on mangrove coastlines.

Code: P 9.62. Can recycled crushed glass be used as a mangrove nursery substrate?

Holevoet, A.,[1] Grimes, K.W.,[2] Krauss, K.,[3] Brandt, M.,[2] & Durdall, A.[2]

[1]Master's of Marine & Environmental Science Program, University of the Virgin Islands, St. Thomas, VI, USA [2]Center for Marine & Environmental Studies, University of the Virgin Islands, St. Thomas, VI, USA [3]U.S. Geological Survey, National Wetlands Research Center, Louisiana

Mangrove restoration nurseries in island communities like the U.S. Virgin Islands (USVI) face unique challenges such as maximizing nursery sustainability while maximizing plant growth. To address these challenges, this study explored the use of crushed glass repurposed from local restaurant waste as a mangrove substrate to offset potting soil costs and reduce our nursery footprint. Propagules were collected from five USVI locations and planted in two substrates (MiracleGrow Potting Soil and recycled crushed glass) with three clumping regimes (one propagule, two propagules, and a propagule and wooden dowel control). Plant survival and growth of *Rhizophora mangle* was measured from seedlings in a nursery setting. Of the 480 propagules planted, six of the eight that died were planted in glass. Plant height and leaf area were measured for six months, after which 120 plants were sacrificed and dried for biomass calculations. A significant relationship was found between soil treatment and site for total plant height, with the biggest plants being those planted in soil from Perseverance Bay, St. Thomas (PR). The success of other sites varied by treatment, but all glass treatments grew less than soil. Clumped propagules exhibited more competition than facilitation in both substrates, and grew shorter than other treatments. Propagules in soil from PR also had the greatest relative (RGR) and absolute (AGR) growth rates over the study period. No significance of site or treatment was found in root to shoot (RSR) data. Our goal was to maximize plant growth and the data showed soil treatments grew taller with greater leaf area. For nurseries prioritizing lower costs, using recycled crushed glass is a viable option. These results highlight efficient and effective restoration techniques with practical applications for restoration teams and local communities in the USVI and beyond.

Code: P 9.27. Comparison of blue carbon techniques for measure in mangrove forests

Hoyos-Ruiz, T.C.,[1] Torres-Duque, J., Bernal, C.A., Sierra-Correa, P.C.

[1]Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis" – INVEMAR, Santa Marta, Colombia

The techniques for measure blue carbon in mangroves may vary according to several factors like the author, the needs of the project, the analytical capacity of the laboratories, or the geographic location, besides it can be modified according to the actual field conditions and/or the type of data to be gathered. Since there are several standard techniques to measure blue carbon in mangroves, this work compares the different protocols, manuals and studies on this subject, in addition to the experience acquired, in order to show the advantages and disadvantages of the field and laboratory techniques and the instruments used for sampling soil and dead biomass pools. We found that there might be some differences in the results of the total carbon in soil, depending on the sampling instrument. For example, in the case of corers, this often compress the sediments, causing changes in the bulk density of the samples and cause biases in the carbon estimation, while augers do not have this downside, but the burial depth will depend on the strength of the person handling it. On the other hand, sampling woody debris (dead biomass) is important after natural catastrophes, since under normal conditions it does not contribute significantly to forest carbon. In addition, the analytical techniques used in the laboratory must be taken into account, since the amount of organic carbon, the time and costs of analysis vary according to the analytical technique used, and thus, together with the quality assurance process, influences the reliability of the information reported.

Code: P 9.96. Trends of carbon accumulation in mangrove sediments in cispata bay as a strategy for blue carbon management

Ibarra-Gutiérrez, K.,[1] Ruíz-Fernández, A.C.,[2] Villamil-Echeverri, C., Espinosa-Díaz, L.F.,[1] & Sierra-Correa, P.C.[1]

[1] Instituto de Investigaciones Marinas y Costeras Jose Benito Vives de Andreis INVEMAR [2] Universidad Nacional Autonoma de Mexico

Mangroves has the capacity to trap organic and inorganic materials suspended in the water column and store them for long periods in their sediments, promoting high rates of sedimentation and accumulation of organic carbon (OC). However, seawater inputs associated with sea level rise (SLR) can affect this capacity. To know the historical accumulation trends of OC in mangrove sediments of the marine protected area “Distrito Regional de Manejo Integrado - DRMI Cispata” (Verra Certified Area), sediment cores were collected up to ~80 cm deep using 10 cm diameter PVC pipes, in two physiographic type of mangrove, border and basin. The cores were cut into 1 cm thick sections. Loss on ignition (LOI_{550}) were determined in each section to estimate the OC content. To establish the OC storage and conservation capacity, the content of each section was related to the accumulation period through ^{210}Pb dating, a technique widely used to reconstruct recent environmental changes (~100 years). In the border mangrove sediments, the LOI_{550} varied between 40 and 80 % in the surface (0 - 40 cm), and between 5 and 40 % in the deeper sections, while in the basin mangrove sediments the LOI_{550} were lower throughout the entire core (5 – 15%). The OC content and ^{210}Pb dating in a core collected in border mangrove sediments, showed trends of increasing upcore in OC contents in younger sediments. These results were used to reconstruct the historical accumulation rates of Carbon in border mangrove sediments of Cispata Bay over a period of ~100 years, and with this, to propose OC accumulation scenarios in the medium term (25 years) as an input for decision-makers to establish management measures for mangrove ecosystems as blue carbon reservoirs and climate change mitigation measures, with the possibility to rise it to other mangroves in the colombian Caribbean.

Code: P 14.7. Visualizing Mangrove Regulating Services in the Form of a Virtual Reality Game

Ikhsan, M.H.,[1,2] Wan, C.T.,[2,3] Chua, S.,[2] Hodgkinson, G.,[1] Horton, B.P.[2,3]

[1] School of Art, Design, and Media, Nanyang Technological University, Singapore [2] Earth Observatory of Singapore, Nanyang Technological University, Singapore [3]Asian School of the Environment, Nanyang Technological University, Singapore

Virtual Reality (VR) has been used to raise awareness of mangroves in recent years, mostly in 360o virtual tours. However, the virtual tour format has the limitation of being unable to visualize the processes or events within the mangrove ecosystem that are considered essential regulating services. An alternative to address this issue is to portray those services in a serious game, as games have been shown to be an effective approach to fostering engagement and promoting awareness about environmental issues among digital natives. This poster will discuss the development of “Bakaus", an educational 3-Dimensional VR game where the player has to protect humans, biodiversity, and the surrounding ecosystems from potential threats in an unhealthy mangrove forest setting. To win, the player must discover clues, solve puzzles, and accomplish tasks to restore the mangrove ecosystem and save vulnerable organisms. This game is designed to depict four different mangrove regulating services: coastal protection, coastal stabilization, climate regulation by carbon sequestration, and bioremediation of pollutants. Game prototyping and user feedback will be conducted to assess the game’s ability to explain the mangrove services. It is hoped that “Bakaus” can contribute to the efforts done by conservationists, scientists, and policymakers to encourage pro-environmental attitudes and behaviors toward mangroves through active game-driven engagement.

Code: P 15.22. Litter Dynamics of Naturally Revegetated Mangrove Forests in Abandoned Aquaculture Ponds in Southern Oriental Mindoro, Philippines

Jacob, P.B., & Salmo, S.G[1]

[1]Institute of Biology, College of Science, University of the Philippines Diliman, 1101 Quezon City, Philippines

Intensive aquaculture in the Philippines destroyed more than 300,000 hectares of mangroves in the 1980s. Mangroves that have been converted to fishponds have now deteriorated and become unproductive and abandoned. Alterations in the stability and sources of organic matter (OM) in these soils usually hinder mangrove regrowth. Despite this, natural recolonization is still possible. Resulting stands can sequester and store carbon stocks but are often understudied. A major autochthonous source of mangrove OM is leaf litter. Evaluating the dynamics of mangrove litter and OM in recolonized forests relative to intact forests is vital in understanding the recovery of forest productivity and the natural restoration process. This study investigated mangrove litter accumulation and leaf litter decay in 13- and 35- year old naturally recolonized abandoned fishponds and compared to an old intact forest in Oriental Mindoro, western Philippines. Results show that the revegetated and intact mangroves differed in terms of litterfall production (by 10-20%) but not in leaf litter decomposition. The rapid rate of leaf litter degradation (-0.51 to -0.56% day^{-1}) in both sites implied that nutrient cycling and energy transfers in younger recolonized fishponds are comparable to older intact forests. This suggests that successful natural recolonization may be more influenced by local hydrodynamics and environmental factors rather than species composition and vegetation structure. These findings provide insights in mangrove rehabilitation which can advise future mangrove forest conservation and restoration strategies.

Code: P 15.66. Ostrom's framework and sustainable management of the Rincón del Mar Mangroves (Sucre, Colombia)

Jiménez, M.I.,[1] & Polanía, J.[2]

[1] Forest engineering student. National University of Colombia. [2] *Dr. Rer. Nat*. Forestry department. National University of Colombia.

The Rincón del Mar (Sucre, Colombia) mangrove forest provides a wide range of ecosystem and economic services to the local community. However, multiple interests and resource use hinder its management and conservation. This study aims to explore the application of Ostrom's framework in this ecosystem and to design an effective management plan for the Rincón del Mar community, composed mainly of families displaced by the armed conflict. The Ostrom framework could strengthen the capacity and resilience of communities affected by the Colombian armed conflict in the reintegration and management of mangrove resources. At the same time, it promotes peace-building and reconciliation at the local level through sustainable and responsible resource management. The research has been divided into three phases: the first phase characterizes the Rincon del Mar community associated with the mangrove based on surveys and interviews; the second phase analyzes the current use and management of the ecosystem to identify strengths and weaknesses; and finally, a third phase compiles the information from the previous ones to design a management plan based on Ostrom's framework. The plan hopes to echo the needs and priorities of the community, and implicate them in decision-making to improve mangrove management and conservation. The scopes include identifying the critical actors in the local mangrove, their role in resource management and the analysis of norms, rules and processes. Finally, it has considered limitations, such as the lack of accurate information or data on current mangrove governance and the type of participation of key stakeholders in the research.

Code: P 9.44. Assessing the utility of crabs and snails as indicators of microplastic pollution in mangrove dominated estuaries: A South African case study

Johnson, J.,[1] Peer, N.,[2] Sershen, & Rajkaran, A.[1]

[1] Department of Biodiversity and Conservation Biology, University of the Western Cape, Robert Sobukwe Way, Bellville, Cape Town, South Africa, 7530. [2] Department of Botany and Zoology, Stellenbosch University, Natural Sciences Building, Merriman Avenue, Stellenbosch Central, Stellenbosch, 7600

Microplastic (MP) pollution is a rapidly growing area of marine pollution research. While the prevalence of MPs has been documented for many habitats, significant knowledge gaps exist for mangrove forests which occur in intertidal wetlands. Biodindicator based approaches can be of value to MP risk mitigation within mangroves. However, the uptake of MPs by ecologically important mangrove species remains largely undescribed, and as such, it is not possible to select suitable bioindicator species. This research is the first to assesses the MP pollution in an urban (Durban Bay) and peri-urban (Mngazana Estuary) mangrove-dominated estuary in South Africa. We quantified MP pollution (typology, abundance, and distribution) in water and sediment in relation to selected disturbances acting on these systems. We reported for the first time, the presence of microplastics in the soft body tissue of ecologically important species *Austruca occidentalis*, *Chiromantes eulimene* and *Cerithidea decollata* in both South African systems. All three invertebrates are considered keystone species and occur in significant abundance within South African mangrove forests. Overall, MP abundance in the sediment-water interface at Durban Bay (disturbed) was significantly higher ($p < 0.05$) than that at Mngazana Estuary (less disturbed). This was mirrored by MP presence in all three species. Microfibres dominated mangrove surface water (69%) and sediment (52%) and similarly were the most abundant MP type found in *C. eulimene* (73%), *A. occidentalis* (72%) and *C. decollata* (57%). Although all three species exhibited MP bioaccumulation, only *C. eulimene* and *C. decollata* exhibited statistical differences ($p < 0.05$) between sites, suggesting their effectiveness as spatial bioindicators of MPs in mangrove forests. The presence of MPs in keystone species could affect their development, reproduction, food intake and the ecosystem services they provide. The identification of appropriate bioindicator species is a step forward in the design of MP environmental monitoring approaches for mangrove ecosystems.

Code: P 9.15. Drivers of mangrove macrofauna and range shifts in South Africa

Katharoyan, C.,[1] Peer, N.,[1] & Rajkaran, A[2]

[1] Stellenbosch University, South Africa [2] University of Western Cape

Global warming has altered ecosystems and their associated biota. In South Africa, mangroves are moving towards a poleward direction, and it is likely that their associated macrofauna are shifting too. The last dedicated study of mangrove invertebrate biodiversity was conducted in 2016. Therefore, it is essential to monitor the changes that have occurred within the last seven years. Mangroves have also been expanding into saltmarsh habitats which can lead macroinvertebrates occupying both habitats. However, the impacts of this is understudied in South Africa. This study aims to (1) investigate changes in mangrove invertebrate biodiversity across the South African east coast since the last dedicated survey in 2016, (2) investigate drivers and potential distributions of three brachyuran species (*Austruca occidentalis*, *Neosarmatium africanum*, *Chiromantes eulimene*), and (3) understand the impact of mangrove-associated fauna encroachment in existing saltmarsh habitats at mangrove southern limits. We selected eight mangrove study sites along the east coast of South Africa, with two of these sites offering a mangrove-saltmarsh gradient. At each site, 50cm x 50cm quadrats will be used to collect invertebrate presence and abundance data along with environmental parameters and physicochemical parameters. In mangrove-saltmarsh habitats, 20 m transects will be used to investigate invertebrate diversity between the two habitats. I will present the results of this study specifically to address whether or not there has been a shift in mangrove-associated invertebrates over time and regarding the potential spread of mangrove-associated invertebrates into saltmarsh habitat.

Code: P 4.10. Mangrove responses following black summer bushfire impact

Kelleway, J.,[1] Green, A.,[1] Quoyle, M.,[1] Woodroffe, C.,[1] & Rogers, K.[1]

[1] School of Earth, Atmospheric and Life Sciences, University of Wollongong, Wollongong, NSW

'Black Summer' fires ravaged the east coast of Australia between July 2019 and March 2020. Coastal wetlands (including mangrove forests, saltmarshes and floodplain wetland ecosystems) that tend to have regular inundation and waterlogged substrates experienced widespread fire impact. Field and remote sensing observations indicate that fire impacts along the Clyde River and Candlagan Creek (southern NSW) were spatially variable, though ecologically devastating in many locations. Observed impacts to the mangrove *Avicennia marina* ranged from partial defoliation to complete incineration of trees. Recovery of this species has varied, with epicormic regrowth generally more common along seaward edges in many locations. The timeframes of epicormic regrowth for *A. marina* also contrasts the rapid response of nearby dry sclerophyll forests, with prospects for long-term survival currently unknown. Regeneration via tidally-dispersed propagules is also spatially variable, and typically concentrated toward the upper elevation ranges inhabited by this species. In contrast, we found no significant difference in aboveground biomass density between of burnt and unburnt coastal saltmarshes dominated by the rushes *Juncus kraussii* and *Machaerina juncea*, within 18 months of fire impact. In some settings, organic-rich substrates may have collapsed due to peat burning or mortality of trees; and these changes to substrate volume can have significant implications for the capacity of coastal wetland vegetation to recover and adapt to other environmental pressures. Given accelerating and compounding impacts of sea-level rise, there is an urgent need to address knowledge gaps and to deliver information required by decision-makers to improve the long-term resilience of coastal wetlands.

Code: P 5.19. Evaluation of seedlings and saplings growth of mangrove species in different sediments

Kitagami, B.E.,[1] Felizardo, K.X.,[1] Da Silva, L.L.,[1] Bueno, P.F.,[1] Flórido, R.,[1], Francisco, T.G.,[1] & Cunha-Lignon, M.[1]

[1]Universidade Estadual Paulista (UNESP), Faculdade de Ciências Agrárias do Vale do Ribeira, Brazil

Mangroves are ecosystems of great importance to the planet, providing numerous ecosystem services, but which have suffered various anthropic and natural pressures. Knowledge about the development of typical mangrove species in different environmental conditions is necessary for better mangrove conservation and restoration practices. The current study aimed to evaluate the growth of propagules, seedlings and saplings of *Rhizophora mangle* (red mangrove), *Avicennia schaueriana* (black mangrove) e *Laguncularia racemosa* (white mangrove) in sediments with different particles sizes. The experiment used a completely randomized design, with three treatments (sand 100%, 100% mud and mixed: 50% sand and 50% mud), with three replications each, totalling nine propagules per species. The samples were kept in a lighting environment at the university laboratory, watered with fresh water and measured weekly for three months (from August to November 2022). Propagules and seedlings of *A. schaueriana* and *R. mangle* had greater development in 100% mud, reaching average growth of 32.5 cm and 28.5 cm, respectively, during the entire study period. Black mangrove seedlings presented better development, during the experiment compared to the other mangrove species. *L. racemosa*, on the other hand, had the greatest development in the mixed substrate, reaching an average growth of 13.8 cm throughout the study, due to its preference for firmer soils rich in organic matter. The mixed sediment indicated good results for all species. All propagules had 100% germination in the three types of sediment. Black and white mangroves have one dead seedling each in sandy sediment. On the other hand, in the 100% sand condition, the three species showed slower growth, as it is a drier soil with lower nutrient content. A better understanding of propagules, seedlings and saplings growth could support more effective proposals for mangrove restoration.

Code: P 4.14. A Bahamian mangrove creek restored: a decade of the Bonefish Pond Mangrove Restoration Project

Knowles, L.,[1] Dahlgren, C.,[2] Burrows, F.,[3] Bullard, J.,[4] & Lundy, A.

[1] Bahamas National Trust
[2] Perry Institute of Marine Sciences, United States of America
[3] The Nature Conservancy, Bahamas
[4] JSS Consulting, Bahamas

Mangroves serve many important ecological functions. Their roots serve as nurseries for juveniles of many economically and ecologically important fish and invertebrate species. They also protect shorelines, sequester Carbon dioxide (CO_2) and serve as rookeries for birds. These mangroves are under threat from natural hazards like hurricanes as well as human impacts resulting from fragmentation, encroachment, and dredging for coastal development. Reduction in mangrove area and increases in mangrove fragmentation impair the ecological functions of mangroves. On New Providence Island, the capital of The Bahamas, approximately 37% of the coastal mangrove creeks have been lost since the 1950s. The Bonefish Pond National Park (BPNP) is one of the few remaining intact mangrove systems in New Providence. But even here, development has altered parts of the mangrove system. In 2013, a team of researchers transplanted over 600 red mangroves *(Rhizophora mangle)* to a selected mangrove rehabilitation site as part of a Global Environment Facility (GEF) Full-size Pilot Project. This pilot project focused on the incorporation of mangrove restoration in conservation planning. Restoration activities consisted of improving the hydrological connectivity of the channel to surrounding waters and transplanting mangroves. Red mangroves were then planted using a variety of transplantation methods and densities and varying sources in 10m long plots along the restored channel. The team monitored the transplants over the past decade measuring survivorship and growth metrics (height, new branches, and new prop roots) to determine the most appropriate methodology of mangrove transplantation for the Bahamian environment. Directly planting propagules to the site had the highest percent of survivorship with greater than 50% surviving.

Code: P 5.38. The Ecological Impacts of Mangrove Patch Size on Fringe Prop Root-Dependent Communities

Knowles, M.A.[1] Grabowski, K.L.[3,2] Altieri, A.[2] Araújo, R.A.[1]

[1] University of Miami, Rosenstiel School of Marine, Atmospheric, and Earth Sciences, Miami, FL [2] University of Florida, Engineering School of Sustainable Infrastructure & Environment, Gainesville, FL [3] McGill University, Quebec Center for Biodiversity Science, Montreal, QB, CAN

The rapid changes in global climate and overexploitation of natural resources are significant factors when considering the persistence and function of mangroves. Mangroves serve as a refuge for a diversity of aquatic, terrestrial, and avian species that generate valuable ecosystem services for human communities that depend on these organisms. Through worsening natural and anthropogenic processes, such as intensified hurricanes and deforestation, widespread loss of mangrove forests results in fragmentation, producing truncated, isolated mangrove patches. Specifically, in Bocas del Toro, Panama, naturally segmented mangrove patches may serve as a proxy to investigate how anthropogenic fragmentation elsewhere may impact ecosystem biodiversity through decreased habitat area. To address this knowledge gap, we collected data on two mangrove fringe-dependent communities to identify significant differences in biodiversity, family evenness, and community structure as a function of different mangrove patch sizes. Specific fish families and epibiont categories displayed significant correlation to increasing mangrove patch perimeters. However, the results did not yield a significant relationship between different mangrove patch sizes and most population metrics of the dependent marine communities. Instead, mangrove patch size had little ecological impact, which expanded the previous hypothesis from patch size having a significant impact to patch assemblage playing a role in the diversity and presence of mangrove-dependent communities. Given that mangrove patches varied in size by several orders of magnitude and had similar fish and epibiont communities, smaller islands may have essential conservation values similar to larger habitat patches and provide redundancy that contributes to overall system equilibrium.

Code: P 5.48. A near-century old baseline unexpectedly suggests limited change in part of Bangka island's mangroves (Indonesia)

Koedam, N.,[1, 2, 3, 7] Gbongboui, W.,[4] Sari, P.,[5] Vancoillie, F.,[5] & Stocken, T.V.[6]

[1]Systems Ecology and Resource Management, Department of Organism Biology, Université libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50, CPi 264/1, B1050 Brussels, Belgium [2] Marine Biology Research group, Universiteit Gent, Krijgslaan 281 – S8, B9000 Gent, Belgium [3] Centre for Environmental Sciences (CMK), Universiteit Hasselt, Agoralaan z/n, B3590 Diepenbeek, Belgium [4]Laboratoire de Biomathématiques et d'Estimations Forestières, Faculty of Agronomic Sciences, University of Abomey-Calavi, 04 BP: 1525 Cotonou, Benin [5] Department of Environment, Remote Sensing, Spatial Analysis lab, Universiteit Gent, Coupure Links 653, B9000 Gent, Belgium [6] Ecology & Biodiversity, Department of Biology, Vrije Universiteit Brussel, Pleinlaan 2, B1050 Brussel, Belgium [7]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), 1196 Gland, Switzerland

Bangka Island (Indonesia) in its equatorial and South-East Asian position has its biogeographically expected share in speciose and typologically diverse mangrove ecosystems. Bangka is also renowned since the 18th century for tin mining, which was expanded in Dutch colonial time. Tin mining here constitutes one of the most important worldwide. Mining and ore processing affected the landscape including the coast, also mangroves, either directly by charcoal requirements or indirectly by mine tailing, adding to the general evolution in mangrove coverage and quality, also in this region, but is different from overexploitation or land use change *per se*. In Dutch colonial time, in Bangka aerial photography was explored early on in surveying vegetation, for exploitation or fundamental understanding. These surveys also covered mangroves. A publication dating from 1934 by the Aviation Division of the Royal Army (captain A. Kint) gives a high-resolution and detailed analysis of part of Bangka's mangroves. This extraordinary and long ranging information constitutes one of the oldest mangrove baselines of such quality. Besides offering an annotated translation of Kint's article (1934) we combine this historical record with remote sensing satellite imagery to assess change in mangrove cover (and composition) in Bangka over 9 decades and comment on the degree and type of change or lack therein. We find that, for the mangrove sites covered by the historical photos, change is quite restricted, certainly in view of the major impacts due to tin exploitation, elsewhere on Bangka. We also comment on the typology of mangroves as described in 1934 and as recognised in a wider survey of Bangka's mangroves. The work is illustrative of the relevance of historical information, often from underexploited colonial archives. At the same time, understanding the historical mangrove data is crucial to understanding the main drivers of change and planning future management strategies.

Code: P 9.31. Mangrove cover mapping for ecosystem monitoring using Sentinel-2 in Google Earth Engine

Kotikot, S.M.[1,2] Spencer, O.,[1,2] & Canty, S.W.J.[2,3]

[1]Department of Geography, The Pennsylvania State University, University Park, PA 16802, USA [2]Smithsonian Environmental Research Center, 647 Contees Wharf Rd, Edgewater, MD 21037, USA [3]Working Land and Seascapes, Smithsonian Institution, Washington, DC 20013, USA

Mangrove ecosystems are among the most productive ecosystems worldwide. They provide numerous ecological and socio-economic co-benefits. Though highly adapted to fluctuating environmental conditions, increasing disturbances from human activities and climate change have in the recent years caused increasing losses. Monitoring is necessary to capture changes in mangrove cover and conditions, and potentially understand causes of mangrove decline and therefore inform better management. Accurate up-to-date data on mangrove cover and condition at national to regional scales is lacking. Managers and policy makers need such data in a format that is easily accessible. We present accurate up-to-date maps for Puerto Rico, U.S. Virgin Islands, and the British Virgin Islands for the years 2020, 2021, and 2022, to support mangrove monitoring. The mapping approach builds upon that of Cissel et al 2020 with additional modifications to improve delineation of mangrove areas. The random forest machine learning technique was used to classify 10m spatial resolution Sentine-2 multispectral imagery to create the maps. Classification accuracies greater than 85% were obtained for all the maps. Because of the high spatial resolution of the data used, our approach was able to capture small patches of fringe mangroves that have never been mapped before. Areas of mangrove cover reduction exhibited defoliation possibly resulting from dieback. We host and present the maps in an easy-to-use tool for managers that allows for evaluation of change over time, and production of subsequent maps by non-professionals.

Code: P 9.42. Estimating carbon capture in coastal wetlands restoration with a process-based model

Kwan, V.[1]

[1]University of Queensland, Australia

Coastal wetlands restoration projects are considered nature-based solutions as they enhance carbon capture. To assess the feasibility of restoration projects for carbon capture, future projections of carbon stored in restored wetlands are vital, but there are few restoration-specific models that can be used to project future carbon capture under different sea level rise scenarios and with varying vegetation communities. In this study, we applied a process-based model (WARMER-Mangrove), parameterised with data from restoration chronosequences (above and belowground productivity), to assess the possible outcomes for restoration of mangroves, saltmarshes and supratidal swamp forests. We compared the model outputs with data from a blue carbon pilot project site at the Sunshine Coast, Queensland, Australia. The model predicted changes in surface elevation and vegetation species composition - and by extension carbon sequestration - across different sea level rise scenarios. Model outputs were generally similar to measured values of carbon capture, suggesting the WARMER-Mangrove model, or other similar models, can be used to project carbon capture with restoration of coastal wetlands.

Code: P 4.6. Identifying suitable sites for mangrove restoration using the low-cost, self-assembled, and open-source 'Mini Buoy' hydrology sensor

Ladd, C.,[1] Vovides, A.,[1] Wimmler, M.,[2] Nguyen, T.,[3] Le, H., Banerjee, S., Ghosh,T., Balke, T.

[1]University of Glasgow, United Kingdom
[2]TU Dresden, United Kingdom
[3] An Giang University, Vietnam

Despite decades of research citing inappropriate hydrological regimes as a leading cause for long-term mangrove restoration planting failure, monitoring of potential restoration sites is still rarely done by practitioners. Here we show how the 'Mini Buoy', a low-cost sensor with associated open-source App, can be used to assess the suitability of areas for mangrove restoration or planting, potentially increasing the probability of success. The Mini Buoy contains an acceleration data logger to monitor inundation duration and frequency, current velocity, and wave orbital velocity at 1-minute resolution for up to six months. The material to assemble and operate Mini Buoys is globally available, and a handbook and online App allow users to easily assemble and analyse data themselves. Drawing on data from mangroves across Asia (Indonesia, Vietnam, and India) and from analogue saltmarshes in Scotland, we demonstrate how Mini Buoys were used to identify tipping points between lateral expansion and erosion of intertidal wetlands. Comparing hydrology at a site earmarked for restoration against reference conditions where mangroves are expanding can identify whether restoration planting is likely to succeed. Our ambition is to build a network of Mini Buoy users around the globe, to better understand the conditions necessary for long-term restoration success.

Code: P 9.29. The Ramsar Site 1602 Tuxpan Mangroves and Wetlands as a biodiversity refuge.

Lara-Domínguez, A.L.,[1] Villanueva, A.I.,[1] Hernández-Sánchez, M.,[1] Rivera-Rodríguez, M.,[1] González-González, Y.,[1] & López-Portillo, J.[1]

[1] Red de Ecología Funcional, Instituto de Ecología, A.C., México

The Ramsar site, "Tuxpan Mangroves and Wetlands," is under high pressure since it is adjacent to growing port facilities and industrial development. As part of the environmental studies to protect the wetlands in the area of influence of Tuxpan Port Terminal and International Fluids Terminal, we are assessing the biodiversity of plants and animals to document any impact of the construction and operation of the projects in the conservation areas. The study area is relatively small (ten ha), dominated by *Laguncularia racemosa* with some *Avicennia germinans* stands and few *Rhizophora mangle* individuals. Also, there is three ha of a *Typha domingensis - Eleocharis mutata* community containing 26 species, two exotic and two protected by law. We registered 103 bird species, one-third of them winter migrants. There were more resident species in spring, when more food was available, especially for insectivorous and frugivorous species. We found five medium-sized mammal species, one rodent species, six bat species in the Vespertilionidae, and four in the Molossidae. Concerning reptiles, there were five threatened species, four of them subject to special protection and two exotic. Four species of amphibians are indicators of suitable environmental conditions, and three are under special protection. We registered seven genera of crustaceans belonging to five families and nine species: the Ocypodidae concentrated most of the species within the *Minuca* genus, followed by the Sersamidae with two genera. We also identified eleven terrestrial families in the Coleoptera and 13 species of aquatic insects in the Coleoptera and Diptera. Lepidoptera was the most diverse group, with 46 diurnal and 107 nocturnal species. Our results indicate that, although it is adjacent to the port and industrial facilities, this relatively small sector is highly diverse and well-preserved compared to other sites due to its connection to the Jacome mangrove forest and adjacent wetlands.

Code: P 15.32. Studying the carbon uptake capacity of mangroves and promising mangrove trees as a response to climate change

Lee, B[1] & Baral, H.[2]

[1] Warm-Temperate and Subtropical Forest Research Center, National Institute of Forest Science, Jeju, Republic of Korea [2] Climate Change, Energy and Low Carbon Development, Center for International Forestry Research, Bogor, Indonesia

The research team was first tasked with finding a solution to the need for more creative ways to contribute to natural carbon capture and storage solutions to meet South Korea's national climate-change objective of reaching net zero by 2050. It was through this, and the unique properties of Korea's southern islands, that true mangroves and mangrove associates (semi-mangroves) were suggested as possible candidates that could promise high carbon absorption rates and adaptability to continue to provide ecosystem services under climate change. Some pre-existing native habitats of semi-mangrove species (e.g. *Hibiscus hamabo, Paliurus ramosissimus*) on Jeju Island had already demonstrated comparatively higher carbon absorption abilities than other broadleaf species as measured by photosynthesis rates and soil carbon storage performance. This study's sole objective is to evaluate candidate mangrove species for their suitability for responsibly planned propagation in South Korea. This includes also evaluating their carbon uptake capabilities in order to forecast projections on the carbon storage and absorption performance of selected species. This study is an opportunity to contribute knowledge towards global emission reduction and climate-change mitigation objectives, especially, given the high concentration of highly vulnerable or at-risk populations in the Asia-Pacific.

Code: P 9.72. Can the Ecological Redline Policy meet the demand of management on blue carbon sequestration in mangrove? A case study in Guangdong, Southern China

Liang, J.,[1,2] Hu, B.,[1,2] Zhao, L.,[1,2] Zhuang, X.,[1,2] He, Z.,[3] & Peng, Y.[1,2*]

[1] School of Environmental Science and Engineering, Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-sen University, Guangzhou, China. [2] Guangdong Provincial Key Laboratory of Environmental Pollution Control and Remediation Technology, Sun Yat-sen University, Guangzhou, China. [3] School of Marine Science, Guangdong Provincial Key Laboratory of Marine Resources and Coastal Engineering, Sun Yat-sen University, Guangzhou, China.

Mangrove ecosystems are famed for their significant ecological functionalities in moderating the global carbon cycling process. The Chinese government implemented the Ecological Redline Policy (ERP) at a nationwide scale in 2017 to protect multiple ecological functions of ecosystem. However, multi-temporal, high-resolution spatial studies were still absent in evaluating the effectiveness of ERP in mangrove protection, incurring latent incommensurate planning on the sustainable management of mangroves. Hence, the current study identified mangroves in Guangdong Province that is featured with the most extensive mangrove distribution in China in 2013, 2017, and 2021, using Landsat-8 OLI images (30 m). The floral components, population density, and biomass of typical mangrove communities were also obtained by field survey. Subsequently, the current storage of blue carbon in mangroves were assessed based on an InVEST Carbon Storage and Sequestration model, followed by the estimation of the future capacity of blue carbon storage and sequestration under different scenarios of mangrove management. The result indicated that the mangrove area increased totally by 1934.83 ha, and approximately 76% of mangroves had currently been enrolled in the ERP zoning plan. Compared to the non-Redline zone, the increment of mangrove under ERP was higher but the growth rate was less conversely as 653.71 ha and 13.6% in the non-Redline zone, and 1216.18 ha and 8.0% in ERP, respectively. We also found 87.2% of carbon storage in mangroves was managed with ERP zone whose biomass and carbon per unit was at least twice as those of non Redline zone. It is suggested the prevailing planning of ERP in China could substantially enhance the function of blue carbon sequestration in the mangrove. However, the current ERP did not fully meet the strategic needs, and optimized planning to reduce tradeoffs between environmental quality and development is needed.

Code: P 9.98. Consequences of the accumulation of natural and anthropogenic impacts on mangrove forests

Lima, N.G.B.,[1] Cunha-Lignon, M.,[2] & Galvani, E.[3]

[1]Instituto de Pesquisas Ambientais, Brazil; nadiag@sp.gov.br [2]Universidade Estadual Paulista, Brazil
[3]Universidade de São Paulo, Brazil

Losses of mangroves can be attributed to multiple stressors on different scales, from localized threats of resource exploitation to global threats of climate change. In many cases, the impact can be enhanced when considering the sum of these phenomena. Our study aims to discuss the consequences of the accumulation of natural and anthropogenic impacts on mangrove forests. We exemplify this context by analyzing a mangrove area submitted to human changes from the opening of the artificial canal in 1852 until today, aligned with impacts caused by the intense climatic event on the southeastern coast of Brazil. The link between the Ribeira River and the coastal system through the artificial canal has led to major environmental changes. The mangrove structure forests were analyzed using a permanent plot. Microclimate was carried out, since 2008, with two meteorological stations. Their variations were interpreted as an indicator of changes in the structure, on edge and inside the mangrove, with greater input of solar radiation into the forest over the years. The intense occurrence of Acrosticum aureum and aquatic macrophytes characterizes the environmental alteration in this area. Despite this, in 2015, the basal area dominance of live trunks of mangrove species was 93%. In 2019 the forest was hit by an intense weather event, which caused defoliation and marks on the trunks of the trees. After this event, more than 94% of the mangrove species died. Although the entire forest was affected, some stretches have presented difficulty in recovery, reflecting the permanence of environmental conditions arising from the opening of the artificial canal. In this way, governments need to implement legal frameworks that reduce the vulnerability of mangroves, considering essential for climate adaptation and mitigation. In view of the cumulative impact climate change and anthropic action become fundamental given the importance of mangrove ecosystem services.

Code: P 9.79. Greenhouse gas emissions from subtropical and tropical mangroves during the tidal cycles

Lin, C.W.,[1] Lin, W.J.,[2] Kao, Y.C.,[2] Yong, Z.J.,[2] Ho, C.W.,[2] & Lin, H.J.[2]

[1]Department of Marine Environment and Engineering, National Sun Yat-sen University, Taiwan [2]Department of Life Sciences, National Chung Hsing University, Taiwan

Blue carbon ecosystems, including mangroves, salt marshes, and seagrass meadows, are important transition areas connecting land, freshwater, and the ocean, providing and supporting many ecosystem services. In addition, blue carbon ecosystems have high productivity since a great amount of litter and roots accumulate and bury in the soil, forming a considerable carbon stock. However, reduction reactions by microbial metabolism in soils can be sources of greenhouse gas (GHG) emissions in mangrove systems. In this study, we reported CH_4 and CO_2 emissions during the tidal cycles in *Kandelia Obovata* and *Avicennia marina* mangroves distributed along the western coast of Taiwan. The research objectives are to (1) quantify the patterns of CH_4 and CO_2 emissions during the tidal cycles; (2) evaluate the relationships between the GHG emissions and water levels. The results indicated that the variations in CH_4 and CO_2 emissions from mangrove ecosystems were high during the observed tidal cycles The CH_4 and CO_2 emissions were generally greater in *A. marina* than in *K. obovata* mangroves during the tidal cycles. The CH_4 fluxes ranged between -1.25 ~ 96.24 μmol CH_4 $m^{-2}h^{-1}$and 2.86 ~ 2662.00 μmol-CH_4 $m^{-2}h^{-1}$from the *K. obovata* and *A. marina* mangroves soils, respectively. The Spearman's rank correlation demonstrated that the relationships between CH_4 emissions and the water level were significantly positive in *K. obovata* mangroves. However, the pattern was the opposite in *A. marina* mangroves. The CO_2 fluxes and the water level were negative relationships in both mangrove ecosystems. Since the variation of GHG emissions was large, to precisely quantify the annual GHG emissions from mangroves, it is suggested that high-frequency and long term monitoring for GHG emissions is required during the entire tidal periods in mangrove habitats.

Code: P 9.78. Mangrove carbon budgets suggest the estimation of net production and carbon burial by quantifying litterfall

Lin, W.J.,[1] Lin, C.W.,[2] Hsueh, M.L.,[3] & Lin, H.J.[1]

[1]Department of Life Sciences, National Chung Hsing University, Taiwan [2]Department of Marine Environment and Engineering, National Sun Yat-sen University, Taiwan [3]Endemic Species Research Institute, Taiwan

Carbon burial in the soil is a major process enabling mangroves to function as carbon sinks. Only autochthonous carbon sources currently meet the additionality constraint in most carbon accounting protocols. However, the amount of mangrove carbon burial derived from its own production is uncertain. In addition, mangrove production is often laboriously estimated by monitoring the stem height and diameter of mangrove stems. In this study, ten carbon budgets covering a variety of habitat features were constructed for the two dominant mangrove species (*Kandelia obovata* and *Avicennia marina*) with distinct root structures in subtropical and tropical Taiwan from 2011 to 2019. The carbon budgets suggest that the litterfall: net production ratio was 20.1%±4.7% for *K. obovata* and 48.2%±5.3% for *A. marina*. The mangrove-derived carbon burial rate was 0.25~1.55 Mg C ha^{-1} yr^{-1} for *K. obovata* mangroves and 0.36~1.00 Mg C ha^{-1} yr^{-1} for *A. marina* mangroves. Combined with other studies using the same species, there were positive and linear correlations between the carbon burial rate and litterfall production rate for the two mangroves. The carbon burial rate for *K. obovata* and *A. marina* can be estimated using 14.8%±7.5% and 10.9%±4.4% of the litterfall production rate, respectively. The results of dbRDA with DistLM models showed that wind speed and precipitation were the main factors affecting carbon burial in *K. obovata* and *A. marina* mangroves, respectively. The carbon budgets suggest that litterfall production can be efficiently used to estimate the net production and soil carbon burial of *K. obovata* and *A. marina*.

Code: P 15.59. Experiential learning: Environmental education experiences for mangrove conservation in Galapagos

Loayza, F.,[1]

[1]Social Communication and a Master by Research in Visual Anthropology.

Galapagos is globally recognized as a natural laboratory that offers countless research opportunities. Moreover, it has become the perfect setting for experiential and placed-based learning opportunities, as it allows for direct exploration of species, ecosystems, biological processes, and socio-ecological interactions. Various institutions and organizations involved in environmental education programs and projects in the islands have sought to adapt teaching methodologies, transforming the natural environment into a "classroom". Considering the fundamental importance of mangroves in the ecological processes of Galapagos, as well as the benefits they provide to other species and the community, several experiential education and citizen science activities have been designed for different local groups.
Children, adolescents, youth, and adults have participated in field activities that enable a direct approach to the mangrove ecosystems existing in the archipelago. Through games, pre-existing knowledge, participatory dynamics, and exploration through the senses, participants had the opportunity to actively and creatively construct their learning *in situ*. They discover, deepen, or expand their understanding of the characteristics of the four mangrove species in Galapagos, their ecological and socio-ecological roles, ecosystem services, intrinsic value, symbiotic relationships, and threats.
Spaces for citizen science have also been created, where young people from the community have had the opportunity to participate in research processes and the production of scientific knowledge through data collection and recording. The opportunities for field-based and direct learning in the environment facilitate a friendlier assimilation of valuable information about key species like mangroves, enabling reconnection, reflection, and environmental awareness for the conservation of these species.

Code: P 5.71. Mangrove sediments support a diverse and abundant microphytobenthos

Loo, Y.P.,[1,2] Lai, D.Y.F.,[2] & Lee, S.Y.[1,3]

[1]Simon F.S. Li Marine Science Laboratory, School of Life Sciences, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR, China. Email: yanpingloo@cuhk.edu.hk
[2]Department of Geography and Resource Management, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR, China
[3]Australian Rivers Institute, Griffith University, Australia

The microphytobenthos (MPB) are known to play important ecological roles in estuarine ecosystems. While tidal flat MPB are widely studied, mangrove MPB are often overlooked due to the common belief that the light-limited environment under the mangrove canopy is not conducive to MPB growth. We evaluated the biomass, diversity, and distribution of MPB in the sediment of mangroves and tidal flats of two sites in Hong Kong. MPB biomass (using chlorophyll *a* as the proxy) was equal in both habitats in summer, and higher in mangroves than on tidal flats in winter. There was no difference in MPB genus richness between the two habitats, but it was generally higher in winter than in summer. MPB genus composition was different across all habitats, sites, and seasons. Porewater salinity, temperature, and pH, as well as irradiance level and surface soil temperature accounted for 23.5% of this variation (adjusted R^2 value). MPB in all sampling locations were dominated by pennate diatoms, while cyanobacteria were common in the estuarine (as opposed to oceanic) site. This study also assessed the productivity of mangrove MPB with respect to that of tidal flat MPB, using rapid light curves generated with pulse-amplitude modulated (PAM) fluorometry. The distinct light responses of mangrove and tidal flat MPB reflect their natural light-acclimation profiles. There are several deviations from other studies, however, that our rapid light curves exhibited: a) no plateau and strong photo-downregulation; b) the same α for MPB from both habitats, suggesting equal photosynthetic efficiency at limiting irradiances; and c) low magnitudes of several light response parameters (E_m, E_k, $rETR_{max}$). This study offers insights into the community ecology and productivity of mangrove MPB, and how they compare with tidal flat MPB, with implications for the significance of MPB in mangrove ecosystem processes.

Code: P 5.55. ABC stories from south American mangroves: Biomass/Abundance comparison of macro-invertebrates from Colombian mangroves in the Pacific and Caribbean coasts suggest moderate disturbance.

López, L.A.,[1] Sierra-Luna, V.A., Vásquez, D.,[1] Ocampo-Rojas, A.A[1]. & Cantera-Kintz, J.R.

[1]Universidad del Valle, Colombia

Mangroves are currently facing an “increasing stressors” scenario which threatens their persistence, an alarming situation given the multiple ecosystem services that mangroves provide to humanity. Effectively assessing the disturbance of mangroves is a crucial for monitoring and developing strategies to conserve this ecosystem. Biomass-abundance comparisons (ABC-curves) have proven useful in evaluating ecosystem disturbance, particularly when applied to marine organisms. In the last 30 years, ABC-curves have identified intermediate to high levels of disturbance in mangroves worldwide. However, despite harboring large mangrove extensions, there are few studies of American coasts. Colombian mangroves are an interesting case study, with mangroves on the Caribbean and Pacific coasts, the former being more degraded. The disturbance of Colombian mangroves was assessed through ABC curves of macro-invertebrates. Seven mangrove localities, two in the Caribbean (San Andres Island: Cove and Old Point) and five in the Pacific (Bahía Buenaventura: San Pedro and Punta Soldado; Bahía Málaga: La Plata; Tumaco: Rompido and Boca Grande), were sampled from Ago-Nov 2022. A total of 66 taxa were included in the ABC analysis. Molluscs and crustaceans were the most abundant groups in both coasts. Mangroves on Colombian coasts exhibited moderate disturbance, with W-statistics of -0.1899 to 0.2058. Interestingly, the biomass curves were above the abundance curves for all Pacific localities, while the inverse was observed in the Caribbean localities, suggesting that these Caribbean mangroves are more disturbed than the Pacific ones. Given the current stressors and climate change forecasts, strategies should be developed to mitigate the impacts on Colombian mangroves.

Code: P 9.73. Trends in sediment surface elevation of tropical mangroves vary among geomorphic settings

Lovelock, C.E.,[1] Carr, J.,[2] Friess, D.,[3] Guntenspergen, G.,[2] Krauss, K.W.,[2] Marchand, C.,[4] Pearse, A.,[1] & Swales, A.[5]

[1]School of Biological Sciences, The University of Queensland, St Lucia, QLD, Australia [2]United States Geological Survey, USA [3]Earth and Environmental Sciences, Tulane University, New Orleans, USA [4]University of New Caledonia, New Caledonia, France [5]National Institute of Water and Atmospheric Science, Hamilton, New Zealand

Mangroves of the Pacific Ocean occur over a range of geomorphic settings with differing sediment availability and conditions for tree growth which are proposed to influence surface elevation dynamics of mangroves and therefore their capacity to maintain elevation with sea level rise. A network of surface elevation table instruments deployed in different geomorphic settings enable evaluation of processes contributing to the maintenance of surface elevation in mangroves. In the main channel of the Daintree River (16.17°S), periodic river flooding enhanced surface elevation in riverine mangroves due to delivery of large volumes of sediment. However, interannual variation in surface elevation was high and levels of shallow subsidence limited surface elevation trends to 0.6 mm/year in upriver locations to 2.4 mm/year in downriver locations closer the river mouth. In the tide dominated South Arm of the Daintree River, interannual trends in elevation were less variable and there were lower levels of subsidence. In this tide dominated setting trends in surface elevation varied between -0.2 mm/year in upriver locations to 5.6 mm/year in downriver locations. In the atoll of Ouvea, New Caledonia (20.65°S) where mangroves occur in a large lagoon, trends in mangrove surface elevation varied between -13.9 mm/year and 12.9 mm/year (mean -1.35 mm/year), but most sites tended to be neutral or negative, reflecting low sediment supply. At some sites in Ouvea highly organic sediments occur. In these sites surface elevation gains of up to 1.6 mm/year were correlated with tree growth rates, suggesting mangrove production underpins surface elevation gains at these sites. Our observations among geomorphic settings were consistent with the hypothesis that sediment availability has a key role in maintaining surface elevation in mangroves, but also demonstrates high levels of spatial variation in trends in surface elevation that are caused by interacting physical and biological processes.

Code: P 15.57. Organic carbon in mangrove roots in two Colombian Pacific forests with biophysical differences

Lopez-Sanchez, M.,[1] Mancera, E.,[1] & Gomez, L.[1]

[1]Universidad Nacional de Colombia, Facultad de Ciencias, Departamento de Biología, Sede Bogotá
Grupo de investigación de Modelación de Ecosistemas Costeros

Mangrove forests play an important role in sequestering organic carbon; they have the capacity to store it both in the soil and in the roots. to aim establish the relationship between root organic carbon (%OC) and soil carbon (SC), sediment samples were collected using a 50 cm x 10 cm corer in two contrasting forests in the Colombian Pacific, one within a bay and another riverine. Differentiating between the edge and the interior of the mangrove. In both forests, the dominant species was *Rhizophora mangle* (>90%); the roots were separated by diameter into fine, small, thick and very thick. They were dried at 70°C/48h and incinerated at 420°C/2h. Evidencing differences between forests, in the bay forest, fine roots predominated, dry weight $\bar{x}$ =133 g/m2 (>85% of the total sample), rhizoidal biomass $\bar{x}$=306.20 g/m2, being higher on the exposed edge to the waves. the SC presented differences between the internal part (297.40 Mg C/Ha) and the exposed part (1365.21 Mg C/Ha), the roots presented a similar %OC in both zones, with 23.37% and 23.44% respectively; On the other hand, the riparian forest had a predominance of thick roots with a dry weight $\bar{x}$=5.45 g/m2 (>60% of the total sample), without differences in root biomass between the two zones, and similar values of SC and %OC in roots of the internal part, 1113.28 Mg C/Ha - 34%OC and edge, 1135.27 Mg C/Ha - 43.39%OC. In both forests, both SC and the %OC had a direct correlation with the two zones (Pearson's coefficient r=0.34 P<0.05). The results can be explained by the biophysical characteristics of each forest, having small trees with a high density in the bay forest, against large trees with a larger basal area in the riverside forest, but a low number of individuals and the degree of exposure to waves of each area of the forest.

Code: P 15.56. Estimating Living Biomass and Carbon Storage in Mangrove Forests through Remote Sensing and Machine Learning: A Case Study in Tumaco-Nariño

Lozano-Arias, L.,[1] Gallego, B.E.,[1] & Selvaraj, J.J.[1]

[1]Universidad Nacional de Colombia

Mangrove ecosystems are crucial in combating climate change as they absorb and store up to five times more carbon than any other forest type. To address this, it is essential to determine the amount of carbon stored in these forests, which can aid decision-makers in formulating action plans to mitigate climate change. Remote sensing is an effective and cost-efficient method for estimating and monitoring carbon storage with high precision and coverage. This study proposes a model for estimating the carbon stored in the living biomass of the Tumaco-Nariño mangrove forest using high-resolution Worldview 2 and 3 images and non-parametric algorithms such as Random Forest for mapping mangrove areas and Support Vector Machine for estimating living biomass. A preliminary classification was carried out with the random forest algorithm presented a RMSE = 0.1755, Overall accuracy= 86.8864% and Kappa's index = 0.8127. This hybrid approach had good precision and facilitated the estimation of mangroves coverage. It is expected that the model for the estimation of living biomass and carbon storage will continue presenting good results due to the combination of good algorithms with current field data and high spatial and spectral resolution images. Finally, it is innovative work because the Nariño mangroves are the least investigated in the country and there are not many studies that use high-resolution images and machine learning algorithms to estimate biomass and carbon store in this area.

Code: P 9.75. Forest Structure and Site-specific Allometric Models of the Dominant Mangrove Species in Letkhokkon Area, Myanmar

Lwin, K.M.,[1,2,3] Chan, N.,[4] & Hien, C.T.T.[3]

[1]Technical Assistant at Worldview International Foundation, No.70, Yaw Min Gyi Street, Dagon Township, Yangon 11191, Myanmar [2]Faculty of Forest and Environment, Eberswalde University for Sustainable Development, Schicklerstraße 5, 16225 Eberswalde, Germany [3]Faculty of Silviculture, Vietnam National University of Forestry, Street 21, Xuan Mai Town, Chuong My District, Hanoi 100000, Vietnam [4]National Institute for Environmental Studies, Tsukuba, 305-8506 Japan

Though mangroves are known to provide many ecosystem services, the fundamental ecological information on the biomass of mangrove forests is still underexplored, probably due to the peculiar tree form of mangroves and the difficulties to conduct field survey. Besides, site- and species-specific allometries are critical to estimate the biomass of the trees/stands, especially in mangrove which is comprised of several tree forms. Therefore, we conducted this study in Letkhokkon (16° 20.286'N and 96° 10.199'E), Kungyangon Township, Yangon, Myanmar to assess the mangrove forest structure and to establish the species-specific allometries for the estimation of mangrove biomass. Three mangrove species (*Avicennia officinalis*, *Sonneratia apetala* and *Sonneratia caseolaris*) were found, and the first two species are dominant in the site. We measured the parameters (Diameter at Breast Height-DBH, Height-H, aboveground biomass-W), and harvested fifteen sample trees of two dominant species for further analysis. Using the wood samples, the specific wood density (ρ) is measured. Using those parameters, we established the allometries of aboveground biomass ($W = \alpha x^b$) for two dominant species. Of these, we selected the best-fit allometries by model selection parameters such as R^2, MSE, AIC, and p-value. Also, we compared these best-fit models with the previously reported allometries. Our study found that volumetric parameter (DBH^2H) gives the best result for both dominant species [$W_{Top} = 0.018\ (DBH^2H)^{1.131}$ ($R^2 = 0.97$, MSE = 5.744, AIC = 30.222, $p < 0.05$) for *A. officinalis*, and $W_{Top} = 0.023\ (DBH^2H)^{1.008}$ ($R^2 = 0.99$, MSE = 9.182, AIC = 37.259, $p < 0.05$) for *S. apetala*]. Also, our equations provided the general trend when compared with other equations reported for Asia, Americas, China and Myanmar. In conclusion, our study established the first site- and species-specific equations to estimate mangrove biomass in Myanmar, and also contribute to the underexplored information on mangrove biomass.

Code: P 14.10. Environmental Communication Through Visual Imagery: Using Wahoo Bay, a GrayGreen Installation in Pompano Beach, Florida, as an Educational Tool

Lynch, S.J.,[1] Araújo, R.J., Rhode-Barbarigos, L., Evans, R.

[1]Rosenstiel School of Marine, Atmospheric, and Earth Science, Department of Environmental Science and Policy, UNIVERSITY OF MIAMI

SEAHIVE™ is an engineered marine and estuarine protection system under development at the University of Miami (UM). The system is a pilot installation in Pompano Beach, Florida, Hillsboro Inlet Park, where Wahoo Bay, an educational marine park, has been envisioned to provide an immersive experience for park visitors, especially young children. The purpose of the park is to raise awareness of the importance of keeping our oceans and reefs healthy and thriving in an entertaining, educational, and memorable way. The internship centered around creating effective educational displays for the public at the Wahoo Bay SEAHIVE installation. Information is mainly on mangroves, marine communities, and how SEAHIVE is representative of sea-level rise and climate change mitigation efforts. Research on public perception, public engagement, and citizen science was conducted to learn how to effectively engage and inform the park audiences. Research includes various delivery methods of conveying information in parks, recreational facilities, and public spaces, both physically and conceptually. Case studies on how similar projects were conducted and exhibits, such as the mangrove exhibit at the Frost Museum of Science, provide technical and literary aspects. Information about Wahoo Bay, mangrove habitats, and marine communities comply with the Americans with Disabilities Act (ADA) and are accessible for people with multiple educational backgrounds. Other duties included visiting the MANG mangrove nursery site, speaking with park and city officials, and obtaining park details to assess the installation of plaques or other display methods. The final project includes sketches, scientific illustrations, written reports, and a general plan to best implement educational outreach. This consists of a park display design proposal and revision suggestions for the Wahoo Bay website. All information will be submitted to the City of Pompano Beach.

Code: P 5.75. Evaluate the Good Ecological Status of mangroves thanks to a Rapid Assessment Method

Macera, L.,[1] & Pioch, S.[2]

[1]Université Côte d'Azur, France
[2]Université Paul Valéry, France

Mangroves are complex socio-ecosystems with a wide range of ecosystem services of great importance to humans, especially in a climate change attenuation context. At the same time, there are very few scientific productions permitting the quantification of the good ecological status (GES) of this ecosystem. However, assess the ecological status of an ecosystem allows, among other things, to draw up an initial status of the environment before restoration actions or, within an environmental impact statement process, propose a compensatory offset. Thus, it could allow to value the performance of a restoration project in order to invest for projects with better ecological costs/benefits ratio. In our presentation, we will propose a method for assessing the GES of mangrove ecosystems and the anthropic pressures on them, through a series of social and ecological indicators. The process to be developed is based on the rapid assessment method (RAM), permitting to qualify within an effective related short time, for minimal cost and with accessible technical skills in order to make it reproducible and feasible in the field. We've worked on a list of indicators drawn up through a literature review, coupled with recognised mangrove experts interviews and ground truth during fieldwork in West Africa mangrove forests, located in the Saloum delta (Senegal). The test of the method was carried out in November 2022 to criticize and optimise our indicators throughout a performance evaluation grid. We have come up with a list of 13 indicators of the good socio-ecological status of mangroves with an adapted protocol for each. The "Mangrove's RAM method" could, in the long term, greatly improve mangrove management by offering, for the first time, a turnkey tool with an adapted field protocol dedicated to the constraints of these precious ecosystems.

Code: P 9.97. Massive mangrove dieback in Maputo River Estuary, Southern Mozambique

Machava-António, V. C. E.,[1,2,3] Mabilana, H.,[1] Macamo, C.,[1] Fernando, A.,[1] Massingue, M.,[1] Bandeira, S.,[1] & Paula, J.[2]

[1] Department of Biological Sciences, Eduardo Mondlane University, P.O. Box 257, Maputo 1100, Mozambique
[2] United States Forest Service, International Programs, 1 Thomas Circle NW, Suite 400, Washington, DC 20005, USA [3] Mare – Marine and Environmental Research Centre, Faculty of Sciences, University of Lisbon, Campo Grande, 1749-016 Lisbon, Portugal

Mangrove forests are resilient to multiple environmental changes and human impacts, and despite knowing the natural condition for mangrove colonization and development, it has been difficult to identify causes of rapid massive dieback of mangrove trees. This study aims to determine the causes and extension of mangrove dieback in Maputo River Estuary in 2019 and its impact. To estimate the change, remote sensing images were assessed, transformed into a Normalized Difference Vegetation Index (NDVI), and a field survey was conducted to validate the mangrove imagery data. In both natural and impacted areas 233 plots of 100 m^2 each were established in 50 m distant transects perpendicular to the coastal line, to determine the species identity, height, diameter at the breast height (DBH), number of live and dead trees, density of stumps, and seedling density per species. In 2019 the mangrove cover was 1377.39 Ha and decreased to 716.17 Ha in 2020, representing a loss of 48.01% (661.22 Ha). The proportion of live and dead trees was 1 to 1, in some areas, 38.71% of trees/ha were completely dead. Five mangrove species were identified, *Avicenna marina* (with highest Importance Value Index), *B. gymnorhiza, C. tagal, R. mucronata* and *X. granatum.* None of the sampling areas have a regeneration ratio that approaches the minimum ecological ratio of 6:3:1. Local communities conducted mangrove replantation, but most of the seedlings die before reaching 40 cm of height. Extreme whether events are becoming more frequent in different parts of the world, and this study documents the first evidence of massive mangrove dieback and continuing degraded conditions 2 years after caused by extreme weather impacts on mangrove forests in Mozambique. These results contribute to understand natural mangrove dieback, the adoption of adequate mangrove recovery actions, climate change adaptation actions and monitoring of mangrove forests in Mozambique.

Code: P 9.34. Araneofauna diversity in ecuador´s mangroves

Macías-Tulcán, M.,[1] Galvis, W.,[2] Molina-Moreira, N.[3]

[1,3]Universidad de Especialidades Espíritu Santo-Ecuador.
[2] Laboratorio de Aracnología & Miriapodología (LAM-UN), Instituto de Ciencias Naturales, Universidad Nacional de Colombia, sede Bogotá, Colombia.

En Ecuador la pérdida de manglares es alrededor de 56000 hectáreas (27%) de su superficie, principalmente por camaroneras y asentamientos humanos. El deterioro del manglar afecta a los usuarios ancestrales que dependen de sus recursos y causa la pérdida de su biodiversidad. Este estudio es la primera investigación de arañas del manglar en Ecuador y es prioritario debido a la megadiversidad de este grupo, con más de 50000 especies descritas hasta la fecha (Catalogo mundial de arañas). En Ecuador su conocimiento aun es insuficiente. Debido a que las arañas son organismos bioindicadores de la salud de los ecosistemas, porque cumplen importantes funciones como controlar diferentes insectos plagas, conocer la araneofauna de los manglares es una herramienta útil para evaluar la salud y la eficiencia de estrategias de restauración del manglar. Se hizo una primera exploración para determinar la diversidad de la araneofauna asociada al manglar. Se seleccionaron nueve sitios) de muestreo a lo largo de la costa ecuatoriana (5 continentales y 4 islas. Se utilizó la metodología de agitación de follaje en transectos de 1000 metros sobre el agua, durante una hora y coleta manual en cuadrantes de $250m^2$.Se mantuvo la colección húmeda en alcohol al 70% para su análisis. Se colectaron 1898 individuos, distribuidos en 12 familias; 30 géneros confirmados, ocho especies confirmadas y 82 morfoespecies. En las islas se encontró mayor diversidad de morfoespecies que en los sitios de manglares continentales. Una de las limitaciones es la dificultad de identificar a nivel de especies, debido a la falta de especialistas. La taxonomía permitirá conocer nuevas especies para la ciencia, reportar nuevos registros para el país, conocer la estructura y composición de la comunidad de las arañas es fundamental para su uso como organismos bioindicadores de la salud del manglar.

Code: P 9.47. Exploring the Vulnerability of Coastal Wetlands to Nutrient Pollution at the Marsh-Mangrove Ecotone

Mack, M.,[1] Chapman, S.,[1] Langley, A.[1]

[1]Villanova University, United States of America

Positioned on the coastal interface, wetlands are continuously impacted by global change drivers from both terrestrial and marine sources. Anthropogenic inputs of nitrogen (N) have increased due to agricultural, aquacultural, and urban runoff. Coastal wetlands in northern Florida, USA are not only experiencing increased N inputs, but also mangrove encroachment due to warming global temperatures. In a shifting ecotone at the Guana-Tolomato National Estuarine Research Reserve (GTMNERR), the mangrove, *Avicennia germinans,* growing along the creek edge are altering the geomorphology of this wetland. However, it is unknown how added N will impact these mangroves or their ability to keep pace with sea level rise. We fertilized half of ten creek-edge and ten interior plots with urea at a loading rate of 93.2 g N $m^{-2}yr^{-1}$in a marsh mangrove ecotone. We investigated the impact of increased N on *A. germinans'* growth, nutrient allocation, and decomposition across differing positions relative to a creek. We found that initial N fertilization only stimulated the growth of creek-edge canopy volume by 64.6%. However, six months after fertilization, interior *A. germinans* grew 17.2% taller while creek-edge mangroves only grew 1.3% taller, suggesting a temporal delay of added N for interior mangroves. However, this stimulation was only aboveground as we found no stimulation of root growth in response to N in either creek-edge or interior plots. Further, N did not alter decomposition rates in either the interior or creek-edge plots. Our findings suggest that aboveground productivity of *A. germinans* is more sensitive to N addition, with creek-edge mangroves responding more quickly than interior mangroves. By understanding how creek-edge and interior mangroves respond to added N both above and belowground, we will be able to predict the impact of N and the potential eutrophication tipping points of these coastal wetlands.

Code: P 4.1. The role of oceanic currents in the dispersal and connectivity of the mangrove Rhizophora mangle on the Southwest Atlantic region

Madeira, A.G.,[1] Tsuda, Y.,[2] Nagano, Y.,[3] Iwasaki, T., Zucchi, M.I., Kajita, T., & Mori, G.M.

[1]UNESP, Brazil
[2]Tsukuba University, Japan
[3]Saga University, Japan

Dispersal is a crucial mechanism to living beings, allowing them to reach new resources such that populations and species can explore new environments, and therefore is of great interest in population ecology studies. However, directly observing the dispersal mechanisms of widespread species can be costly or even impracticable, which is the case for mangrove trees. The influence of oceanic currents on the mangroves' propagules' movement has been increasingly evident; however, few studies mechanistically relate the patterns of population distribution with the dispersal by oceanic currents under an integrated framework. Here, we evaluate the role of oceanic currents on dispersal and connectivity of Rhizophora mangle along the Southwest Atlantic basin. Samples were collected from eleven sites along the Brazilian coast, from subtropical to equatorial sites. We inferred population genetic structure and migration rates based on single nucleotide polymorphisms, simulated the displacement of propagules along the region with both a probabilistic and a mechanistic approach, and tested our hypotheses with Mantel tests, spatial eigenvector analysis and redundancy analysis. We observed a two populations structure, north and south, which is a pattern observed in the region by other studies with Rhizophora, with other mangroves and with other coastal plants. The inferred recent migration rates do not indicate recent gene flow between the sampled sites. Conversely, long-term migration rates were low across groups and with contrasting dispersal patterns within each one, which is consistent with long-distance dispersal events. Our hypothesis tests suggests that both isolation by distance and isolation by oceanography (derived from the oceanic currents) can explain the neutral genetic variation of R. mangle in the region. Our findings expand current knowledge of mangrove connectivity and highlight how the association of molecular methods with oceanographic simulations improve the interpretation power of the dispersal process, which has ecological and evolutionary implications.

Code: P 5.98. Challenges of the Colombian Network of Estuaries and Mangroves for the implementation of the recent law (2243) aimed at protecting mangroves country-wide.

Mancera-Pineda, J.E.,[1] Peña-Salamanca, E.J.,[2] Blanco-Libreros, J.F.,[3] Castellanos-Galindo, G.,[4] Sierra, P.C., Palacios-Peñaranda, M.L.,[6] Cantera-Kintz, J.R.,[2] Medina-Calderón, J.H.,[1] Perdomo-Trujillo, L.V.,[1] Duque, F.,[5] Sánchez- Núñez, D.A., Guzmán, A., Santos-Martínez, A., Gavio, B.,[1] Leal, J., Riascos, J.,[3] & Rodríguez, A.

[1] Universidad Nacional de Colombia [2] Universidad del Valle, Colombia [3] Universidad de Antioquia, Colombia [4] Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Germany [5] Universidad de Cundinamarca, Colombia [6] Universidad Autónoma de Occidente

Colombia is home to a great diversity of mangrove forests along the Caribbean and Pacific coasts and oceanic islands, with an approximate area of 2,891 km2. It is among the top 20 countries with mangroves and the fifth in the Americas. Before 1990, research on mangroves in Colombia was scarce, carried out independently by researchers from different institutions and with little impact on the orientation of management policies at the national and departmental levels. The Colombian Network of Estuaries and Mangroves (RCEM) was created in 1995 as a joint academic effort to promote the study, scientific research, conservation, and management of mangroves through the exchange of knowledge and dialogue between researchers and other stakeholders of the socio-ecosystem. During the first years of consolidation, the network started the “Semanglares” Seminar Cycle as a strategic academic space. Around 85 research papers have been presented at these events and national and international alliances have been strengthened. The RCEM represents a national platform to develop scientific and technical capacities around knowledge for the environmental management of mangroves. As a result of the coordinated work of the RCEM with other national institutions, the national government approved Law 2243 of July 8, 2022. This Law, which aims to protect and restore mangrove ecosystems in Colombia, orders the design and implementation of a national plan of mangrove research. However, there are many challenges to taking rapid action for science-based transformative management. This study analyzes the main challenges to improve assertive communication between communities, academic institutions, and the political and economic sectors. Mechanisms to promote inter-institutional cooperation in the face of competition are also discussed. The involvement of academia as well as other underrepresented sectors in the design of policies for the protection of mangroves is a key factor in Colombia and in other countries where mangroves play an important role for society.

Code: P 9.64. The socio-economic role of mangroves and their conservation framework in the Western Indian Ocean region

Mangora, M.M.,[1] Macamo, C.,[2] Manzi, H.K.,[3] Rabemananjara, Z.H.,[4] Bandeira, S., Japhet, E., Kamnde, E.K., Kirui, V.C., Medard, M., Ndagala, J., Nyaega, L., Okalo, F.A., Rakotosoa A.L., Ralison, H.O., Ramahaleo, T., Ramos, I., Randriamanantena, D., Navale, A.A., Ratsimbazafy, R., Ravelona, M., Razafindratsimba, S., Sberna, T., & Puk, L.

[1]University of Dar es Salaam, Tanzania [2]University of Eduardo Mondlane, Mozambique [3]Geospatial Research International, Kenya [4]University of Antananarivo, Madagascar

In the Western Indian Ocean (WIO) region, around 60 million people live within 100 km of the coastline, many depending on mangroves for their livelihoods. Mangroves cover approximately 1 million hectares of area in the WIO, of which 99% is found within only four countries: Kenya, Madagascar, Mozambique and Tanzania. While awareness of the ecological and socio-economic importance of mangroves has increased, they continue to be threatened by human activities including overexploitation of the wood resources, conversion to other land uses and inadequacies in their governance. We conducted a review of literature, field surveys and policy analysis to understand the use values of mangroves, threats driving mangrove forest decline and conservation landscape. The key socio-economic benefits to local communities were the extraction of firewood and/or charcoal, fishing and ecotourism. The economic value of coastal protection, flood control, and carbon storage consistently contributed a considerable amount towards the overall socio-economic value of the mangrove ecosystems, albeit varying among countries. We confirmed that the main threat to mangrove ecosystems is the exploitation of wood extraction, most commonly including wood fuel and poles, conversion to support urban expansion and coastal development, solar salt making, aquaculture and agriculture. Natural pressures, such as cyclones, extreme winds or floods, have also heavily impacted mangrove ecosystems specially in Mozambique and Madagascar. There is a breadth of important legislations, showing that there are restrictions in the use of mangrove ecosystems. However, the coordination among conservation actors, the harmonization with other sectors and enforcement are inadequate. Inclusion of non-government key stakeholders, such as local communities, NGOs and private industry interests, are important but overlooked. We discuss the role of restoration, management frameworks, business models, and the opportunity to include private sector investments into mangrove conservation. We provide recommendations to enhance mangrove ecosystem conservation in the region.

Code: P 5.43. Combining approaches for modelling trophic pathways supporting a species of fishery importance in a tropical mangrove

Medina-Contreras, D.,[1,2] Guevara-Torres, C.,[2] Estrada-Padilla, J.,[3] Zetina-Rejón, M.,[1] Sánchez-González, A.,[1] & Cantera-Kintz, J.[2]

[1]Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, Av. Instituto Politécnico Nacional S/N Col. Playa Palo de Santa Rita, La Paz, B.C.S Código Postal 23096, México

[2]Departamento de Biología, Facultad de Ciencias Naturales y Exactas, Grupo de Investigación en Ecología de Estuarios y Manglares, Universidad del Valle, Calle 13 No. 100-00, Ciudad Universitaria Meléndez, Valle del Cauca, Cali, Colombia

[3]Departamento para el Desarrollo Sustentable de Zonas Costeras, Universidad de Guadalajara, Gómez Farías No. 82. San Patricio Melaque, Jalisco. Código Postal 48980. México.

Ecological modeling using stable isotopes combined with network analysis provides a holistic view of how different trophic pathways support the productivity of fishery species. A combination of these methods were used to analyze the food web of the yellow snapper *Lutjanus argentiventris* in a near pristine mangrove system of the central Colombian Pacific. We analyzed 75 juvenile snapper specimens of three size classes, small (4 to <10 cm), medium (10-20 cm), and subadults (>20 cm) presenting $\delta^{13}C$ and $\delta^{15}N$ values between -25.8 to - 21.4‰ and 9.3 to 11.2‰ respectively; and 226 prey specimens with $\delta^{13}C$ and $\delta^{15}N$ values between -27.5 to - 19.1‰ and 2.1 to 10.0‰ respectively. Carbon values of smaller-size juveniles were ^{13}C depleted compared to fish of other classes indicating the assimilation of different food sources, and also confirmed with Simmr yielding a greater probability contribution from benthic fish. Also, for all specimens the highest probability contribution originating from benthic fish ($\bar{x}$=28%), detritivore shrimps ($\bar{x}$=25%) and subtidal fish ($\bar{x}$=12%). Trophic position (TP) was between 3.6 and 4.1, placing *L. argentiventris* as a top predator in the mangrove along the three size classes. Network analysis indicated that the food web involving *L. argentiventris* consists of 16 trophogroups and 72 connections tending towards homogeneity. Modularity analysis indicated the presence of four trophic communities along this food web. This work provides evidence of a highly complex mangrove food web by obtaining a network of four communities despite only modeling a single top predator species.

Code: P 15.40. High-resolution mapping of forest characteristics in Eastern Pacific mangroves using consumer-grade drones

Mejía-Rentería, J.C.,[1] Schürholz, D.,[2] Blanco-Libreros, J.F.,[3] Cantera-Kintz, J.R.,[1] Chennu, A.,[2] Osorio, J.D.,[4] Osorio, A.,[4] Casella, E.,[5] & Castellanos-Galindo, G.A.[6,7,8]

1. Universidad del Valle, Colombia, Cali, Colombia 2. Leibniz Centre for Tropical Marine Research, Bremen, Germany 3. Universidad de Antioquia, Colombia, Medellín, Colombia 4. Universidad Nacional del Colombia, Medellín, Colombia 5. University Ca' Foscari, Venice, Italy 6. Smithsonian Tropical Research Institute, Balboa, Panama 7. Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany 8. Freie Universität Berlin, Berlin, Germany

Traditional satellite-based remote sensing products provide useful information about coastal ecosystems for management and conservation, including mangroves. However, their spatial and temporal resolution, particularly in high-cloud cover locations, can preclude their use when fine-grained information is needed in small mangrove forest patches. Unoccupied aerial vehicles (UAVs) can map at the centimeter scale different attributes of mangroves allowing a better understanding of the spatial and temporal dynamics of these forests. Here, using Structure-from-Motion (SfM) photogrammetry and image segmentation techniques (convolutional neural networks for instance and semantic segmentation), we present a workflow to describe mangrove forests dominated by the Neotropical endemic mangrove species *Pelliciera rhizophorae*. With ~1500 RGB photographs taken by commercial consumer drones, the complete mangrove area (~100 ha) was mapped within a MPA (Utría National Park) in the northern Colombian Pacific coast. We constructed orthomosaics and digital elevation models at < 10 cm/pixel resolution. The image segmentation process allowed to: (1) differentiate between different types of vegetation, mudflat, and water, (2) generate digital terrain and canopy height models, and (3) identify *P. rhizophorae* trees and estimate individual height. Tree height was validated with an existing ground forest inventory. The workflow provided here has the potential to provide powerful Tier 3 estimates of mangrove carbon stocks at the site level (< 200 ha) and can be used to cost-effectively monitor mangrove cover and forest structure in small areas.

Code: P 9.58. Towards sustainable mangrove management using Ostrom's framework

Melo-Flórez, L.G.,[1,2] Hugé, J.,[1,2,4] Polanía, J.,[5] Blanco-Libreros, J.F.,[6,8] José M. Riascos, J.M.,[7,8] Dahdouh-Guebas, F.[1,2,3]

[1]Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles, Belgium. [2]Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel, Belgium. [3]Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, 1050, Brussels, Belgium. [4]Department of Environmental Sciences, Open University of the Netherlands. [5]Research Group in Ecology and Wildlife Conservation Department of Forestry, Faculty of Agricultural Science Universidad Nacional de Colombia Sede Medellín. [6]Instituto de Biología, Facultad de Ciencias Exactas y Naturales Universidad de Antioquia, Colombia. [7]Interdisciplinary research group on coastal marine systems Marine Science Campus, Turbo. Universidad de Antioquia, Colombia. [8]Corporation Center of Excellence in Marine Science-CEMarin, Bogotá, Colombia

Mangrove forests are social-ecological systems (SESs) that provide a wide range of socio-economic benefits to many communities in tropical and subtropical countries. Linkages between ecological and social properties of mangroves can be examined through the operation of analytical frameworks as the one proposed by Elinor Ostrom in 2009. This framework consists of a set of variables representing attributes underlying collective action, supporting in this way that collaborative management is an approach that can live up to the needs of local populations and tackle broader conservation goals. This research presents a qualitative and quantitative analysis on sixty-one co-managed mangrove sites in different countries using Ostrom's SES framework. Secondary data was obtained from literature review to identify key attributes that describe co-management in mangroves. Based on the analysis, fifteen out of the 53 second-level variables proposed by Ostrom were identified as key variables for conducting sustainable mangrove management. Moreover, we identified and proposed third-level variables to this framework that are purely specific to mangroves. As a result of these new third-level variables, nineteen variables were relevant for sustainability in the co-managed mangrove sites. In order to make our findings applicable to local contexts for mangrove management, and trying to show how these variables can be used, we tested the key second and third-level variables in the mangrove SES of Ciénaga de la Virgen in Colombia. This is a multi-use mangrove forest area located in a peri-urban context of a metropolitan area with particular socio-ecological settings and significant environmental degradation. Structured questionnaires were conducted with stakeholders in this site to assess their perception based on the key variables identified in this study. This allowed us to gather information about the current mangrove management in the site. In addition, we proposed co-management recommendations based on this information.

Code: P 9.5. Microplastic Accumulation in Southeast Asian Mangroves

Michie, L.A.,[1, 2] Wood, L.E.,[1] Cordova, M.,[3] Hoa, P.T.,[4] Neo, M.L.,[5] Onda, D.F.,[6] & Cragg, S.[1]

[1] Institute of Marine Sciences, University of Portsmouth, Portsmouth, Hampshire PO4 9LY, United Kingdom [2] Mangrove Action Project, 1455 NW Leary Way, Suite 400, Seattle, WA 98107, USA [3] Research Centre for Oceanography, Indonesian Institute of Sciences (LIPI), Jalan Pasir Putih 1, Ancol Timur, Jakarta 14430, Indonesia [4] School of Biotechnology, International University, Vietnam National University, Ho Chi Hinh City, Viet Nam [5] St. John's Island National Marine Laboratory, Tropical Marine Science Institute, National University of Singapore, 18 Kent Ridge Road, Singapore 119227, Singapore [6] University of the Philippines Diliman Marine Science Institute, P. Velasquez St., Diliman, Quezon City, Philippines 1101

Southeast Asia is considered to have some of the highest levels of marine plastic pollution in the world. It is vitally important to increase our understanding of the impacts and risks of plastic pollution to marine ecosystems and the essential services they provide, and to support the development of mitigation measures in the region. Coastal ecosystems are particularly at risk, especially those located in proximity to river mouths where plastic waste is discharged into the ocean. This study aimed to investigate the accumulation of microplastics in mangrove sediments from across Southeast Asia, namely Singapore, Indonesia, Vietnam and the Philippines. The mangrove sites selected in these countries are all situated near to large cities in Singapore, Jakarta, Ho Chi Minh and Manila that are major sources of marine plastic pollution. Microplastic load was quantified to establish baseline information on the occurrence of plastic debris. Plastic polymer types were identified, and annual proportions have been estimated based on historical data. Microplastics were extracted from mangrove sediments via a floatation method using zinc chloride, followed by digestion using Fenton's reagent, and then counted and categorized according to particle shape and size. Initial findings reveal plastic at all sites, with sizes ranging from 0.01 to 5 mm, suggesting that long-term monitoring of marine debris along coastlines is necessary to help improve national policies and measures related to marine plastic debris.

Code: P 5.62. Application of GIS-based landscape metrics for monitoring mangrove restoration and natural regeneration: A local scale approach

Millán, S.,[1 &] Rodríguez-Rodríguez, A.[1]

[1] Institute of Marine and Coastal Research. "José Benito vives de Andréis" INVEMAR. Colombia

Because of their role in counteract erosion, restoring and connecting mangrove patches over the coastline is a priority. Monitoring implemented actions is critical to adaptative management. We developed a methodology based on the application of landscape metrics using the ArcGIS software to identify changes in landscape structure at the Toribio River mouth (Magdalena, Colombian Caribbean) as a consequence of mangrove restoration actions performed between 2021 and 2022. In 2020, a cartographic layer of coverage (1:1000) was built up and replicated in 2021 and 2022. The cartographic edition was based on on the interpretation of aerial photo mosaics taken by a drone at 50 m, with an RGB camera, using control points taken with differential GPS. As a result, a highly dynamic landscape was identified by the variation of coastal vegetation cover, the decrease of beach strips and the appearance of coastal lagoons. Despite this dynamism, structural connectivity based on mangrove cover increased, mainly due to the merging of nearby patches, the reduction of clearings within the forest due to restoration actions and the canopy expansion due to tree growth. It was evidenced in 4 metrics: (1) Core area, by increasing 4.2 %; (2) Percent connectivity by increasing 3.2 %; (3) Landscape proportion with an increase of 2.7 %; and (4) Largest patch by increasing 1.1 %. Some metrics were unclear, such as "Patch Shape", which presented a tendency towards irregularity, indicating a greater possibility of fragmentation and the "Number of patches metric" because occurrence and loss remained in the same proportion. Here we demonstrate that monitoring mangroves using GIS-based landscape metrics allows the follow-up of restoration actions and could help reorient them by recognizing particular hotspots to strengthen connectivity and reduce the risk of forest fragmentation. This study was developed under the VIVO TORIBIO project as part of a cooperation agreement between PRODECO and INVEMAR.

Code: P 5.72. Crab species-specific excavation and architecture of burrows in restored mangrove habitat

Min, W.W.,[1] & Kandasamy, K.

[1]Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai: 608 502, India.

Burrowing crabs are considered to be the ecosystem engineers, playing a vital role in mangrove ecosystems through bio-geochemical transformation. The present work was undertaken to deal with species-specific burrow excavation and architecture so as to identify the most influential functional species in a restored mangrove habitat vegetation artificially raised along the northern banks of Vellar estuary in southeast coast of India (Lat. 11^0.29'N and Long. 79^0.46'E). Sampling was made for three intertidal zones namely, *Rhizophora*, *Avicennia*, and open zone for three seasons: monsoon (Nov. 2019), post-monsoon (Feb., 2020) and summer (June 2020). Crab burrow casts were made using plaster of Paris in randomly selected burrows of a quadrat of 1 sq. m laid for each of three intertidal zones. The complexity of burrow architecture was calculated as the ratio between TBL and TBD. The data was subjected to statistical analysis using SPSS.17 for testing the significance between crab species for crab size or burrow architectures. Fourteen crab species were found to construct the burrows of 13 different shapes with predominance of 'I','J','L'. Sesarmids were found to construct burrows mostly in *Rhizophora* zone with larger in size and wider opening, simple burrows at horizontal position, digging shorter and shallower burrows while fiddlers in *Avicennia* or open zones constructed complex burrows at vertical position, making longer and deeper burrows in contrast to sesarmids. The sesarmids had smaller burrows without branching in mangrove zones, whereas the fiddlers had larger burrows with or without branching in open and *Avicennia* zones. The fiddler crabs especially *Austruca occidentalis* and *A.annulipes* had separate openings and passage for exit and entry as an adaptation against predators. The present work identified *Austruca occidentalis* and *A. annulipes* as the most potent bio-turbating crab species for restored mangrove habitats due to their efficiency in soil excavation and to form large-sized burrows.

Code: P 5.68. A cooperative ecological and social survey in Inhambane Bay, Mozambique: bio -indicators, livelihoods, and conservation

Miranda, N.A.F.,[1,2,3] Come, J.,[4] Peer, N.,[2] Nhamussua, J.L.,[5] Macamo, C.CF.,[6] Denise Nicolau, D.,[7] Cabral, A.S.,[8] Madivadua, H.,[8] Zacarias, D.,[9] Narciso, J.,[10] & Snow, B.[11]

[1]Argonaut Science Pty Ltd, Cape Town, South Africa, [2]Department of Botany and Zoology, Stellenbosch University, Stellenbosch, South Africa, [3]Department of Zoology, Nelson Mandela University, Gqeberha, South Africa, [4]Department of Development Studies, Nelson Mandela University, Port Elizabeth, South Africa, [5]Conselho Comunitário de Pesca, Inhambane, Mozambique, [6]Department of Biological Sciences, Eduardo Mondlane University, Maputo, Mozambique, [7]BIOFUND – The Foundation for Biodiversity Conservation, Maputo, Mozambique, [8]Ocean Revolution Moçambique, Inhambane, Mozambique, [9]Escola Superior de Hotelaria e Turismo de Inhambane, Eduardo Mondlane University, Inhambane, Mozambique, [10]Instituto Oceanográfico de Moçambique, Inhambane, Mozambique, [11]One Ocean Hub, University of Strathclyde, Glasgow, Scotland

Mangrove ecosystems are impacted by anthropogenic pressures and climate change but there is limited research on their conservation and management, particularly including indigenous knowledge in its conceptualization, practical execution, and interpretation. Mozambican mangroves in Inhambane have a wide range of uses and there is a drive led by local communities to protect and restore key sites. There is a need to identify bio-indicator species and understand local perceptions of mangroves. Social and ecological approaches were integrated to describe mangrove ecosystems in Inhambane Bay. Biodiversity surveys, semi-structured interviews and participant observations were conducted in six locations. Locations were selected in zones that represent a gradient of anthropogenic pressures (low to high), according to expert judgement. At each location, three 5 × 5m quadrats were randomly demarcated within seaward mangrove tree strands. Within these quadrats, three 0.5 × 0.5m sub quadrats were randomly outlined to estimate average crab and snail density. *Avicennia marina* trees were found at all locations. In low anthropogenic pressure zones, *Ceriops tagal* and *Rhizophora mucronata* were found in muddy substrates, overall macrofauna assemblages were dominated by *Austruca occidentalis* fiddler crabs and species richness was higher. Zones influenced by high anthropogenic pressure tended to be sandy with low tree diversity, while *Terebralia palustris* mangrove whelks and *Dotilla fenestrata* sand-bubbler crabs were very abundant. Perceived mangrove benefits include provisioning, supporting and regulating services. Community initiatives include the enforcement of environmental laws, prohibition to cut mangrove trees, and replanting. Developing supportive scientific knowledge and tools together with local custodians can improve community involvement in conservation practices, and enable efficient data collection to continuously inform those practices. Community initiatives for enforcement of laws and mangrove rehabilitation, play significant ongoing roles in raising awareness and active mangrove protection.

Code: P 9.22. Importance of mangrove for fish communities in a highly impacted tropical estuary

Molina, A.,[1] Duque, G.,[2] Gamboa, E.,[3] & Cogua, P.[4]

[1] Grupo de Investigación en Ecología y Contaminación Acuática. Universidad Nacional de Colombia, Sede Palmira. Facultad de Ingeniería y Administración. [2] Universidad Nacional de Colombia, sede Palmira. Facultad de Ingeniería y Administración. [3] Grupo de Investigación en Ecología y Contaminación Acuática. Universidad Nacional de Colombia, Sede Palmira. Facultad de Ciencias Agropecuarias. [4] Universidad Santiago de Cali, Facultad de Ciencias.

The Buenaventura Bay (Eastern Tropical Pacific) is the main port of Colombia, so historically it has been highly impacted and currently some port expansion proposals would be developed over extensive mangrove areas. The aim of this research was to determine the importance of the mangrove for the fish communities of the Buenaventura Bay. For this, artisanal trawling was used (April, June, September and November 2015), in two areas with high mangrove influence and two with little influence. In total 4674 individuals were collected, belonging to 69 species of 29 families, with an average absolute density of 0.112 ± 0.015 individuals $m^{-2}$and absolute average biomass of 3,168 ± 0.397 g m^{-2}, the most abundant species was *Sphoeroides trichocephalus* (35% of the total density) and the highest biomass was *Urotrygon rogersi* (23% of the total biomass). The area with high mangrove influence showed greater richness, density and biomass (18.08±4.53 species, 0.20±0.09 individuals m^{-2}y 5.08±2.38 g m^{-2}, respectively) than the area with little mangrove influence (12.08±4.08 species, 0.07±0.03 individuals m^{-2}y 1.92±1.07 g m^{-2}, respectively). The importance of the mangrove for representative species (high density and frequency of occurrence) was also identified. *S. trichocephalus*, *Haemulopsis nitidus* and *U. rogersi*, showed preference for the mangrove area throughout the year and *Ophioscion typicus*, during the high rainy season. The results of this research demonstrate the importance of the mangrove for the fish community of Buenaventura Bay and the need to protect it, since its loss can have strong effects on the ecosystem.

Code: P 9.32. First record of insects in mangroves of gender rhizophora in ecuadorian cost

Molina-Moreira, N.,[1] Arias, M.,[1,2] Medranda, P.,[1] Espin, N.,[1,] Mendoza, R.,[1.]

[1]Universidad Espíritu Santo-Ecuador. km 2.5 vía Samborondón, Guayas, Ecuador. [2]Sociedad Entomológica Ecuatoriana.

Ecuador's mangroves face problems of human settlement, cattle ranching, agriculture, and aquaculture, causing irreversible changes that have favored the presence of insect pests. They are located in estuaries of the Mataje-Santiago-Cayapas, Muisne, Cojimíes rivers in the province of Esmeraldas, Chone in Manabí, Gulf of the Guayas River in the province of Guayas, and Jubones Santa Rosa-Arenillas, in El Oro. The study was conducted during the rainy and dry seasons of 2019 at eight sites: Majagual, Isla Corazón, Isla Santay, Churute, Nuevo Porvenir, Isla Puná, Isla Bellavista and Puerto Pitahaya. The collection was carried out in 250m2 quadrants and in 1000 m transects, with nets and entomological sheets at high tide with the help of boats, the samples were preserved in 70% alcohol in labeled bottles. The taxonomy and trophic groups of the insects were determined in the laboratory. Thirteen orders were identified: Orthoptera, Blattodea, Mantodea and Isoptera with 1 family; Colembola, Thysanoptera and Neuroptera, 2 families; Lepidoptera with 8; Diptera 9; Psocoptera 11; Hymenoptera 12; Coleoptera 13 and in Hemiptera 19 families. The percentages of participation of ten trophic groups were established: predators with 36.26 %; phytophagous 33.42%; omnivores 18.43%; parasitoids 5.03%; detritivores 3.85%; hematophagous 1.68%; frugivores 0.69%; fungivores 0.50%; aquatic 0.17% and xylophagous 0.08%. The 52.52% are beneficial insects: predatory parasitoids and detritivores and the difference phytophagous, so we consider that there is biological balance. This new knowledge is the basis for sustainable integrated management and future research in the mangrove ecosystems of the Ecuadorian coast.

Code: P 9.33. Research program: sustainable biodiversity from mangrove to coral reefs

Molina-Moreira, N.,[1] et al.

1Universidad Espíritu Santo-Ecuador. km 2.5 vía Samborondón, Guayas, Ecuador.

The program aims to achieve the sustainability of biodiversity in existing ecosystems on the Ecuadorian coast from mangrove to coral, through the study of the diversity of insects, spiders, birds, mammals, herpetofauna, plants and fungi, as well as microbiota, with tools of molecular biology, taxonomy, ethnobiology and ocean education to strengthen the integrated management of watersheds and conservation of coastal marine resources. The antecedent of this program was the Mangroves of Ecuador Project: an integrated study between academia and ancestral knowledge within which the 1st Mangroves of America Congress was held in 2019. In 2021 we will continue the studies of the different groups. We obtained a Framework Contract for Access to Genetic Resources, valid until 2025, to achieve the expected results, as well as an agreement with the Galapagos National Park for five years. Cooperation with the University of California San Diego to conduct microbiome studies and with Stanford University to study greenhouse gases. An Environmental Defense Fund (EDF) award was obtained for this study. Finally, as part of this program, in 2023 a contract was obtained with the Sustainable Environmental Investment Fund (FIAS) for 22 months to implement mangrove restoration actions in 400 ha in four provinces of Ecuador: Esmeraldas, Manabí, Guayas and El Oro.

Code: P 5.67. Evaluation of the damage caused by *Coccotrypes rhizophorae* in *Rhizophora* propagules along the Ecuadorian coast.

Molina-Moreira, N.,[1] Arias, M.,[1,2] Rodriguez, R.,[1] Medranda, P.,[1] Massuh, D.,[1] & DeSisto, C.[3]

[1] Universidad Espíritu Santo-Ecuador 1; [2] Sociedad Entomológica Ecuatoriana [3]Duke University Nicholas School of the Environment-USA

Coccotrypes rhizophorae (Coleoptera), an insect native to Indonesia, has been introduced to several American countries, including Ecuador and the Galapagos Islands. *C. rhizophorae* is the principal pest of mangrove species in the genus *Rhizophora*. Here, we examine the damage caused by *C. rhizophorae* infestations in a mangrove forest at eleven locations along the Ecuadorian coast throughout one year. We collected 13,200 *Rhizophora* spp. propagules in total (1,200 individuals per site per year). The total *C. rhizophorae* infestation rate was 45%. The total prevalence of *Rhizophora* spp. propagules infested by *C. rhizophorae* was significantly higher during the rainy season (55%) compared to the dry season. Bellavista Island, Corazón and Fragatas Island, and Guayaquil Historical Park showed higher damage prevalence compared to other sites. In all sites and in both seasons, the prevalent location of damage in affected propagules was in the basal area (59,81%). There was an inverse relationship between the population size inside the propagule (larvae and adults) and rainfall. The number of holes created by *C. rhizophorae* in *Rhizophora* spp. propagules was associated with the damage intensity. These results are critical for the management, conservation, and restoration of mangrove forests in Ecuador and other countries where *C. rhizophorae* is present.

Code: P 15.21. Variation in the concentration of nutrients in the soils of mangrove forests exposed to different degrees of anthropic intervention and its relationship with environmental variables, in the Colombian Pacific.

Mondragón-Díaz, L.F.[1] Molina, A.,[1] & Duque, G.[2]

[1]Grupo de investigación en Ecología y Contaminación Acuática, Universidad Nacional de Colombia, Sede Palmira, Palmira, Colombia. [2]Universidad Nacional de Colombia, Sede Palmira–Facultad de Ingeniería y Administración, Palmira, Colombia.

Mangroves are affected by anthropogenic and natural disturbances. The objective of this research was to determine the concentration of nutrients in interstitial water and its relationship with physicochemical parameters and soil composition of mangroves with different degrees of anthropic intervention in the Colombian Pacific. Interstitial water and sediment samples were taken from forests with high intervention in Piangüita and less in San Pedro of Buenaventura, and greater in Rompido and less in Bocagrande of Tumaco. The highest nutrient values were presented in Buenaventura, however, it was high in both bays in all forests. In Buenaventura during dry season, alkalinity (164.51±60.48 mg/l), nitrates (0.77±0.95 mg/l) and ammonium (1.93±1.65 mg/l) were higher. Between sites, phosphates were higher in Piangüita (0.25±0.25 mg/l) and in San Pedro nitrates (0.99±0.89 mg/l) and ammonium (2.05±1.58 mg/l). In Tumaco, during the season, nitrates (0.63±0.63 mg/l) and ammonium (1.69±1.63 mg/l) were higher. Between sites, in Bocagrande phosphates (0.13±0.1 mg/l), and nitrites (0.04±0.02 mg/l) and ammonium (2±1.39 mg/l) were higher, with significant differences. In Rompido, nitrates were higher (0.58±0.64 mg/l). In Buenaventura, there was a positive correlation where the higher the concentration of nitrates, the higher the pH, and negative for ammonium with oxygen and phosphates with salinity. In Tumaco, there was greater alkalinity in the sites with higher pH, as well as high ammonium and low nitrate concentrations in the sites with the highest proportion of fine sand. Nutrients can be related in Buenaventura pollutant discharges and agricultural runoff, and in Tumaco to the type of forest and nearby settlements, and their dynamics are related to environmental variables and soil type, as found in other tropical mangroves.

Code: P 5.79. Changes in plant and benthic community structure in urban mangroves

Morales, K.,[1] Parra-Velandia, F.J.,[2] & Riascos, J.M.[3]

[1]Programa de Ecología de Zonas Costeras - Corporación Académica Ambiental. Universidad de Antioquia - Sede Ciencias del Mar. [2]Corporación Académica Ambiental. Universidad de Antioquia - Sede Ciencias del Mar. E-mail: fjose.parra@udea.edu.co. Grupo GEOc, Grupo GISMAC. [3]Corporación Académica Ambiental. Universidad de Antioquia - Sede Ciencias del Mar. Corporation Center of Excellence in Marine Sciences - CEMarin, Bogotá, Colombia.

Mangrove forests have been recently described as a highly vulnerable ecosystem because they exhibit an extremely low diversity and functional redundancy. Urbanization and the induced loss or reduction of mangrove forests covert directly influences the loss of habitat and species diversity, leading to mangrove homogenization and degradation and regime changes in such as nutrients and energy fluxes. Then, our aim was to assess changes in plant and animal community structure (species abundance and composition) related with urban encroachment of mangrove forests. We registered and collect flora and invertebrate fauna species along transects established from the low tide mark to the transition to terrestrial vegetation in three types of mangrove forests along an urban-rural gradient of the Urabá Gulf (Caribbean coast of Colombia). We found that alien and alien-invasive species, such as ornamental plants, increased the diversity in urban mangroves. On the other hand, the diversity of the animal community did not present significant changes along the urbanization gradient, despite the presence of alien species in urban mangroves; however, the abundance of individual species had large differences. This demonstrate that urbanization benefit the development of certain species, while reducing the number or disappearing of indigenous, specialist species.

Code: P 5.22. Rapid mangrove monitoring and blue carbon assessments to support Mesoamerican Reef restoration efforts

Morrissette, H.,[a,b] Andino, J.,[c] Galvez, G.,[d] Novelo, K.,[e] & Canty, S.[a,b]

[a]*Smithsonian Environmental Research Center, Edgewater, MD 21122, USA*
[b]*Working Land and Seascapes, Smithsonian Institution, 1000 Jef erson Drive SW, Washington, DC 20560, USA*
[c]*Centro de Estudios Marinos, MR43+GJG, Cuyamel 21000, Honduras*
[d]*Foundation for Eco-development and Conservation, 2-39, 25 Calle, Cdad. de Guatemala, Guatemala*
[e]*Mesoamerican Reef Fund, 22 avenida 0-59, Zona 15 Vista Hermosa II Guatemala, C.A. 01015*

Mangroves, despite their global importance for climate change mitigation, are consistently threatened by sea-level rise, development, nutrient loading, and deforestation. It has been proven that mangrove ecosystems need to be conserved for the health and survival of coastal systems and beyond. Mangrove degradation is a double-edged sword, leading to both a decrease of soil carbon accumulation and storage and an increase of erosion and emissions. Healthy, functioning mangrove ecosystems accumulate massive amounts of carbon over many years, but it is not significant until mangroves are at maturity. Countries of the Mesoamerican Reef (MAR) region are increasing their planting and ecological restoration efforts to fill priority needs as stated by the Regional Environmental Framework Strategy (ERAM), the Central American Commission on Environment and Development (CCAD), country-specific Nationally Determined Contributions (NDCs), and regional action plans. Here, we present preliminary results for Guatemala and Honduras from a Mesoamerican-wide effort to assess mangrove health, establish permanent monitoring sites for restoration, and determine potential blue carbon stocks from healthy areas as a restoration goal. Local partners, Centro de Estudios Marinos (CEM) in Honduras and the Foundation for Eco-development and Conservation (FUNDAECO) in Guatemala, chose permanent monitoring sites based on the healthiest forests of the area - designated by their experience - in proximity to future restoration zones. Rapid monitoring protocols (adapted from the Point Centered Quarter Method) and blue carbon transects were conducted beside the permanent reference sites to provide total ecosystem carbon stock assessments for the region of interest and a summary of forest community structure. Health, biodiversity, and ecosystem type varied significantly between the two countries, thus highlighting separate goals and strategies for each restoration location. This project, supported by the MAR Fund, strengthened local capacity, built regional ties for collaboration, and determined critical baselines to increase restoration success.

Code: P 15.38. Mangroves cover change trajectories 1984-2020: The gradual decrease of mangroves in Colombia.

Murillo-Sandoval, P.J.,[1,2] Fatoyinbo, L.,[1] Simard, M.[3]

[1]NASA Goddard Space Flight Center, 8800 Greenbelt Rd, Greenbelt, MD, 20771, United States
[2]Departamento de Topografía, Facultad de Tecnología, Universidad del Tolima, Ibagué, Colombia
[3]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, United States

Awareness of the significant benefits of mangroves to human lives and their role in regulating environmental processes has increased during the recent decades. Yet there remains significant uncertainty about the mangrove change trajectories and the drivers of change at national scales. In Colombia, the absence of historical satellite imagery and persistent cloud cover have impeded the accurate mapping of mangrove extent and change over time. We create a temporally consistent Landsat-derived dataset using the LandTrendr algorithm to track the historical land cover and mangrove conversion from 1984-2020 across Colombia. Over this period, mangrove extent decreased by ~48.000ha (14% of total mangrove area). We find a gradual reduction of mangrove extent along the Pacific coast since 2004, whereas, in the Caribbean, mangrove cover declined around during 1984-1988 and also after 2012 . Our time-series analysis matches with drivers of mangrove change at three local sites. For instance, hydroclimatic events, dredging activities, and high sediment loads transported by the rivers have collectively improved mangrove recovery in some sites. In contrast, human activities pressure linked to agricultural expansion and road construction have degraded mangroves. The transition from dense mangrove to other vegetation types is the most significant conversion affecting mangrove cover in Colombia, impacting an area of 38,469 ±2,829 ha. We anticipate increased mangrove loss, especially along the Pacific coast, resulting from intensified human activity. Prioritization of conservation areas is needed to support local institutions, maintain currently protected areas, and develop strategies (e.g. payment for ecosystem services) to preserve one of the most pristine mangrove regions in the Western Hemisphere.

Code: P 4.11. Assessment of Fish Biodiversity in Two Biogeographic Regions (Sorsogon and Oriental Mindoro) using eDNA metabarcoding: An Emerging Tool in the Philippines

Naputo, C.F.P.,[1*] Isowa, Y.,[2] Artigas, M.D.,[2] Gerona-Daga, M.E.,[1,3] Kajita, T.,[2] & Salmo S.G.[1]

[1]Institute of Biology, College of Science, University of the Philippines Diliman, 1101 Quezon City, Philippines [2]Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, 870 Uehara, Taketomi-cho, Yaeyama-gun, Okinawa 907-1541 Japan [3] Division of Natural Sciences and Mathematics, University of the Philippines Visayas Tacloban College, 6500 Tacloban City, Philippines

Biodiversity assessments are important in designing mangrove conservation and restoration programs. In the Philippines, conventional methods (e.g., trap nets, visual census) can be time-consuming, labor-intensive, and expensive. In recent years, environmental DNA (eDNA) metabarcoding has been an emerging tool for rapid monitoring as it is fast, non-intrusive, and can provide broader detection of mangrove faunal diversity. It is expected to be applied for biodiversity monitoring in Philippine mangroves. We applied the eDNA metabarcoding method to document and assess fish biodiversity in mangroves from two biogeographic regions: Oriental Mindoro in the West Philippine Sea and Sorsogon in the Northern Philippine Sea. Using 12S genetic markers from eDNA water samples, we detected 83 fish species from 42 families. Only nine species were commonly detected in both sites. Thirty-six species were found in the Philippine's list of economically important aquatic organisms while two species were classified as Vulnerable in IUCN's Red List of Threatened Species (the native *Epinephelus fuscoguttatus* and the exotic *Acanthopagrus sivicolus*). More species were detected in Sorsogon where sampling sites were within a seascape of coral reefs and coastal fringes with mangroves and seagrasses. Less species were found in Oriental Mindoro since sampling points were limited to seaward mangrove areas. Our results serve as baseline data and the first obtained using this method in the country. However, we observed some limitations: (1) low eDNA reads which could be attributed to insufficient on-site filtration due to turbid seawaters common in Philippine mangroves; (2) possible contamination due to detection of species outside their resident range; and (3) absence of a comprehensive reference database specific to Philippine aquatic organisms. Despite these limitations, we were able to demonstrate the usefulness of this technique in doing rapid assessments which could address knowledge gaps in Philippine mangrove biodiversity and contribute to its conservation efforts.

Code: P 9.83. Accommodation space provided by paleochannels in late-Holocene mangrove environments of Singapore

Nathan, Y.,[1] Chua, S.,[2] Chong, A.,[1] Chan, N.,[1] Friess, D.,[3] & Horton, B.[1,2]

[1]Asian School of the Environment, Nanyang Technological University, Singapore, [2]Earth Observatory of Singapore, Nanyang Technological University, Singapore, [3]Department of Earth and Environmental Sciences, Tulane University, USA

Many mangroves will be heavily threatened by sea-level rise. Palaeochannels can act as sites of accommodation space for the accumulation of inorganic and organic material in mangrove environments. However, palaeochannels are understudied as settings which provide accommodation space compared to other hydrogeomorphic settings. We reconstructed the evolution of a palaeochannel in Jurong Lake, Singapore using stratigraphy, sedimentology and microfossils. We used a Bayesian age-depth model and plant macrofossil radiocarbon ages to determine sediment accumulation rates. Our core ranged in elevation from -1.8m to -7.2m Singapore Height Datum. We found basal units (Units I and II) comprising light and dark grey silty clay, respectively. We found overlying units, separated by a sharp contact, comprising dark brown sandy silt (Unit III) and light brown clayey silt (Unit IV). Our sedimentological results revealed loss-on-ignition values (5–7% for Unit III and 14–31% for Unit IV). Our microfossil analyses of Unit III revealed a presence of *Rhizophora* and *Sonneratia* pollen (32– 58%) and no foraminifera. Our microfossil analyses of Unit IV showed a presence of *hizophora* and *Sonneratia* pollen (40–66%) and a presence of agglutinated foraminifera (e.g., *Trochammina inflata*). Our age-depth model suggests the ages of Unit III (1,250–990 calibrated years BP) and Unit IV (620–150 calibrated years BP). We found mangrove sediment accumulation rates of up to 25 mm yr^{-1}, with median rates of 10–15 mm yr^{-1}. Our results suggest an estuarine channel within a mangrove environment between 1,250–990 calibrated years BP, and a mangrove environment with rapid sediment accumulation between 620–150 calibrated years BP, interspersed by a maximum 38 hiatus of 550 calibrated years. Our study provides evidence to suggest that mangroves can survive high thresholds of sediment accumulation and that palaeochannels with high sediment accumulation can provide accommodation space in late-Holocene mangrove environments.

Code: P 9.88. Soil organic carbon stocks in the mangrove forest along the coast of Suriname

Ngu-Chin-Tjonm A,S.,[1] Feyen, J.[2] Hanoeman, N.,[3] Sewotaroeno, M.,[3] Doelatip, S.,[2] Crabbe, S.,[2] & Wortel, V.[3]

[1]Soil-Chemical Lab, Centre for Agricultural Research in Suriname (CELOS) Paramaribo, Suriname, [2]Foundation for Forest Management and Production Control, Paramaribo, Suriname [3]Department of Forest Management, Centre for Agricultural Research in Suriname (CELOS) Paramaribo, Suriname

Soil organic carbon (SOC) stocks are the largest reservoir of carbon in the biosphere, important sinks of CO_2 from the atmosphere, and have the potential to help mitigate the impacts of present day and future climate changes. Accurate and reliable estimates of SOC are therefore critical in developing strategies to help mitigate impacts of climate change as well as improving wetland productivity. In Suriname the distribution of soil organic carbon (SOC) stocks up to 1 m depth has not been investigated comprehensively. One component within Suriname's REDD+ program is the National Forest Monitoring System (NFMS) that initially did not include Mangrove Forest. But since recent studies have indicated that wetlands including Mangrove forest harbor more SOC than tropical forests, the NFMS was expanded with the addition of Mangrove forests, subsequently strengthening the NFMS and reporting obligations to the UNFCCC. Therefore, this study aims to assess the SOC stored in the coastal wetlands of Suriname. To measure the SOC pool three parameters were quantified: soil depth, soil bulk density and organic carbon concentration. For each profile, the vertical distribution of SOC and bulk density were measured at standard depths: 0-15, 15-30, 30-50, 50-100 cm. Preliminary results indicate that SOC in wetlands dominated by mangrove vegetation is higher than SOC in wetlands where mangroves are limited or absent. In addition, at depth 0-15 and 50-100 cm a higher SOC content is found then at depth 15-50 cm. This study will support the government of Suriname to develop policies to mitigate the impacts of climate change.

Code: P 9.45. Microplastics in Hong Kong mangroves: Spatial and temporal patterns

Not, C.,[1,2] So, MWK[1,2], Vorsatz, LD.,[2,3,4] & Cannicci, S[2,3,5]

[1]Department of Earth Sciences, University of Hong Kong, Pokfulam, Hong Kong Special Administrative Region [2]The Swire Institute of Marine Science and the School of Biological Sciences, The University of Hong Kong, Pokfulam Road, Hong Kong, Hong Kong SAR [3]Area of Ecology and Biodiversity, School of Biological Sciences, The University of Hong Kong, Hong Kong Special Administrative Region [4]Department of Biological Sciences, University of Cape Town, South Africa [5]Department of Biology, University of Florence, Sesto Fiorentino, 50019, Italy

Microplastics have been found in all marine environments from the poles to the tropics and occur in surface waters to deep trenches, and mangroves are no exception. Indeed, mangroves are potentially one of the ecosystems mostly under pressure from plastic pollution due to its structural complexity that provides many opportunities for debris to be entangled. In addition, mangroves are commonly present in countries with less developed waste management systems, where they are also associated with rivers, streams and estuaries, which all have been identified as important sources of plastic debris and microplastics into coastal environments. Yet far less is known on the level of plastic pollution of mangroves than other coastal habitats. Here we investigated the spatial and temporal pattern in microplastics pollution of Hong Kong mangroves by quantifying microplastics present in water and sediment of eight mangrove stands in the wet and dry seasons, during a 2-year period. An average of 72 ± 179 pcs 100 l^{-1} and 330 ± 815 pcs kg dw^{-1} were detected in water and sediment respectively, indicating a moderate level of contamination when compared to mangrove from other regions. No spatial or temporal trends are observed from water samples. In the sediment, we observed higher abundance of microplastics during the wet season and in the landward area of each mangrove stand, as well as significant differences between forests but a limited influence from the Pearl River. Together these results suggest that microplastic accumulated in Hong Kong mangroves may be rather land-based and primarily sourced from local human activities.

Code: P 5.64. The importance of partnership expansion and its success for mangrove research, conservation, and management

Novelo, K.,[a] Martinez, N.,[b] Chevez, L.,[c] Morales, J.,[a] Rivas, A.B.,[a] Morrissette, H.,[d,e], Canty, S.[d,e]

[a]Mesoamerican Reef Fund, Guatemala City, Guatemala [b]University of Belize Environmental Research Institute, Belmopan, Belize [c]Secretaría de Turismo de Honduras, Tegucigalpa, Honduras [d]Smithsonian Environmental Research Center, Maryland, USA [e]Working Land and Seascapes, Smithsonian Institution, Washington, DC, USA

Coastal ecosystems such as mangrove, seagrass, and coral reefs extend far past individual nations' borders, and should be conserved through a holistic seascape approach that combines stakeholders at all levels. However, mangrove conservation projects often encounter various obstacles such as ecosystem complexity, unclear government jurisdiction, and diverse land development interests. Exclusion of relevant stakeholders from planning, inefficient communication throughout implementation, and lack of building capacity contribute to mangrove conservation and restoration inadequacies. Recently, there have been more comprehensive efforts towards mangrove management, and we present a few examples from the Mesoamerican Reef ecoregion of successful collaboration here in the framework of combining international, regional, and local partnerships. International collaborations play to organizational strengths, shifting priorities to regional strategies that assess mangrove ecosystems as a whole. This allows for protection and restoration of these critical coastal wetlands to be policies that reach interconnected systems, with sustainable implementation and in situ work guided by local involvement, support, and capacity. The Belize Blue Carbon project, an internationally-cooperative project to estimate a national mangrove carbon stock for Belize, highlighted the effectiveness of knowledge-sharing with 14 institutions collaborating to research and conserve Belize's mangroves. The Regional Strategy for Mangrove Management, Conservation, Restoration, and Monitoring in the Mesoamerican Reef, co-led by MAR Fund and Smithsonian, brought institutions from eight countries together for a goal of recognizing regional threats, and developing pathways to protecting mangrove ecosystems. This drove the production of the Manual for the ecological restoration of mangroves in the MAR system and the Wider Caribbean, as a way to integrate these partnerships into action. Additionally, the regional strategy has facilitated local actions, such as the implementation of mangrove restoration and monitoring activities. Having community-led initiatives have proven successful across all levels, and should be prioritized for future marine resource protection and restoration.

Code: P 15.74. Exploring Gender-Inclusive Mangrove Conservation in Lamu, Kenya

Nyaega, L.[1]

[1]Wetlands International Eastern Africa

The relationship between the environment and the lives of women and men is both complex and multi-dimensional. To understand this relationship, it is important to analyse the experiences of both women and men in managing natural resources, dealing with environmental hazards, and promoting environmental conservation. Wetlands International's mangrove conservation initiatives in Lamu, Kenya provide a glimpse into the importance of considering gender and structural factors linked to socio-economy, politics and culture in mangrove conservation. This study focuses on exploring gender-inclusive mangrove conservation practices in Lamu, Kenya. The goal is to improve gender equality by figuring out who is involved, their roles, rights, and responsibilities, and coming up with local solutions. It identifies the drivers of mangrove degradation and loss and analyses the potential synergies and tensions between multiple resource use and objectives. The findings from the study demonstrate that considering gender and structural factors is crucial for the effective utilisation of mangrove resources and for improving the lives of both women and men in the community. By taking gender differences and structural factors into account, natural resource management can come up with options for managing mangrove ecosystems that are efficient, relevant to the area, and fair. Only then can different groups of women and men be able to effectively utilise the resources they manage and enhance their assets and agency to improve their lives and those of their households and community members. In conclusion, this study highlights the need for a gender-inclusive approach to mangrove conservation as well as considering the experiences and perspectives of both women and men, toward equity and sustainability.

Code: P 9.71. Assessing ecosystem services of mangroves at country scale (Colombia) based on expert opinion.

Ocampo, M.A.,[1] Sanchez, D.,[2] Cantera-Kintz, J.R.[1]

[1] Universidad del Valle [2] Universidad Nacional de Colombia

The Ecosystem Services (ES) approach has provided tools to manage and protect nature, by identifying the benefits that humanity can obtain from it. Mangrove ecosystems provide a wide range of services, which represent the basis of their subsistence for some communities. The close relationship between these ecosystems and human well-being has driven a growing demand from decision makers to develop a series of ES assessment and mapping tools, linking land cover types with ES Supply Capacity (ESSC). However, due to the lack of spatial information at the national scale, assessments based on expert knowledge give a quick estimate of potential ecosystem benefits in an area. In this study, the areas of the country where mangroves are found were classified into ecological units; these units were grouped into ecosystem types in different ecoregional districts. ESSC was estimated by multiplying the potential ES supply with integrity; considering integrity as a proxy for resilience, viability, and support functions. The potential supply of ES was estimated through an expert-based assessment, with interviews with experts on coastal ecosystems in Colombia (n = 40). Integrity was estimated using ecological unit integrity assessments based on secondary data. The ESSC of the mangrove forest ranged from 1.0-3.4 (on a scale of 1.0-5.0); being the highest values compared to other ecosystems. However, lower integrity values decreased the maximum value of the ESSC range. This approach will be useful to identify areas with high service supply value for national base area management and conservation efforts where information is scarce.

Code: P 15.61. Public perception and framing of #mangrove and #coral through qualitative image analysis on social media.

Olefs, L.,[1,2] Hugé, J.,[1,3,4] Stocken, T.V.,[5,6] Koedam, N.,[4] Poti, M.,[1,4] Dahdouh-Guebas, F.[1,4,7,8]

[1]Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium
[1]White Green Blue – Sustainable You. Baal, Belgium
[3]Department of Environmental Sciences, Open University of the Netherlands. Valkenburgerweg 177, Heerlen 6419AT, the Netherlands
[4]Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, 1050, Brussels, Belgium
[5]Faculty of Sciences and Bio-engineering Sciences, Biology Department. Pleinlaan 2, 1050 Brussels, Belgium
[6]NASA Jet Propulsion Laboratory, California Institute of Technology
[7]Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, 1050, Brussels, Belgium
[8]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN)

Social media use is on the rise and it is becoming easier to share news, images, and research online. Public perceptions of ecosystems and their individual components (such as individual species – think of flagship species) can be influenced by the framing of a message or an image. Certain framings may induce positive behaviours towards nature restoration and conservation whereas others might constrain the social validity of those same behaviours. Public perceptions and perceived value of ecosystems have an impact on conservation funding, project success and general awareness of both ecosystem services and threats to the ecosystem. Mangrove forests have historically been portrayed in a negative light. In contrast, coral reefs have been known as beautiful and colourful places. Both mangroves and corals are threatened by anthropogenic activities and climate change. After using qualitative coding to analyse 200 images of mangroves and corals on each of the following platforms; Google Images, Flickr, Twitter and Instagram, we found that neither ecosystem is perceived as a social-ecological system but rather valued for their unique intrinsic traits and unique ecosystem services. The framing of images varied from platform to platform. Images posted to Flickr and Google Images highlight the intrinsic value of both ecosystems whereas images posted on Twitter and Instagram highlighted threats to and ecosystem services of both mangroves and corals. Mangroves are valued for coastal protection, fishing, carbon storage and ecotourism whereas corals are very popular among scuba divers, snorkelers, aquarists, and jewelry enthusiasts. The gap is closing between the murky mangroves and the catchy corals on social media predicting a brighter future for mangrove forests.

Code: P 9.93. Aboveground biomass loss: can a SE Brazilian mangrove forest recover from a massive mortality?

Oliveira, C.F.,[1] Gaurisas, D.,[1] Oliveira, E., Souza, F.M., [1] Freitas, H.C., Bernardino, A.F.[1]

[1] Universidade Federal do Espírito Santo, Brazil

Droughts, heat waves, hailstorms, and other extreme climate events can impact mangrove ecosystems resulting in their mortality. The death of mangrove forests causes loss of carbon stocks through wood decomposition and soil erosion. Here we evaluate the aboveground carbon of tropical mangrove stands from SE Brazil, 7 years after a mortality event over 500 ha. We measured tree biomass in eight locations along an estuary representing paired natural and impacted mangrove forests and compared to previous studies of our group from 2017, 15 months after the initial impact. From 2017 to 2022, aboveground carbon stocks decreased 30% in preserved sites (118.4 ± 34.6 to 83.4 ± 46.94 Mg C ha^{-1}) and 52% in disturbed sites (59.9 ± 27.0 to 28.8 ± 39.25 Mg C ha^{-1}). Additionally, the loss of aboveground carbon within the dead mangrove area increased 96%. Our results indicate that mangrove biomass may take decades to recover from climate disturbance events and the need for active restoration efforts to accelerate recovery after mortality events.

Code: P 9.59. Factors influencing governance of coastal wetland protection and restoration: A case study in Brazil

Oliveira, M.,[1] Morrison, T.,[2], O'Brien, K.R.,[3] Lovelockm, C.E.[1]

[1]University of Queensland, Australia [2]James Cook University, Australia [3]School of Chemical Engineering, Australia

Governance processes have the potential to produce positive and/or negative feedbacks in coastal wetlands social-ecological systems (SES). Despite advances in governance studies, governance systems are often inappropriately structured to support healthy and resilient coastal wetland SES. The governance of coastal wetlands SES occurs under complex legislative and institutional arrangements, often across different jurisdictions and involving a range of government agencies, non-government institutions, and local communities. In this study, we sought to assess the drivers of governance influencing coastal wetlands protection and restoration. We conducted a literature review and semi-structured interviews with institutions involved in coastal wetlands protection and restoration in the Environmental Protected Area Cananeia- Iguape- Peruibe, Brazil. This study highlighted the importance of the participation of local communities for the maintenance and resilience of these ecosystems. The factors influencing governance were related to politics, land tenure, institutions, behaviour, economy, and resources all of which affect the participation and rights of local communities and the protection and restoration of coastal wetlands.

Code: P 5.21. A biotic perspective of mangroves health in South Africa

Osorio, J.A.,[1,2] Beer, Z.W.,[2] Wingfield, M.J.,[2] & Roux, J.[2]

[1]Programa de Biología, Universidad del Quindío, Armenia (Q), Colombia.

[2]Department of Biochemistry, Genetics and Microbiology, faculty of Natural and Agricultural Sciences,Pretoria, DST/NRF Centre of Excellence in Tree Health Biotechnology, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, South Africa.

Mangrove trees provide essential economic and environmental benefits for numerous tropical and subtropical countries, such as food, fuel and coastal protection. However, these benefits are under threat because of the direct and indirect effects of anthropogenic activities which compromise tree health and cause large-scale of losses of mangrove trees. Extensive assessments were conducted to determine the health status of the five mangrove species that occur in South Africa, sampling of biological material, followed by isolation and identification of pathogens and insects using morphological and molecular data were carried out. Results from this study showed the presence of at least three diseases, two on *Avicennia marina* and one on *Barringtonia racemosa*, in South Africa. Furthermore, results depicted a correlation between disease incidence and habitat disturbance, with higher levels of diseases of *Avicennia marina* in areas such as Isipingo and Richards Bay, and low levels in areas such as Nahoon. Additionally, there has been an increase of pathogens and insects impact to these trees globally, this is the case of a variety of previously unknown fungal species that were identified from true mangroves and mangrove associates in the country. It is estimated therefore, that the number of opportunistic pathogens and diseases may increase progressively due to stress that mangroves are subjected. Virtually nothing was known regarding fungal and insect associates of mangroves in South Africa prior to this study, which arose from a number of unexplained mangrove death reports.

Code: P 9.68. Flow of ecosystem services in Brazilian Amazon mangroves

Owuor, M.,[1] Santos, T.,[2] Otieno, P.,[2] Mazzzuco, A.C.A.,[2] Iheaturu, C.,[3] & Bernardino, A.[2]

[1]Wyss Academy for Nature at the University of Bern, Bern, Switzerland [2]Departamento de Oceanografia, Universidade Federal do Espírito Santo, Vitória, Brazil 3. University of Bern, Institute of Geography, Bern, Switzerland

Mangroves in Brazil have been under state protection over the years but some sites are still impacted by land use due to poor law enforcement. These changes pose a serious threat in terms of sustainable forest harvesting and management to Amazon coastal communities. This study evaluated the flow of ecosystem services and quantied their spatial distribution across land use land cover classes in the Brazilian Amazon. Surveys were conducted through local workshops with participants coming from twelve coastal villages, where mangrove ecosystem services were classified into provision, cultural and regulation services, and then presented to local community representants stakeholders through workshops for prioritization and habitat connection through scoring. A total of 23 ecosystem services were selected by the key informants through a focus group discussion. Scores revealed a high flow of ecosystem services linked to mangroves: intergenerational values (91%), intrinsic value (93%), nursery and breeding ground (94%), climate regulation (89%), biodiversity conservation (96%) and storm protection (87%). Conversely, mangroves had low flow for fishing vessels (86%), coal (86%), wood for construction (83%), livestock feeds (97%), hunting (95%), bee keeping (86%). There were varied perception on the flow of other services including crafts and ornamentals, fuelwood, fishing gears, mariculture, phytotherapy, recreation, flood control, sediment control, soil erosion, and water purification. Perceptions varied according to the duration of stay in the area, whether one extracts benefits/ecosystem services from the mangrove ecosystem, the nature of main type of livelihood source, and the knowledge on the roles that mangroves play in nature such as climate regulation. Considering the current multiple stressors in mangroves, the ability to follow map and estimate changes in ES in space and time through ES mapping and modelling will allow researchers accurately estimate how drivers impact on ES delivery.

Code: P 9.94.The difference in the greenhouse gas emissions from the soil of dead and live 2 mangrove forests in Brazil

Pacheco, C.F.,[1] Mazzuco, A.,[1] Ferreira, T.O.,[2] Nobrega, G.N.,[2] & Bernardino, A.[1]

[1]Universidade Federal do Espírito Santo, Brazil [2]Departamento de Ciência do Solo, Brazil

Mangroves reduce the effects of climate change by storing a significant quantity of carbon in their biomass and soil. Nevertheless, these ecosystems may become a source of atmospheric greenhouse gases (GHG) if they are disturbed. Extreme climate events can cause mangrove mortality and affect GHG emissions. This study assesses the carbon dioxide (CO_2) and methane (CH_4) fluxes from the soil of a tropical mangrove severely impacted by climatic extremes in the Southeast of Brazil. Using static transparent and opaque soil chambers, gas samples were collected in areas with dead and live mangrove forests at 0-, 15-, 30-, and 45-minute intervals in a dry season (October 2019) and a wet season (March 2020). The live mangrove forests had 2.6- folder higher rates of CO_2 flux, ranging from 113.8 ± 150.7 mmol/m^2/day to 278.33 ± 393.49 mmol/m^2/day at day and night, respectively. CH_4 emissions in living forests during the day (1219.76 ± 561.12 μmol/m^2 /day) were >3-fold higher than the average global mangrove sediment flux of 391.2 ± 153.4 μmol/m^2/day. During the wet season, the emissions of CO_2 and CH_4 were lower at all sites. Our findings revealed that live mangrove forests emitted significantly more CO2 in the wet season than dead forests. However, the methane fluxes were not significantly different in both forests.

Code: P 5.95. Local perception of the state of mangroves in rural and peri-urban areas (Coincidences and mismatches) in the Urabá Gulf, Colombian Caribbean.

Pacheco, M.J.,[1] Blanco-Libreros, J.F.,[2] Dahdouh-Guebas, F.,[3,4,5,6] & Riascos, J.M.[7]

[1]Programa de Ecología de Zonas Costeras - Corporación Académica Ambiental. Universidad de Antioquia - Sede Ciencias del Mar. E-mail: mariaj.pacheco@udea.edu.co. [2]Universidad de Antioquia, Facultad de Ciencias Exactas y Naturales, Instituto de Biología, Grupo de Investigación "Procesos Ecosistémicos a la Escala del Paisaje", 050010 Medellín, Colombia. [3]Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, Brussels, 1050, Belgium. [4]Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, 1050, Brussels, Belgium. [5]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN). [6]Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, 1050, Brussels, Belgium. [7]Corporación Académica Ambiental. Universidad de Antioquia - Sede Ciencias del Mar. E mail: jose.riascos@udea.edu.co.

Mangroves are highly productive ecosystems located in tropical and subtropical coasts of the world. Historically, human populations have benefited from the ecosystem services provided by mangrove forests. However, urban expansion linked to population growth has emerged as a key threat to the conservation of tropical ecosystems. Since the 1960's, the Urabá Gulf has been an epicenter of armed conflicts and the war on drugs in Colombia, with victims and displaced persons settled in rural (*i.e.* underveloped) and urban areas, which could influence their perceptions about the value and conservation of coastal ecosystems. We hypothesized that the perception of local communities on mangrove conservation in rural areas -in contrast to that in urban areas- will coincide with actual changes in forest cover. For this, the perception of the Afro-descendant communities of Bocas del Atrato (rural) and the Turbo city port (urban) on the uses of mangroves and changes in mangrove cover was evaluated using semi-structured surveys. These perceptions were compared with remotely-sensed estimates of mangrove cover change for the 2010- 2020 period. In contrast to our hypothesis, we found that the perception about mangrove loss of people in Bocas del Atrato did not coincide with observed increases in forest cover, whereas the perception of communities in Turbo city rightly identified forest losses. Communities tend to mainly take advantage of the mangrove swamp as fuel, construction materials and fishing grounds, with *Rhizophora mangle* being the most important species for its additional use as a dye and medicine. This work emphasizes the different perceptions that rural and peri-urban communities may have about the conservation and local uses of the mangrove, which provides criteria to guide the management and protection of this ecosystem.

Code: P 9.20. Influence of wave dissipation on erosion-accretion dynamics in mangroves of the Colombian Pacific.

Padilla-Mendoza, C.,[1] Osorio, A.,[1] & Sanchez, D.[2]

[1]Universidad Nacional de Colombia, Colombia
[2]Universidad Nacional de Colombia Sede La Paz, Colombia

Mangrove forests with direct sea interaction dissipate waves and can be vertical erosion-accretion scenarios due to their supporting root system. The present study shows the influence of wave dissipation rates on steep erosion-accretion rates at two sites on the Pacific coast of Colombia. Dissipation rates were calculated from pressure sensor data located along transects in the wave-mangrove interaction zone. To determine the vertical erosion-accretion dynamics, groups of fixed rods were placed at the edge and inside the mangroves. The average steep accretion rates along the Bay of Buenaventura and Tumaco coasts are 2.52 cmyr-1 and 3.95 cmyr-1, respectively. The dissipation rates at the edge and inside the mangrove in Buenaventura Bay were 0.056 and 0.063 cmyr-1, respectively. While in Tumaco, they are of the order of 0.2 m-1. There is no significant correlation between wave dissipation and erosion-accretion rates; however, in Tumaco, the wave and tide directly impact the forest because the sediment particles lose velocity and fall according to their mass; meanwhile, the Bay, the extended beach allows the wave energy to decrease and most of the sediments are distributed along to the beach. According to the results, considering only the rates, it isn't possible to establish the influence of one process on the other; however, they acquire relevance considering the hydrodynamic conditions.

Code: P 15.73. Community Perceptions of Mangroves in the U.S Virgin Islands and Implications for Mangrove Restoration Efforts

Palomino, L.,[1] Grimes, K.W.,[2] Durdall, A.,[2] Bowen, D.,[3] Peterman, K.,[4] & Stewart, H.A.[5]

[1]Master's of Marine & Environmental Studies, University of the Virgin Islands [2]Center for Marine & Environmental Studies, University of the Virgin Islands [3]College of Science & Mathematics, University of the Virgin Islands [4]Catalyst Consulting Group, Durham, North Carolina [5]Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, Florida

Mangrove habitats in the U.S Virgin Islands were severely impacted by two category 5 hurricanes in 2017. To facilitate mangrove recovery, restoration efforts by several agencies, including the University of the Virgin Islands, have taken place across the territory. Existing restoration and education efforts can be enhanced by incorporating information about local perceptions, understanding and use of mangroves. The purpose of this project is to develop a baseline understanding of current knowledge of mangroves ecosystem services in the USVI and identify where mangrove education and restoration efforts should be focused. Similar to previous studies, this project utilizes an exploratory, sequential, mixed-method approach through a territory-wide mangrove perception survey and several community listening sessions (focus group discussions) to identify individuals' relatedness to nature, awareness of ecosystem benefits, perceptions of potential mangrove loss, and how those are influenced by mangrove use, demographics, and socioeconomic factors. To-date, 328 USVI residents have been surveyed at community events on St. Thomas, St. John, and St. Croix. Preliminary analyses reveal differences in interest of mangrove conservation activities across islands. These results will help design community-based mangrove restoration efforts that are tailored to each island community in the USVI.

Code: P 5.40. Baseline assessment of carbon stocks before hydrological restoration for a pilot blue carbon project.

Pearse, A.,[1] Bennion, V.,[1] & Lovelock, C.[1]

[1]School of Biological Sciences, The University of Queensland, St Lucia, QLD, Australia.

Policies which incentivize coastal wetland restoration can support climate change mitigation strategies worldwide. Australia's recently released Tidal Restoration Blue Carbon Method incentivizes coastal wetland restoration with Australian carbon credit units for projects achieving carbon abatement via re-introduction of tidal flows to unused or degraded coastal wetland habitat. Pilot blue carbon projects can validate and improve the blue carbon method's carbon abatement modelling. In this study in South East Queensland, we quantified above-ground and soil carbon stocks of a tidally restricted 40ha degraded agricultural paddock to give a comprehensive baseline dataset to compare after restoration using a Before, After, Control, Impact (BACI) design. In line with the Blue Carbon Method, the site was delineated by elevation into High (>0.75 AHD), Medium (0.5 – 0.75 AHD) and low elevation (0.25 – 0.5 AHD) strata. Above ground and soil carbon stocks were measured across this elevation gradient within the restoration site as well as at three reference mangrove forest sites. Soil carbon stocks were similar between the restoration and reference sites with 340Mg C ha^{-1} ± 51 and 367 Mg C ha^{-1} ± 13 respectively. Within the restoration site there was no difference in soil carbon stocks between elevation strata. Above-ground carbon stocks were much greater at reference sites (295 Mg C Ha^{-1} ± 30) when compared to the restoration site (95 Mg C ha^{-1} ± 51). Differences in above-ground carbon stocks between the restoration and reference sites were due to differences in vegetation communities. The restoration site was dominated by low density freshwater and brackish reed species while the natural mangrove forest reference sites were dominated by *Avicennia marina*. With restoration, we anticipate an increase in above-ground carbon stock's contribution to the restoration sites total carbon stocks as the successional patterns in vegetation transition from freshwater ephemeral wetland to tidally influenced coastal wetland.

Code: P 9.43. Assessment of Macro- and Microplastics in the Mangrove Bay of Gazi (Kenya): Identity, Quantity, Distribution and Sources

Pelsmaekers, E.P.B.,[a,b] Janssen, C.,[c] Cannicci, S.,[d,e] Munga, C.N.,[f] & Dahdouh-Guebas, F.[a,b,d]

[a] Laboratory of Systems Ecology and Resource Management, Université Libre de Bruxelles, Av. F.D. Roosevelt 50, Cpi 264/1, B-1050 Brussels, Belgium. [b] Ecology & Biodiversity, Vrije Universiteit Brussel, Brussels, Belgium [c] Department of Animal Sciences and Aquatic Ecology, GhEnToxLab, Ghent University, Coupure Links 653, 9000 Gent, Belgium [d] Department of Biology, University of Florence, Sesto Fiorentino, Italy [e] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN) [f] Department of Environment and Health Sciences, Marine and Fisheries Program, Technical University of Mombasa, P.O. Box 90420 - 80100, Mombasa, Kenya

Environmental plastic pollution in Kenya is a major issue as more than 80% of the total waste is inadequately managed. Even though the Kenyan Government introduced several bans on the use and import of single-use plastics, the country is still drowning in plastics. Numerous studies focused on the presence of plastic pollution in the marine environment, but studies on mangrove ecosystems are largely missing. This study aimed to provide primary evidence of plastic contamination in the mangrove forest of Gazi Bay, south coast Kenya. Macro- and microplastic distribution and abundance along the mangrove and the coastline were recorded and the plastic recovered was categorised according to its type and use. To investigate the relationship between our findings and the perception and behaviour towards plastic use and disposal of the inhabitants of Gazi, a questionnaire was developed. The average abundance of debris was 0.79 ± 2.21 items.m-2, while an average of 0.16 ± 0.25 items.tree-1 (0.1 ± 0.24 items.m-2) was found in the trees. The landward zone contained 3 to 8 times more plastic on the ground than the seaward zones and beaches, while plastic abundance and cover in the trees were highest on the seaward transects. Overall, unidentifiable plastic fragments and bottles were most recovered. The concentration of large microplastics (LMPs: 1-5 mm) varied strongly between sites. While the landward transects contained the most LMPs on average (0.41 ± 0.06 LMPs kg-1 dry), the beach zone contained the most replicates that were contaminated (25.93% of all replicates). Both the data and the information gathered by the questionnaire confirmed that most plastic recovered on the landward side was of domestic origin. Littering, dumping and burning are still considerable plastic disposal methods used in Gazi. Consequently, this study strongly advocates for the availability of better waste management and recycling opportunities in Kenya.

Code: P 9.39. Acquisitive functional traits driving the tree invasion in mangrove-*Spartina* ecotone in southern China

Peng, D.,[1] & Zhang, Y.[1]

[1]Key Laboratory of the Ministry of Education for Coastal and Wetland Ecosystems, College of the Environment and Ecology, Xiamen University, Xiamen 361102, Fujian, China

Biological invasions are changing the species composition and community structure of native mangroves in southern coast of China, which dominated by a novel ecosystem consisting of the invasive grass *Spartina alterniflora* and the exotic mangrove *Sonneratia apetala*. *Spartina* occupied unvegetated mudflat and formed dense monospecific intertidal grasslands, suppressed growth and recruitment of native mangrove seedlings. While *S. apetala* can encroach into native mangrove forests and dense *Spartina* meadow, even replace them. Functional traits affect individual performances, which, in turn, determine individual fitness, population growth, and community assembly. However, how functional traits to drive the encroachment of *S. apetala* remain unknow. We transplanted seedlings of native *Avicennia marina* and exotic *S. apetala* in heterogeneous habitat (native mangrove stand, *Spartina* meadow, mudflat) at Zhangjiang Estuary (higher latitude) near the northern limit of mangroves, and Leizhou Bay (lower latitude) near the southern limit of *Spartina* in China. We monitored survival, height, woody density, leaf area, specific leaf area (SLA), leaf dry mass content (LDMC), and leaf lifespan of these two species, which correlated with the world-wide whole plant economics spectrum. Results showed that *S. apetala* has higher survival and growth than *A. marina* in three habitats in two study sites, but *A. marina* could not survive in vegetated habitats. Growth of *S. apetala* gradually increased with light availability and can outcompete native mangrove shrub and *Spartina* meadow in two or three growing seasons. A simulated shading greenhouse experiment confirmed higher growth rate and acquisitive functional traits (high SLA, low LDMC, short leaf lifespan) of *S. apetala* as a function of light intensity gradient, driving the encroachment of *S. apetala* in heterogeneous habitat. Fast plant economics spectrum and acquisitive strategy may accelerate *S. apetala* invasion and transform native mangrove forests and monospecific *S. alterniflora* grasslands into non-native mangrove forests in southern coast of China.

Code: P 9.70. Mangrove restoration: perspectives from local communities in the CGSM

Peña, N.,[1] Babilonia, B.,[1] & Rueda, M.E.[1]

[1]Instituto de Investigaciones Marinas y Costeras José Benito vives de Andréis – INVEMAR, Programa de Calidad Ambiental Marina.

The Ciénaga Grande de Santa Marta (CGSM) is the largest estuarine lagoon complex in Colombia. Its hydrological and geomorphological settings, place it as one of the most productive ecosystems in the tropics, providing ecosystem services of great importance for human well-being, food security and life quality of local communities. However, it has been exposed to different anthropic pressures that have caused soil hypersalinization, decrease in fishing resources, species losses and the degradation of a large extent of mangrove cover. To tackle this degradation trajectory, actions have been implemented for its recovery, through ecological restoration measures with a community focus such as the Sustainable Landscapes Project. Within this project, strategies to strengthen the capacities of the communities from Puebloviejo and Sitionuevo, Magdalena have been carried out, in order to strengthen their active role in the planning, implementation and monitoring of mangrove restoration processes in the CGSM. In this sense, it was possible to identify and understand the perspectives built by local communities regarding mangrove restoration processes. The work was developed under a qualitative approach based on the experiences and stories of women and men, members of community organizations that have historically been involved in environmental, fishing and restoration activities. Our descriptive results showed the ways in which local experiences and knowledge were integrated at an organizational, administrative, technical and symbolic level in mangrove restoration actions and how they contribute and maintain future processes framed in the territory sustainability.

Code: P 9.28. Foliar phenotypic plasticity of Rhizophora mangle and Avicennia germinans as potential bioindicators of environmental stress

Pérez-Gaviria, C.J.,[1] Sarmiento-Serge, W.E.,[1] Bohórquez-Herrera, J.[1]

[1] Biology program, FExact and Natural Sciences Faculty. Universidad de Cartagena.

Mangroves present necessary physiological adaptations to develop in places with stressful environmental conditions; however, the continuous interaction with variable environmental conditions, such as salinity, pH, nutrients, among others, can generate instability in the development of seedlings. Which in turn causes significant morphological differences in these organisms and even their death. Due to this and other factors, mangrove ecosystems have declined considerably. This project focuses on establishing whether the foliar phenotypic plasticity of *Rhizophora mangle* and *Avicennia germinans* can be a potential bioindicator of environmental stress. In the same way it seeks to analyze the morphological variations of the leaves of the different mangrove species in areas with conditions of variable environmental stress. The study area is located in the El Corchal Flora and Fauna Sanctuary (San Onofre - Arjona, Colombia), where 3 zones with high differences in salinity were selected, implementing transects of 10 x 100 m, divided into quadrants of 10 x 10 m, in which physical-chemical parameters will be taken. In addition, individuals of *R. mangle* and *A. germinans* with a DAP greater than 2.5 cm will be selected for the collection of their leaves. The analysis of the samples will be carried out using the geometric morphometric techniques applied to the morphology of the collected leaves. After the morphometric analysis, statistical procedures will be carried out to observe relationships between the physicochemical parameters and the leaf structures, this in order to determine if leaf asymmetry can be used as a bioindicator of developmental instability due to environmental stress in the different mangrove species. This would allow observing how the ecosystem is located and see if its conditions are optimal for the development of new individuals.

Code: P 5.18. An estimate of the efficiency in the filtration capacity of mangrove oyster (*Crassostrea brasiliana*) in Southeastern Brazil

Pessoa-Vidal, V.H.B.,[1] Cunha-Lignon, M., Montealegre-Quijano, S.

[1]Universidade Estadual Paulista (UNESP), Brazil.

The mangrove oyster species, *Crassostrea brasiliana*, has great economic importance in Brazil. In addition, it directly favours water quality, through the filtration process, which removes particulate matter, contributing to the ecosystem services of mangroves. The current study aims to compare the efficiency in the filtration capacity of *C. brasiliana* between summer and winter, in southeastern Brazil. Morphometric data of 6,900 individuals of *C. brasiliana,* collected in eight stations in August/2019 (winter) and March/2020 (summer), were used to estimate the filtration capacity, measured as the filtration rate (FR) as a multiplicative function of visceral weight (VW), with parameters $\alpha = 6.79$ and $\beta = 0.73$. We considered three life stages: seeds (up to 11 mm in height), juveniles (12 to 24 mm), and adults (> 25 mm). Filtration efficiency was evaluated by comparing both, the total mean FR, and the life stage's FR between the seasons of the year. It was observed that oysters in the early stages of the life cycle (seed and juvenile) have lower FR values than oysters in the final stages (adult), no matter summer or winter. We obtained an estimate of all studied mangrove oysters at a filtration rate of 106,314 litres of water per hour, with a mean of 14 litres per individual per hour. Thus, the current study reinforces the ecosystem service provided by mangrove oysters, highlighting the importance of adult oysters. Management strategies must contemplate this information to promote mangrove conservation considering the traditional fisheries activities.

Code: P 5.66. Population genetics of mangroves among the Galápagos archipelago

Poprick, T.,[1,2] Moity, N.,[3] Helfer, V.[1]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany
[2] Faculty 2 Biology/Chemistry, University of Bremen, Bremen, Germany
[3] Charles Darwin Research Station, Charles Darwin Foundation, Puerto Ayora, Galápagos Islands, Ecuador

Genetic diversity is an essential component of biodiversity, driving the resilience or the evolutionary potential of species to adapt to changing environmental conditions. Determining spatial patterns of genetic variation contributes to a better understanding of those factors that affect local genetic diversity and gene flow, thereby better informing conservation or restoration actions to maintain or restore connectivity across populations. Studies on population genetics of mangrove plant species still remain scarce. The Galápagos archipelago, under strict protection since 1952, provides a unique opportunity to study patterns of intraspecific genetic variation of mangrove species in an environment with minimal anthropogenic impact, where the major forces at play consist of natural processes. While the spatial distribution and extent of mangrove ecosystems has been thoroughly reassessed in 2019, patterns of genetic diversity within and between mangrove forests and the connectivity among those still remain unknown. This study addresses this knowledge gap for the three major mangrove species of the Galápagos: *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa*, within and across the eight islands identified as harboring mangroves. The sampling scheme will target both fringe and land-locked mangrove forests, to evaluate the effects of the geomorphic setting. Combining molecular data generated through double-digest restriction site-associated DNA sequencing (ddRADseq) technique, plant functional trait data and environmental parameters, this project will shed light on genetic diversity within and across islands and potential local adaptation of mangroves in the Galápagos. This information will help assess what populations might be at risk under future environmental change, and thereby could inform management actions to increase their adaptation potential and resilience. We will here present our global approach and preliminary results, focusing on the plant functional trait datasets collected for the three mangrove species.

Code: P 15.62. Shifted baselines: governance of coastal wetlands in a post-tsunami land subsidence context

Poti, M.,[a,b,c], Shanker, K.,[c,d] Hugé, J.,[a,b,e,f], Koedam, N.,[b] & Dahdouh-Guebas, F[a,b,g,h]

[a] Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles – ULB, 50 Av. F.D. Roosevelt, CPi 264/1, 1050, Brussels, Belgium [b] Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel – VUB, 2 Pleinlaan, VUB-APNA-WE, 1050, Brussels, Belgium [c] Dakshin Foundation, 2203 D Block, 8th Main, 16th D Cross, Sahakar Nagar, Bangalore, 560092, India [d] Centre for Ecological Sciences, Indian Institute of Science, Bengaluru 560012, Karnataka, India e. Department of Environmental Sciences, Open University of the Netherlands, 177 Valkenburgerweg, 6419AT, Heerlen, the Netherlands [f] Centre for Environmental Sciences, Hasselt University, 42 Martelarenlaan, 3500 Hasselt, Belgium g. Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), c/o Zoological Society or London (ZSL), London, United Kingdom [h]. Interfaculty Institute of Social-Ecological Transitions, Université Libre de Bruxelles – ULB, 50 Av. F.D. Roosevelt, 1050, Brussels, Belgium

The Andaman and Nicobar Islands (ANI) in India were heavily impacted by the 2004 Sumatra Andaman earthquake and tsunami, resulting in major changes in land topography and loss of mangrove vegetation. We describe the impacts of the tsunami on the governance of coastal ecosystems (mangroves in particular) in South Andaman. Through content analysis of 'grey' and peer-reviewed literature and thorough in-depth semi-structured interviews with key stakeholders, we map the discourses, rules and regulations governing the system. Land availability, ownership and tenure are major sources of conflict in ANI, where 86% of the land is protected by the Forest Department and only 6% is used for revenue purposes (i.e. development). This study focuses on South Andaman (2980 km²), where the tsunami-induced subsidence of 0 – 2.85 m caused the inundation of around 40 km² of coastal agricultural land, making it unsuitable for cultivation. Since these tsunami created wetlands are now tidally influenced, mangrove recolonisation has occurred at many sites. Results show that issues related to coastal land tenure were exacerbated after the tsunami, since a majority of the subsided land is privately owned. With a rapidly growing urban population, the land is perceived as being more valuable for infrastructural development through land reclamation instead of for wetland conservation. However, the governance of these wetlands remains fuzzy. Mangrove ecosystems are protected under the Island Coastal Regulation Zone Notification 2019. Since these tsunami created wetland areas are governed by the Revenue Department, mangrove conservation regulations are not implemented. Moreover, policies have not (yet) adapted to the changing environmental context. In light of future environmental uncertainties, a potential solution to address this conflict could be for the Forest and Revenue Departments to work together in revising policies to ensure the balance between land availability for infrastructural use and wetland conservation.

Code: P 14.6. Mangrove belowground biomass and necromass in Gulf of Nicoya, Costa Rica

Poveda, D.,[1] Rovai, A.,[1] Twilley, R.,[1] Pineda, J.A.,[2] Torres, D.,[3] Gutiérrez, O[2], Brenes, R.,[4] Cifuentes-Jara, M.,[5] Mackenzie, R.,[6] Gutenberg, L.,[6] & Wong, J.[2]

[1] Louisiana State University, United States of America [2] SINAC, Costa Rica [3] Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica [4] Silvestrum Climate Associates, United States of America [5] Conservation International [6] USDA, United States of America

Mangrove belowground biomass (live roots) and necromass production contribute to soil formation via direct organic matter inputs into the soil. Necromass is mostly composed by dead root material but also woody debris and to a lesser extent litterfall, which altogether represent the soil refractory organic matter pool. However, belowground necromass is often overlooked and its contribution to soil vertical accretion rates underestimated. Mangrove belowground bio- and necromass allocation may vary both among and within coastal environmental settings in response to geomorphic forcings and gradients in resources (nutrients), regulators (salinity, sulfate) and hydroperiod (flooding frequency, depth and duration). Here, we used the trench method (0.5x0.5x0.5m) to assess the variability in mangrove belowground bio- and necromass in two sites (Isla Verde=IV and Estero Pochote=EP) along the Gulf of Nicoya, a tide-dominated setting along Costa Rica's Pacific coast. We found no difference between sites for biomass classified in large (means ± 1SE; IV: 4.72 ± 2.05 Mg/ha, EP: 7.24 ± 1.91 Mg/ha) and small roots (IV: 19.78 ± 2.63 Mg/ha, EP: 20.42 ± 2.26 Mg/ha). For both sites large roots had less mass than smaller roots. Necromass was larger at EP (99.48 ± 7.17 Mg/ha) than at IV (4.12 ± 0.69 Mg/ha). These differences may reflect changes in hydroperiod and nutrient availability (analyses currently underway). Our findings highlight the significance of belowground necromass to soil formation, which at EP was nearly 4 times higher than biomass. To our knowledge, we deliver the first field-based belowground bio- and necromass estimates for Costa Rican mangroves. Our findings contribute to Costa Rica's National Blue Carbon Inventory and provide more accurate estimates of total root mass that are essential to parametrize soil cohort models that can predict sediment vertical accretion and carbon sequestration rates across other estuaries and deltas in Costa Rica and elsewhere.

Code: P 9.17. On contrasting mangrove forests and aquaculture in facing sea level rise

Priska, T.S.,[1,2] Murdiyarso, D.,[1,2] Kusmana, C.,[3] Bengen, D.G.,[4] MacKenzie, R.,[5] & Marrin, P.[2]

[1]IPB University, Faculty of Mathematics and Natural Sciences, Indonesia [2] Center for International Forestry Research (CIFOR), Bogor, Indonesia [3]IPB University, Faculty of Forestry and Environment, Indonesia [4]IPB University, Faculty of Fisheries and Marine Science, Indonesia [5] Institute of Pacific Islands Forestry, USDA Forest Service, United States of America

Low-lying coastal areas, including those stretch in Demak Regency, Central Java are vulnerable to sea level rise (SLR) due to the changing climate. By comparing the 30-year records of sea level with surface elevation change (SEC) via 18 rod surface elevation tables (rSETs), we evaluated the effect of management regimes in two contrasting Sub-regencies, Sayung, where coastal barriers and mangrove planting were artificially introduced, and Wedung, where mangroves regenerated naturally and no barriers were installed. Based on bi-monthly observations of SEC, it was indicated that mangrove forests in Sayung and Wedung of 1.46 ± 4.41 cm yr^{-1} and 7.58 ± 0.77 cm yr^{-1}respectively can cope with SLR of 0.45 cm yr^{-1}. On the contrary, abandoned ponds, which changed in ground elevation with respective rates of -4.54 ± 2.52 cm yr^{-1} and -0.50 ± 0.91 cm yr^{-1} have been failing to cope with SLR. In working ponds, however, Sayung site with SEC of 2.83 ± 1.53 cm $yr^{-1}$is better off than Wedung of 0.38 ± 0.82 cm yr^{-1}. These results suggest that leaving forest mangrove intact or managing aquaculture ponds protect the landscape from rising sea level. It is also observed that the coping mechanism is primarily contributed by the capacity of the landscape in accreting sediment, which ranged from -0.11 ± 0.56 cm $yr^{-1}$to 8.92 ± 0.29 cm yr^{-1} and has been estimated by marker horizon. It was observed that such capacity is undermined by shallow subsidence especially in regimes where mangrove is absent, i.e., in abandoned ponds with subsidence rates of 8.26 ± 4.50 cm yr^{-1}in Sayung, and working ponds of 4.77 ± 3.72 cm yr^{-1} and 5.16 ± 3.72 cm yr^{-1}in Sayung and Wedung respectively.

Code: P 9.76. Disaster risk reduction through mangrove management: A case study of Sundarbans and surroundings

Quader, M.A.,[1] Islam, M.J.,[2] & Abdul, M.[3]

[1]Professor, Department of Geography and Environment, Jagannath University, Dhaka 1100, Bangladesh, quader@geography.jnu.ac.bd [2]Post Graduate Student, Department of Geography and Environment, Jagannath University, Dhaka-1100, Bangladesh [3]Associate Professor, Department of Geography and Environment, Jagannath University, Dhaka-1100, Bangladesh

Mangrove forests are prevalent in regions of the tropics that are rich in wildlife and other non-forest resources. They provide a wide range of raw materials for manufacturing processes. They are a significant source of income and subsistence for the local population. The Sundarban Estuary is one of the world's most active estuarine deltas. Several river channels traverse the Sundarban Delta, bringing with them tons of silt from terrestrial sources and playing a significant part in the erosion of this shallow marine estuary. In this research, multispectral satellite imagery from 1972 to 2020 was used for Sundraban and 10Km Buffer area. Machine learning algorithm is used for image classification. All other segments, such as accuracy evaluation, change detection, and neighborhood under coverage, are analyzed using the contingency table, cross tabulation, and vector overlay methods, respectively. From 1980 to 2020, Dense Forest, Medium Dense Forest, and Sparse Forest was changed by 9.63 percent, 6.20 percent, and 1.24 percent, respectively. The largest transitions from dense to medium-density forest occurred in an area of approximately 1,325 square kilometers (8.34% of the total area). In this research, we highlight these trends and introduce this special issue of disaster risk devoted to the significant and recurring reduction of Mangrove risk. Compartmental and zonal-based analysis revealed risky areas that should be monitored. In response to abrupt and rapid sea level rises most mangrove plants and animals that live with them are hardy or resistant to most changes in their environment because they live on a harsh edge between land and sea.

Code: P 5.97. Plastic pollution in mangrove forests in the Colombian Pacific coast: a case study in Buenaventura bay

Quesada, C.A.,[1] Peña, E.J.,[1] Mejía-Rentería, J.C.,[3] Palacios-Peñaranda, M.L.,[2] Cantera-Kintz, J.R.[1]

[1] Universidad del Valle, Cali, Colombia [2] Instituto de estudios para la Sostenibilidad, Colombia [3] Institute of Marine Sciences and Limnology Incimar, Colombia

The presence of microplastics (MPs) has been observed globally in every marine environment, including mangroves. The aim of this study was to evaluate the impact of plastics in mangroves forests of two localities, San Pedro (SP) and Punta Soldado (PS) in Buenaventura Bay. Between February and December of 2022 six sampling sites per locality, three for outer mangroves (EXT) and three for interiors (INT) were established. Debris greater than 2.5 cm on the ground was collected, along transects of 28 m^2 transects inside the forests. Drone flights were carried out to monitor adjacent beaches and identify debris. In March, 86 residues were collected (PS 35 residues 1281.98 g, INT: 776.62 g and EXT: 1045.36 g, averaging 0.24 residues/m^2 and 12.52 g/m^2 and SP 51 residues 882.67 g, INT:261.64 g and EXT:621.03 g, averaging 0.35 residues/m2 and 6.16 g/m2) in August 147 residues (PS 51 residues 917.38 g, INT:543.43 g and EXT: 373.95 g with a density of 0.35 residues/m^2 and 3.30 g/m^2 and SP 96 residues 1662.45 g, INT:302.69 g and EXT:1359.76 g with densities of 0.66 residues/ m^2 and 11.43 g/m2). Drone monitoring on adjacent beaches resulted in 0 residues. In PS more plastic waste were accumulated due to its location in front of the coastline and the poor management of solid waste in the Bay. On the other hand, SP has a sandy beach and rocky cliffs in front of the coastline that prevent tidal waves from reaching the mangrove directly, and the waste is probably associated with tourist activity.

Code: P 14.9. Configuration of the socio-ecological system from the community management of the mangrove forest in the Estero de Jaltepeque, El Salvador.

Quintanilla-Magaña, A.A.[1]

[1]The University of Rhode Island, United States of America

The coastal zone is one of the areas most affected by climate change, especially by rising sea levels, increased natural phenomena such as hurricanes, accelerated coastal erosion, and the loss of mangroves and marshes. At this point, the community becomesrelevant because they are transforming a series of cultural patterns, social processes, and subsistence mechanisms used by them. In El Salvador, the Jaltepeque estuary shows an essential scenario of these dilemmas between conservation-use-exploitation, which can be seen from a systemic approach. As a study proposal, socio-ecological systems seek to explain the integration, transformation, and adaptation of social relations with their environment to establish appropriation mechanisms that lead to social and ecological modifications. As a result of being understood from a community scale, efforts are being made to take advantage of them sustainably and not allow external agents to generate disturbances that threaten subsistence. In this way, we sought to answer the following research question: How are community conservation practices constituted as a process of strengthening the components of the socio-ecological system in the Jaltepeque estuary? This led to explaining the functioning of this system through the generation of strategies of socio-spatial organization in defense of coastal ecosystems, specifically the mangrove forest. The research was conducted from April 2019 to February 2020 in eight communities whose main characteristic is to border the mangrove forest. We worked in a 59 km2 area with a population of 2700 people. A mixed methodology with a sequential transformative design was used, whose first collection process derived from the collection of qualitative data through semi-structured interviews and community tours, then giving way to the use of quantitative and cartographic techniques, through the use of a stratified survey by the community and the study of points of interest for the protection of the community and cartographic projection. As a main result, the socio-ecological system in Jaltepeque is generated through a mechanism of understanding concerning finding the limits of community action that expands before the scenario of loss of a resource of Common Use (the mangrove), first before internal agents of the populations, but mainly by the actions of external actors.

Code: P 15.18. Salinity influence on the flows and accumulation of organic carbon in open waters karstic mangroves

Quintero-Alvarado, A.P.,[1] Medina-Calderón, J.H.,[2] & Mancera-Pineda, J.E.[3]

[1]Instituto de Estudios en Ciencias del Mar - CECIMAR – Universidad Nacional de Colombia – Sede Caribe – c/o INVEMAR, Calle 25 2-55, Playa Salguero – Rodadero Sur, Santa Marta, 40006 – Colombia. [2]Jardín Botánico San Andrés, Universidad Nacional de Colombia - Sede Caribe, Isla San Andrés, Colombia. [3]Departamento de Biología – Facultad de Ciencias – Universidad Nacional de Colombia – Sede Bogotá – Ciudad Universitaria, Bogotá.

Salinity is one of the main regulators of the structure and functioning of mangrove forests, so the objective of this study was to evaluate its influence on the dynamics of aboveground and underground organic carbon accumulation. Open water karstic forests were selected, since this type of mangroves have been the least evaluated globally. To test the hypothesis of inverse relationship between salinity and organic carbon accumulation, we selected forests from the island of San Andrés, Colombian Caribbean with low salinity- oligohaline- (10.9±0.3 UPS), intermediate (39.1±0.3 UPS) and high –euhaline-(63.62±0.45 UPS). In each forest, permanent plots of 400 m^2 were established. During the period 2011 to 2019, baskets (n=70) of 0.25 m^2 were installed for the monthly collection of litter. Root production was assessed using the ingrowth core soil implant technique (84 soil cores), selecting live roots according to their diameter (<2 mm; 2–5 mm and 5–20 mm). The average content of organic carbon in the dry litter was 9.74 ± 0.28 Mg C $ha^{-1}a^{-1}$; 6.83 ± 0.27 Mg C $ha^{-1}a^{-1}$; and 4.68 ± 0.12 Mg C $ha^{-1}a^{-1}$; and dry roots was 2.53 ±0.98 Mg C $ha^{-1}a^{-1}$; 5.78±1.30 Mg C $ha^{-1}a^{-1}$; 5.04 ± 1.67 Mg C $ha^{-1}a^{-1}$; for the oligohaline forest; intermediate and euhaline salinity, respectively. These statistically significant differences support the proposed hypothesis and highlight the findings on the increasing influence that salinity could have on the carbon cycles of these forests.

Code: P 5.47. Carbon dynamics in various mangroves climate zones and habitat characteristics in Asia and the Pacific

Qur'ani, C.G.,[1] Sasmito, S.D.,[2,3] Maulana, A.M.,[1] Seol, M.,[1] Lee, B.,[4] & Baral, H[1,5]

[1]Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF), Situ Gede, Bogor 16115, Jawa Barat, Indonesia
[2]NUS Environmental Research Institute, National University of Singapore, 21 Lower Kent Ridge Road, Singapore 119077
[3]Department of Geography, National University of Singapore, Singapore 117411 [4] Warm Temperate and Subtropical Forest Research Center, National Institute of Forest Science, Jeju, Republic of Korea
[5] School of Ecosystem and Forest Science, University of Melbourne, Parkville, Vic 3010, Australia

Global mangrove loss from 2000 to 2016 was 3363 km^2 and carbon emissions have been projected to reach 2391 TgCO2 eq by the end of the century (2020-2100). Mangrove rehabilitation projects have been conducted around the world with careful consideration on species' selection for effective carbon absorption ability and carbon storage capacity, which are believed to differ according to the climate zone. Here we review and synthesize the ability of the variety of mangrove species in the Asia-Pacific region to absorb and store carbon, seeking to answer the primary question: how do local climates' physical characteristics (micro-meteorological) affect species' carbon absorption ability and carbon storage capacity? We focused on carbon dynamics, including absorption ability, stock, fluxes and sequestration of mangrove species under particular, local, climate characteristics. The review was based on peer-reviewed and grey literature (including unpublished studies) from 2018 onwards. Initial results indicate, that in tropical monsoon mangroves in Indonesia, *Rhizophora* sp. — one of the most dominant species — has higher carbon absorption ability than *Sonneratia* sp. and *Bruguiera* sp. at the same age of natural stands. The results showed differences at the same location, where *Sonneratia* sp. had the highest carbon absorption than other species. It is likely that local habitat characteristics contribute more to the species' carbon absorption ability, such us soil fertility, water salinity, and tree biomass, than climate zone. However, in another tropical monsoon climate in China, mean annual precipitation and radiation stimulated species' growth and density, which contributed to a higher ability of the species to absorb carbon, as shown by *Kandelia obovata* with highest carbon density (148.03 t ha^{-1}) followed by *Avicennia marina* (104.79 t ha^{-1}) and *Aegiceras corniculatum* (99.24 t ha^{-1}). Our results will be helpful for policy makers to select the suitable species in supporting rehabilitation programme in the future to compensate the emission of carbon due to the mangrove loss. It is highly suggested to select the most suitable species based on local habitat conditions for better results in rehabilitation programmes.

Code: P 15.50. Determination of ecosystem boundary, definitions, and parameters of ecosystem health

Rahmil, Y.I.,[a*], Suyadi[a*] Ulumuddin, Y.I.,[b] Prayudha, B.,[b] & Julzarika, A.[c]

[a]Research Center for Ecology and Ethnobiology, National Research and Innovation Agency, Bogor Indonesia [b]Research center for Oceanographic , National Research and Innovation Agency, Bogor Indonesia [c]Research center for Geospatial, National Research and Innovation Agency, Bogor Indonesia

Mangroves are transitional ecosystems between the sea and terrestrial as the name implies, a type of forest located on the coastline and river estuaries, whose existence is naturally influenced by tides, sedimentation from land, and the interaction of coastal ecosystems as a whole. However, the health condition of the ecosystem continues to decline due to anthropogenic activities which decrease ecological function, ecosystem services, and benefits for society. Therefore, an *ecosystem health index* (EHI) is needed which can be a reference in determining the health status of the ecosystem. Several criteria and index are already available such as standard criteria for vegetation damage and vegetation health index s, but these criteria and indexes still need to be developed again to become ecosystem health index s. Location selection based on mangrove typology, namely sedimentary setting and geomorphic setting geomorphological environmental setting. This study uses the method of identifying mangrove ecosystems, namely tides, which is part of the definition of mangrove ecosystems. Technically, this study uses microtopography as a *Digital Terrain Model* (DTM) with a sub-meter vertical resolution. High-resolution DTMs are created from a combination of high-resolution satellite optical imagery (i.e., *Planet Scope* and *WorldView-3*) and radar interferometry (i.e., Sentinel 1). High-resolution imagery is used to create digital surface models (DSMs), while radar is used to determine the true deformation of the Earth's surface. This method can produce DTM with a vertical resolution of 50 cm to 3 m with a confidence level of 95%. This model can be used to identify the location of intertidal areas, which are suitable for mangrove formation. Several methods such as Focus Group Discussion and Systematic Literature Review are used to obtain parameters of ecosystem health index.

Code: P 14.5. Assessing Potential Interactive Impacts of Urbanization and ENSO on Mangrove Greenness in the Colombian Caribbean

Ramírez-Ruiz, K.,[1,5] Dahdouh-Guebas, F.,[1,2,3,4] & Blanco-Libreros, J.F.[5]

[1] Systems Ecology and Resource Management Research Unit (SERM), Department of Organism Biology, Université Libre de Bruxelles - ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium [2] Ecology & Biodiversity, Biology Department, Vrije Universiteit Brussel - VUB, Pleinlaan 2, VUB-APNA-WE, 1050, Brussels, Belgium [3] Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN) [4]Interfaculty Institute of Social-Ecological Transitions - iiTSE, Université Libre de Bruxelles - ULB, Brussels, Belgium [5] Procesos Ecosistémicos a la Escala del Paisaje (PEEP), Instituto de Biología, Facultad de Ciencias Exactas y Naturales, Universidad de Antioquia, Medellín, Colombia

Mangroves are tropical coastal ecosystems threatened mainly by land cover change due to commodities. The effect of urbanization on mangroves has been overlooked due to the low percentage of area loss globally. However, it can be an important driver of mangrove loss at local scales. Besides, highly fragmented mangrove areas dominated by small patches might be more sensitive to climatic variability as occur in terrestrial forests. These effects would be more dramatic in the future since cyclones, heavy rainfall, and droughts are predicted to become more frequent due to climate change. However, little is known about the interactive effects of these less globally important drivers of mangrove loss, namely urbanization and extreme atmospheric events. Using the Colombian Central Caribbean as a case study, we describe the mangrove ecosystem response in terms of greenness (*i.e.*, Normalized Difference Vegetation Index - NDVI) to urbanization and El Niño-Southern Oscillation (hereafter ENSO) events. Our objectives are: (i) Evaluate the greenness variability relative to patch size and urbanization context; (ii) Relate greenness variability in mangrove patches to ENSO phases. Both objectives are achieved using remote sensing tools and GIS. This study demonstrates that understanding the impact of urbanization and ENSO-driven extreme atmospheric events on mangrove forests is key to its persistence and to inform conservation efforts, particularly for vulnerable species and in areas at risk.

Code: P 5.56. Spatio-temporal changes in mangrove forest biomass levels of Bhitarkanika Wildlife Sanctuary

Rasquinha, D.,[1*] Mishra, D.,[2] & McEntire, K.[3]

[1] Global Science, World Wildlife Fund, Washington, D.C., USA.
[2] Department of Geography, University of Georgia, Athens, GA,USA.
[3] Queens University of Charlotte, NC, USA.

Mangroves line highly dynamic environments and, in the process, are exposed to frequent tropical cyclones, along with other environmental interactions that shape the trajectory of this ecosystem. A range of environmental drivers (climate, physical or social) work in tandem with both large-scale and small-scale events that alter mangrove vegetation structure which ultimately influences aboveground biomass (ABG). This study focuses on the cumulative impacts of such events on mangrove biomass by quantifying the changes in biomass over the last seven years using high resolution satellite imagery, and by modelling this change using an agent-based model (ABM). The ABM results suggest that firewood extraction impacts on ABG occur at highly localized forest edges with almost negligible impact on the overall ABG estimates of the forest. In contrast, tropical storm impacts on ABG were found to significantly correlate with the storm path and wind speeds associated with the incoming storm. When compared with the overall change in forest ABG over the past seven years, greater decreasing changes were observed along edges while forest interiors showed signs of biomass accumulation. The clear pattern in ABG loss and gain along fragmented parcels of the forest indicates the plausible role of salinity fluctuations and subsequent changing species composition in this region in influencing the overall accumulation or loss of ABG. Through this comprehensive theoretical and empirical synthesis, this study highlights the significance of spatial variability in ABG change as an important factor to consider while planning restoration activities in this region considering the differential impact of environmental drivers on forest loss, growth, and health.

Code: P 5.87. Testing a site-specific approach for ecological restoration of degraded mangrove ecosystems, species communities and ecosystem services: Case study from Indian Sundarbans

Ray, K.,[1‡*] & Basak, S.K.[2‡]

[1]Environmental Biotechnology Group, Department of Botany, West Bengal State University, Berunanpukuria, Malikapur, Barasat, Kolkata 700126, India
[2]Sarat Centenary College, Dhaniakhali, Hooghly 712302, West Bengal, India

To date, degraded mangrove ecosystem restoration accomplished worldwide primarily belong in the continuum of ecological restoration to rehabilitation encompassing the major component of human-assisted large-scale plantations essentially with mono-species or a handful of mangrove species. However, researchers admit that success rate of most of these initiatives are either surprisingly low or statistical data are direly inadequate except for some remarkable restoration ventures. An integrating framework of holistic, scientific, applicable at community level-type ecological restoration approach for degraded mangrove ecosystem is being reported here from Indian Sundarbans. The lessons learnt from earlier successes/failures were scientifically addressed in this ecology-based approach to yield an active adaptive management for mangrove forest restoration. This study demonstrates an integrative restoration framework experimented during 2014-2023 (still continuing), in a small ~3.16 ha degraded shoreline mangrove patch with the final goal of full recovery of functionality of the ecosystem, supporting human well-being as well, considering the species assemblage and succession patterns of co-located protected mangroves under Sundarban Biosphere Reserve, India as the reference ecosystems. The site-specific strategies/key activities are based on novel scientific/ecological rationales, under-exploited in mangrove restoration. Both conventional and unique metrics are used to evaluate the restoration success. All the results indicate a gradual return of functional independence of the experimental ecosystem. This referred site was provisionally added to the OECM India internal database of potential OECMs and being closely monitored for stability and nature's ecological preference acting on introduced mangrove and associate species community. At present, this comprehensive restoration framework as a model for mangrove forest restoration is being demonstrated for another experimental ~60 ha of multi-site degraded mangrove ecosystem with financial assistance from Indian Government. This restoration framework, being more appropriate for stressed forest ecosystems could be applicable also for similarly-stressed terrestrial forests/ wetlands across the world, irrespective of their nature of degradation.

Code: P 9.80. Ecosystem Restoration Standard: a new approach to certify mangrove-based projects in the Voluntary Carbon Market

Raynaud, P.,[1] & Sorret, T.[1]

[1]ERS by Wildsense, *France*

Falling under the umbrella of Nature-based Solutions, mangrove restoration projects have multiple benefits for the sustainable development of coastal communities, such as increasing protection and resilience, supporting the local economy, providing habitat and breeding ground for biodiversity and contributing to global climate change mitigation efforts. Ecosystem services provided by healthy mangroves are worth at least USD 1.6 billion annually, with invaluable cultural and heritage assets. Mangrove restoration projects have gained substantial attention in the voluntary carbon market (VCM) recently. However, existing VCM Standards fail to capture the full potential of these projects as they solely focus on rapid carbon sequestration. Drawing on a decade of learnings, Wildsense created the first standard to certify ecosystem restoration projects, the Ecosystem Restoration Standard (ERS), based on four pillars: ecosystem recovery, climate, biodiversity and livelihoods. For each pillar, project developers perform a baseline assessment and select a reference ecosystem to define the objectives, targets and action plans. Putting community engagement at the core of the project design, ERS projects target the highest level of recovery and re-create the conditions for an ecosystem to thrive. ERS employs a mix of digital tools (field apps and cutting-edge remote satellite imagery), innovative technologies (LiDAR scanning, eDNA sampling and bioacoustics) and is building a network of local scientific institutions and specialists to access precise ecosystem data. These methodologies aim to deliver an accurate, efficient and robust monitoring and verification process for each pillar. As such, ERS seeks to bring integrity and transparency to the VCM while fostering community empowerment and securing finance for high-quality restoration projects.

Code: P 5.44. The potential of West and Central African coastal protected areas for Blue Carbon projects and mangrove restoration

Resende, C.H.,[1,2] Fatoyinbo, L.,[2] Barenblitt, A.,[2,3] Bailleux, R.,[4] Assogba-Sessou, L.,[4] & Desramaut, N.[5]

[1] University of Maryland, Baltimore County/ GESTAR II
[2] NASA Goddard Space Flight Center
[3] University of Maryland / ESSIC
[4] International Union for Conservation of Nature
[5] The World Bank

Despite the well documented ecological, economic and social benefits they provide, mangroves continue to suffer high rates of degradation and destruction, with global losses of 1-2% per year, exceeding those of terrestrial tropical forests. The West-African mangroves, approximately 11% of the world's mangrove area, constitute a major carbon sink at the global scale, and their protection is a priority in the context of climate change. Coastal conservation projects in West-African Marine Protected Areas (MPAs) have suffered from a lack of local funding and relies heavily on international funding sources, a less than ideal solution in the long run. Thus, finding local, durable funding solutions is a priority for these protected areas. The goal is to assist in the development of pathways for blue carbon projects in West Africa to access blue carbon finance and promote regional cooperation for climate change mitigation and adaptation through the restoration, conservation and sustainable use of mangroves at local, national and regional scale. To achieve this, we propose the development of mapping and monitoring approaches using remote sensing in order to evaluate the potential to put together Blue Carbon projects on the MPAs. We used a Landsat-based compositing approach (LandTrendr) and machine learning classifiers to develop annual land cover (eight key land cover classes, including mangrove forests, from 2000 to 2022) for approximately 275,000 Km^2 along the coast from Mauritania to the Democratic Republic of Congo, covering more than 235 MPAs. The yearly trend of land cover and mangrove extent allowed to identify restorable areas and key coastal MPAs to develop projects to be financed by the carbon credit market for climate change mitigation and adaptation.

Code: P 15.60. The mangrove swamp as classroom-laboratory space for addressing climate and environmental change: Innovative educational-research approaches in marginal rural communities of the Pacific (Golfo de Tribugá) and Caribbean (Isla Fuerte) coasts of Colombia

Restrepo-Moreno, S.A.,[1,2] Arroyave-Gómez, D.M.,[3] Henao, A.F-.,[4] Osorio, A.F.[5,6]

[1] PhD. Assiciete Profesor. Departamento de Geociencias y Medio Ambiente, Universidad Nacional de Colombia Sede Medellín (Colombia) [2] Adjunct Researcher-Professor. Department of Geological Sciences, University of Florida, Gainesville (USA) [3] PhD. Posdoctorate Laboratory of Aquatic Ecology University of Parma (Italy) [4] Undergraduate Student Forestry Engineering. Departamento de Ciencias Forestales, Facultad de Ciencias Agrarias. Universidad Nacional de Colombia Sede Medellín (Colombia). [5] PhD. Professor. Departamento de Geociencias y Medio Ambiente, Universidad Nacional de Colombia Sede Medellín (Colombia) [6] Director. Corporación Centro de Excelencia en Ciencias Marinas - CEMarin (Colombia)

The mangrove ecosystem is the epicenter of dynamic, diverse, and interconnected processes that involve the terrestrial subsystems, *geosphere*, *atmosphere*, *hydrosphere* and, of course, *biosphere*. From the anthropic point of view, the mangrove is also an important scenario for interactions within the *technosphere* with the other realms of the terrestrial systems, since the wide range of goods and ecosystem services the mangrove provides are key in maintaining the quality of life-livelihoods of the communities in their territories, and hence, their sustainability. However, this interesting geo-biotic domain has not been sufficiently "exploited" on the basis of its potential, and vital role, as an educational setting for multi-ethnic rural communities in coastal zones of Colombia. In our work we approach the mangrove to promote and incite the occurrence of multicultural, transdisciplinary conversations (geology, biology, chemistry, climatology, oceanography, etc.) with the territory, and in the territory, that will serve children, young people, teachers, and the community at large, in advancing local education agendas for the comprehension of diverse phenomena in earth sciences and the environment at the local level, albeit implications at the regional and global scales. We foster the development of diverse cores of pedagogical and didactic activities around the mangrove in the field of immersive, collaborative, problem based, place based learnings, so that the forms of production-appropriation-use of knowledge in the sciences, can occur in a close relationship with the space where the life of the communities develops, and on which those communities fully depend, particularly in the context of several UN´s SDGs. We focus for now on two locations. The first one, in the Caribbean, is related to small mangrove patches in Isla Fuerte (Bolívar) that are home to 4 mangrove species: white (*Laguncularia racemosa*), red (*Rhizophora mangle*), black (*Avicennia germinans*) and zaragosa (*Conocarpus erectus*). In this area, we are carrying out an alternative educational project with the support of the National Geographic Society, and with focus on the students and teachers that belong to the local (very precarious) public school institution. In the second locality we are concentrating our efforts on extensive and pristine mangrove stands of the Equatorial Pacific of Colombia in the Gulf of Tribugá (Chocó), where two additional species can be found, e.g., piñuelo mangrove (*Pelliciera rhizophorae*) and nato mangrove (*Mora oleifera*). At Tribugá, we are advancing an emerging interinstitutional research-education effort (U. Nacional, U. Tecnológica del Chocó, U. Parma, U. Florida, CEMarin) that involves local communities at the school level, as well as individuals that converge in other forms of social organizations (Consejos Comunitarios, fishermen, agriculturalists-peasants, and small entrepreneurs on eco-tourism). Geographically, both cases fall on important ecological hotspots (Caribe and Tumbes-Chocó, respectively) where the mangrove ecosystem is a key geo-biotic component that can also be utilized in the socio-environmental dimension as the cornerstone for building meaningful and useful academic commitments in which we seek collaboration with the local communities to advance in the investigation of carbon capture, sequestration and storage processes in the context of Blue Carbon (BC) strategies. We are convinced that BC offers excellent opportunities to guarantee mangrove conservation while improving environmental-human health, and hence the well-being and quality of life of coastal communities in Colombia. This approach also contributes to strengthening nature-based solutions to the pressing situation of global-local climate and environmental change. Although our work falls within challenge #5 (*Expanding the Global Mangrove Observing Systems, and implementing inclusive technological innovations and education to increase awareness*) posed by the MMM6 event "*Mangrove Ecosystems for Human Well-being in a Changing Planet*", we are committed to a strategy that, by enhancing the didactic-pedagogic experiences for the new generations, allows an integration of technological and cultural innovations at the local scale that would help placing the mangrove ecosystem as the epicenter of the educational-training process (and of land management) in marginal rural contexts, thus contributing in additional domains implied by the other 5 MMM6's challenges.

Code: P 15.64. A bioengineer in the city: the Darwinian fitness of fiddler crabs (*Minuca vocator*) inhabiting urban mangrove forests.

Riascos, J.M.,[1,2] Gomez, N.,[3] Quiceno, P.[1,2]

[1]Corporación Académica Ambiental, Universidad de Antioquia-Sede Ciencias del Mar, Turbo, Antioquia, Colombia.
[2]Corporation Center of Excellence in Marine Sciences - CEMarin, Bogotá, Colombia.
[3]Programa de Ecología de Zonas Costeras - Corporación Académica Ambiental. Universidad de Antioquia - Sede Ciencias del Mar.

Mangrove forests close to coastal cities are accumulating huge amounts of anthropogenic litter more than any other coastal ecosystem. Hence, populations of fiddler crabs which actively dig and maintain burrows in mangrove sediments—recognized as ecosystem engineers—may be significantly affected. As counterintuitive as it may seem, large populations of fiddler crabs are developing in urban mangroves, suggesting emerging adaptive phenotypic plasticity. To understand this, we first characterized phenotypic changes (abundance, body size and condition, length at sexual maturity and mortality) of the fiddler crab *Minuca vocator* inhabiting three types of mangrove forests along an urban-rural gradient of the Urabá Gulf (Caribbean coast of Colombia). Thereafter we estimated the lifetime reproductive success -an estimator of Darwinian fitness- in urban versus rural conditions during three spawning seasons (March to May 2022). Urban fiddler crabs were larger, exhibited higher body condition and longer (female) reproductive life span. Although urban female crabs consistently produced more eggs at any given age, there was no difference in the estimated number of eggs produced during the crab’s lifetime in urban versus rural forests. This can be explained by differences in size frequencies and particularly by higher female mortality in urban areas, suggesting increased predation rates. Our results highlight the fact that while fiddler crabs might be thriving in highly polluted mangrove forests, altered interspecific interactions in human dominated coastalscapes may impose significant challenges.

Code: P 9.53. Leaf litter degradation in an urban semi-arid mangrove forest (New Caledonia)

Robin, S.L.,[a] & Marchand, C.[a]

[a]Institute of Applied and Exact Sciences, University of New Caledonia, New Caledonia

Mangrove trees have high rates of primary productivity and the litterfall decomposition on the mangrove forest floor actively participates in the energy and material flow in the forest and constitutes an energy source for coastal productivity. Leaf litter decomposition has been investigated worldwide and multiple factors seem to influence decay rates and nutrients dynamics including leaves' chemical structures, tidal regime, and the microbial community of the forest floor. Therefore, results may differ with species and forest types.

In this study, leaf litter decomposition was investigated in a semi-arid mangrove forest (New Caledonia) for the two dominant species *Avicennia marina* and *Rhizophora stylosa*. The study site receives urban rainwater discharges for more than 50 years. Litterbags containing senescent leaves placed on the mangrove floor were collected after 7, 14, 28, 56, and 72 days. Macronutrients, total C and N contents with their stable isotopes were monitored during decomposition. Leaf litter follow a double exponential decay rate, with *R. stylosa* showing greater mass loss than *A. marina*, which is different from most studies. On the one hand, species developing closer to the seaside, in this case *A. marina*, usually show faster litterfall decomposition rates due to highest inundation frequency. On the other hand, species with the highest N content, here *A. marina*, show faster degradation, as it represents higher nutritional value for decomposers. We suggest that the urban runoff, delivered in the landside where *R. stylosa* develop, results in greater decay rates in this stand. Results show that the C/N, ^{13}C, ^{15}N, and macronutrients dynamics are species specific, determined by either the chemical structure of the leaves or the properties of their soil.

This study is part of a thesis, which aims to reduce the knowledge gap on the effects of urbanization on litterfall decomposition and organic matter dynamics in mangrove forests.

Code: P 15.30. Effect of interstitial salinity on growth and survival of individuals of *Rhizophora mangle* originating in environments with contrasting salinity

Robles, A.,[1] Mancera-Pineda, J.E.,[2] & Medina-Calderón, J.H.[3]

[1] Departamento de Biología – Facultad de Ciencias – Universidad Nacional de Colombia – Sede Bogotá – Ciudad Universitaria, Bogotá. [2]Departamento de Biología – Facultad de Ciencias – Universidad Nacional de Colombia – Sede Bogotá – Ciudad Universitaria, Bogotá. [3]Jardín Botánico San Andrés, Universidad Nacional de Colombia - Sede Caribe, Isla San Andrés, Colombia.

Rhizophora mangle presents phenological variability associated with interstitial salinity and has a crucial role within the ecosystem as a pioneer in ecological succession. Therefore, it is important to estimate how the growth and survival of the species are affected by a possible hypersalinization caused by climate change, as this will allow to take measures in terms of rehabilitation and restoration. Therefore, the aim of the study was to determine the effect of interstitial salinity on the growth and survival of individuals of *R. mangle* originating in contrasting conditions of this factor through a population crossing. 270 *R. mangle* propagules were selected from three structurally different mangrove forests with different ranges of natural salinity (Oligohaline: 11.6 PSU; intermediate salinity : 20.12 PSU and euhaline 37.67 PSU), which were sown in 2*2 m plots within these sites as follows: 90 propagules in the native forest and 90 propagules for each of the other forests. Growth, survival, presence of pathogens and salinity were measured in each plots of the three forests every two months for one year. It was hypothesized that individuals of euhaline and intermediate origin will have greater growth and survival in the three forests compared to individuals originating in the oligohaline forest. The results showed that the survival and the presence of pathogens were higher in individuals originating in euhaline and intermediate salinity forests. Growth rates were higher for individuals of euhaline and intermediate salinity origin in both their native forests and differential salinity forests. Research findings suggest that the growth, survival and adaptability of *R. mangle* propagules is greater when obtained in euhaline and intermediate salinity environments, allowing us to determine that these populations will be more successful for the rehabilitation and restoration processes against the hypersalinization caused by climate change in mangrove forests.

Code: P 9.92. Salinity and bulk density influence on the morphoanatomy and carbon content in underground roots of the main neotropical mangrove species

Robles, A.,[1] Quintero, A.P.,[2] Medina, J.H.,[3] & Mancera-Pineda, J.E.[4]

[1] Departamento de Biología – Facultad de Ciencias – Universidad Nacional de Colombia – Sede Bogotá – Ciudad Universitaria, Bogotá. [2] Instituto de Estudios en Ciencias del Mar - CECIMAR – Universidad Nacional de Colombia – Sede Caribe – c/o INVEMAR, Calle 25 2-55, Playa Salguero – Rodadero Sur, Santa Marta, 40006 – Colombia. [3] Jardín Botánico San Andrés, Universidad Nacional de Colombia - Sede Caribe, Isla San Andrés, Colombia. [4] Departamento de Biología – Facultad de Ciencias – Universidad Nacional de Colombia – Sede Bogotá – Ciudad Universitaria, Bogotá.

Bulk density (BD) and interstitial salinity have been found to be regulators of the structure and functioning of mangrove forests. However, its specific effect at the root level has been little explored. The objective of the present investigation was to evaluate the influence of these two factors on the organic carbon (OC) accumulated in the roots and the morphoanatomy (root diameter and aerenchyma size) of the subterranean secondary roots of the main neotropical mangrove species, *Avicennia germinans, Rhizophora mangle* and *Laguncularia racemosa*. To test the hypothesis of the inverse relationship between BD and salinity with the diameter of the secondary roots and the aerenchyma lacunaes, and direct relationship with the OC content in the roots, three forests were selected from the island of San Andrés, Colombian Caribbean. An euhaline forest (37.67 UPS), a forest with intermediate salinity (20.12 UPS), and an oligohaline forest (11.16 UPS). The BD of each forest (0.16, 0.17 and 0.11 g cm^{-3}, respectively) and the average OC content were estimated from the implant bag technique, selecting live roots <2 mm. Likewise, 240 root samples were taken for tissue analysis. The results show that the OC content in roots and soil decreased from the euhaline and intermediate salinity to then to the oligohaline (0.91 and 72.33; 1.52 and 81.35; 0.76 and 66.09 Mg C ha^{-1} yr^{-1}, respectively). It was found also, that under low oxygen availability and higher BD and salinity values, secondary roots with reduced aerenchyma occur, while thicker roots and prominent aerenchyma occur in environments of intermediate and oligohaline salinity. The morphoanatomical variation of secondary roots caused by salinity and BD are key to increasing nutrient up-take, which results in better rates of carbon sequestration in the soil. These findings allow generating conservation strategies for mangrove ecosystems.

Code: P 9.25. Assessment of temporal changes in the mangrove forest structure following hydrologic rehabilitation actions in the Ciénaga Grande de Santa Marta, Caleta del Tambor sector

Rodríguez, J.C.,[1,3] Cortés, I.C.,[1] Rodríguez, A.[2]

[1] Marine and Coastal Research Institute "José Benito Vives de Andréis"- INVEMAR. Marine quality program, marine and coastal restoration ecosystems. Santa Marta, Colombia [2]Deakin University, School of Life and Environmental Sciences, Blue Carbon Lab, Burwood, VIC 3125, Australia

Nearly 50% of the mangrove coverage in the Ciénaga Grande de Santa Marta was lost in the 1950s due to the hydrologic imbalance derived from anthropic pressures. The measures implemented for the ecosystem rehabilitation included the opening of some channels to reestablish the water flow between the main water body and the Magdalena River. These actions promoted the gradual recovery of the vegetation cover; however, in 2017 an increase in salinity was again registered along with mangrove cover loss in the Caleta del Tambor sector. Therefore, dredging and maintenance work was carried out on some channels. The aim of this study was to assess the mangrove structural changes over the period 2017 - 2022, as a performance indicator of the rehabilitation measures implemented. To do so, 100 m^2- permanent plots were installed, in which all individuals with diameter at breast height - DBH >2.5 cm were identified, and the main structural attributes such as height and DBH were measured. Salinity and water level were also recorded, and some parameters such as basal area, abundance, frequency and importance value index were estimated. Our results showed that in 2022 abundance and basal area were 18% and 50% higher, respectively, compared to 2017. In both years, trees mostly distributed in rather low diametric size classes were registered, being *Laguncularia racemosa* the predominant species. Pore water salinity decreased from 33 psu in 2017 to 26 psu in 2022, while the surface salinity from 7.4 psu in 2017 to 0.4 psu in 2022. The maintenance and dredging actions implemented in the channels adjacent to the sampling area promoted the decrease in salinity, one of the key factors in the establishment and development of mangroves, which contributed to vegetation growth.

Code: P 9.65. Closure period for *Anadara tuberculosa* y *Anadara similis*: participatory management experience in the mangroves of Bahía Golfito, Puntarenas, Costa Rica

Rodríguez-García, M.J.[1]

[1] Universidad de Costa Rica

Anadara tuberculosa and *Anadara similis*, are two species of mollusks extracted in the mangrove swamp of Bahía Golfito in Costa Rica for more than 30 years. Since 2016, the Mixed Association of Piangueros de Purruja (APIAPU) has worked on the responsible management of the piangua, according to the conditions requested by the state to operate properly as an association that extracts mangrove resources. APIAPU's work has been accompanied by state institutions such as the University of Costa Rica, the National Institute of Fisheries and Aquaculture (INCOPESCA) and the National System of Conservation Areas (SINAC) to support the construction of management instruments for both species. After many years of inter-institutional work together with APIAPU, a ban was decreed for mollusk species (piangua) in December 2022. As of January 2023, more institutions joined to organize the actions required by the ban period of a mollusk in Costa Rica. Many gaps have been found to achieve sustainable socioeconomic development of piangua extraction in Golfito and equity for people who have dedicated themselves to doing it responsibly.

Code: P. 9.74. Structured decision-making process to prioritize mangrove restoration: a proposal for the Ciénaga Grande de Santa Marta (Colombia)

Rodriguez-Rodriguez, J.A.,[1,2] Ocampo, D.,[3] Megan, S.,[4] Rojas, Y.,[2] Montes, C.,[2] Rodrigo, B.[4]

[1] Deakin University, School of Life and Environmental Sciences, Blue Carbon Lab, Burwood, VIC 3125, Australia. [2] Marine and Coastal Research Institute "José Benito Vives de Andréis"- INVEMAR. Marine quality program, marine and coastal restoration ecosystems. [3] Foundation Commonwealth Scientific and Industrial Research Organization (CSIRO) Chile, Santiago, Chile [4]Commonwealth Scientific and Industrial Research Organization (CSIRO), Environment, St Lucia, Australia

For their multiple benefits, mangroves have been considered one of the most important ecosystems to restore in this decade. Barriers to implementing restoration projects massively, including a shallow rate of political will and involvement of stakeholders, highlight the need to improve the participatory processes and increase public trust in decisions in mangrove restoration. Structured Decision Making (SDM) is a framework that guides the thinking to take decisions informed, transparent and defensible way to achieve desired outcomes. SDM has been applied broadly in the context of conservation and restoration ecology of terrestrial ecosystems but scarcely in coastal systems. Considering the potential of SDM to support the decisions of practitioners with multiple and competitive views, this study built an SDM proposal using as a study case the Cienaga Grande de Santa Marta, a wetland with more than 60 years of spatially explicit degradation, recovery, restoration and persistence. To estimate biophysical feasibility, a retrospective analysis of the swamp was conducted. To explore the specific inflection points, Normalized Difference Vegetation Index (NDVI) and mangrove coverage maps were used to examine the vigour and temporal variability of the vegetation between 1985 and 2020. Based on the historical extent, water and vegetation permanence and past restoration actions, six mangrove clusters were identified, and nine actions to recover coverage and their feasibility. In total, 13.100 ha of mangroves could be recovered (95% of target coverage). The complete conceptual model requires the definition and consensus with multiple stakeholders about restoration objectives and their trade-offs, logistical, social feasibility and cost-effectiveness analysis, which we suggest developed in subsequent studies. The proposal could be used as a decision analysis model in mangroves worldwide requiring restoration.

Code: P 5.32. A conceptual model to support decisions in mangrove restoration based on techniques, knowledge, and experiences in colombia

Rodriguez-Rodriguez, J.A., [1,2] Tavera H.,[3] & Cortes, I.[2]

[1] Deakin University, School of Life and Environmental Sciences, Blue Carbon Lab, Burwood, VIC 3125, Australia.
[2] Marine and Coastal Research Institute "José Benito Vives de Andréis"- INVEMAR. Marine quality program, marine and coastal restoration ecosystems.
[3] Ministerio de Ambiente y Desarrollo Sostenible, Colombia

Failures in mangrove restoration highlight the need to have evidence and practical tools to identify and choose the most effective techniques. By compiling and combining knowledge from multiple sources, evidence synthesis can increase complex processes' explanatory power and provide decision-makers support and confidence. In this talk, five mangrove restoration experiences implemented in Colombia in 2021 will be shown including the main components of their designs, the stakeholders involved and the preliminary implementation results. As a result of these experiences and lessons learned, a conceptual model was built to guide the selection of proper restoration techniques to face different challenges.
The conceptual model is advisory and intended to help guide thinking rather than be prescriptive since conditions are particular in each site, and different ecological and social factors must be considered. In any case, following literature and protocols reviewed and experiences in some restoration contexts, the conceptual model attempt to guarantee the improvement of biophysical conditions to face diverse stressors through the application of techniques such as hydrological restoration, sediment elevation, cleaning competitive vegetation, to improve management measures and local governance, reforestation, monitoring and a combination of them. The conceptual model proposed is a simplified view to describe the hypothesis that further evidence synthesis may aim to test. It is a starting point to identify knowledge gaps to guide the development of a restoration-relevant research agenda and guide decision-makers and practitioners easily.

Code: P 9.95. Root dynamics and effect of logging in a delta estuarine mangrove of the Colombian Caribbean

Rojas-Aguirre, A.S.,[1] Mancera-Pinedo, J.E.,[1] & Sánchez-Núñez, D.[1]

[1]Universidad Nacional de Colombia

Mangroves, as part of blue carbon ecosystems, provide an important service by capturing and storing carbon in their aboveground biomass and soil. In recent years, blue carbon research has growth, but few studies have related belowground biomass and root production in response to logging activities, which will increase the knowledge about the contribution of roots to the soil, considered as the main carbon pool in mangroves. In a highly dynamic deltaic estuarine mangrove in the Colombian Caribbean, the root biomass was assessed and the production, turnover, and longevity of live underground roots (≤20 mm in diameter) was analyzed using the in-growth core technique, one year later of applying four treatments in 40 plots of 49 m^2: Control without logging, low logging and high logging (reduction of 10, 30, and 50% of the basal area, respectively). The results showed low root production (between 28.0 ± 3.6 and 39.9 ± 11.6 g m^{-2} a^{-1}) compared to other Caribbean mangroves (between 80 and 643 g m^{-2} a^{-1}), and not significantly differences between the four treatments (Q=0.96; GL=3; p=0.416). Contrary to other studies and regardless of the treatment applied, root longevity was high (between 68.8 ± 17.4 and 88.7 ± 18.2 y) and the root turnover was slow (between 0.013 ± 0.002 and 0.019 ± 0.007 y^{-1}). This was related to the low root production and the high biomass of belowground roots found in this mangrove (between 2,244.9 ± 254.1 and 2,639.0 ± 268.0 g m^{-2}), which in turn was associated to the continuous availability of nutrients from the Sinú river, the reduced depth of the soil, and the permanent flood conditions (11 months) and high salinity (>43). It was concluded that, beyond the impact of logging, the root dynamic of this mangrove was determined by the natural conditions of the deltaic estuarine system.

Code: P 9.91. Mangrove blue carbon in islands vs mainland located in the Caribbean and Pacific coasts of Colombia

Rojas-Aguirre, S.,[1] Torres-Duque, J.,[1] Hoyos-Ruiz, T.,[1] Mosquera-Quejada, E.,[1] Herrera-Fajardo, S.,[1] Hernández-Ortiz, M.,[1] Hernández, L.,[1] Pardo-Spiess, S.,[1] & Diana Gómez-López, D.[1]

[1]Instituto de Investigaciones Marinas y Costeras “José Benito Vives de Andréis” – INVEMAR, Santa Marta, Colombia

In Colombia, one of the main ecosystem services of mangroves in the Pacific and the Caribbean is carbon sequestration, which depends on the type, state, and conditions of the forest area. This study contrasted the results of blue carbon stocks in four mangrove areas, measured in rectangular plots of 500 m^2 and circular plots of 452 m^2, in which data and samples of three carbon pools were collected: Soil (to 50 cm depth), aboveground living biomass and aboveground dead biomass. The results showed that the highest carbon contents were stored in soils (58-84%). Regarding the total carbon contents, the highest average reported was in an oceanic island in the Caribbean (461.7 ± 97.1 MgC ha^{-1}). In the second place, the mangroves of an estuarine delta complex in the Colombian continental Caribbean, with an average of 457.0 ± 86.6 MgC ha^{-1}; this area is part of the first blue carbon credit certified Project, where management measures have been implemented under a mitigation approach to deal with climate change. In the third place, the mangroves of a bay with high rainfall located in the continental Pacific, with an average of 220.4 ± 57.8 MgC ha^{-1}, and last but not least, the lowest contents were recorded on mangroves in the Colombian continental Caribbean affected by changes of land use (206.4 ± 19.1 Mg C ha^{-1}). The characteristics of each mangrove area showed the variability of their capacity as carbon sinks, which is consistent with the general pattern of carbon contents and confirms the importance of this ecosystem in terms of its contribution to climate change mitigation.

Code: P 15.31. Estimation of Blue Carbon for the Mangrove Community of La Playa Mermejo, Gulf of Montijo, Ramsar Site, Panama.

Romero, T.E.,[1,2,5] Vargas, S.,[2] Mojica, M.,[3] Fernandez, A.,[2] & Martinez, E.[4]

[1] Colectivo de Ecólogos [2] Universidad Marítima Internacional de Panamá [3] Universidad Autonoma de Chiriqui [4] Tecnología, Red, Educación, Naturaleza y Ambiente [5] Smithsonian Tropical Research Institute

Panama had one of the largest expanses of mangroves in Central America. Mangrove loss between 1969 and 2007 is estimated to have left less than 50% of the original cover. This reduction is associated with different anthropogenic activities,including extension of agricultural and livestock frontier, unplanned urban development, and modification of the coast for ports, industry, and tourism. The remaining mangroves increase is of national importance as blue carbon initiatives gain traction. We collaborated with local community members to study the 820 ha mangrove at the Playa Mermerjo, Gulf of Montijo Ramsar Site on the Pacific Coast, Panama. This community, composed of so-called peasant settlements, has evolved to take advantage of the fishing resources and those directly associated with the mangrove swamp. Community members identified this area as threatened and requested research to understand their observed changes in mangrove cover. To this end, we generated a baseline, we estimated the total ecosystem carbon stock (TECS) using the methods generated by the Blue Carbon initiative and adapted by the Ministry of the Environment of Panama for this site. We provide a preliminary data on the TECS found an average value of 178.36 ± 10.28 Mg/C ha. The component with the greatest contribution is the aerial component of live trees which contributed 139.53 ± 83.67 Mg/C ha. Dead trees were uncommon, which was reflected by their low contribution to total carbon (1.47 ± 36 Mg/C ha). This study provides the first carbon estimates for this Ramsar site that represents 11% of Panama’s total mangrove cover. These results highlight the potential of carbon storage in this area to contribute to national climate change mitigation and adaptation.

Code: P 5.73. Mangroves as Fish Habitat: A review of field studies published since 2006

Ross, B.[1]

[1]University of Miami, United States of America

Mangroves have drawn increasing attention as fish habitat since the 1950s. One of the main contributions made by mangroves to marine ecosystems is their role as habitat for fishes, often of commercial and recreational importance. Over the past two decades, there have been many mangrove-fish field studies, which have provided key information for resource managers and researchers. It has been sixteen years since the last review of mangroves as fish habitat was published, and many additional studies have been performed in the interim. This project consisted of an update of a previous review of mangrove-fish field studies that were published from 1955 to 2005 (Faunce and Serafy, 2006). As with the previous article, all literature reviewed was required to fit two criteria: (1) the study must be available in primary literature listed in the science citation indices of Scopus, Web of Science, and/or ASFA (Aquatic Sciences and Fisheries Abstracts); and (2) publications must include empirical data on fishes in natural mangrove systems. Reports in conference abstracts, commentaries, news articles, and editorials were not considered. Data were gathered on geographical location, study purpose, methodologies used, types of data gathered (biotic and abiotic habitat metrics), and statistical tests performed from 2006-2022.most recent publication on this topic (i.e., Faunce and Serafy 2006).

Code: P 5.29. Visual surveys reveal coral growth in mangrove fringes in a subtropical metropolis

Ross, B.,[1] Flowers, K.,[1] Golembeski, P.,[1] & Karp, R.[2]

[1]University of Miami, United States of America
[2]Marine Biology and Ecology, United States of America

Coexisting mangrove coral habitats (CMC) can be found globally yet are still underreported. This study aimed at locating CMC habitats in Miami, Florida and categorizing them. Miami-based surveys of these habitats occurred in the spring of 2022. CMC habitats were found at Virginia Key Outdoor Center (VKOC) and Bill Baggs Cape Florida State Park (Bill Baggs). These sites were categorized based on terminology from Stewart et al. (2022) :(1) lagoon, (2) inlet, (3) edge, and (4) canopy. HOBO pendant loggers were deployed at each site to record temperature and light parameters. The VKOC site represented an inlet habitat, because of the restricted water flow of the area and the corals' location in the channel. The corals, *Siderastrea radians*, were only observed on the west side of the channel inside the mangroves' canopy shade growing on the sandy bottom. Tissue biopsies of seven corals were taken from this site and processed at the Rosenstiel School of the University of Miami to identify symbiont community composition using a modified DNA extraction protocol and quantitative-PCR for the actin genes of *Symbiodinium*, *Breviolum*, *Cladocopium* and *Durusdinium*. No Name Harbor, located inside of Bill Baggs, is semi-enclosed by mangroves and has restricted water flow making this site a lagoon habitat. This location had a mix of sand/rock substrate with *Siderastrea radians, Porites divaricata,* and *Oculina diffusa* growing on the east shore of the lagoon. These colonies were partially shaded by the mangrove canopy. Coral tissue samples were extracted from 18 corals and processed as described above. The average temperature range between the two sites was 26.7°C-30.91°C. Light levels ranged from 303.9-505.3 (lx).
For the first time, coexisting mangrove-coral habitat has been documented and described in Miami-Dade County. These results urge other academics to search for CMC habitats.

Code: P 5.57. Biodiversity and connectivity of mangrove-seagrass ecosystems in South Africa using a metabarcoding approach

Rossouw, E.,[1] Peer, N.,[1] Heyden, S.[1]

[1]Stellenbosch University, South Africa

Coastal vegetated ecosystems (CVEs) such as mangroves and seagrass have been highlighted as harbors of high biodiversity over small geographic ranges. These high levels of species richness are facilitated by habitat connectivity as well as through their ability to provide nursery ecosystem functions. In the Anthropocene, a consistent theme is the need for regular monitoring of mangrove and seagrass systems to detect change in ecosystem health and distribution. However, the need for more detailed biodiversity surveys, and ongoing monitoring is limited in part by the need for less extractive and destructive sampling methods as well as funding limitations for high resolution data, which can be circumvented by eDNA metabarcoding. This study aims to address the lack of genetic barcodes for mangrove-associated fauna to (1) assist with primer development, (2) investigate the mangrove-seagrass gradient in terms of invertebrate diversity, and (3) investigate the mangrove-seagrass gradient in terms of nursery function. The data will be collected along South Africa's eastern coastline, covering two biogeographical regions. To assist with primer development, representative mangrove-associated decapod and gastropod species will be collected, whereafter these samples will be subjected for barcoding. We will collect sediment and water samples for eDNA metabarcoding to investigate the mangrove-seagrass gradient. Against this, background I will present preliminary results regarding the community assemblages captured by the eDNA.

Code: P 9.21. Global patterns of Mangrove genetic diversity

Rowntree, J.K.,[1] Avicena, N.R.,[2] Bin, A.A.,[2] & Shan, A.K.,[2]

[1]School of Biological and Marine Science, University of Plymouth, Plymouth, UK
[2]University of NoKngham Malaysia, School of Environmental and Geographical Sciences, Semenyih, Malaysia

Molecular tools have become invaluable in ecological studies since their development, providing essential information on species' connectivity and dispersal. A wide range of population genetic studies have been undertaken in mangroves, but each generally focusing on specific species, either at a relatively small geographic range, or sampling fewer locations at a larger scale. This approach is fundamental for answering ques1ons about population genetic and phylogeographic structure, but makes it difficult to understand universal patterns governing mangrove genetic diversity. Using the frame work of a systematic review, we have gathered published microsatellite data on the population genetic diversity of mangrove species from over 70 studies across the globe into a single database. This has resulted in over 1,000 individual data points, with over 400 from the Atlantic East Pacific and over 600 from the Indo West Pacific regions. We collected information from 14 genera in total, although the vast majority of studies focused on two (*Rhizophora* and *Avicennia*). We have used this informa1on to map how genetic diversity is distributed within and among species and to assess geographic and environmental factors influencing the distribution. Our work highlights missing data in geographic coverage and species, allowing us to focus future data collection efforts. We hope to use this initiative to bring together a network of mangrove population genetic researchers to share data for wider and more in depth analyses and to develop standardised methods and sampling strategies to support future research foci.

Code: P 14.1. Use of terrestrial laser scanner to determine allometric equations and carbon stocks in aboveground biomass of mangrove forests in semi-arid region (New Caledonia)

Roy L.,[a,b] Marchand, C.,[b] Macher, H.,[a] Landes, T.,[a] & Grussenmeyer, P.[a]

[a]University of Strasbourg, CNRS, INSA Strasbourg, ICube Laboratory UMR 7357, Photogrammetry and Geomatic Group, 67000, France. (helene.macher, tania.landes, pierre.grussenmeyer)@insa-strasbourg.fr

[b]Institut des Sciences Exactes et Appliquées (ISEA EA7484), Université de la Nouvelle-Calédonie, 145 Avenue James Cook, Nouville, BP R4 98851, Nouméa Cedex, New Caledonia (leyla.roy, cyril.marchand)@unc.nc

Mangroves belong to the “blue carbon ecosystems” because of their great capacity to store carbon in their soil and in their biomass. Mangroves aboveground biomass (AGB) depends mainly on the species and on the climate. To obtain a precise knowledge of carbon stocks, allometric equations must be determined for each species and in each climatic region. Currently, tropical mangroves are more studied that those developing in arid, semi-arid, or temperate regions. The west coast of New Caledonia is subject to a semi-arid climate. Mangroves cover more than 80% of this coast, and are dominated by Rhizophora stylosa (55%) developing on the seaside, and Avicennia marina (14%) developing at higher elevation. If some studies were interested in soil carbon stocks, none was focused on AGB, and no allometric equations were developed for this specific context. Determining allometric equation is labor intensive, time consuming and mainly performed by destructive methods. We offer an accurate and non destructive method to estimate the AGB for Rhizophora stylosa and Avicennia marina. This method uses tree compartment volumes using point clouds acquired from terrestrial laser scanner. Forty trees per species were scanned to determine the tree compartment (trunk, branches, roots and leaves) volumes. In addition, tree samples were collected, measured, and weighted to determine the density of each tree compartment. We combined volumes and densities to estimate the different biomasses and determine specific allometric equations. Results show lower carbon stocks in AGB in the site studied than in tropical mangroves, probably because of the semi-arid climate that limits mangrove growth. However, R. stylosa stock more carbon than A. marina. We suggest that their position on the seaside of the forest limits soil salinity, favor nutrient inputs and thus their growth conversely to A. marina that develop on highly saline soils.

Code: P 9.23. Cartagena mangroves: reservoir of bacteria with biotechnological potential

Rubiano-Labrador, C.,[1*] Acevedo-Barrios, R.,[1] Gutierrez, M.,[1] García, A.,[1] Colina, A.F.,[1] Perez, D.,[1] & Correa, J.C.,[1]

[1]Universidad Tecnológica de Bolívar, Colombia

Mangroves are widely distributed worldwide in tropical and subtropical regions. The biochemical characteristics and environmental conditions of these ecosystems make them considered hot spots of microbial diversity and represent a source of metabolites with metabolic potential. In Cartagena (Colombia), mangroves cover an area of 824 ha and represent one of the predominant ecosystems. Although the biological and economic value of these mangroves is evident, it is essential to know in depth their biodiversity to achieve their sustainable use. Therefore, the objective of this study was to characterize cultivable bacteria associated with mangroves in Cartagena and identify their metabolic potential. The methodology used consisted of: (i) isolation of bacteria from mangroves located in Cartagena, (ii) phenotypic and molecular characterization of isolated bacteria, and (iii) evaluation of the metabolic potential (hydrolytic enzyme activity, resistance to heavy metals, perchlorate reduction capacity and antimicrobial activity). In this study, we isolated 30 heterotrophic, aerobic, and halotolerant bacteria related to the genus *Bacillus*. The evaluation of the metabolic potential revealed that most of the isolates produced amylases (89%), followed by proteases (74%) and lipases (8%). Likewise, it was detected that 63% of the isolated strains are resistant to Pb and 16% to Ni. In addition, some of the isolated strains presented perchlorate reduction percentages of up to 25%. Additionally, 5 strains presented antimicrobial activity against the evaluated pathogenic bacteria and one strain presented antagonistic activity against *Rhizoctonia solani*. This study showed that the mangroves of Cartagena are a source for the isolation of bacteria with biotechnological potential due to their capacity to produce hydrolytic enzymes, resistance to heavy metals, reduction of perchlorate and antimicrobial activity.

Code: 5.65. Nature-based solutions: Restoration of the systems of canals, marshes, mangroves and corks as a mechanism to address the effects of the salt wedge, rising sea levels and coastal erosion in the Sanctuary of Flora and Fauna El Corchal "El Mono Hernández".

Ruiz-Morales, O.

Declared in 2022 as a protected area, the Sanctuary of Flora and Fauna El Corchal "El Mono Hernández" (SFFCMH), has 3899 hectares of which 1,961 are mangrove forests, in which the five species of mangroves registered for Colombia are found; in addition, there are the only representative samples of pure stands of swamp forests of "cork" (*Pterocarpus officinalis*) in the Colombian Caribbean. Among the conservation objectives of the SFFCMH is the conservation of mangrove and cork ecosystems in its area of influence, proposing the active restoration of 434 hectares of mangrove and cork forests in the SFFCMH. To achieve this, restoration areas will be established where red mangrove (*Rhizophora mangle*), black or salty mangrove (*Avicennia germinans*), mangrove (*Laguncularia racemosa*) and cork (*P. officinalis*) will be planted using chinampas or planting cores techniques, taking advantage of natural materials such as sediments and plants of the Typha genus. The SFFCMH also seeks to reestablish hydrology by reconnecting water flows with freshwater and/or brackish-marine water sources through the rehabilitation of natural canals and the creation of new lateral canals. Another of the strategies implemented in the SFFCMH are conservation agreements with the actors that generate pressures on the strategic ecosystems within the protected area, through the strengthening of green businesses. All the activities involve members of the communities surrounding the SFFCMH area. It can be concluded that stream rehabilitation actions are fundamental to maintaining the dynamics and good health of the mangrove and cork forests, given the high sedimentation rate observed in the SFFCMH, and should be applied periodically. The actions developed by the environmental authorities along the Magdalena River basin should be articulated and integrated, so that the impacts are manageable in the coastal areas; likewise, integrating the communities in the environmental rehabilitation and recovery processes qualifies the population and prepares them for future changes that may occur in their environment.

Code: P 5.88. Optimizing "Blue Carbon" Information as a Complementary Strategy to Mangrove Conservation and Restoration: A Meta-Analysis on Carbon Stocks in Philippine Mangroves

Salmo, S.G.,[1*] Corcino, R.C.,[1] Gerona-Daga, M.E.,[1,2] Naputo, C.F.,[1] Ticman, K.D.,[1] Samoza, S.C.,[1] Fraga, J.K.,[1] & Blanco, A.C.[3]

[1]Institute of Biology, College of Science, University of the Philippines Diliman, 1101 Quezon City, Philippines
[2] Division of Natural Sciences and Mathematics, University of the Philippines Visayas Tacloban College, 6500 Tacloban City, Philippines
[3] Department of Geodetic Engineering, College of Engineering, University of the Philippines Diliman, 1101 Quezon City, Philippines

Mangrove conservation and restoration programs were implemented in the Philippines as early as the 1990s. These programs ideally helped maintain mangrove "ecosystem health". Despite these, most Philippine mangroves remain degraded, although some areas are still relatively intact. Since mangrove health is directly related to its efficiency to sequester and store carbon, "blue carbon" science provides a new dimension that helps enhance mangrove conservation and restoration. To date, knowledge on the contribution of these programs to blue carbon remains unexplored. The contrasting intact and disturbed mangrove forests in the Philippines vis-a-vis high typhoon frequency, coastal development needs, and unsuccessful mangrove rehabilitation programs present a unique case study. We compiled blue carbon studies in Philippine mangroves and analyzed the factors that contributed to trends in carbon stocks (CS). Our results recorded 81 studies spanning 13 years in 20 (out of 82) provinces. Mangrove blue carbon studies became apparent only in the last five years. Average total ecosystem CS was 400 Mg ha^{-1}(range: 58 to 1,747 Mg ha^{-1}) which is 32 to 55% lower than most SE Asian countries. This wide variation can be attributed to inherent environmental complexities and exposure to disturbances. Among tested variables, total biomass ($R^2 = 0.83$), areal extent ($R^2 = 0.53$), and soil temperature ($R^2 = 0.44$) have the strongest relationship to CS. These are also known to affect biodiversity, a major indicator of conservation success. Results of this study can be used to complement conservation metrics, which helps enhance blue carbon research and policy. In the Philippines, future actions should prioritize sustained research and monitoring of vegetation conditions, mangrove cover, and post-disturbance recovery. These, in turn, drive implementation of policies that support the integration of blue carbon in conservation and climate change adaptation strategies.

Code: 5.91. Trophic niches of estuarine fish and evidence of mangrove-fishery causal links in the Southern Caribbean (Colombia)

Sandoval, L.A., [1,2], Erős, T., [1] Blanco-Libreros, J.P.,[3] & Delgado-Huertas, A.[4]

[1] Balaton Limnological Research Institute, ELKH, Klebelsberg K. u. 3., 8237 Tihany, Hungary.
[2] Universidad de Antioquia, Corporación Académica Ambiental, 057860 Turbo, Colombia.
[3] Universidad de Antioquia, Facultad de Ciencias Naturales y Exactas Instituto de Biología, 050010 Medellín, Colombia.
[4] Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Avda. de las Palmeras, 4-18100 Armilla, Granada, Spain.

Mangroves provide habitat to numerous fish species in tropical estuaries but demonstrating a trophic linkage remains elusive in many locations. Fish trophic guilds have been used in mangrove-dominated estuaries to simplify the understanding of trophic ecology by reducing the diversity of feeding interactions that exist between fish and their prey into manageable groups. To improve our understanding of trophic structure of fish communities in a major Southern Caribbean delta (Atrato River), we used $\delta^{15}N$ and $\delta^{13}C$ to assign trophic guilds of the most abundant fish species and estimated their trophic niches through Bayesian models. We also examined the relationships between the abundance of the trophic guilds (catch per unit effort) and environmental variables in this area. The zoobenthivore guild was dominant in terms of number of species. The isotopic niche width, based on the Bayesian estimate of the standard ellipse areas (SEA_B), was larger for planktivores (4.6 ‰^{2}) and carnivores (4.4 ‰^{2}) than for omnivores (1.4 ‰^{2}) and phytobenthivores (0.8 ‰^{2}). The trophic niche overlapped only between carnivores and planktivores (3.8-4.37 %). The considerable niche segregation of the fish community confirms diversity in food sources in the estuary. Zoobenthivore fish linearly correlated to mangrove area and zooplankton biovolume (R^2 = 0.60) while omnivores were positively associated with mangrove area (R^2 = 0.56). Mangrove area was the main factor explaining trophic guilds (omnivores and zoobenthivores) at the bottom of the trophic chains, supporting that the causal links between mangrove habitat and local fishing yield may be explained through the trophic contribution of mangroves and mangrove-related sources. These results can potentially be used for guiding ecosystem-based management of fisheries in mangrove-dominated estuaries.

Code: P 5.61. Deterioration of mangroves and its impact on eutrophication increase: evidence in a tropical estuarine lagoon complex

Santos-Becerra, L.,[1] Mancera-Pineda, E.,[1] Arteaga-Sogamoso, E.,[2] Vivas-Aguas, L.J.,[2] Franco-Angulo, J.C.[2]

[1]Universidad Nacional de Colombia
[2]Instituto de investigaciones marinas y costeras José Benito Vives de Andréis - Invemar

We used IRMA eutrophication index to analyze the occurrence of fish mass mortality risk during the last 25 years at 28 sampling sites in the Ciénaga Grande de Santa Marta complex (CGSM), the largest and most productive lagoon-estuary system in Colombia. The CGSM provides a dramatic example of negative anthropogenic effects, where the loss of a large mangrove area (~350 km2) and a significant reduction in commercial fish populations were induced by salinity concentration routinely exceeding 90 UPS on mangrove soils. The mechanisms involved in the recurrent fish die-offs reported in CGSM during the last three decades are associated with the increase in PO4 concentrations, which stimulates the massive growth of microalgae, mainly atmospheric nitrogen-fixing cyanobacteria. After overproduction, the cyanobacteria collapse, producing extensive dead zones, where hypoxia/anoxia causes massive fish kills. To understand the relationship between mangrove decline and eutrophication increased, we used the IRMA index to predict the risk of fish mortality based on PO4, chlorophyll, and dissolved oxygen concentrations from CGSM. We calculated IRMA in lagoons surrounded by different live mangrove: dead mangrove ratios (LM:DM) (0,28; 0,66; 0,56; 0). The results show a clear inverse relationship between the LM:DM ratio and the risk of massive fish mortality. The control exerted by the mangrove on the water quality of the adjacent lagoons is evident, which highlights the need for actions to rehabilitate the forests of the CGSM to avoid an even greater decline in fishing.

Code: P 5.76. Post hurricane response and restoration protocol Of mangrove forests on San Andrés island

Santos-Martínez, A.,[1] Prato-Valderrana, J.A.,[1] Mancera-Pineda, J.E.,[2] Yanelis Cantillo[2] & Ochoa-Sanabria, L.[2]

[1]Universidad Nacional de Colombia - Sede Caribe, asantosma@unal.edu.co
[2]Universidad Nacional de Colombia - Sede Bogotá,

Perturbations generated by extreme weather events can deteriorate the structure and function of mangroves. The Archipelago of San Andrés, Providencia and Santa Catalina (SAI) experienced the passage of the level 5 hurricane Iota, which devastated Providencia and Santa Catalina and caused damage in San Andrés. The present work was carried out considering the potential deterioration of ecosystem services (ES) provided by mangroves in the face of the predicted increase in extreme weather events, with the purpose of providing a conceptual framework for the prevention, control and risk mitigation in case of the threat of hurricanes and guide actions for mangroves restoration if necessary. The protocol proposes configuration of work teams to develop the proposed actions during the mitigation stages; impact assessment and restoration. It is concluded that the restoration must be based on specific ecological knowledge and the factors that modified the natural conditions and that prevent natural regeneration. Restoration is recommended when the ecosystem has been altered beyond self-repair. Costs can vary between US$3,000 and US$1,250,000/ha; hydrological rehabilitation between US$2,000 and US$100,000/ha; and the combined actions between US$1,200 and US$5,000/ha, depend on the type of action, depending on the level of impact and the proposed objectives. In a hypothetical case of total restoration of the mangrove swamp in the Archipelago, the cost would be around US$1,000,000. This is a low amount of money, considering the estimated value of ES provided by mangroves, which amounts to US$194,000/ha/year.

Code: P 15.44. Monitoring Mangrove Dynamics Using Sentinel-1 and Sentinel-2 Data Fusion Mangrove affected by the tin mining operation on Teluk Kelabat Dalam, Belinyu, Bangka Island

Sari, S.P.,[1,2] Koedam, N.,[3,4,5,6] Stocken, T.V.,[7] & Coillie, F.V.[1]

[1]Remote Sensing Spatial Analysis Lab (REMOSA), Department of Environment, Ghent University, 9000 Ghent, Belgium
[2]Marine Science Department, Universitas Bangka Belitung, 33172 Bangka, Indonesia
[3]Systems Ecology and Resource Management, Department of Organism Biology, Université libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50, CPi 264/1, B1050 Brussels, Belgium
[4]Marine Biology Research group, Universiteit Gent, Krijgslaan 281 – S8, B9000 Gent, Belgium [5]Centre for Environmental Sciences (CMK), Universiteit Hasselt, Agoralaan z/n, B3590 Diepenbeek, Belgium
[6]Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), 1196 Gland, Switzerland
[7]Ecology & Biodiversity, Department of Biology, Vrije Universiteit Brussel, Pleinlaan 2, B1050 Brussel, Belgium

In many parts of the world, mangrove forests are still being deforested and degraded at high rates. In Indonesia, mangrove loss is driven predominantly by expansion of aquaculture, conversion to agriculture, palm oil plantations, as well as mining. Tin mining operations in mangrove areas have negatively impacted mangrove extent and quality in Bangka Island (Indonesia). The open-pit mining system is observed to have a major impact due to extreme changes in soil quality, vegetation cover, and landscape, but research-based information is mostly lacking. Tin mining operations on Bangka Island are conducted not only legally but also illegally (not registered), and small-scale mining constitutes a significant part of tin mining on this island. This makes it difficult to monitor the operations of small-scale miners, while it may also lead to environmentally damaging practices. Most tin mining operations by small-scale miners are conducted inside mangrove areas. As a result, the destruction is not noticeable along the coastline as it occurs within the mangrove area of (amongst others) Teluk Kelabat Dalam (Belinyu, Bangka Island). Therefore, mapping and monitoring mangrove ecosystems through satellite images are essential to understand the anthropogenic drivers of mangrove dynamics, both in extent and quality. In this study, we aimed at monitoring mangrove extent (2019 to 2022) using Sentinel-1 and Sentinel-2 data fusion in Google Earth Engine (GEE) to determine the major causes of mangrove changes. Vegetation indices (NDVI, NDWI, MNDWI, and MVI) and Random Forest classification were applied to mapping mangrove extent. The result shows a decrease in mangrove extent of approximately 38.74 Ha from 2019 to 2022 and an expansion of the mining area. The information generated from the study might serve as a baseline for a mangrove inventory, systematic conservation planning and management, and possible restoration.

Code: P 5.81. Mangrove propagules are viable five times longer than previously thought

Satyanarayana, B.,[1,2,3,*] Wolswijk, G.,[1,2] Ishak, M.N.,[1] Peris, A.,[4] Syafiq, M.,[1] Akhir, M.F.,[1], Stocken, T.V.,[2,5,6] Dahdouh-Guebas, F.[2,3,5]

[1]*Mangrove Research Unit (MARU), Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu (UMT), Kuala Nerus 21300, Malaysia*
[2]*Systems Ecology and Resource Management Research Unit (SERM), Université Libre de Bruxelles-ULB, 1050, Brussels, Belgium*
[3]*Mangrove Specialist Group (MSG), Species Survival Commission (SSC), International Union for the Conservation of Nature (IUCN), c/o Zoological Society of London, London, United Kingdom*
[4]*Reef Check Malaysia, Wisma Central, Jalan Ampang, Kuala Lumpur 50450, Malaysia*
[5]*Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel-VUB, 1050 Brussels, Belgium*
[6]*Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA*

Mangrove forests have been widely studied for their importance in terms of biodiversity and ecosystem services, however the lessons learnt from the propagule dispersal window - specifically long-distance dispersal - were bounded by short-term buoyancy and viability experiments. The possible shift in mangrove species' distributional range due to climate change makes it fundamental to conduct such investigations on a long-term basis to identify potential areas for propagule stranding and establishment and to plan both conservation and management measures pro-actively. For *Rhizophora apiculata* Blume propagules, the literature claims only 89 days of longevity period and hence the true end of its dispersal story remains speculative. To clarify this picture, we have conducted an 18-month long experiment to quantify the buoyancy and viability of *R. apiculata* propagules and recorded for the first time a maximum longevity period of 14 (in 30 ppt salinity) to 17 (in 15 ppt salinity) months. This novel finding of a more than 500% longer viability period than previously known is not only going to change the propagule dispersal and establishment scenarios identified for *Rhizophora*, but also warrants a careful observation for other mangrove species that largely depends on nautohydrochory for their dispersal.

Code: P 9.61. Carbon farming for resilient livelihoods and landscapes in Mt. Batur, Bali, Indonesia

Seol, M.,[1] Qur'ani, C.G.,[2] Baral, H.[1]

[1]Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF)
[2]University of Muhammadiyah Malang

Carbon farming is essential for the management of local carbon pools in soils, vegetation and decayed plant material to control the flows and GHG fluxes at farm level for the purpose of minimizing emissions or capturing carbon in vegetation and soils. The most widely recognized practices are afforestation and reforestation, in addition to other practices including agroforestry, cover cropping, grazing management, pasture cropping, permaculture, biochar, natural fertilizers and zero tillage. Our projects have multiple objectives: 1) identified and designed locally appropriate carbon-farming practices in target landscapes based on local suitability and farmers' preferences; 2) Framework developed for implementing carbon-farming systems for both activity-based and results-based payments' methods, with outcomes compared; 3) Locally customized carbon-farming practices piloted in various types of degraded landscapes; and, 4) Multiple ecosystem goods and services quantified, mapped and valued, primarily, but not limited to, carbon and associated benefits from carbon-farming practices under a range of scenarios. Based on our data analysis, in-depth interviews and survey, it turned out that carbon farming can bring farmers economic benefits for contributing to the global good. Farmers on degraded and marginal land, or who have low-diversity and low-productivity farms, could stand to gain economically from participating in carbon farming, not just by selling carbon credits but also from receiving payments for other ecosystem services and commercializing the goods derived from carbon-rich systems. Additionally, carbon farming involves managing land, water, plants and animals at the landscape scale to meet the quadruple goals of i) healthy, restored landscapes; ii) improved resilience of farming systems; iii) increased productivity and incomes; and iv) secured household and community food and nutrition supplies. Projects promoting carbon farming that follow the CIFOR-ICRAF principle of growing 'the right tree for the right purpose in the right place' have proven to be as a promising way to attract landowners and community groups to participate in restoration efforts at minimal cost. Carbon farming also benefits a whole range of stakeholders with various demands for ecosystem goods and services.

Code: P 9.1. Diversity of bacterial and archaeal communities in mangrove sediments of the Pacific Coast of Mexico

Servín-Garcidueñas, L.E.,[1] Rojas-Alanis, A.,[1] & Ramos-Madrigal, C.[1]

[1] Microbiomics Laboratory, National Autonomous University of Mexico, Morelia, Mexico

Mangroves are important ecosystems due to the multiple ecosystem services they provide. Mangroves are reservoirs of microbial diversity that play an important role in biogeochemical cycles and ecosystem functions by participating in various steps of litter decomposition and mineralization. Most microbial communities in environmental samples have yet to be described and traditional culture-based microbial techniques are insufficient to assess the taxonomic and functional diversity of microbial communities associated with mangroves. Here we report a bacterial and archaeal diversity survey of mangrove sediments collected from a protected wetland within the coastal area of Lazaro Cardenas in western Mexico through massive amplicon sequencing of 16S rRNA genes and community-based analyzes. The region of study is subject to increasing industrial and urban development as it contains one of the main Mexican seaports. Sequencing reads were processed using QIIME2, to obtain taxonomic information on the microbial community. Sequencing results produced a total of 481,562 paired-end reads. Taxonomic assignment allowed the identification of 48 bacterial phyla and showed the predominance of the Proteobacteria, Bacteroidota, Desulfobacterota, Verrucomicrobiota, Actinobacteriota, Chloroflexi, Firmicutes, and Acidobacteriota phyla. Sequencing data also allowed the identification of archaeal reads corresponding to the Nanoarchaeota phylum. The main phyla identified in this study are consistent with other studies of bacterial and archaeal diversity associated with mangrove sediments. However, only a minor fraction of the reads could be classified at the genus level, which suggests that there is a great diversity of poorly characterized bacteria in the analyzed samples. Bacteria known to involved in biogeochemical cycles of carbon, sulfur, and nitrogen could be detected and may be relevant to mangrove growth, development and resilience to environmental changes. This study will help future research focused on the molecular characterization of microbial communities associated with mangrove forests. These techniques are necessary to formulate effective management and conservation strategies.

Code: P 9.7. Landscape-scale biophysical controls on mangrove blue carbon distribution in Singapore

Shribman, Z.I.,[1] Lim, K.E.,[2] Iram, N.,[2] & Friess D.A.[1]

[1]Department of Earth & Environmental Sciences, Tulane University
[2]Centre for Nature-Based Climate Solutions, National University of Singapore

Mangrove blue carbon has received huge scientific and policy interest for climate change mitigation. However, our understanding of what controls carbon distribution across landscapes is still limited. Therefore, we investigated landscape-scale biophysical controls of aboveground carbon (AGC), and soil organic carbon (SOC) in Singapore. Sites were selected to capture local variations in several environmental gradients including geomorphic setting, NDVI, sediment supply and hydrology. To estimate AGC, diameter at breast height was measured and tree species were identified within 7 m radius forest structure plots. To assess SOC, soil cores up to 1 m were excavated (n = up to 6 per site) and subsampled for elemental analysis. Sites were compared across environmental gradients, using landscape-scale datasets and local site conditions. Initial results suggest that AGC varies across sites from 102 ± 22 to 202 ± 31 MgC ha-1(Chek Jawa, n = 5; Lim Chu Kang, n = 3 respectively). AGC for other sites was 129 ± 23 MgC ha-1 at Berlayer Creek, 147 ± 50 MgC ha-1 at Mandai, 141 ± 7 MgC ha-1at Pasir Ris, 116 ± 35 MgC ha-1at Pulau Semakau, 195 ± 61 MgC ha-1at Sungei Buloh, and 107 ± 10 MgC ha-1at Sungei Ubin. AGC differed with forest structure and mangrove typology. Ongoing soil analyses show that bulk densities ranged from 0.54 to 1.05 g cm-3 across Singapore, and SOC stocks at the smaller riverine system Berlayer Creek reached 184 MgC ha-1, which is substantially lower than estimates at larger tide-dominated sites such as Chek Jawa. Identifying landscape-scale controls of ecosystem carbon stocks can provide a comprehensive approach to predicting blue carbon distribution and the climate change mitigation potential of mangroves.

Code: P 5.27. Do Global Change Variables Alter Mangrove Decomposition? A Systematic Review

Simpson, L.T.,[1] Chapman, S.K.,[2] Simpson, L.M.,[3] & Cherry, J.A.[4]

[1]Florida Oceanographic Society, Stuart, Florida, 34996, USA, [2]Villanova University, Villanova, Pennsylvania, 19085, USA, [3]University of Alabama, Tuscaloosa, Alabama, 35487, USA

Global change is expected to modify the magnitude and trajectory of organic matter decomposition in mangrove ecosystems. Yet, the degree and direction of that change is unknown, especially considering the large C storage potential that mangroves provide. We performed a systematic review of primary literature to examine the influence of species litter quality, latitude and global change proxies (temperature, nutrient loading, sea level rise, and precipitation) on the decomposition of mangrove litter fractions (leaf, root, and wood).
We complied a dataset of 480 decomposition rates, including species, litter fraction, latitude and relevant biophysical data. We tested the influence of species, tissue type, latitude, nutrients, inundation and season on decomposition rates in mangroves using linear models and nonparametric approaches. Collectively, latitudinal relationships suggest that factors other than temperature, such as tissue and genus type, may regulate decay rates within mangroves' tropical to subtropical distribution range. Decay rates of leaf litter and roots converge on a value of 0.009 ± 0.0005 and 0.002 ± 0.0001, respectively, across continents and geomorphological settings. Decay rates may be altered by global change variables, but the scale of change may not be as large as expected and likely will not elicit large changes in blue C storage potential. The relatively minor alterations in decay rates detected across the distributional range and under global change proxies are likely due to the small latitudinal range that mangroves inhabit and the submerged environment within which the litter decomposes. These results suggest that biomass quality and quantity, and its allocation between above- and belowground components, will be the main drivers of soil organic matter incorporation into blue C stocks. This work examines the alteration of decomposition using proxies of global change and underscores the need for future work that experimentally manipulates global change variables.

Code: P 5.69. Community structure of macroinvertebrates associated with submerged roots of red mangrove in the Rionegro Cove (Necoclí - Antioquia)

Sisquiarco-Torreglosa, C.A.[1]

[1]Corporación académica ambiental, niversidad de Antioquia

The characterization of the macroinvertebrate community structure associated with submerged roots of Red Mangrove (Rhizophora mangle) in the Rionegro Inlet was carried out to determine the relationship between macroinvertebrate community structure and some physicochemical and spatial parameters. Submerged roots of Red Mangrove were collected in different patches of mangrove forest. Conductivity, temperature, salinity and density were measured with the help of a Castaway CTD. A total of 23,878 organisms were recorded and the highest abundances corresponded to Mollusca (92.7%), Arthropoda (6.3%) and Bryozoa (1%), distributed in 5 classes, 13 families and 17 species. The species Mytilopsis sallei was the most abundant (52.9%) in the area. Multivariate analyses to characterize the macroinvertebrate community indicated that the study area is divided into two zones: the northern zone far from the mouth of the Cove, which presented high abundance of Mytilopsis sallei, Brachidontes exustus and Crassostrea rhizophorae; and the southern zone with stations near the mouth of the Cove, which presented high abundance of C. rhizophorae, Perna perna and M. sallei. The arrangement of the stations yielded similarity values between 65% and 80%.

Code: P 9.37. Assessment of Fish Diversity in Mangrove Ecosystem of Thailand using eDNA metabarcoding

Sivaipram, I.,[1] Isowa, Y.,[2] Punnnarak, P.,[3] Artigas, M.D.,[2] Kettratad, J.,[1] Ponyong, B.,[1], Paphavasit, N.,[1] Kajita, T.[2]

[1]Department of Marine Science, Faculty of Science, Chulalongkorn University, Thailand [2]Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, Okinawa, Japan; [3]Aquatic Resources Research Institute, Chulalongkorn University, Bangkok 10330, Thailand

Mangrove is one of important habitat enhancing fish production as it provides food and shelter for many fish. Number species of fish use mangrove is significant for evaluation ecosystem condition, which is also useful for natural resources management. Traditionally, fish survey is done by using different fishing gears to capture fish and identify in the laboratory. This method takes time and selective. Here we used environmental DNA (eDNA) metabarcoding to determine fish biodiversity in two different mangrove ecosystems (the Gulf of Thailand and Andaman Sea) and compare to the previous traditional studies. Fish communities in the Gulf of Thailand differed from Andaman Sea. More fish species were obtained from eDNA data compared to traditional studies. The result showed that eDNA metabarcoding serve as a helpful tool to expand information on fish diversity in mangrove ecosystem.

Code: P 5.58. Around the world with mangrove laws: a global snapshot of national legal frameworks for mangrove conservation and sustainable use

Slobodian, L.,[1] Baker, S.,[2] Alvarez, S.,[2] Wood, K.,[2] Bell-James, J.,[3] Brown, C.J.,[4] Buelow, C.,[4] Bukoski, J.,[5] Carrie, R.,[6] Calzada, A.,[7] Golebie, E.,[8] Heck, N.,[9] Villarreal-Rosas, J.,[4] Turschwell, M.,[4] & Andradi-Brown, D.A.[10]

[1]Environmental Law and Policy Program, Georgetown University Law Center, Washington, D.C., US; [2]Georgetown University Law Center, Washington, D.C., US; [3]University of Queensland, Australia; [4]Griffith University, Australia; [5]Conservation International, USA; [6]Sustainability Research Institute, University of Leeds, West Yorkshire, UK; [7]WWF- Mexico; [8]University of Illinois Urbana-Champaign, USA; [9]East Carolina University, North Carolina, USA; [10]Ocean Conservation, World Wildlife Fund, Washington, D.C., US.

Numerous case studies have demonstrated the challenges in effective governance of mangrove ecosystems. However, there is a lack of comprehensive data on mangrove legislation around the world. Here we have addressed this through a global study of national policies, laws and regulations related to mangrove management. We undertook a legal review of 73 countries — representing >99.5% of the world's mangroves — using a standardized analytical matrix. We searched national government websites, legal databases and secondary sources, and regularly checked responses to ensure consistency. We identified 16 countries with national laws or policies focused explicitly and exclusively on mangroves. We also identified 39 countries that have explicit prohibitions or restrictions on cutting, clearing or conversion of mangroves in their national legal frameworks. Of these, 16 countries prohibit all mangrove cutting or clearing; 14 countries prohibit all cutting, clearing or conversion for certain uses but allow or require a permit for other uses; and 9 countries require a permit for some or all uses. We determined that mangrove cutting or clearing prohibitions often take one of two forms: (i) a specific legal provision that prohibits cutting or clearing of mangroves explicitly, or (ii) areas with mangroves present are automatically classified as a form of protected ecosystem or area. We also identified other policies used to protect mangroves, such as community-based conservation and coastal zone planning, and determined trends in the use of such policies. These results are the first step in understanding how best to govern and protect mangrove ecosystems. This research establishes a baseline in global mangrove governance which can be used to evaluate improvements in the future. It will also be an important component in future analysis of the effectiveness of different legal tools at reversing mangrove loss.

Code: P 9.36. Effects of crab bioturbation on wetland vegetation productivity at a mangrove-marsh ecotone

Spanier, N.,[1] Adgie, T.,[1] Yang, P.,[2] & Chapman, S.[1]

[1]Villanova University [2]University of Rhode Island

Mangroves are moving poleward into grass-dominated marshes and are altering the habitats into which they are encroaching. In this wetland ecotone, certain crab species, such as *Minuca pugnax* (Atlantic marsh fiddler) and *Sesarma reticulatum* (marsh crab), create burrows that have the potential to impact soil conditions. We have previous knowledge on how burrowing crabs could impact wetland nutrient cycling and vegetation growth by oxygenating soils in marshes and mangrove forests but not in the mangrove-marsh ecotone. To understand the impact that crab burrowing has on wetland vegetation growth and mangrove pneumatophore investment, we conducted an observational study at two sites in northeastern Florida, USA within the mangrove-marsh ecotone. We measured the pneumatophore density, internode length, root ingrowth, and soil characteristics along a crab burrow density gradient. Through a path analysis, we found that organic matter decomposition increased with crab burrow density, and decomposition negatively correlated with mangrove internode length. In addition, we found that crab bioturbation did not impact the belowground productivity of the wetland vegetation, as measured via root ingrowth bags. Thus, our results indicate that crab bioturbation is antagonistic to mangrove growth and poleward encroachment by indirectly hindering the aboveground internode growth of mangroves. Our findings suggest that burrowing crabs may increase sediment suspension along with tidal flow in the mangrove marsh ecotone, which could alter nutrient dynamics in the system. We also found that the production of pneumatophores increased with the density of crab burrows. We suggest that elevation was an important covariate with crab activity and pneumatophore abundance in this experiment and that elevation should be measured in future experiments investigating the effects of crab burrowing on ecosystem processes.

Code: P 15.16. Estimation of carbon pools in the vegetation biomass and soil of major mangrove ecosystems of India

Sreelekshmi, S.,[1] Nandan, S.B.,[2] & Harikrishnan, M.[1]

[1]School of Industrial Fisheries, Cochin University of Science and Technology, Kochi-16, Kerala, India
[2]Department of Marine Biology, Microbiology and Biochemistry, School of Marine Sciences, Cochin University of Science and Technology, Kochi-16, Kerala, India

Indian mangroves are facing intense development pressures even though sustainable mangrove management has the potential to significantly lower national GHG emissions. The regional carbon stock data of mangroves that are on the verge of degradation are rarely reported, although they are essential for reducing and managing the effects of climate change. In response, the study aimed to investigate the environmental parameters, organic carbon pool in the vegetation biomass, and sediments of two major mangrove ecosystems of India, the Sundarbans, and Andamans. Samples were collected from 10 major islands in Indian Sundarbans and 21 mangrove sites under five forest divisions in the Andamans. The mean biomass carbon storage, accounting for both aboveground and belowground biomasses, was 160.88±135.03 Mg C ha^{-1} for the Sundarbans and 655.87±588.66Mg C ha^{-1} for Andamans. The carbon stock in dead or downed wood biomass, however, was 4.4 ± 2.22 Mg C ha^{-1} for the Sundarbans and 5.09 ± 2.81Mg C $ha^{-1}$for the Andamans. While the mean soil carbon stock in Sundarbans was 146.705 ± 37.62 and in Andamans was 39.16±11.41Mg C ha^{-1}. Bulk density, salinity, soil pH, and mangrove structure were shown to be the correlated variables for the differences in carbon stock among the various mangrove ecosystems. These findings will enhance the knowledge and datasets on carbon stocks, lowering uncertainty regarding estimations and modeling of carbon pools in the Indian mangrove ecosystems, which also serve as a significant climatic threshold for mangrove distribution globally.

Code: P 4.8. Natural establishment of mangroves: Lessons from the muddy open coast of French Guiana

Staquet A.,[1,2,3] Proisy C.,[1,2] Gardel A.,[3] Attali A,.[1,4] Augusseau P.E.,[1,2,3,5,6] Santos V.F.,[7] Brunier G.,[3,8] & Anthony E.J.[9]

[1]AMAP, IRD, Cayenne, French Guiana, France [2]AMAP, IRD, CIRAD, CNRS, INRAE, Univ. Montpellier, Montpellier, France [3]LEEISA, CNRS, Univ. Guyane, Cayenne, French Guiana , France [4]Université Libre de Bruxelles, Bruxelles, Belgique [5]French Environment and Energy Management Agency (ADEME), Angers, France [6]Direction Générale des Territoires et de la Mer (DGTM Guyane), Cayenne, French Guiana, France [7] - Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá (IEPA), Macapá, Amapá, Brazil [8]BRGM, Cayenne, French Guiana, France [9]Aix-Marseille Université, CNRS, IRD, INRAE, Coll France, CEREGE, Aix en Provence, France

Does the functioning of intact mangroves reveal how ocean and climate processes impact the coastal interface? In addressing this question, we find that the 320-km long mangrove shoreline of French Guiana, South America has a unique story to tell. The northwestward migration of giant mud banks controls mangrove shoreline fluctuations through the succession, at any point of the coast, of interbank erosional and bank accretional phases: spatial observations compiled since 1950 indicate that mangrove removal and establishment rates along the cross-shore direction can both attain up to 500 m per year [1,2]. In other words, the renewal of coastal mangroves in French Guiana is so rapid and extensive that neither the message about irremediable and continuous mangrove loss nor the necessity of mangrove restoration apply there. Previous research in French Guiana showed that a terrain elevation of 2.35 m above the hydrographic zero [3]appears to be a threshold altitude decisive for upper sediment layer consolidation, leading sometimes to the formation of desiccation interstices[4], a characteristic favorable to mangrove establishment[5]. To analyze further, since early 2022, we have been monitoring terrain topography and distributional patterns of new mangrove seedlings on a bare mud bank using repeated UAV-based centimetric photogrammetric surveys. We will show the topographic and hydrographic transformation of the bare mud bank over months and the expansion patterns of mangrove seedlings as a function, among other parameters, of the terrain elevation. Preliminary results confirm that sediment structuring is essential to the anchorage and survival of mangrove seedlings. Many factors, such as heavy rainfalls or wave patterns at high tide, can locally rework the mud substrate, this depending on macroscale mud bank topography and offshore wave damping. We will discuss our results particularly in the perspective of the 'artificial' practices of mangrove restoration or rehabilitation.

1 Proisy, C., Walcker, R., Blanchard, E., Gardel, A. & Anthony, E. J. in *Dynamic Sedimentary Environment of Mangrove Coasts* (eds D. Friess & F. Sidik) Ch. 2, 47-63 (Elsevier, 2021). 2 Brunier, G., Anthony, E. J., Gratiot, N. & Gardel, A. Exceptional rates and mechanisms of muddy shoreline retreat following mangrove removal. *Earth Surface Processes and Landforms* 44, 1559-1571, doi:https://doi.org/10.1002/esp.4593 (2019).
3 Fiot, J. & Gratiot, N. Structural effects of tidal exposures on mudflats along the French Guiana coast. *Marine Geology* 228, 25-37, doi:https://doi.org/10.1016/j.margeo.2005.12.009 (2006). 4 Gardel, A. *et al.* A Better Understanding of Mud Cracking Processes Gained From in Situ Measurements on an Intertidal Mudflat in French Guiana. *Journal of Coastal Research*, 424- 428 (2009).
5 Proisy, C. *et al.* Mud bank colonization by opportunistic mangroves: A case study from French Guiana using lidar data. *Continental Shelf Research* 29, 632-641, doi:https://doi.org/10.1016/j.csr.2008.09.017 (2009)

Code: 11.3B. Combining loss-on-ignition with sedimentary and geomorphic settings to characterize mangrove soils: Part 2, Total Nitrogen

Steinmuller, H.E.,[1] Breithaupt, J.L.,[2] Rovai, A.S.,[3] Engelbert, K.M.,[4] Smoak, J.M., Chambers, L.G., Radabaugh, K.R., Moyer, R.P., Chappel, A., Vaughn, D.R., Bianchi, T.S., Twilley, R.R., Pagliosa, P., Cifuentes-Jara, M., & Torres, D.

[1]Dauphin Island Sea Lab, United States of America [2]Florida State University, United States of America [3]Louisiana State University, United States of America [4]FSU Coastal & Marine Lab, United States of America

Using loss on ignition (LOI) measurements of soil organic matter (SOM) to estimate soil organic carbon (OC) content is an internationally-recognized and decades-old practice. In spite of well understood uncertainties, LOI continues to be necessary for many coastal wetlands researchers and conservation practitioners without access to an elemental analyzer. Multiple measurement, reporting, and verification (MRV) standards recognize the need (and uncertainty) for using this process. However, no framework exists to explain the substantial differences between equations used to calculate OC from SOM and consequently, equation selection can be a haphazard process leading to widely divergent and inaccurate estimates. To address this lack of clarity, we used a dataset of 1,246 soil samples from 17 mangrove regions in North, Central, and South America and calculated conversion equations for six unique types of coastal environmental setting. A framework is provided for understanding differences and selecting an equation based on a study region's SOM content and whether mineral sediments are primarily terrigenous or carbonate in origin. This approach identifies the positive dependence of conversion equation slopes on regional mean SOM content and indicates a distinction between carbonate settings with mean (± 1 S.E.) OC:SOM of 0.47(0.002) and terrigenous settings with mean OC:SOM of 0.32(0.018). This framework, focusing on unique coastal environmental settings, is a reminder of the global variability in mangrove soil OC content and encourages continued investigation of broadscale factors that contribute to soil formation and change in blue carbon settings.

Code: P 5.23. Using mangrove monitoring to inform and guide restoration efforts

Stewart, H.,[1] Hearne, S.,[1] Craig, C.,[1] Moyer, R.P.,[2] McDevitt, E.,[3] Mitchell, J.,[3] Simpson, L.,[4] Garriga, M.,[5] & Radabaugh, K.[1]

[1] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, [2] TerraCarbon LLC, St. Petersburg, FL [3] Florida Fish and Wildlife Conservation Commission, Habitat and Species Conservation [4] Florida Oceanography Society, Stuart, FL [5] Florida International University, Miami, FL

Anthropogenic disturbances that alter natural hydrology in mangrove forests can result in stressed trees and eventual mortality. These chronically stressed forests have reduced capacity for recovery from hurricane impacts and other acute stressors. Further, changes to tidal inundation and associated physiochemical factors impact forest structure. Long-term monitoring of two Florida mangrove forests with varying degrees of restricted tidal flow validates the importance of hydrology on mangrove forest health and informs restoration practices in the region. Using a before-after-control-impact design, permanent plots were established in three sections of mangrove forests within Jensen Beach Impoundment (JBI) and Oleta River State Park (ORSP) and classified as either stressed, intermediate stress, or control (minimal stress). JBI is a 69-hectare impounded mangrove wetland that had standing water following Hurricane Irma, leading to the death of >20 hectares of mangroves. ORSP is Florida's largest urban state park totaling >405 hectares and lost 11 hectares of mangroves due to surrounding roads restricting water flow, resulting in ponding. Both sites were selected by the Florida Fish and Wildlife Conservation Commission to restore water flow in the mangrove forests. Mangrove forests had reduced tidal amplitude compared to adjacent open water. The tidal amplitude of JBI control forests was 74% of the tidal amplitude measured in the lagoon. Stressed and intermediate stress mangrove sites had tidal amplitudes 43% and 5% of the tidal amplitude measured in the lagoon, respectively. One month following installation of the culvert connecting the lagoon to stressed forests, tidal amplitude of intermediate and stressed mangrove sites increased to 48% and 18% of the amplitude in the lagoon. Semiannual monitoring of JBI and ORSP pre- and post-restoration is tracking changes in forest structure and physiochemical factors to provide guidance for restoration practices over time and will be used to evaluate when successful remediation has been achieved.

Code: P 5.28. Benefits of mangrove restoration in different geomorphic settings

Stewart-Sinclair, P.,[1,4] Hagger, V.,[1] Klein, C.,[2] Bateman, L.J.,[3] & Lovelock, C.E.[1]

[1]School of Biological Sciences, The University of Queensland, St Lucia, QLD 4072, Australia
[2]Centre for Biodiversity and Conservation Science, School of Earth and Environmental Sciences, The University of Queensland, St Lucia, QLD 4072, Australia [3]Land, Environment, Economics and Policy Institute, University of Exeter Business School, Rennes Drive, Exeter, EX4 4ST, UK [4]NIWA, Gate 10 Silverdale Road, Hillcrest, Hamilton 3216, New Zealand

Mangrove habitats provide essential ecosystem services, including carbon sequestration, coastal protection, and fish nursery services. However, large losses in the spatial extent of mangroves has led to increasing ecological restoration by a range of local to international organisations. Restoration success is dependent on selecting sites that are appropriate in their biophysical attributes, including appropriate geomorphic settings. A global assessment of the geomorphic setting of global mangroves categorised coasts as deltaic, estuarine, lagoonal, or open coast. Here, we calculate the net benefits of restoration of coastal marine ecosystems among these four geomorphic settings, which are a function of costs, benefits, and feasibility of restoration projects. Using a global database of marine coastal restoration projects, we were able to assess net benefits of 22 mangrove restoration projects across four geomorphic settings. Costs, feasibility, and benefits varied greatly within each geomorphic setting for mangrove restoration projects. The highest net benefits for mangrove restoration were in estuaries. High net benefits for mangrove restoration were not significantly correlated with any one restoration action or ecosystem service type, which may be due in part to small sample sizes and large range in parameter estimates. Incorporating economic parameters into restoration decision-making can help to prioritise sites for restoration to meet global restoration goals (e.g., the Ramsar Convention on Wetlands of International Importance, the Sustainable Development Goals, the Bonn Challenge, and the Global Mangrove Alliance).

Code: P.9.86. Mangrove Forest Growth and Carbon Storage With Blockchain Technology

Svensson, K.,[1] Grange, A.,[1] Schubert, L.,[1] Araújo, R., D'Alessandro, E.,, Kelly, M., Alvarez, A.

[1]Open Forest Protocol

Effectively combating unsustainable forest and marine ecosystem exploitation requires tactical measures to encourage and support the proliferation of restoration and conservation efforts. Measurement, Reporting, and Verification (MRV) is the most common method of tracking, recording, and validating field data related to restorative practices, such as afforestation and reforestation. Legacy MRV standards are expensive, inaccessible, and lack the technical modernization needed to scale globally. Globally aligned corroboration of mangrove ecosystem rehabilitation calls for a reformation in the monitoring methods used to track sustainable development goals. This project builds on Open Forest Protocol's blockchain-based MRV system to develop a public (open-access) system for mangrove forest monitoring. This will provide free MRV tools to global mangrove restoration projects, enabling field data collection and third-party verification of project data to occur rapidly and at a minimum cost by using an unbiased network of remote sensing data validators. The result is a digital platform and transparent database of region-based and species-specific allometric equations that synthesize collected field data with GHG emission removal calculations to produce estimated carbon sequestration rates for each mangrove restoration project at no extra effort for the project proponents. Mangrove restoration projects around the world will gain access to carbon financing through the use of these tools. The first long-term mangrove monitoring plot will be set up on Broad Key, a research station leased by the University of Miami's Rosenstiel School of Marine, Atmospheric & Earth Science. The distribution of quality carbon credits to mangrove landowners will act as a conservation and restoration incentive, as they are a financial substitute to income generated from deforestation, allowing landowners to prioritize replantation and conservation over destruction.

Code: 6.5B. Spatiotemporal pattern of mangrove blue carbon in Southeast Asia as a nature-based solution

Syahid, L.N.,[1,2] Ward, R.D.,[3,4] Sakti, A.D.,[1,2] Rosleine, D.,[5] & Wikantika, K.[1,2]

[1] Center for Remote Sensing, Institut Teknologi Bandung, Bandung 40132, Indonesia
[2] Remote Sensing and Geographic Information Science Research Group, Faculty of Earth Science and Technology, Institut Teknologi Bandung, Bandung 40132, Indonesia.
[3] Centre for Aquatic Environments, University of Brighton, Lewes Road, Brighton BN2 4GJ, UK. [4] Department of Landscape Management, Estonian University of Life Sciences, Fr. R. Kreutzwaldi 1, 51014 Tartu, Estonia. [5] Ecology Research Group, School of Life Sciences and Technology, Institut Teknologi Bandung, Indonesia.

Mangroves are coastal plants that store more than five times the carbon of temperate, boreal and tropical terrestrial forests, equivalent to 2.5 times annual global CO_2 emissions. This means that mangroves are capable of playing a vital role in climate change mitigation, capturing, and conserving large amounts of carbon that can help reduce anthropogenic atmospheric CO_2 inputs using nature-based solutions. Southeast Asia has attracted a lot of international interest in mangrove research as it has the greatest mangrove area coverage and the greatest species diversity in the world. However, Southeast Asia has also experienced the greatest deforestation of mangroves,
which has resulted in the loss of the carbon stored in mangrove forest biomass and soils. This loss has been exacerbated by climate change, which has resulted in the complete loss of mangroves in some areas of Southeast Asia. Better management of mangroves can reduce CO_2 emissions and increase the sequestration potential of disturbed forests. In this study, we demonstrate the spatial variation in blue carbon storage and sequestration in mangroves across Southeast Asia. This study integrates remotely sensed, modelling, and statistical data, with data from literature studies to determine the significance of mangroves in mitigating CO_2 emissions in Southeast Asia using several IPCC emission scenarios. The results of this study indicate that mangroves can play a significant role in reducing CO_2 emissions in Southeast Asia. Mangroves can capture more than a third of the total CO_2 emissions in Southeast Asia. Thus, mangroves can play an important role in achieving the target of reducing net CO_2 emissions committed by countries in Southeast Asia to help to achieve sustainable development goal targets. Thus, this research provides important information that can be used in policy making by presenting how significant a mangrove-based solution can be in mitigating climate change in the World.

Code: P 15.29. Applying Global Datasets to Recognize Mangrove Carbon Stocks Within the World Bank's Inventory of the Changing Wealth of Nations.

Taggart, M.,[1] Beers, L.,[1] Lebrasse, C.,[1] Crooks, S.,[1] & Onder, S.[2]

[1]Silvestrum Climate Associates, [2] World Bank

Mangroves – and the ecosystem services they provide – are of critical importance on local and global scales for biodiversity and humanity. Carbon sequestration is one ecosystem service which can have profound impacts on climate mitigation efforts as well as economies. If mangroves are to be considered as a tool in climate mitigation actions and planning economic resilience, it is important for governments to understand the quantity and spatial variability of mangrove carbon stocks. A spatial assessment of global carbon storage in mangrove ecosystems was completed for 121 countries for the years 1996, 2010, 2015 and 2020. The assessment was completed using biomass carbon stock data from Simard *et al.* (2019), soil organic carbon stock data from Sanderman *et al.* (2018), along with mangrove ecosystem extent data from Global Mangrove Watch (Bunting *et al.,* 2018, 2022). ESRI's ArcGIS software in conjunction with integrated python coding was leveraged to conduct the analysis and assess the temporal and spatial changes in global carbon stocks. The resulting dataset contains estimates of mangrove biomass and soil carbon stocks at country, regional and income levels for each year of the assessment. Carried out in support of the World Bank's new edition of its wealth report, The Changing Wealth of Nations (CWON), results from this assessment will inform the inclusion of carbon storage within mangrove ecosystems as a form of renewable natural capital and improve understanding of the broad range ecosystem services mangroves provide. Carbon stock estimates can serve as initial measures for informing decisions on mangrove restoration and management as well as future efforts aimed at fine-scale estimation of mangrove carbon, and to enhance understanding of the role natural capital play in ensuring growth, sustainability, and resilience to shocks and stressors such as climate change.

Code: P 15.49. Mapping spatial dynamics of mangroves over seventy years: lessons learnt from French overseas territories

Taureau, M.F., & Caillaud, A.[1]

[1]French Tropical Wetlands Network

Mangrove losses over the past decades is known to be considerable, with rates of loss having diminished in the past 15 years. Studies that have been conducted to monitor these spatial dynamics of losses and gains over time have principally relied on satellite data and remote sensing analyses, but authors have faced two main limitations. Firstly, although satellite data is suitable to monitor large patches of mangroves, it is inadequate for small mangrove extents – particularly Landsat time series. Secondly, the quality and operability of Landsat TM data decreases as you get back in time. Mangroves found in French Overseas Territories in the Caribbean, Indian Ocean and Pacific regions are relatively small and therefore, particularly affected by these limitations. Indeed, altogether, mangroves in these territories (about 87 000 ha) are spread across 10 different territories, with over 60% located in French Guiana (Amazonia). For the other French territories, we conducted an analysis of old aerial photos released in 2021 by the French Government to map mangrove extent dynamics since 1950. Results have showed that, whilst some territories like Saint-Martin or Saint-Barthelemy in the Caribbean have lost over 50 % of their mangroves since 1954, mangrove extent in other territories such as Martinique (Caribbean) and Mayotte (Indian ocean) has remained stable. In Guadeloupe (Caribbean) and Wallis (Pacific), mangrove gains have even been demonstrated (about 18% for both), mainly due to mangrove expansion into saltmarshes. In French Polynesia, where mangroves were introduced in 1933, mangrove extent has increased by 50% since 2011 on average, over the six islands that it has colonized. This diachronic mapping exercise will be presented along with lessons learned, as well as results for each territory (Saint-Martin, Saint-Barthelemy, Guadeloupe, Martinique, Mayotte, Wallis, New Caledonia and French Polynesia).

Code: 16.5B. Structural Characteristics of the Tallest Mangrove Forests of the American Continent: A Comparison of Ground-Based, Drone and Radar Measurements

Tavera, H.,[1,2] Zapata-Padilla, L.A.,[2] Simard, M.,[3] Casella, E.,[4] & Castellanos-Galindo, G.A.[2,5]

1. Ministerio de Ambiente y Desarrollo Sostenible, Bogotá, Colombia 2. WWF Colombia, Cali, Colombia
3. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States
4. Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany 5. Smithsonian Tropical Research Institute (STRI), Panama City, Panama

The Panama Bight eco-region along the Pacific coast of central and South America is considered to have one of the best-preserved mangrove ecosystems in the American continent. The regional climate, with rainfall easily reaching 5–8 m every year and weak wind conditions, contribute to the exceptionally tall mangroves along the southern Colombian and northern Ecuadorian Pacific coasts. Here we evaluate the use of different methods (ground-based measurements, drone imagery and radar data [Shuttle Radar Topography mission-SRTM and TanDEM-X]) to characterize the structure of the tallest of these forests. In 2019, three mangrove sites with canopy heights between 50 and 60 m, previously identified with SRTM data, were sampled close to the town of Guapi, Colombia. In addition to *in situ* field measurements of trees, we conducted airborne drone surveys in order to generate georeferenced orthomosaics and digital surface models (DSMs). We found that the extensive mangrove forests in this area of the Colombian Pacific are almost entirely composed of *Rhizophora* spp. trees. The tallest mangrove tree measured in the three plots was 57 m. With ca. 900 drone photographs, three orthomosaics (2 cm pixel^{-1} resolution) and digital surface models (3.5 cm pixel^{-1}) with average area of 4,0 ha were generated. The field-measured canopy heights were used to validate the drone-derived and radar-derived data, confirming these mangrove forests as the tallest in the Americas. The orthomosaics showed significant patches of the Golden Leather Fern, *Acrostichum aureum*, an opportunistic species that can be associated to mangrove degradation, indicating that the mangrove forests investigated here may be threatened by selective logging requiring improvements and effective implementation of the current mangrove management plans in Colombia. On-going community-based mangrove restoration work around these areas seek to contribute to the preservation of these iconic mangrove forests.

Code: P 9.9. Nature-based flood risk mitigation in a river delta context: evaluating impacts of mangrove conservation versus human conversion

Temmerman, S.,[1] Pelckmans, I.,[1] Belliard, J.P.,[1] Ramos-Veliz, J.A.,[3] Rosado-Moncayo, A.M.,[3] Nath, J.,[4] Gourgue, O.,[1,2] & Dominguez-Granda, L.E.[3]

[1] University of Antwerp, Ecosphere research group, Antwerp, Belgium [2] Royal Belgian Institute of Natural Sciences, Brussels, Belgium [3] Escuela Superior Politecnica del Litoral (ESPOL), Centro del Agua y Desarrollo Sostenible, Guayaquil, Ecuador [4] Instituto Oceanografico de la Armada (INOCAR), Guayaquil, Ecuador

Mangrove forests are generally valued for their role in nature-based climate adaptation in the coastal zone. They are considered to reduce coastal flood risks, through attenuation of the landward propagation of extreme sea level events, triggered by storm surges or climate fluctuations like ENSO, which are expected to intensify with global climate warming. Hence conversion of mangroves into human land use, such as aquaculture and agriculture, which is globally prevalent, is considered then to further aggravate coastal flood risks. However, so far there are not much quantitative analyses on how much mangroves can contribute to extreme sea level attenuation, and how this depends on the spatial configuration of mangrove conservation versus conversion, for specific tropical estuaries or delta systems. Here, we present a combined data and modelling analysis of high water level propagation through the Gulf of Guayaquil and Guayas delta (Ecuador), the largest estuarine system (ca. 12 000 km²) along the Pacific coast of Latin America, home to about 3 million people, around 1400 km² of mangrove forest, and ca. 400 km² of human mangrove conversion since the 1970s (mostly into shrimp aquaculture ponds). Our data analysis shows that extreme high water levels, produced by El Nino events, are amplified in the landward direction along the delta. A hydrodynamic model of the entire gulf and delta is developed, reproducing the observed water level dynamics, with special attention for the representation of the bio-geomorphic properties of intertidal mudlfats, channel networks, mangrove vegetation structure and aquaculture areas. Model scenarios show significant impacts of scenarios of mangrove conversion into aquaculture on increased amplification of extreme high water levels. This suggests that nature-based approaches, through spatial planning of mangrove conservation and restoration, are a relevant strategy that can help to mitigate increasing flood risks imposed by global change on vulnerable delta societies.

Code: P 5.82. Feeding specialisation and partitioning of nitrogen sources in a subtropical mangrove highlighted by isotope of amino acids

Thibodeau, B.,[1] Allais, L.,[2, 3] Agusto, L.E.,[3] Kwan, M.W.,[2, 3] & Cannicci, S.[4]

[1]School of Life Sciences & Simon F.S. Li Marine Science Laboratory, The Chinese University of Hong Kong, Hong Kong, Hong Kong Special Administrative Region, PR China SAR [2]Department of Earth Sciences, University of Hong Kong, Hong Kong, Hong Kong Special Administrative Region, PR China. [3]The Swire Institute of Marine Sciences, The University of Hong Kong, Hong Kong, Hong Kong Special Administrative Region, PR China SAR [4]Department of Biology, The University of Florence, Sesto Fiorentino, Italy,

Mangrove forests are characterised by a specialised fauna with low ecological redundancy. Their faunal diversity is also decreasing across the tropics, with cascading effects on the ecosystem services provided by these forests. Traditional tools often failed to assess the importance of different sources of nutrients and a reliable trophic position estimate in mangroves, although this information is crucial to better advise on effective conservation strategies. Here, we present nitrogen and carbon isotope data of individual amino acids measured in primary producers and fauna inhabiting a subtropical mangrove. We quantified the relative importance of vascular and non-vascular source of nitrogen in the mangrove food web and highlighted previously unreported difference in term of trophic position and source of food for several species, which were previously thought to have overlapping feeding preferences. Our data thus suggest that the inherent lack of ecological redundancy present in mangrove may even be more severe than predicted by recent estimates.

Code: P 5.26. A decadal change on the mangrove colonization on the new intertidal habitats of Andaman and Nicobar archipelago – a post tsunami and subsidence scenario

Thirumurugan, V.,[1,2] Singh, A.R., [1,3] Gnanasekaran, G.,[2] & Prabakaran, N.[1]

[1]Post box No: 18, Wildlife Institute of India, Chandrabani, Dehradun 248001, India
[2]Department of Botany, Madras Christian College (Autonomous), Tambaram East, Chennai 600 059, India
[3]Gurukul Kangri (deemed to be) University, Haridwar 249404, India

The 2004 Sumatra-Andaman earthquake caused a devastating tsunami in the Indian Ocean, triggering extensive damage to the coastal biodiversity of Andaman and Nicobar Islands (A&N). In addition to the high-intensity tsunami waves, the mangroves of A&N were severely impacted by land drowning (up to 2.85 m) and uplift (up to 1.35 m) caused by tectonic slips. The subsidence caused permanent inundation of mangrove habitats, resulting in a 97% loss of mangroves in the Nicobar Islands and roughly 50% loss in South Andaman. This also resulted in forming new intertidal habitats suitable for mangrove colonization in the previously terrestrial zones. Nevertheless, it's been nearly two decades since the tsunami, and it is critical to understand the succession of mangrove vegetation, their response, and colonization on a decadal level change following a unique large-scale natural disturbance. We studied the decadal change in the community composition, and recruitment pattern (seedling and sapling) of mangrove species in the subsided sites of A&N. Linear transect method was followed to assess the species composition and structure in Andaman and Nicobar Island groups. On each site, three transects consisting of Eighteen plots (Nine in landward and Nine in seaward zones) were laid to cover the maximum heterogeneity. A total of 6396 trees, 809 palms, 738 saplings, and 921 seedlings belonging to 33 species (13 families and 18 genera) were enumerated in 494 plots. The mangrove composition and diversity indices are high in Andaman than the Nicobar; the species composition and tree density of Andaman group subsided sites are 81 % (1244 trees/ha.) and only 19 % (424 trees/ha.) were found in the Nicobar group. The alpha diversity (H'=Shannon-Wiener index) was significantly higher in the recruitment layer than in trees (H'=1.95). Species richness and composition varied significantly across the two groups of the Island (p-value < 0.01). The dominant species in the Andaman Group (IVI) are *Rhizophora apiculata* (40.5%), *Bruguiera gymnorhiza* (13.9%), and *Ceriops tagal* 13.2%), while in the Nicobar group *Bruguiera gymnorhiza* (22.8%), *Sonneratia alba* (15.1%), and *Sonneratia caseolaris* (13.1%) show dominance. The Andaman mangroves have remnant mangrove patches that contribute to the high species richness and composition, while most of the Nicobar group mangroves are emerging mangroves in the new intertidal areas. The insights from this study would benefit the habitat management of this critical landscape.

Code: P 15.35. Reconstructing mangrove inundation dynamics with spaceborne data

Thomas, N.,[1,2] Urbazaev, M.,[3] Stovall, A.E.L.,[1] Hess, L.,[4] Armston, J.,[3] Neuenschwander, A.,[5] Duncanson, L., & Fatoyinbo, L.[2]

[1]Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD 20706, USA [2]Biospheric Sciences, NASA Goddard Space flight Center, Greenbelt, MD 20771, USA [3]Department of Geographical Sciences, University of Maryland, College Park, MD 20706, USA [4]Earth Research Institute, University of California, Santa Barbara, CA, USA 93106 [5]Center for Space Research, University of Texas at Austin, Austin, TX 78701, US

Understanding mangrove inundation is a time-intensive locally-specific task that relies upon in situ instrumentation that is prone to damage, failure and loss. However, inundation frequency and duration is a central driving parameter of carbon cycling in these ecosystems, including the burial of organic carbon and emission of methane. Without the knowledge of inundation depth and frequency, large uncertainties will remain in carbon cycle models. For the first time, we use newly available spaceborne lidar data to see beneath the canopy, that obstructs our view in other remote sensing datasets, to get direct measures of inundation depth. Lidar penetrates vegetation canopies and reflects off the sub-canopy surface and varies in elevation with inundation depth through time. We were able to successfully detect the presence of sub-canopy water levels in mangroves from lidar data and observe changes in inundation depth across a range of mangrove forests globally. We demonstrate an ability to measure both modest (<20 cm) and large (1.5 m) changes in sub-canopy inundation. We were able to retrieve this information irrespective of mangrove density, species and environmental setting and construct a time-series of inundation through time to retrieve the full range of depth. Through the aggregation of data, we can now reconstruct inundation depth and duration across a mangrove forest without the collection of in situ data. This enables a gain in knowledge on one of the most important constraints on carbon cycling in wetland ecosystems and can be applied to any mangrove forest quickly and without cost. This new data will allow the scientific community to reduce the uncertainty in their carbon models and produce the most accurate carbon stock estimates for international carbon initiatives such as Nationally Determined Contributions. This is critical for countries where mangroves and other flooded wetlands comprise a large part of their carbon budget.

Code: P 15.55. Blue carbon soils methodology applied in a conglomerate of the national forest inventory, on mangrove ecosystem

Torres-Duque, J.A.,[1] Hernández-Ortiz, M.,[1] Rojas-Aguirre, A.S.,[1] Hernández, L.,[2] Pardo, S.,[3] Sierra-Correa, P.C.[1]

[1] Instituto de Investigaciones Marinas y Costeras Jose Benito Vives de Andreis INVEMAR [2] Universidad Nacional de Colombia [3] Pontificia Universidad Javeriana, Colombia

The National Forest Inventory (NFI) seeks to obtain reliable information about the state and characteristics of the country's forests. Colombia has large extensions of terrestrial forests, but it also has mangroves that can also form important areas of forests in internal protected areas; and that are not usually accounted by the NFI methods. Thanks to the importance that mangroves have gained due to the role they can play in terms of climate change, as blue carbon ecosystems, this year INVEMAR worked, among others, on a blue carbon estimation project in Mallorquín swamp in Barranquilla and simultaneously carried out the first assembly of a forest conglomerate in mangroves. It is worth mentioning that the NFI methodology was built for continental or mainland forests, so it was necessary to adapt the methods for mangrove fieldwork. This text describes the application of the methodology for estimating carbon content in soils on the NFI methodology adapted for mangroves. The NFI uses a sampling unit that consists of a conglomerate of 3,535 m^2 made up of five (5) circular subplots arranged in the form of a cross with a radius of 15 m each (707 m^2), with a distance of 80 m between the centers. Soil information was taken in the four extreme subplots (the central one was omitted). In each subplot, was obtained three combined samples up to 50 cm deep, divided in the following depth ranges: 0-15, 15-30 and 30- 50 cm, unlike NFI which takes samples only from a range up to 30 cm. Additionally, other samples were taken in order to determine the bulk density to gather the complete information on carbon contents. The results show that the conglomerate is useful for obtain information in blue carbon ecosystems.

Code: P 9.82. Effect of tree geometry and spatial zonation on sediment blue carbon capture in mangrove forests

Twomey, A.J.,[1] Cowley, D.,[2] Callaghan, D.P.,[3] Lovelock, C.E.[1]

[1]School of Biological Sciences, The University of Queensland, St Lucia, QLD 4067, Australia
[2]School of Earth and Environmental Sciences, The University of Queensland, St Lucia, QLD 4067, Australia [3]School of Civil Engineering, The University of Queensland, St Lucia, QLD 4067, Australia

Mangroves are nature-based solutions for coastal protection however, their ability to attenuate waves and stabilise and accrete sediment varies with their species-specific architecture and frontal area. Hydrodynamic models are typically used to predict and assess the coastal protection afforded by mangroves, but without species or genus architectural geometries and spatial distribution information, the results can be significantly different from reality. Globally, frontal species were identified from existing mangrove zonation diagrams to create the first global mangrove genus distribution map. For the three most frequently occurring frontal mangrove genera, *Avicennia*, *Sonneratia* and *Rhizophora*, a meta-analysis identified the common geometries of each (roots, trunk, crown) using datasets and allometric equations where datasets were incomplete. Xbeach was used to run 1D hydrodynamic models, including short-wave dissipation and flow interaction through mangroves. The inclusion of mangroves into the model was done via the schematising of roots, trunks and canopies via their height, width, density and drag coefficient using the genus geometry data from the meta-analysis. Model scenarios were run to test the effect of mangrove geometry between genera, stand maturity, forest band width, forest zonation, and forest density on sediment accretion. Results can be used to more accurately predict sediment accretion within mangrove forests across a range of geometric and spatial variables in everyday wave conditions with implications for predicting blue carbon capture.

Code: P 9.2. Spatio-temporal dynamics of mangrove forest diversity in Eastern Thailand?

Uday PIMPLE[1]

[1]Thailand

In the United Nations decade on ecosystem restoration 2021–2030, coastal ecosystems such as mangroves are listed as a priority for biodiversity restoration. Therefore, understanding large scale mangrove species diversity and temporal changes are important for predicting ecosystem health, viability, and resilience against changing climate and human pressure. However, it is also crucial to understand the effects of conservation interventions when considering future conservation efforts and policies for mangroves. To address these concerns, we must improve our ability to gather reliable forest inventory measurements, spatial scale biodiversity predictions, and good practices for using Earth observation data. In this study, we investigated the knowledge gaps considering potential spatial diversity, intertidal zonation, and the historic state of mangrove forest species, and tested the role of environmental settings such as topography and anthropogenic (rehabilitation or plantation) settings on diversification. We have successfully integrated historic multi-satellite data, current ecological data, and micro topographic measurements to establish a historic state and species distribution for the mangrove forests in the Trat Province of Thailand. The method introduced in this study allows us to overcome the technical limitations of monitoring protocols and provides a powerful decision-support system to assess the forest recovery period, structural growth, and species composition of plantations and natural native stands over three decades. This study also identifies the main influencing factors that hinder the quality of Earth observation data and propose best practices specific to mangrove ecosystem monitoring. In addition, we developed the “automatic regrowth monitoring algorithm (ARMA)” tool and summarized the functional indicators (secondary succession) by type. ARMA can identify plantation years, recovery period, age, and structural development of rehabilitated mangroves compared with their adjacent natural and naturally regenerated mangroves. We believe that our study makes a significant contribution to mangrove biodiversity research, as it has several potential applications for restoration management planning, and therefore will be a useful tool to measure and evaluate biodiversity and thereby improve ecosystem-based mangrove forest management.

Code: P 5.60. Natural Recovery for a Mangrove-Coral Community in Hurricane Hole, St. John, USVI

Uzzell, L.L.,[1] Brandt, M.E.,[2] Rogers, C.S.,[3] Stewart, H.A.,[4] Grimes, K.W.

[1]University of the Virgin Islands, United States of America [2]MMES, United States of America [3]USGS, United States of America [4]FFWS, United States of America

Hurricane Hole is a renowned mangrove-coral habitat and storm mooring harborage located within the Virgin Islands Coral Reef National Monument in St. John, U.S. Virgin Islands. After two, consecutive, category five hurricanes hit the territory in 2017, many mangrove trees and coral colonies were damaged or destroyed throughout the mangrove-coral habitat. This study aims to monitor the natural recovery of mangroves and corals 5-6 years after storm damage and to survey how living mangroves may facilitate the growth and abundance of corals in Hurricane Hole. Field surveys began in December 2022 and will occur every four months for one year (until December, 2023) within living, shaded regions of mangrove fringe and non-living, woody and open sections of shoreline. Preliminary results show benthic cover, coral abundance throughout living and non-living mangrove shoreline, and red mangrove (*Rhizophora mangle*) seedling growth and survivorship over two measurement periods. At one year, coral recruitment will be assessed from plates deployed at the beginning of the study. Results on overall mangrove and coral recruitment will provide a baseline dataset for future restoration efforts of this globally rare habitat.

Code: P 15.39. Mangrove forest: cover and fragmentation in protected and unprotected areas in the Colombian pacific

Vásquez D.,[1] Mejía-Rentería, J.C.,[1] Ortiz, A.M.,[1] & Cantera-Kintz, J.R.[1]

[1]Grupo de Ecología en Estuarios y Manglares, ECOMANGLARES, Universidad del Valle, Cali, Colombia

The loss of mangrove forest and the increase of fragmentation can disrupt ecological connectivity and affects ecosystem services. About 60% of the mangrove forest of the Colombian Pacific coastal region has protection status, and these are grouped in ten (10) protected areas with different protection categories. By means of four (4) data bases: (1) Global Database of Continuous Mangrove Forest Cover for the 21st Century (CGMFC-21) of Hamilton & Casey (2016), (2) Mangrove global watch (MGW) of Bunting et al. (2022), (3) Manglares de Colombia 2019-2020 of Valencia-Palacios & Blanco-Libreros (2021), and (4) SIGMA of INVEMAR (2022), we estimated the variation of mangrove cover inside and outside the marine protected area of the Colombian Pacific coast for the years available in these databases. By means of an analysis of variance associated with a mixed linear model we compared de data. For the study of fragmentation, we use four (4) indexes: (1) clumpiness, (2) perimeter-area fractal dimension (PAFRAC), (3) mean patch area and (4) the mean distance to a patch's nearest neighbor. The results show differences in coverage and fragmentation between databases due to the methods used. Coverage is decreasing and fragmentation is increasing but in a lower rate when compared to the rest of the world. Each protected area is challenged to implement an effective way to preserve and monitor its mangrove forest by extent and category. This study aims to improve monitoring within protected areas by providing data on how they change from year to year.

Code: P 15.58. Changes in mangrove coverage post-Hurricane María and their possible implications in the coastal management of Guayama, Puerto Rico (2017-2019)

Vázquez-Feliciano, M.O.[1]

[1]United States of America

We study the changes in mangrove cover post Hurricane Maria (HM) and Fiona (HF) in the municipality of Guayama, P.R. (periods 2017-2023). The main goal is to identify distribution changes in mangrove cover after the passage of HM/HF and its implications for coastal management in the area. 1) Identify changes in mangrove cover by February 2023; 2) Assess the current condition of the mangrove and adjacent beaches; 3) Identify implications of the changes on coastal management; and 4) Recommend courses of action for mangrove recovery. Geographic Information Systems (GIS), evaluation and analysis of images captured by drones, use of geospatial data, technical reports, interviews and field visits were used for mangrove characterization. Healthy or dry mangrove cover information layers were generated for March/September 2017 and July 2018. For the characterization of the February 2023 period, a mosaic of images will be generated via drone. Findings for the 2017 and 2018 period demonstrate a reduction in healthy mangrove cover in the area following the passage of the HM in September 2017 (change in cover from 98.4% to 17.6%). Recent field observations show an increase in coastal exposure to flooding and beach erosion in sections of the coast. Through digitization for post-hurricane periods it will be possible to observe how the mangrove recovery process has been impacted.

Code: P 9.55. Accumulation and distribution of microplastics in sediments of mangrove forests in the bay of Tumaco and Buenaventura, Colombian Pacific

Vásquez-Molano, D.,[1] Molina, A.,[1] & Duque, G.[1]

[1]Grupo de Investigación Ecología y Contaminación Acuática, Universidad Nacional de Colombia, Sede Palmira, Palmira, Colombia.

Microplastics (MP) are a major global concern due to their increasing accumulation in diverse ecosystems, such as mangroves. The objective of this study was to determine the distribution, density and type of MP in mangrove forest sediments in the Colombian Pacific. Mangrove sediments were analyzed in a more intervened and less intervened forest in the bays of Tumaco and Buenaventura. MP were obtained by density separation and classified according to their shape; additionally, granulometry and soil organic matter were determined. The MP content was significantly higher ($p<0.05$) in Buenaventura sediments (21.62 particles/kg-1) compared to Tumaco (7.06 particles/kg-1). Fibers and fragments were the most abundant MP morphologies at both sites. In Buenaventura there was a higher accumulation of MP during the rainy season compared to the dry season. However, the dry season in Tumaco presented a higher accumulation of MP compared to the rainy season. The level of ecosystem disturbance was a determining factor in the presence of MP in the areas evaluated; disturbed mangroves presented a greater amount of PM than undisturbed mangroves. Additionally, fibers were indirectly related to mud and organic matter; and fragments were more abundant in areas with lower amounts of mud in Tumaco Bay. The results indicate that MP is heterogeneously distributed in the studied ecosystem and its accumulation is higher in disturbed sites, which are close to population centers and are related to human activities, which is consistent with what was found in other studies in China.

Code: P 15.28. Lateral Carbon Fluxes from the Florida Everglades

Vaughn, D.,[1] Raymond, P.,[1] Rosentreter, J.[2] Lagomasino, D.,[3] Poulter, B.,[4] Norton, M.[1]

[1] Yale University, United States of America [2] Southern Cross University, Australia [3] East Carolina University, United States of America [4] NASA, United States of America

Mangrove ecosystems cover a small portion of Earth's land surface but disproportionately bury large amounts of "blue carbon" in their soils. While the soils and vegetation represent a potential sink for atmospheric carbon dioxide (CO_2), data on the carbon that is exchanged between mangrove ecosystems and the oceans is lacking. As part of a recently funded NASA Carbon Monitoring System grant, we will present lateral carbon flux data from the Everglades National Park, which represents the largest distribution of mangroves in the continental United States. Data collected from the dry (March 2022 and March 2023) and wet (October 2022) seasons will be presented, including organic (dissolved organic carbon [DOC], dissolved organic matter [DOM] absorbance) and inorganic (dissolved inorganic carbon [DIC], alkalinity) carbon fluxes obtained using ISCO portable samplers, EXO2 sondes, and a Picarro gas concentration analyzer. As we continue to collect and analyze this data, we hope to create data products that can be used by decision makers to inform mangrove restoration, conservation activities, and carbon mapping.

Code: P 15.26. Pollution by microplastics in surface waters of mangrove forests of the Colombian Pacific with different degrees of anthropic intervention.

Vidal-Torralba, L.V.,[1] Molina, A.,[2] & Duque, G.[3]

[1]Grupo de investigación en Ecología y Contaminación Acuática, Universidad Nacional de Colombia, Sede Palmira, Palmira, Colombia. [2]Grupo de investigación en Ecología y Contaminación Acuática, Universidad Nacional de Colombia, Sede Palmira, Palmira, Colombia. [3]Universidad Nacional de Colombia, Sede Palmira– Facultad de Ingeniería y Administración, Palmira, Colombia.

Mangroves accumulate microplastics from terrestrial and marine anthropic sources, acting as filters between land and sea. This study aims to determine the influence of climatic seasons and physicochemical variables on the concentration of microplastics, present in surface waters of mangrove forests with different degrees of anthropic intervention. For this, physicochemical variables were measured and water samples were collected in disturbed and undisturbed mangrove forests located in two bays of the Colombian Pacific during two climatic seasons. Subsequently, oxidation processes and density separation were carried out for the identification and quantification of microplastics. The results showed an accumulation seven times higher in the Buenaventura Bay (130.02±207.1 particles/m^3) compared to the Tumaco Bay (18.52±19.6 particles/m^3). The most abundant microplastics were fragments in Buenaventura (70.09±97.25 particles/m^3) and fibers in Tumaco (11.57±18.49 particles/m^3). The climatic seasons and the anthropic intervention directly influenced the concentration of microplastics, finding higher accumulations in the rainy season and in the most intervened forests of both bays. In Buenaventura, low water temperatures were significantly related to higher amounts of fibers and pellets. Likewise, in Tumaco, the lowest salinities were significantly related to the highest amount of microplastics. The high concentrations of microplastics in Buenaventura were associated with its proximity to the human settlements and the port of Buenaventura. In turn, to high tourism and inefficient waste management. The results of climatic seasons and anthropic impact coincide with other studies, which associate human activities and runoff with the transport of microplastics.

Code: P 9.16. The mangrove-saltmarsh ecotone: Explaining observed vegetation patterns with a fully coupled mechanistic modelling approach considering plant-soil-water-feedback

Vollhüter, J.,[1] Peters, R.,[2] Wimmler, M.C.,[2] Bathmann, J.,[2] Berger, U., Tietjen, B.

[1]Freie Universität Berlin, Germany [2]TU Dresden, Germany

(Sub)tropical coastal wetlands often consist of mangrove and salt marsh habitats, where mangroves are mostly usually located in the lower, regularly flooded zones close to the sea, and saltmarsh plants usually occur in the upper intertidal, dryer and hypersaline zones. The transition between the two habitats, the so types is called "mangrove-saltmarsh ecotone", and is characterised byshaped by multiple feedbacks between the local abiotic environment factors and the prevailing vegetation. We hypothesize that these feedbacks result in characteristic vegetation patterns that are reflected, for example, in the height structure of the vegetation and the sharpness of transition between the two habitat types. While models exist that describe the dynamics of mangroves or saltmarshes separately, an integrative approach that accounts for both vegetation types and their interactions with their biotic and abiotic environment does not exist. Therefore, a mechanistic understanding of the mechanisms underlying ecotone patterns and their dynamics, also under global change, is still missing. To close this gap, we build on the hybrid process-based simulation system tool pyMANGA that describes feedbacks between mangroves vegetation and subsurface hydrodynamics. The typical zonation of mangrove forests has already been successfully reproduced with this tool. We are extending the model by a component describing the potential saltmarsh habitat, which requires not only the description of salt marsh plants, but also the unsaturated soil conditions, in which saltmarshes are often found. The final model describes the interactions between saltmarsh plants, mangrove shrubs, mangrove trees and soil water and thus allow the simulation of the entire mangrove-saltmarsh ecotone. We use the modelIt allows to systematically investigate the emergence, persistence and temporal shift of different ecotone patterns under changing hydrological conditions. Here, we introduce our the model concept of the fully coupled model and provide a proof of its suitability by will presenting first results of the modelling of a case study of a mangrove-saltmarsh ecotone in north Brazil.

Code: P 5.20. Mangrove restoration trajectories seen through macrozoobenthic community assemblages – a tool for local managers

Vovides, A.G.,*[1], Basyuni, M.,*[2] Bimantara, Y.,[2] & Balke, T.[1]

[1] School of Geographical and Earth Sciences, University of Glasgow, UK
[2] University of Sumatera Utara, Indonesia

The recognition of the high value of mangrove forests and the wide array of ecosystem services they provide has motivated worldwide investment in restoration efforts. However, current metrics of functional restoration (other than seedling survival rates and plant community composition) are often not readily available for local community managers. We recognize the urgency to implement continuous monitoring and adaptive management to improve restoration outcomes. This recognition highlights the need to identify easy-to-measure indicators to assess the functionality of restored mangroves. The macrozoobenthic community could be such practical indicator, as macrozoobenthic communities are sensitive to changes in their environment and can be easily surveyed within local managing programs. Focusing on three main mangrove management conditions (natural, planted, and naturally regenerated) in North Sumatra and the province of Aceh, Indonesia, we compared vegetation and macrozoobenthic community diversity indices and identified environmental variables that best describe the forest management conditions and their associated macrozoobenthic community assemblage. Our results showed that community assemblage, rather than macrozoobenthic diversity index, was associated with management conditions. The highest dissimilarity in macrozoobenthic community assemblages occurred between planted versus natural mangroves, with nonsignificant dissimilarity between natural and naturally regenerated mangroves. The Lined Nerite gastropod (*Nerita balteata*) was identified as an indicator of natural mangroves, and the invasive Giant African snail (*Achatina fulica*) was abundant in mangrove plantations, but also in natural mangroves bordering harbours, oil palm plantations, and aquaculture ponds, suggesting associated anthropogenic pressures. We conclude that the macrozoobenthic community can reflect restoration trajectories and inform on adaptive management actions to improve restoration outcomes.

Code: P 5.86. Genomic evolution underlying propagule dispersal via seawater: A case of *Heritiera* mangrove species

Wang, J., Shi, S.,[1] & Guo, Z.[1]

[1]State Key Laboratory of Biocontrol, Guangdong Key Lab of Plant Resources, School of Life Sciences, Sun Yat-Sen University, Guangzhou, Guangdong, China.
⁎Corresponding authors: Z. Guo (guozx8@mail.sysu.edu.cn); S. Shi (lssssh@mail.sysu.edu.cn)

One third of the world human population lives in coastal areas where are sheltered by coastal forests, particularly mangrove forests in tropical and subtropical regions. Many mangrove species disperse across seas via buoyant propagules. We deciphered the genomes of *Heritiera littoralis* and *Heritiera fomes*, two mangrove species with typical buoyant fruits, to uncover the origination and genomic evolution of seawater-dispersing propagules. The phylogenomic analysis revealed the monophyletic clade of *H. littoralis* and *H. fomes* diverged from terrestrial relatives at ~6.08 Mya, predated by a whole genome duplication (WGD) that occurred at ~35 Mya. The WGD event has made a dominant contribution to gene gains of the two species. Many of the expanded gene families function in lignin and flavonoids biosynthesis, which might have facilitated the origination of their buoyant fruits. The high content of lignins and tannins in fruits, as well as the cuticle, are essential for buoyancy and dispersing across sea for the two *Heritiera* species. By quantifying the gene expressions at young, middle-aged and mature stages of *H. littoralis* fruit development, we found young and middle-aged fruits synthesize both methoxylated lignins (G, 5H and S types) and non-methylated lignins (H and C type), but mature fruits mainly synthesize non-methylated lignins. In comparison, tannins are synthesized throughout all developmental stages. We also figured out the pathways of cutin polymer and cuticular wax biosynthesis in *H. littoralis*. These non-methylated lignins, tannins, cutin polymers and cuticular wax might have played key roles in evolving buoyant fruits with unpermeability, pathogen and herbivore resistance, and salt tolerance. Our study highlighted the potential of genomic studies to uncover genetic underlying of plant traits with high ecological value.

Code: P 9.12. Mangroves of the Amazon estuary: a hotspot for global carbon sequestration.

Ward, R.D.,[1,2,3] Lacerda, L.D.,[4] Cerqueira, A.S.,[5,6] & Giarrizzo, T.[1,4,7]

[1]Núcleo de Ecologia Aquática e Pesca da Amazônia and Grupo de Ecologia Aquática, Universidade Federal do Pará, 2651 Avenida Perimetral, Belém, Pará, Brazil [2]Centre for Aquatic Environments, University of Brighton, Cockcroft Building, Moulsecoomb, Brighton, BN2 4GJ, United Kingdom. [3]Institute of Agriculture and Environmental Sciences, Estonia University of Life Sciences, Kreutzwaldi 5, EE-51014, Tartu, Estonia. [4]Instituto de Ciências do Mar, Universidade Federal do Ceará, Fortaleza, Ceará, Brazil. [5]Department of Geography, King's College London, Bush House, North East Wing, 40 Aldwych, London, WC2B 4BG, United Kingdom. [6]Zoological Society of London, Institute of Zoology, Regent's Park, London, NW1 4RY, United Kingdom. [7]Grupo de Ecologia Aquática, Espaço Inovação do Parque de Ciência e Tecnologia do Guamá, Belém, Pará, Brazil

Vegetated coastal systems such as mangroves, seagrasses and saltmarshes provide a wide range of ecosystem services. In recent years their ability to sequester and store carbon, termed as 'Blue Carbon' has been highlighted as one of the most important ecosystems services of coastal environments. Brazil hosts the second largest extent of mangroves in the world, and 70% of this is located in the Amazon Macrotidal Mangrove Coast (AMMC) in North Brazil, including mangroves of the Amazon estuary around the largest fluvio-marine island in the world, Marajo. This region is largely understudied compared to other global regions, due its extent and the difficulty to access this remote region. To address this, we undertook a field assessment of the mangroves and *varzea* ecosystems around Marajo Island, to assess the soil carbon sequestration rates in these systems, where the bulk of the carbon is stored. Carbon sequestration rates varied between 111-3,487 gC m^2 $year^{-1}$ across all sites, providing an average of 1,718 gC m^2 $year^{-1}$. This can be compared with previously reported global averages of 134-226 gC m^2 $year^{-1}$, which suggests that the mangroves and *varzea* systems of this region sequester an order of magnitude more carbon than global averages. These high rates of carbon sequestration are likely driven by the inputs of organic material from allochthonous fluvial sources (including that provided by the Amazon and Tocantins Rivers), together with that from the adjacent the Bragança Mangrove, itself the second largest contiguous mangrove in the world. This largely understudied area is providing a vital ecosystem service, mitigating climate change, however, with recent changes in Brazilian legislation it is vital that conservation strategies are put in place to protect the structure, function and full extent of the mangroves and *varzea* within the Amazon estuary.

Code: P 15.51. Mangrove Species Discrimination Using Spectrometry of Landsat 8 OLI Spectrum

Winarso, G.,[1,2] Rosid, M.S.,[1] Harsa, H.,[2] Anggraini, N.,[2] Marini, Y.,[2] Suardana, A.,[3] Asriningrum, W.,[2] & Supriatna, J.[1]

[1] Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Depok 16424, Indonesia [2] Research Center for Remote Sensing, National Research and Innovation Agency (BRIN), KST Dr. (Hc) Soekarno Jl. Raya Bogor Cibinong KM 46 16911 Indonesia [3] Research Center for Oceanography, National Research and Innovation Agency (BRIN), Jl. Pasir Putih I Ancol Timur, Jakarta 11048, Indonesia

The world's longest sensor system series is Landsat series which already reached 9th generation. The availability of data around the world is one of the biggest treasures for researchers and scientists. The Landsat 8 spectrum provided data for wide applications including water, land, and vegetation resources. The SWIR 1 and SWIR 2 bands on the sensor are useful for vegetation analysis when the reflectance from the soil is low for example in a wetland area. Mangrove is lying on tidal lands which periodically inundated by seawaters generated wet land area. The purpose of this research is to examine the potency of Landsat 8 spectrum to discriminate mangrove species from spectrometer data using machine learning. The ASD Fieldspec spectrometer was used to measure the reflectance on 400-2500 nm spectrum of some species mangroves leave in the field at Sembilang National Park South Sumatera Province Indonesia. For comparing the reflectance, the leave non mangrove was measured also. The mangrove leave reflectance was generally same with some reference, but the non-mangrove leave was mixed with mangrove leave reflectance, different from the previous study. It seems because of the area behind the mangrove area is a wetland that generates the adaptation of rich water content on the soil of the vegetation, even if it is still not clear. The reflectance on the spectrum of Landsat 8 was clearly able to discriminate from the reflectance curve. The decision tree C5.0 machine learning of 22 mangrove species resulted in only 4 % of error, this is good discrimination. The Landsat 8 spectrum was the potential to discriminate mangrove species and the next research is how to apply this model to the satellite data.

Code: P 9.85. The fate of mangrove-derived organic matter in the land-coast-sea continuum: a pledge for finding answers to pressing questions

Wölfelschneider, M.,[1,2] Helfer, V.,[1] Hatje, V.,[3] Zimmer, M.[1,2]

[1] Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany [2] Faculty Biology/Chemistry, University of Bremen, Bremen, Germany [3] Centro Interdisciplinar de Energia e Ambiente, Universidade Federal da Bahia, Salvador, Brazil

When calculating carbon dioxide removal by coastal vegetated ecosystems, such as mangrove forests, and estimating their climate change mitigation potential, the differentiation between allochthonous and autochthonous sources of organic matter in an ecosystem of interest is currently being re-visited. Not only does its origin drive the fate of sediment organic matter through differences in quality, but the amount of organic matter transported between ecosystems will also affect carbon pools and the dynamic of these ecosystems themselves and thereby their potential for climate change mitigation. Thus, the presence of mangroves might highly increase the burial rates of organic matter in connected seagrass meadows upon export and by burying the allochthonous seagrass material upon import in the mangrove forest itself. The connectivity of ecosystems in terms of organic matter exchange is not yet considered in carbon-offsetting or management plans, as characterizing the precise origin of organic matter is still challenging. Here we used py-GC/MS to investigate the origin and transport of organic matter in a mangrove estuary in Brazil. Identifying compounds that are unique for mangrove, seagrass, and macroalgae species, enabled us to map the transport and deposition of the organic matter from these different sources within the estuary, the bordering mangroves, and the present seagrass meadows. Our results will contribute to more accurately calculating the contribution of allochthonous and autochthonous sources to carbon stocks in different coastal vegetated ecosystems. Documenting organic matter dynamics among ecosystems will help design better connected and much more efficient management plans for tropical coastal regions enhancing their climate change mitigation potential.

Code: P 15.45. Molecular fingerprinting sheds light on the biogeochemical cycling of mangrove derived dissolved organic matter along the land-ocean continuum

Wölfelschneider, M.,[1,2]* Seidel, M.,[3] Hatje, V.,[4] Zimmer, M.,[1,2] & Dittmar, T.[3]

[1]*Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany*
[2]*Faculty of Biology/Chemistry (FB2), University Bremen, Bremen, Germany.*
[3]*Institute for Chemistry and Biology of the Marine Environment (ICBM), University of Oldenburg, Oldenburg, Germany*
[4] *Centro Interdisciplinar de Energia e Ambiente, Universidade Federal da Bahia, Salvador, Brazil* *
Corresponding author: mirco.woelfelschneider@leibniz-zmt.de

Observing and understanding organic matter (OM) dynamics in mangrove-fringed estuaries and coastal ecosystems remains a challenging task because these ecosystems are located at the transition zone between land and sea with highly complex biogeochemical cycles as well as various OM sources and sinks. Research of OM cycling in mangroves and coastal waters is often focused on particulate OM dynamics and only a limited number of studies have investigated mangrove-derived dissolved organic matter (DOM) dynamics in coastal mangrove-fringed waters. However, the sheer quantity of mangrove derived DOM contributing to carbon outwelling in tropical coastal ecosystems alone highlights its importance for the coastal and global marine carbon cycles. Our case study on mangrove-derived DOM in a Brazilian mangrove estuary (Rio Jaguaripe, Bahia, Brazil) using ultrahigh-resolution mass spectrometry (FT-ICR-MS) as a tool for molecular fingerprinting aims to decipher the biogeochemical dynamics of DOM in these coastal waters. We used molecular markers previously established for tracing mangrove porewater-derived DOM in combination with a newly developed index for mangrove leaf derived DOM to track the fate of potentially recalcitrant and freshly produced DOM in the coastal ecosystem, respectively. We hypothesize that the analysis of the DOM molecular composition can be used to assess the stability and transport of the different mangrove-derived DOM pools to the coastal ocean. Such insights will help to identify how fresh mangrove-derived DOM contributes to active coastal carbon cycling since the bioavailable DOM is a microbial carbon source whereas outwelled, porewater derived DOM may contribute to recalcitrant carbon in marine DOM that is stable on millennial time scales. Integrating molecular analytical tools with quantitative data on OM cycling will help us to understand how increasing anthropogenic threats will impact biogeochemical cycles in mangroves and other rapidly changing coastal tropical ecosystems.

Code: P 9.10. Tree growth and dynamics in mangrove forests in the coast of Suriname

Wortel, V.,[1] Ospina, M.A., Ngu-Chin-Tjon, A.S., Feyen, J., Hanoeman, N., Sewotaroeno, M., Doelatip, S., & Crabbe, S.

[1]*Centre for Agricultural Research in Suriname (CELOS)*

Mangrove forests are recognized as key contributors to climate change mitigation and adaptation. These forests have the ability to sequester and capture carbon (mitigation) and protect coastal areas through stabilizing erosion, reducing storm surges, and preventing inland soil salinization (adaptation). In the last decade, in Suriname an increasing awareness of the importance of mangroves is noticeable, such that mangroves are also incorporated in national climate policies, including the National Mangrove Strategy and REDD+ Strategy for Suriname. But little research was conducted to improve Mangrove Forest management. To inform decisions on Mangrove Forest management, a Mangrove Biodiversity Monitoring System (part of the National Forest Monitoring System), was established in 2019. Along the 386 km coastline of Suriname in Permanent Sample Plots (PSPs) data were collected on biomass, carbon stocks, forest structure, and biodiversity. Initial results showed that about 6.5% of the total mangrove area size (estimated 97100 hectare) were dead mangrove stands. A total of three mangrove species were encountered: *Avicennia germinans*, *Rhizophora mangle* and *Laguncularia racemosa* of which *A. germinans* is the most dominant followed by *R. mangle* and *L. racemosa*. The mean carbon storage of these 3 mangrove species were 147.56 ±31.6-ton C/ha while non- mangrove species were 0.44 ± 0.35-ton C/ha. Standing dead trees attributed to a mean carbon storage of 27.88 ± 4.04-ton C/ha and living trees 119.83 ± 30.12-ton C/ha. In 2022, a second initiative took place to strengthen the Mangrove Biodiversity Monitoring System and included parameters to assess the health of Mangrove forests. Data generated from this Monitoring System will enable the Government of Suriname to improve Mangrove Forest management that in turn will help us better adapt and mitigate adverse effects of climate change in Suriname. This data will also support restoration activities of degraded mangrove forests.

Code: P 5.25. Coexisting mangrove-coral habitat use by reef fishes in the Caribbean

Wright, J.L.,[1] Stewart, H.A.,[*2,3,4] Candanedo, I.,[3] D'Alessandro, E.K.,[1] Estevanez, M.,[5] & Araújo, R.J.[1]

[1]Department of Marine Biology and Ecology, Rosenstiel School of Marine, Atmospheric & Earth Science, University of Miami, Miami, Florida 33149
[2]Department of Biology, McGill University, Montreal, Quebec H3A 1B1, Canada
[3]Smithsonian Tropical Research Institute, Box 2072, Balboa, Panama
[4]Current address: Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, Florida 33701
[5]Department of Marine Environmental Science and Policy, Rosenstiel School of Marine, Atmospheric & Earth Science, University of Miami, Miami, Florida 33149

Caribbean seascape connectivity is high resulting from low tidal amplitudes. This allows for red mangroves to commonly occur near coral reefs, and studies have documented corals growing in mangrove habitats. These coexisting mangrove-coral (CMC) habitats can act as a refuge for corals by reducing light stress, leading to increased coral richness. Despite the crucial role of CMC habitats for corals and their associated fauna, CMC habitat utilization by fishes remains poorly understood. This study contributes to the growing body of knowledge on CMC habitats, analyzing the effect of coral presence in mangrove habitats on the fish assemblage through visual fish surveys in CMC habitats and mangrove habitats without corals (non-CMC). We conducted comparative visual fish surveys in CMC and non-CMC habitats throughout Bocas del Toro, Panama.
We observed 30 fish species, of which 16 species occurred in both habitats, and 7 species were unique to each habitat. Most fishes encountered during the study were juveniles with no significant difference in percentage of juveniles between habitat types. Our study revealed that CMC habitats harbor distinct fish assemblages compared to mangrove habitats without coral, with greater species richness and increased herbivore abundance. We found habitat complexity to be greater in CMC habitats compared to non-CMC habitats from a combination of vertical relief and shelter provided by increased prop root density along with rugosity and shelter holes provided by the coral. The combination of these factors is likely enhancing CMC fish species richness.
CMC habitats serve a critical role as nursery habitat for herbivorous reef fish species, which can help replenish depleted populations on coral reefs. Therefore, conservation efforts should focus on locating and protecting CMC habitats, as this habitat type provides an opportunity to understand how mangroves, corals, and fishes interact and offers unique possibilities for conservation of key species and ecosystems.

Code: P 5.85. *Nypa fruticans* genome reveals its origin and long-term adaptation to the intertidal zones

Wu, W.[1]

[1]State Key Laboratory of Biocontrol, Guangdong Key Lab of Plant Resources, School of Life Sciences, Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-sen University, Guangzhou, China. Email: wuwh25@mail2.sysu.edu.cn

The *genus Nypa*, one of the most ancient lineages of mangroves, has lived in the stressful intertidal zones since the Late Cretaceous with only one extant species, *Nypa fruticans*. It is a good object for studying low speciation rate and the long-term sustained adaptation. Here, we presented a chromosome-level genome assembly for *N. fruticans* and performed comparative genomics analysis to investigate its origin and adaptation. We inferred that *N. fruticans* originated at about 75.8 million years ago (MYAs) and confirmed that a whole-genome duplication (WGD) event occurred approximately 89 MYAs in a common ancestor of all palms, which was crucial to the early palm evolution. We noted that the *N. fruticans* protein-coding genes had a lower mutation rate and suffered strong purifying selection. *N. fruticans* maintained a stable genome over long-time evolution by limiting long terminal repeat (LTR) insertions, gene duplications, and WGD duplicates losses. Preferentially retained WGD duplicates and positive selection of key genes (e.g. ERF-VIIs) promote *Nypa*'s waterlogging tolerance in intertidal zones. We also found that a frameshift mutation (site 391 deletion) in the Seed Dormancy Regulator 4 (SDR4) coding region might relate to the crypto-vivipary trait in *N. fruticans*. In summary, this study provides genomic insights into *Nypa*'s long-term adaptation to extreme environments and the early evolution of palms.

Code: P 5.84. Gene loss facilitates gene regulatory network stability and adaptive trait evolution in mangroves invading unstable intertidal zones

Xu, S.,[1,2] Shao, S.,[1] Shi, S.,[1] & He,Z[1]

[1]State Key Laboratory of Biocontrol, Guangdong Key Lab of Plant Resources, School of Life Sciences, Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-sen University, Guangzhou, China
[2] School of Ecology, Sun Yat-sen University, Guangzhou, China

When mangroves colonizing the intertidal zones, the extremely fluctuating environments are the major challenges and the highly specialized phenotypic traits are significant adaptive features. Gene loss is common during genome evolution, but it is still unclear whether it can be a significant player in environmental adaptation. Among ten independent mangroves that invade the most unstable intertidal habitats, we identified a common trend of extensive gene loss. To explore the adaptive role of gene loss, we conducted comparative genomic analyses in eight *de novo* assembled genomes of the largest mangrove clade Rhizophoreae. We find that gene loss has promoted gene regulatory network (GRN) stability in unstable environments where cellular homeostasis should be crucial. Furthermore, gene set simplification that maximizes the effects on GRN stability simultaneously minimizes the influence on essential growth and development processes. More strikingly, gene loss has contributed to crucial adaptive traits. Gene families that participate in seed dormancy have been significantly reduced or even lost in Rhizophoreae genomes, leading to the emergence of viviparous seeds. Loss of critical regulators has conferred high salinity tolerance on Rhizophoreae mangroves. Reduction of gene families that mediate tannin oxidation or tannin monomer consumption and increased expression of key genes in the tannin biosynthesis pathway jointly contribute to high tannin content. In summary, the extensive gene loss in Rhizophoreae genomes plays a crucial role in transcriptome stability and promotes phenotype innovation, helping the most successful mangrove clade adapt to extreme environments.

Code: P 5.45. Genome of mangrove without specialized phenotypes reveals common requirements of adaptation to intertidal environments

Yulong, Li.[1,2]

[1]State Key Laboratory of Biocontrol, Guangdong Key Lab of Plant Resources, School of Life Sciences, Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-sen University, Guangzhou, China
[2]School of Ecology, Sun Yat-Sen University, Guangzhou, China Email: yl.lee2014@hotmail.com

Whether there is a common molecular mechanism for independently originated mangrove plants to colonize the extreme intertidal environment is a general concern. A few mangrove clades have evolved specialized phenotypes, such as vivipary, salt-secreting and aerial root. However, the clades without such specialized phenotypes and well adapted to intertidal zones would help understand the common molecular mechanism of intertidal environment adaptation. In this study, we sequenced and assembled the genome of *Scyphiphora hydrophylacea* (Gentianales: Rubiaceae), which is the only true mangrove in Gentianales and lacks specialized phenotypic traits. We found that *S. hydrophylacea* entered the intertidal zones during the climatic optimum period of global warming and sea level rises. In the absence of whole genome duplication (WGD), *S. hydrophylacea* responded to the two major intertidal environmental stressors, high salinity and hypoxia, mainly through gene tandem duplications. For example, the copy number expansion of genes related to cation transport, reactive oxygen species scavenging, osmoregulation and protein protection may have contributed to the evolution of the salt accumulation tolerance mechanism. The massive tandem duplication of transcription factor *ERF74* may promote the adaptation to the hypoxic environment. When extending the analyses to five independent mangrove clades, we found a convergent expansion of the *HKT1* gene and *ERF74* gene, which are core genes of salt tolerance and hypoxia tolerance, respectively. The results indicated that the convergent expansions of core genes in the stress tolerance pathways were a common adaptive strategy for mangrove plants to adapt to the intertidal environment. Our study provides new insights into molecular adaptation and convergent evolution in mangrove plants.

Code: P 15.54. Environmental education for the management of blue carbon in mangroves in Latin America under the Ocean Teacher Global Academy strategy

Zamora-Bornachera, A.,[1] Hernández-Narváez, D.,[1] Sierra-Correa, P.C.[1]

[1]Institute of Marine and Coastal Research"José Benito Vives de Andréis" – INVEMAR, Santa Marta, Colombia

Blue carbon initiatives in mangroves have gained importance for climate change mitigation, which requires wide dissemination and shared construction of knowledge. Faced with this, it is important to train local communities, environmental authorities, decision-makers, and scientific researchers in coastal marine issues for the implementation of tools that favor these blue carbon initiatives, facilitating biodiversity management, collaboration and learning. In this regard, through the IODE-IOC UNESCO Ocean Teacher Global Academy (OTGA) strategy, Invemar, as a Regional Training Center, has facilitated the implementation of five (5) international courses called "Climate change: Blue carbon and adaptation based on ecosystems", where 135 people (67% women and 45% men) have been trained between the period 2018 - 2022, coming from 15 countries of Latin America. This is a significant contribution to environmental education and dissemination of updated knowledge at the coastal marine level in terms of techniques and advances in estimating carbon in mangroves and other blue carbon ecosystems such as seagrasses, as well as the generation of spaces for the exchange of experiences and knowledge between countries; In the same way, it has been possible to provide tools for climate change management, environmental conservation, the promotion of nature-based solutions, and sustainable dynamics at the continental level in mangrove ecosystems.

Code: P 9.13. Permeable structures for climate adaptation in the Colombian Pacific Coast

Zapata, N.,[1] Castaño, B.P.,[1,2,3] Delgado, J.K., Gallego[3] Osorio, A.F.,[1] Cabrera, C.A.,[1] Acevedo, S.,[1] Rocío, G.,[1] & Urrego, L.E.[1]

[1]Universidad Nacional de Colombia [2] CEMarin, Colombia [3] Cornell University, Coastal Solutions Fellows Program, United States of America

Mangrove ecosystems of the Colombian Pacific Coast (CPC) are considered as one of the most important *hot-spots* for carbon sequestration in the world. These ecosystems are natural structures that protect coastlines from erosion. Therefore, mangroves are key for both climate change mitigation and adaptation. Punta Soldado Island is one of the sites located in the CPC threatened by climate variability phenomena which affect coastal ecosystems as well as local communities. This has been observed through several events that have progressively driven beach erosion, mangrove forest destruction and community relocation within Punta Soldado. As a strategy for addressing the problem, we proposed the design and building of a Nature Based Solution (NbS) pilot jointly with the local community. It consists of a permeable structure made of local materials which allows the accumulation of suspended sediment transported by currents or waves within a specific area. Sediment accumulation may boost mudflats recovery and then bring on mangroves' recolonization, through which coastal protection would be favored as well as other ecosystem services. Permeable structures have been widely applied in different scales of Southeastern Asia where considerable accretion rates have been obtained yearly. This review has the purpose to present the advantages, disadvantages and lessons learnt from the design, building and monitoring of a permeable structure for mudflats recovery in Punta Soldado as a strategy for coastal resilience to climate change. Through the design and construction of the permeable structure, we have acknowledged the importance of detailed studies to choose the most suitable site for the structure's placement. Community involvement is essential for making the building process an effective tool for strengthening capacity for climate adaptation strategies. NbS are the most promising methods as a mangrove regeneration accelerators, nevertheless, intersectoral collaboration is crucial for the success for large scale implementation of these types of strategies.

Code: P 5.54. Biotic homogenization increases with human intervention: implications for mangrove wetland restoration

Zhang, Y.,[1] & Wang, W.[2]

[1]Xiamen university, China
[2]National Observation and Research Station for the Taiwan Strait Marine Ecosystem, Key Laboratory of the Ministry of Education for Coastal and Wetland Ecosystems, College of the Environment and Ecology, Xiamen University, Xiamen, Fujian 361102, China

The large-scale conversion of natural mangroves to aquaculture reduces species richness and diversity. Large areas of abandoned aquaculture ponds in areas where mangroves formerly predominated in China and southeast Asia represent important potential effective targets for mangrove restoration. Here, we empirically assessed the α-diversity (species richness) and β-diversity (variation in community composition) of mangrove, macrobenthos, fish and waterbird in a tropical mangrove bay on Hainan Island, China. We compared sites subjected to different pond-to-mangrove restoration programs more than 20 years ago (passive restoration without planting and active restoration with planting) to nearby reference site with natural mangrove forests and mudflats. To better understand how β-diversity responds to restoration, we also distinguished between β-diversity turnover and nestedness (richness difference). In general, α-diversity values for both fish and waterbird communities and β-diversity values for the mangrove, macrobenthos and waterbird communities were lower at the restoration sites than at the reference site, suggesting that the strong homogenizing effects of anthropogenic habitat alternation were still apparent after more than 20 years since aquaculture ceased. In addition, spatial turnover, not nestedness, dominated total β-diversity both across the whole study area and at individual sites, suggesting that multiple processes, such as environmental filtering, helped to shape multi-taxa community structures. Moreover, we found no evidence that planting in the abandoned ponds, in addition to standard hydrological restoration, supported greater species diversity of taxa like macrobenthos and waterbird than the naturally regenerated site after more than 20 years' recovery. Our results underline the importance of avoiding the conversion of natural mangrove stands to aquaculture wherever possible and the urgent need to design effective mangrove restoration techniques in tropical Asia.

Code: P 5.46. High-quality genome of a pioneer mangrove *Laguncularia racemosa* corroborates its utility in reforestation efforts

Zhu, R.[1]

[1]State Key Laboratory of Biocontrol, Guangdong Key Laboratory of Plant Resources, School of Life Sciences, Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, Guangzhou, China Email: zhurr@mail2.sysu.edu.cn

Over the past 50 years, the mangrove ecosystems that became susceptible to recent habitat perturbations declined globally by 20% - 35%. Its ecological restoration is crucial for tropical coast conservation. The white mangrove *Laguncularia racemosa*, a pioneer species inhabiting intertidal environments of the Atlantic East Pacific (AEP) region, has been introduced to China for reforestation for decades thanks to its fast growth. But the excellent growth ability also puts *La. racemosa* in the contradiction between reforestation and invasiveness. As the molecular mechanisms underlying this species' adaptation and potential uncontrolled invasion remain unknown, we sequenced the *La. racemosa* genome and carried out comparative genomic analyses. We completed a high-quality *La. racemosa* genome assembly using PacBio Single-Molecule Real-Time sequencing. The genome covers 1104.06 Mb with scaffold N50 of 3.41 Mb. The genomic phylogeny shows that *La. racemosa* invaded intertidal zones during a period of global warming. Multi-level genomic convergent evolution between *La. racemosa* and three widely distributed mangrove clades shows its vast distribution potential. Convergent amino acid substitutions may facilitate nutrient absorption, while convergent gene loss likely contributes to high salinity tolerance. Both are critical for invading intertidal environments. Unlike many other mangroves that experienced recent whole-genome duplication, *La. racemosa* has many tandem duplications in key genomic regions that harbor genes involved in auxin biosynthesis, intense light stress, and cold stress response pathways. These genomic features may explain *La. racemosa*'s ability to grow fast under varying environmental conditions when used for reforestation. In summary, our study identifies shared mechanisms of intertidal environmental adaptation and sheds light on the molecular mechanisms of the white mangrove's utility in ecological restoration.

Code: P 14.4. Tracking loss and recovery of mangrove forests from repeat hurricanes using Landsat

Zhu, Z.,[1] Yang, X.,[2] Zhu, Z.,[2] Krauss, K.,[1] & Ward, E.[1]

[1]U.S. Geological Survey, [2]University of Connecticut

Hurricanes and other high-intensity storms exsert destructive impacts on mangrove forests worldwide. The loss and recovery of mangrove forests from the storms may be quantified by using dense time-series Landsat imagery. We used such a remote sensing model to estimate the magnitude of aboveground biomass loss and time needed to recover to pre-hurricane conditions for a mangrove forest at the Ding Darling National Wildlife Refuge in Sanibel Island, Florida. The mangrove forest was hit by a scale-4 Hurricane Charley in 2004, and again a scale-4 Hurricane Ian in September of last year, both times within the epicenters. Using a remote sensing model and ground inventory data tracking the changes after 14 years of Hurricane Charley, we estimated the damaged area of mangrove at 61 ha out of 1,173 ha, less than half of the damaged area were recovered by 2018. We noted that most of those not yet recovered were in tidal-restricted zones. What might be the impact of last year's Hurricane Ian, and would the recovery follow a similar pattern? While we currently do not have long-enough observations from the satellite to assess the impact, nor the recovery which would require much longer observation as well as use of predictive modeling, initial observations show that the reduction of Landsat greenness values was higher immediately after Ian than Charley, and the initial impact tended to be more scattered. Whether the disturbed mangrove areas can be traced to relations between the two repeated hurricanes need to be confirmed with more on-the-ground studies.

Code: P 5.52. Mangrove species-specific herbivore communities, potential drivers of their occurrence, and effects of their activity

Zimmer, M.,[1] et al.

[1] Leibniz Centre for Tropical Marine Research, Germany

Herbivorous insects contribute substantially to the taxonomic and functional diversity in many ecosystems. However, herbivores and herbivory have rarely been studied in mangrove forests. We performed field surveys and experiments in the Matang Mangrove Forest Reserve, Malaysia, as a primer to better understanding herbivore diversity and their effects on mangrove forests. Individual plants of *Acanthus ilicifolius*, *Bruguiera parviflora*, *Excoecaria agallocha* and *Rhizophora apiculata* were screened for herbivore attacks and damages, and surveyed for the insect herbivore community. Overall, *Bruguiera* and *Rhizophora* were more heavily attacked by herbivores than *Acanthus* and *Excoecaria*. Physico-chemical leaf characteristics did not provide a straightforward explanation for this observation. The species composition of the herbivore community was clearly distinct across species. Thus, *Bruguiera* and *Rhizophora* were characterised by similar communities but different leaf traits, whereas *Rhizophora* and *Acanthus* were similar to each other regarding their leaf traits but hosted contrasting herbivore communities. Experimental exposure of young and mature leaves to herbivores or artificial leaf damage resulted in both short- and long-term changes in some physico-chemical leaf traits, particularly the content of phenolic compounds, that were also reflected by herbivory-induced changes in chemical fingerprints of leaves. Our study sheds light on a complex but vastly understudied plant-insect interaction with diverse players, and suggests that the local or regional loss of individual mangrove species will result in reduced herbivore diversity.

Code: P 15.25. Combined effects of burrowing crabs and tides on carbon fluxes in sediments

Zimmer M.,[1] et al.

[1]Leibniz Centre for Tropical Marine Research, Germany

While faunal effects are often neglected in budgeting dynamics of carbon stocks in mangrove sediments, crab burrows are known to impact these dynamics. Burying leaves into the sediment can increase the sediment carbon stock. On the other hand, crab burrows can enhance the release of carbon dioxide (CO2) into the atmosphere. Both particulate and dissolved organic matter are relevant reservoirs of organic carbon in either process, but the latter is rarely considered. This laboratory study, using the sesarmid crab *Neosamartium africanum*, employed an experimental approach to shed light on the complex relationship between burrowing crabs, tides, and carbon stocks under controlled conditions. The study was designed to test whether (1) crabs increase the carbon content in the sediment porewater by burying leaves, and (2) the positive coupling between crab activity and carbon stocks would be counteracted by the enlarged sediment-air interface of crab burrows and flushing effects of the tidal pump.

Neither hypothesis was supported by our findings. The presence of crabs did not affect the dissolved organic carbon concentrations in the porewater – possibly because of substantial consumption and utilization of soluble organic compounds by crabs, leaving behind a greater proportion of insoluble and recalcitrant organic matter. Further, CO_2 emissions were significantly lower, when crabs were present – possibly because crab burrows partly collapsed during the experiment and may have trapped particulate organic carbon inside the sediment. While this is most likely a laboratory artefact, we conclude that temporal dynamics, collapsing and formation of crab burrows might have to be taken into account in sediment carbon budgets in the field. Overall, this study provides new insights into the complex relationship between crab burrows and tides and highlights the need for further research on organic carbon storage in mangrove forests, including the effects of (i) particulate organic matter burial and consumption, (ii) tidal flushing, and (iii) temporal burrow dynamics on carbon dynamics in mangrove sediments.

Code: P 9.84. Sea4soCiety - searching for solutions for Carbon sequestration in coastal ecosystems

Zimmer, M.,[1] sea4soCiety-Consortium[2] ManceraPineda. J.E.,[3] Amir, A.A.,[4] Estebán Zarza, E.,[5] & Lee, J.N.[6]

[1] Leibniz Centre for Tropical Marine Research, Germany [2] CDRmare, Germany [3] Universidad Nacional de Colombia [4] Universiti Kebangsaan, Malaysia [5] Universidad del Sinú sede Cartagena, Colombia [6] Universiti Malaysia Terengganu

Climate change mitigation requires immediate and long-lasting drastic reductions in anthropogenic greenhouse gas emissions. As some of these emissions cannot easily be avoided, the net-zero emissions aim can only be reached through carbon dioxide removal (CDR) strategies. Many of these rely on technical, physical or chemical approaches that are promising but not yet fully implementable nor fully accepted by society (https://cdrmare.de/en). Nature-based Solutions (NbS), by contrast, may be less efficient but enjoy high societal desirability and methodological feasibility. sea4soCiety aims at developing innovative approaches to enhance the potential for carbon sequestration in mangrove forests and other blue carbon ecosystems (saltmarshes and seagrass beds), e.g., through expanding their spatial extent into new areas, if and where ecologically feasible, environmentally sound, legally and ethically unobjectionable, and socially acceptable, and economically viable. In a series of presentations, we will shed light on the general concept, progress and first findings specifically with respect to methodology, organic matter stability and origin, faunal effects on carbon fluxes, and societal perception and acceptance. This contribution, on behalf of the entire project team and associated partners, will provide an overview of, and introduction into, our approach.

Code: P 14.12. Strengthening Inter-sectoral Convergence in Ecological Mangrove Restoration of Abandoned Brackish-water Fishponds in the Philippines

Zuniga, J.B.M.,[1] Gestiada, A.S.,[2] Manahan, J.R.F.,[2] & Villamor, C.[2]

[1]Department of Science and Technology - Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development Paseo de Valmayor, Brgy. Timugan, Los Banos, Laguna
[2]Department of Environment and Natural Resources - Ecosystems Research and Development Bureau College, Laguna

Rehabilitation of abandoned brackish-water ponds in the Philippines is often problematic due to uncoordinated institutional policies and conflicts in ownership. Ecological Mangrove Restoration (EMR), which puts a premium on restoring natural hydrology to restore abandoned fishponds, has been applied in several countries but is not fully practiced in the Philippines. This study was done to pioneer ecological mangrove restoration in the Philippines, identify gaps in the current institutional arrangement, and recommend the roles of key stakeholders in the implementation of EMR. The selection of abandoned brackish-water fishponds was coordinated with national government agencies such as the Department of Environment and Natural Resources (DENR) and the Bureau of Fisheries and Aquatic Resources (BFAR). Other sectors involved in the implementation of EMR include the Local Government Units, Academe and Research Institutions, People's Organization and local community members. The identification of the lead and cooperating agencies and their roles in each step of the EMR process were determined based on their mandates and technical capacities. Suggested modifications in the EMR process are presented such as sustainability mechanism options and the combination of natural regeneration with active planting for better applicability in the Philippine setting. The results are seen to contribute to policy recommendations to mainstream EMR in mangrove rehabilitation projects and initiatives.

ALL IN ONE

Cartagena Colombia

July | 24-28 | 2023

ENVIRONMENT

Cartagena Colombia
July | 24-28 | 2023

SEA

Cartagena Colombia
July | 24-28 | 2023

MANGROVES

Cartagena Colombia
July | 24-28 | 2023

THE PLACE

Cartagena Colombia
July | 24-28 | 2023