Report of the International Mangrove Center Workshop on Mangrove Conservation and Restoration (2024 1st Term)

Dates: July 25 – August 8, 2024

Venues: Shenzhen, Guangdong Province and Hainan Province, China

Organizers: International Mangrove Center (IMC), Guangdong Neilingding Futian National Nature Reserve Administration Bureau, and the National Academy of Forestry and Grassland Management

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1. Introduction

1.1. Background and rationale

The First International Mangrove Center Workshop on Mangrove Conservation and Restoration took place from July 25 to August 8, 2024, in Shenzhen and Hainan. As the inaugural workshop since the official establishment of the IMC, this event served as a key initiative to thoroughly implement the guiding principles of President Xi Jinping's important speech at the opening ceremony of the 14th Conference of the Contracting Parties to the Ramsar Convention and to accelerate international cooperation in mangrove management.

This workshop represented a breakthrough from zero to one, marking China's enhanced role in global wetland diplomacy. The event was organized with strong support from national and local governments, demonstrating the high-level leadership commitment to mangrove conservation and restoration efforts worldwide. The workshop aimed to implement the principles outlined by President Xi Jinping at the Ramsar COP14 opening ceremony and to strengthen China's position as a leader in global environmental governance.

1.2. Workshop objectives

The objectives of the workshop were to build the capacity of government officials and experts in mangrove management, to strengthen the international exchange of experiences, and to promote the creation of an international network dedicated to mangrove conservation and restoration. The training combined lectures, field visits, and cultural experiences to ensure participants gained both theoretical knowledge and practical insights.

1.3. Target audience and participants

A total of twenty-three participants attended, representing twenty countries from Asia, Africa, Latin America, and Oceania. Special priority was given to the three IMC co-sponsoring countries, China, Madagascar, and Cambodia, each of which received two places. The participants were mainly mid- to senior-level government officials responsible for wetland management, forestry, and natural resources. Preparations included the recruitment and selection of participants, the choice of expert faculty, the design of the curriculum, assessments of training sites, and the establishment of logistical and safety measures.

2. Program and methodology

The training lasted fifteen days and combined theoretical instruction, field visits, and cultural exchanges. The first phase, held in Shenzhen, emphasized classroom lectures and case studies. Leading experts from universities, research institutes, international organizations, and non-governmental organizations delivered lectures on topics such as mangrove ecology, restoration practices, climate change, alien species management, blue carbon, ecological monitoring, and migratory bird conservation. These sessions were complemented by interactive exchanges in which participants presented case studies from their own countries and shared lessons learned from national experiences.

The second phase took place in Hainan Province and focused on field instruction. Participants visited national nature reserves, wetland parks, ecological parks, and the Hainan International Blue Carbon Research Center. These visits allowed them to observe restoration techniques, coastal protection measures. They also witnessed the integration of urban development with ecological conservation in Shenzhen and Hainan, which served as tangible demonstrations of China's achievements in this field.

In addition to the technical programme, cultural activities were organized to strengthen mutual understanding and networking. These included the practice of Chinese tea culture, visits to museums and urban planning exhibitions, and explorations of tropical forests and rainforests. Such activities deepened the cultural dimension of the exchange and reinforced the spirit of cooperation among participants.

Participant profile:

Participants were drawn from a wide range of cultural, professional, and geographical contexts. They included senior officials from ministries of environment, forestry, and natural resources. While English was the main working language, interpretation in French was also provided. The diversity of backgrounds enriched the discussions and fostered cross-country learning.

Geographic Representation:

- **Asia:** Bangladesh, Cambodia, China, Laos, Myanmar, Pakistan, Samoa, Thailand
- **Africa:** Burkina Faso, Comoros, Gabon, Guinea, Liberia, Libya, Madagascar, Sierra Leone, Zimbabwe
- **South America:** Venezuela
- **Central America:** Panama

3. Opening Ceremony

The opening ceremony for the inaugural session of the 2024 International Mangrove Center Mangrove Conservation and Restoration Workshop was solemnly held on the morning of July 26, 2024, at the Shenzhen Hall of the Guohui Hotel. Prior to the event, the venue was meticulously prepared to foster an atmosphere that was both dignified and welcoming, featuring a striking blue backdrop with white lettering flanked by the national flags of the 20 participating countries. The ceremony commenced with participants taking their pre-assigned seats and was presided over by Professor Bao Daming, Director General of the Interim Secretariat of the International Mangrove Center.

The event was honored by the presence of senior officials, including Mr. Chan Yaodong, Deputy Secretary-General of the Shenzhen Municipal Government; Mr. Xia Jun, Director-General of the Department of International Cooperation and Development at the National Forestry and Grassland Administration; and Mr. Yuan Jiming, Director-General of the Department of Wetlands at the National Forestry and Grassland Administration. Opening remarks were delivered by Mr. Chan Yaodong, Mr. Xia Jun, and Mr. Julien Noël Rakotoarisoa from Madagascar, who served as a participant representative. The speakers underscored the workshop's critical importance as a platform for strengthening international cooperation on mangrove conservation and restoration, expressing a shared commitment to advancing global efforts in sustainable mangrove management. Following the addresses, the attendees convened for an official group photograph. The ceremony was also attended by Mr. Liu Chunyuan, Party Secretary of the National Forestry and Grassland Administration Management Cadre College, and the representative of the Shenzhen Municipal Ocean Development Bureau.

Photo 1 : Prof. BAO Daming, Director General of IMC at IMC workshop Opening ceremony

4. Summary of thematic sessions

The thematic sessions provided a comprehensive overview of mangrove ecosystems, covering their ecological functions, restoration techniques, climate resilience, and socio-economic value. Lectures were delivered by leading Chinese and international experts from universities, research institutes, and international organizations. Case studies presented by participants highlighted country-specific challenges and innovative approaches, ensuring knowledge exchange was both theoretical and practical.

4.1. China's Mangrove Conservation Framework

Dr. YUAN Jiming, Director General of the Department of Wetland Management at the National Forestry and Grassland Administration, delivered this foundational session that provided comprehensive insights into China's national approach to mangrove conservation. The presentation covered the current status of mangrove ecosystems in China, major challenges facing conservation efforts, and strategic actions being undertaken at national and local levels to address these challenges.

Dr. Yuan outlined China's remarkable mangrove conservation achievements, including the significant expansion of protected areas and notable restoration successes that have contributed to ecosystem recovery from historical lows. The session explored the integration of conservation efforts with economic development priorities, demonstrating how China has successfully balanced environmental protection with continued economic growth through innovative policy frameworks and strategic planning approaches.

Key discussion points included China's mangrove area recovery from historical minimum levels, the successful integration of conservation priorities with economic development needs, comprehensive policy frameworks supporting mangrove protection at multiple governmental levels, and ongoing challenges in balancing development pressures with long-term conservation requirements.

Photo 2 : Dr. YUAN Jiming, Director General of the Department of Wetland Management at the National Forestry and Grassland Administration

4.2. International Cooperation and Wetlands Convention

Dr. XIA Jun, Director General of the Department of International Cooperation at the National Forestry and Grassland Administration, emphasized the critical importance of international cooperation in mangrove conservation efforts while highlighting China's strong commitment to the Ramsar Convention and multilateral environmental agreements. The session provided detailed insights into how international cooperation mechanisms can enhance conservation effectiveness and promote sustainable management practices across national boundaries.

The presentation explored implementation of Ramsar Convention principles in practical conservation contexts, bilateral and multilateral cooperation mechanisms that facilitate knowledge and resource sharing, China's evolving role in global environmental governance and leadership, and emerging opportunities for enhanced international collaboration in mangrove conservation and restoration efforts.

Discussion focused on practical approaches to implementing international cooperation agreements, mechanisms for sharing technical expertise and financial resources across borders, China's contributions to global environmental governance and policy development, and specific opportunities for participants to engage in enhanced international collaboration upon returning to their home countries.

Photo 3 : Dr. XIA Jun, Director General of the Department of International Cooperation at the National Forestry and Grassland Administration

4.3. Mangrove Ecosystem Fundamentals and Restoration

Professor WANG Wenqing from Xiamen University provided essential background on mangrove ecosystem structure, function, and restoration principles, covering the ecological foundations necessary for effective conservation planning and implementation. The session addressed fundamental concepts in restoration ecology while providing practical guidance for designing and implementing successful restoration initiatives.

The presentation covered comprehensive analysis of mangrove ecosystem services and ecological functions, detailed exploration of restoration ecology principles and best practices, scientific approaches to site selection criteria for restoration projects, and development of appropriate success metrics for evaluating restoration initiative effectiveness over time.

Participants engaged in discussions about practical applications of ecosystem service valuation, adaptation of restoration principles to diverse geographical and climatic contexts, criteria for selecting optimal restoration sites given local constraints and opportunities, and development of measurable indicators for assessing restoration success and adaptive management needs.

Photo 4 : Prof. WANG Wenqing, Xiamen University

4.4. Science, Technology and Innovation for Sustainable Restoration

Professor FAN Hangqing from the Guangxi Academy of Marine Sciences explored cutting-edge technologies and innovative approaches in mangrove restoration, drawing from extensive research conducted at the Guangxi Mangrove Research Center. The session highlighted how scientific advances and technological innovations can significantly enhance restoration effectiveness and long-term sustainability.

Key topics included advanced remote sensing applications in mangrove monitoring and assessment, genetic approaches to enhancing restoration success and ecosystem resilience, community-based restoration techniques that integrate local knowledge with scientific methods, and opportunities for technology transfer and capacity building across international boundaries.

Discussion points encompassed practical applications of remote sensing technology for monitoring restoration progress, potential for genetic approaches to improve restoration outcomes in diverse environmental contexts, methods for integrating community knowledge and participation in restoration planning and implementation, and strategies for facilitating technology transfer and capacity building among participating countries.

Photo 5 : Prof. FAN Hangqing, Guangxi Academy of Marine Sciences

4.5. Pollution Control and Bioremediation

Professor Nora Fung-yee TAM from City University of Hong Kong addressed critical issues of pollution impacts on mangrove ecosystem health while exploring the significant potential role of mangroves in water treatment and environmental remediation applications. The session provided comprehensive analysis of pollution threats and innovative approaches to utilizing mangrove systems for environmental restoration.

The presentation examined various pollutant impacts on mangrove ecosystem health and functionality, the remarkable potential of mangroves as natural water treatment systems, practical applications of bioremediation techniques using mangrove systems, and strategies for integrating pollution control measures with broader conservation and restoration initiatives.

Participants discussed identification and assessment of pollution sources affecting mangrove systems, practical implementation of mangrove-based water treatment systems, evaluation of bioremediation potential in different environmental contexts, and development of integrated approaches combining pollution control with ecosystem conservation and restoration strategies.

Photo 6 : Professor Nora Fung-yee TAM, University of Hong Kong

4.6. Ecological Monitoring and Evaluation

Professor LI Ruili from Peking University, Shenzhen Graduate School focused on systematic approaches to monitoring mangrove ecosystem health and evaluating the effectiveness of conservation initiatives. The session provided practical guidance for developing and implementing comprehensive monitoring programs that support adaptive management and evidence-based decision making.

Key elements included development and implementation of robust monitoring protocols, identification and utilization of appropriate indicator species and ecosystem health metrics, evaluation of data collection methodologies and emerging technologies, and application of monitoring results to support adaptive management strategies and policy development.

Discussion topics covered practical considerations for designing monitoring protocols appropriate to local contexts and resource constraints, selection of indicator species and metrics that provide reliable information about ecosystem health, evaluation of cost-effective data collection methodologies and technologies, and utilization of monitoring data to inform adaptive management decisions and policy development processes.

Photo 7 : Professor LI Ruili, Peking University

4.7. Alien Species Management

Professor ZHANG Yihui from Xiamen University addressed the growing challenge of invasive species in mangrove ecosystems, providing comprehensive analysis of prevention, detection, and control strategies. The session explored how invasive species threaten mangrove ecosystem integrity and presented proven approaches for managing these threats effectively.

The presentation covered systematic approaches to identifying invasive species threats and assessing their potential impacts, development and implementation of prevention and early detection systems, evaluation of control and eradication techniques appropriate to different species and contexts, and promotion of regional cooperation in invasive species management to address transboundary threats.

Participants engaged in discussions about practical methods for identifying and assessing invasive species risks, implementation of cost-effective prevention and early detection programs, selection and application of appropriate control techniques for different invasive species, and development of regional cooperation mechanisms for addressing invasive species threats that cross national boundaries.

Photo 8 : Professor ZHANG Yihui, Xiamen University

4.8. Climate Change and Mangrove Conservation

Professor LIN Guanghui from Tsinghua University explored the complex relationships between climate change impacts and mangrove ecosystem responses, including comprehensive analysis of adaptation strategies for maintaining ecosystem resilience under changing environmental conditions. The session addressed one of the most critical long-term challenges facing mangrove conservation efforts globally.

Key topics included analysis of sea level rise impacts and mangrove migration patterns, assessment of temperature and precipitation changes affecting mangrove distribution and health, evaluation of extreme weather event impacts on mangrove ecosystem stability, and development of climate adaptation planning strategies for mangrove conservation initiatives.

Discussion focused on practical approaches to assessing climate change vulnerability in mangrove systems, strategies for facilitating mangrove migration and adaptation to changing environmental conditions, methods for building ecosystem resilience to extreme weather events, and integration of climate adaptation considerations into conservation planning and management decisions.

Photo 9 : Professor LIN Guanghui, Tsinghua University

4.9. Regional Conservation Strategies (South-East Asia)

Professor A. Aldrie Amir from Kebangsaan University Malaysia provided valuable regional perspectives on mangrove conservation, focusing specifically on Communication, Education, Participation and Awareness (CEPA) strategies that have proven effective in Southeast Asian contexts. The session highlighted how regional cooperation and community engagement can enhance conservation outcomes.

The presentation examined successful regional conservation initiatives and their key success factors, approaches to cross-border conservation cooperation and coordination, effective community engagement and participation strategies that respect local cultures and needs, and methods for integrating traditional knowledge with contemporary conservation approaches.

Participants discussed adaptation of successful regional conservation models to different geographical and cultural contexts, development of effective cross-border cooperation mechanisms, strategies for meaningful community engagement in conservation planning and implementation, and approaches to integrating traditional ecological knowledge with scientific conservation methods.

Photo 10 : Prof. Aldrie Amir, Kebangsaan University Malaysia

4.10. Wildlife Conservation and Migratory Birds

Professor ZHOU Haichao from Shenzhen University highlighted the critical role of mangroves in supporting wildlife populations, with particular emphasis on migratory birds that utilize the East Asian-Australasian Flyway. The session explored the intersection between mangrove conservation and international wildlife conservation efforts.

Key elements included analysis of migratory bird habitat requirements in mangrove systems, development and implementation of monitoring and protection strategies for wildlife populations, promotion of international flyway conservation cooperation, and approaches to balancing tourism development with wildlife protection priorities.

Discussion topics encompassed practical methods for assessing and enhancing habitat quality for migratory species, implementation of effective monitoring programs for wildlife populations, development of international cooperation mechanisms for flyway conservation, and strategies for managing tourism impacts while maintaining wildlife protection goals.

Photo 11 : Professor ZHOU Haichao, Shenzhen University

4.11. Practical Conservation Applications - Mai Po Case Study

Dr. WEN Xianji, Director of Mai Po Nature Reserve and Flyway Program at WWF-Hong Kong, presented practical conservation management experiences from Mai Po Nature Reserve, recognized as one of Asia's most important wetland sites. The session provided concrete examples of successful conservation implementation and management strategies.

The presentation examined integrated management approaches that balance multiple conservation objectives, effective stakeholder engagement strategies that build broad-based support for conservation, methods for integrating scientific research with practical management decisions, and development of sustainable funding mechanisms for long-term conservation programs.

Participants discussed practical implementation of integrated management approaches in diverse contexts, strategies for building effective stakeholder engagement and support, methods for incorporating scientific research into management decision-making processes, and development of diversified funding strategies for conservation programs.

Photo 12 : Dr. WEN Xianji, Director of Mai Po Nature Reserve and Flyway Program, WWF-Hong Kong

4.12. Ecological Character Maintenance

Professor LYU Cai from Beijing Forestry University addressed the critical challenge of maintaining ecological integrity in mangrove systems while managing the pressures of development and human activities. The session explored approaches to preserving essential ecosystem characteristics while accommodating necessary human uses and development.

Key topics included development and application of ecological character assessment methodologies, strategies for maintaining ecosystem integrity during development planning and implementation, approaches to restoration of degraded ecological character in impacted systems, and implementation of long-term monitoring programs to track ecological changes over time.

Discussion focused on practical methods for assessing and defining ecological character in diverse mangrove systems, strategies for maintaining ecological integrity while accommodating development pressures, techniques for restoring ecological character in degraded or impacted areas, and development of effective monitoring systems for tracking long-term ecological changes.

Photo 13 : Prof. LYU Cai, Beijing Forestry University

4.13. Blue Carbon and Ecosystem Services

Professor LYU Shuguo from the Hainan International Blue Carbon Research Center explored the critical role of mangroves in carbon sequestration and climate change mitigation through blue carbon mechanisms. The presentation covered comprehensive approaches to blue carbon quantification and measurement techniques, evaluation of carbon credit mechanisms and financing opportunities, strategies for integrating blue carbon considerations into national climate strategies and policies, and promotion of international cooperation on blue carbon initiatives and research.

Participants engaged in practical discussions about implementation of blue carbon measurement and monitoring programs, development of carbon credit projects and financing mechanisms, integration of blue carbon strategies into national climate policies and international commitments, and promotion of international collaboration in blue carbon research and implementation efforts.

Photo 14 : Professor LYU Shuguo, Hainan International Blue Carbon Research Center

5. Countries presentation

- **China**

China's Shenzhen region demonstrates remarkable progress in mangrove restoration, with coverage expanding from 169.70 hectares in 2005 to 296.18 hectares in 2021, representing a 74% increase over sixteen years. The city maintains a conservation rate of 62% and has implemented a comprehensive action plan for 2020-2025.

The initiative operates under direct guidance from President Xi Jinping's conservation directives and aligns with multiple national and provincial frameworks, including the National Mangrove Protection and Restoration Action Plan (2020-2025) and the Guangdong Province Mangrove Protection Implementation Plan. The establishment of the "International Mangrove Center" in Shenzhen, announced at the Wetland Convention opening, positions the city as a global hub for mangrove research and conservation.

The conservation strategy follows four fundamental principles: prioritizing legal compliance and conservation, bridging policy frameworks with local adaptation, clarifying departmental responsibilities, and establishing long-term management mechanisms. This systematic approach emphasizes nature-based solutions while ensuring sustainable restoration across different districts.

- **Madagascar**

Madagascar encompasses 390,853 hectares of mangroves, representing 1.53% of the national territory. However, the country faces significant deforestation challenges, losing between 3,000 and 7,000 hectares annually from 1995 to 2018, totaling approximately 74,050 hectares during this period.

The governance structure reveals a mixed management approach where 25% of mangroves fall within protected areas, 32% are managed by local communities through management transfers, and the remainder operates under state management. This distributed responsibility model emphasizes community engagement as central to conservation success.

Madagascar has pioneered the Community-Based Environmental Mangrove Restoration (CBEMR) approach, which focuses on improving household livelihoods and reducing dependence on mangrove resources. The country has also incorporated innovative technologies, including drone applications for restoration activities, demonstrating a commitment to modernizing conservation techniques.

Key challenges include inadequate infrastructure for boundary demarcation, insufficient communication tools for awareness campaigns, problematic law enforcement despite existing legislation, and equipment limitations affecting surveillance capabilities.

- **Cambodia**

Cambodia's mangroves cover approximately 51,603 hectares as of 2023, distributed across four coastal provinces: Koh Kong (75%), Preah Sihanouk (16%), Kompot (6%), and Kep (3%). The ecosystem is dominated by Rhizophora apiculata and Rhizophora mucronate species.

The country faces multiple threats including logging for construction and fuel, deforestation for aquaculture, agricultural land encroachment, and pollution. In response, Cambodia has developed a comprehensive restoration strategy following established guidelines for mangrove restoration, emphasizing multi-species replantation and expanded coastal nurseries.

The "Green Sprout" campaign represents a significant public engagement initiative, mobilizing community participation and awareness. The restoration effort involves extensive collaboration between NGOs (including CEPA, Wetlands International, IUCN, and Mangrove for the Future), government agencies, and private sector partners such as British Chevening Alumni Association and major corporations like Panasonic and Heineken Cambodia.

Community involvement extends beyond planting activities to include patrol services, livelihood diversification, community-based ecotourism development, and knowledge-sharing workshops that combine practical experience with scientific understanding.

- **Laos**

Although landlocked, Laos contributes to regional wetland conservation with approximately 1,082,600 hectares of wetlands, representing 5% of the country's total area. The wetland types include seasonally inundated grasslands, marshes, swamps, lakes, ponds, rivers, streams, reservoirs, and rice fields.

The primary threats mirror those faced by coastal nations: encroachment, hunting and over-harvesting, invasive species, habitat degradation, hydrological modification, climate change, and pollution. Laos has responded with a forward-looking strategy that includes publishing wetland protection decrees, conducting awareness and capacity-building programs, continuing wetland inventory and demarcation efforts, formulating and enforcing regulations, improving livelihoods, and managing Ramsar sites through integrated approaches.

The country plans to propose additional Ramsar sites, including Nongkhamsen and Beungsanan, while emphasizing national cooperation in wetland conservation efforts.

- **Myanmar**

Myanmar ranks among the world's seven largest mangrove regions, with 448,000 hectares distributed across six coastal regions and supporting 34 true mangrove species. The ecosystem sustains over 5.8 million coastal inhabitants and plays a crucial role in national development.

Despite facing significant challenges from land use changes, human settlement, rice field encroachment, shrimp farming, charcoal production, and fuelwood cutting, Myanmar has achieved substantial restoration progress. Between 2017 and 2023, the country established 12,000 hectares of mangrove plantations by planting 36.3 million seedlings.

The restoration program encompasses community participation across 60 coastal townships, public awareness campaigns including International Mangrove Day celebrations, and the development of a National Integrated Coastal Management Program ready for adoption. This comprehensive approach demonstrates Myanmar's commitment to balancing economic development with environmental conservation.

- **Bangladesh**

Bangladesh hosts the world's largest mangrove forest in the Sundarbans, covering 47,201 square kilometers across parts of India and Bangladesh. This UNESCO World Heritage site supports 24 true mangrove species from 9 different angiosperm families and represents one of the most biodiverse ecosystems globally.

The Sundarbans harbor exceptional biodiversity including 250 fish species, 300 bird species, and marine mammals such as dolphins. However, the region faces substantial threats from natural calamities, high tide damage affecting major species survival, declining blue carbon supply, and continued fuelwood cutting.

Conservation efforts focus on the forest's multiple ecosystem services: unique biodiversity conservation, soil erosion prevention, livelihood provision, and carbon capture. The region serves as a critical research center for species studies and demonstrates the importance of large-scale mangrove preservation for both local communities and global climate regulation.

- **Thailand**

Thailand manages 277,923 hectares of mangroves with a documented trend analysis spanning from 1961 to 2020, providing valuable long-term data for conservation planning. The country has established comprehensive conservation and protection legislation while maintaining detailed records of wildlife populations within mangrove ecosystems.

Thailand has developed practical restoration tools, including mangrove planting handbooks that standardize restoration techniques and ensure best practices across different regions. The emphasis on people's participation in conservation and restoration activities reflects a community-centered approach that recognizes local stakeholders as essential partners in ecosystem management.

- **Pakistan**

Pakistan's Indus Delta mangroves, located across Thatta, Sujawal, Badin, and Karachi Districts, represent a conservation success story despite significant challenges. Originally covering 344,000 hectares when declared "Protected Forest" in 1958, the area was reduced to 260,000 hectares by 2010, with only 160,000 hectares maintaining dense and medium forest coverage.

Historical records document eight mangrove species, though only four currently survive: Avicennia marina, Rhizophora mucronata, Aegiceras corniculatum, and Ceriops tagal. By the 1990s, over-exploitation, heavy grazing, and water diversion had reduced coverage to just 86,000 hectares.

The Sindh Forest Department's rehabilitation efforts since 1986 have yielded extraordinary results, earning three Guinness World Records (2009, 2013, and 2018) for restoration achievements. The economic value of these efforts is substantial, with well-stocked mangrove forests valued at US$58,000 per hectare, making the overall current asset value approximately US$12.2 billion.

The mangroves provide crucial ecosystem services including fish biomass, livestock provisioning, carbon sequestration, soil erosion control, coastal protection, nursery habitats, waste remediation, and recreation services. However, threats persist from freshwater shortages, enhanced salinity, coastal erosion, industrial pollution, and continued harvesting pressure.

- **Mozambique**

Mozambique's 302,735 hectares of mangroves represent Africa's second-largest coverage after Nigeria, with over 50% located in the Zambezi Delta Ramsar site. The mangroves extend 200 kilometers along the coastline, reaching up to 50 kilometers inland.

The country faces anthropogenic pressures concentrated in urban areas where construction materials and fuelwood demand drive degradation. Additional challenges include conversion for salt production and aquaculture, while natural factors such as sedimentation, erosion, cyclones, and flooding create ongoing threats.

The National Strategy and Action Plan for Mangrove Management (2020-2024) emphasizes community involvement through local knowledge valorization, effective partnerships, climate change adaptation, strong monitoring systems, local capacity strengthening, environmental education programs, and family income improvement initiatives. This comprehensive approach recognizes that sustainable conservation requires addressing both environmental and socioeconomic factors.

- **Liberia**

Liberia's 37,142 hectares of mangroves support six species, with Avicennia germinans and Rhizophora racemosa being most common. The country operates under the Environmental Protection & Management Law (2003) and Wetland Policy 2014, providing legal frameworks for conservation.

Major degradation drivers include fuelwood harvesting, unsustainable fishing practices, wildlife hunting, wetland reclamation for construction, waste dumping, charcoal burning, and industrial effluent discharge. Despite these challenges, Liberia has significant opportunities through ongoing gazettement of internationally important wetlands, government-partner collaborations including Conservation International, the Blue Ocean project funded by Sweden, and the establishment of international marine protected areas with Sierra Leone.

- **Libya**

Libya maintains over 250 wetlands including natural coastal lagoons, gulfs, sabkhas, salinas, wadis, springs, oases, islands, and tidal areas, alongside artificial wetlands such as dams, reservoirs, sewage farms, and aquaculture facilities. The country has designated two Ramsar sites: Ain Elshakika (33 hectares) and Ain Elzarga (50 hectares).

Libya's 2,000-kilometer coastline supports varied topography and habitats, making it one of the Mediterranean's most biologically diverse countries. The marine environment serves as feeding and resting grounds for migratory birds, contains crucial nesting areas for loggerhead turtles, and potentially provides refuge for Mediterranean bluefin tuna juveniles. The region between Tunisia's Gulf of Gabes and Libya's Gulf of Sirte contains over 1,500 square kilometers of seagrass meadows, the Mediterranean's largest.

- **Comoros**

The Comoros archipelago consists of four islands: Ngazidja (Grande Comore), Mwali (Mohéli), Ndzwani (Anjouan), and Mahoré (Mayotte). With a total land area of 2,236 km² and a population of approximately 867,605, the islands have been recognized for their ecological significance since June 9, 1995, when three sites were designated as Ramsar sites covering a total area of 16,030 hectares. Mangroves in Comoros cover an area of 108 hectares and host nine species. Conservation and restoration activities include restoration actions on Ndzwani Island in Oini, the establishment of a nursery on Ngazidja Island, and cleaning initiatives for Moroni's mangrove areas.

Photo 1: Comoros presentation

➢ **<u>Panama</u>**

Panama's mangrove ecosystems span approximately 183,774 hectares. However, these vital areas face threats such as pollution, land filling, sedimentation, and deforestation. To address these challenges, a reforestation project is underway on Galeta Island, incorporating standard ecological restoration procedures and applying mangrove reforestation techniques. The project also aims to tackle biodiversity challenges, ensuring the sustainability of these ecosystems.

➢ **<u>Guinea</u>**

Guinea's mangrove ecosystems are home to diverse wildlife, including numerous bird species such as the Ibis ibis, Ciconia episcopus, and Ardea goliath, as well as amphibious hippos and crocodiles. Of the eight marine turtle species found globally, five inhabit Guinea. The mangrove vegetation comprises various species, including Rhizophora, *Laguncularia racemosa*, and *Conocarpus erectus*. However, these ecosystems face threats from uncontrolled industrialization, population growth, and climate change. Conservation efforts involve deploying teams for safeguarding and monitoring, revising wildlife regulations, and promoting sustainable salt extraction projects.

- **Samoa**

Samoa contains five mangrove species, including two recently identified through surveys. The largest mangrove area is located in Vaiusu Bay, covering a total of 217.85 hectares across Upolu and Savaii. Mangroves play a crucial ecological role by protecting shorelines and lagoons, filtering water, and stabilizing coastal areas against erosion. They also provide significant community benefits, such as supporting eco-tourism, supplying firewood, and serving as a source of medicinal resources. However, human activities, cyclones, and flooding threaten these ecosystems. Conservation initiatives include establishing protected mangrove reserves, rehabilitation programs, and public awareness campaigns.

- **Zimbabwe**

As an inland state, Zimbabwe lacks mangrove ecosystems; however, it has extensive wetlands, constituting 34% of the country's total area (13,659,580 hectares). Wetlands are vital for the rural population, with varying quality statuses. Zimbabwe is a signatory to the Ramsar Convention and has registered seven Ramsar sites. The country has applied for accreditation of Victoria Falls as a wetland city, recognized for its exceptional geological features. Threats to wetlands include settlement and agricultural encroachment, invasive species, and deforestation. Challenges in wetland restoration involve dealing with legacy encroachments and budgetary constraints for rehabilitation projects.

- **Venezuela**

Venezuela boasts five Ramsar sites, two wildlife reserves, and three national parks, covering a total area of 313,139 hectares. The country has implemented five management plans that include guidelines for the care of mangroves and associated vital spaces. Conservation efforts focus on preserving functional and ecosystem services as well as cultural spaces.

Photo 15 : Venezuela presentation

6. Group work and panel discussions

Interactive group work and panel discussions formed integral components of the workshop design, creating opportunities for participants to engage deeply with the material while sharing experiences and developing collaborative solutions to common challenges. These sessions were designed to explore the specific priorities and challenges of mangrove conservation in participants' respective countries while encouraging peer-to-peer exchange, practical problem-solving, and collaborative development of pilot project proposals.

The group work sessions facilitated extensive knowledge sharing that went beyond formal presentations, creating space for informal discussion of implementation challenges, resource constraints, and innovative solutions that participants had developed or encountered in their professional experiences. The diversity of experiences shared among participants created a rich learning environment and provided a strong platform for building lasting partnerships that would extend beyond the workshop period.

Two major panel discussions anchored the group work component of the program. The first panel focused on identifying priorities and challenges in mangrove conservation and restoration, providing a forum for participants to present their most pressing concerns and to explore collaborative approaches to addressing common problems. This discussion revealed both the universal nature of many conservation challenges and the diverse approaches that different countries and regions have developed to address similar issues.

The second panel concentrated on needs for mangrove restoration research and pilot project development, emphasizing opportunities for international cooperation and knowledge sharing. This discussion generated concrete ideas for collaborative research initiatives and pilot projects that could be developed through ongoing partnerships among participating countries and institutions.

Photo 16 : Group Work presentation

The panel discussions were structured to encourage maximum participation while ensuring that all voices were heard and that diverse perspectives were incorporated into the conclusions and recommendations. Facilitators guided discussions to identify common themes and opportunities for collaboration while respecting the unique circumstances and priorities of each participating country.

During the panel discussion course on August 7, moderated by Professor Lei, the first cohort of trainees summarized their recommendations for IMC's future development strategy, structured into four main areas:

Knowledge Sharing and Collaborative Research

- Establish a comprehensive knowledge management platform on mangroves and related biodiversity. This should include not only an online database but also a physical regional knowledge-sharing center.
- Provide necessary equipment and set up expert advisory teams to promote cross-border exchange and the sharing of practical experiences.
- Prioritize the establishment of conservation and restoration demonstration projects in participating countries, with a particular focus on the management of internationally significant wetlands.
- Organize preparatory workshops on blue carbon projects to ensure mechanisms are practical and adaptable.

Global Blue Carbon and Pilot Projects

- Compile and standardize methodologies from different countries on blue carbon, while ensuring the provision of necessary equipment and investment in priority local projects.
- Develop a standardized manual for blue carbon projects, including measurement methods and conversion formulas, while emphasizing the importance of baseline data.
- Set up pilot education centers on blue carbon to raise awareness of this emerging topic and highlight its benefits for both national economies and ecological improvement.
- Submit a proposal on blue carbon projects at the 15th Conference of the Parties (COP15) to the Ramsar Convention.
- Strengthen awareness and understanding of blue carbon among relevant authorities.

Wetland Education and Public Awareness

- Enhance awareness among policymakers at all levels about the importance of wetland conservation, particularly in African countries, to promote strong top-down policy support.
- Establish wetland education centers and provide support for designating internationally important wetlands.

- Assist and guide local communities and governments in improving wetland education, developing suitable teaching materials and curricula, and promoting policy guidelines.

- Introduce mangrove conservation and restoration courses in local schools.

Capacity Building and International Wetland Networks

- Provide technical support to carry out comprehensive ecosystem-wide monitoring of wildlife, and improve data management systems, including collection, analysis, sharing, and long-term monitoring.

- Create online wetland platforms for different ecological regions, particularly in Asia and the Indian Ocean, while stressing the importance of developing management plans for protected area networks to ensure coordinated efforts.

- Strengthen professional training for practitioners so they can effectively operate and manage various technical equipment.

- Appoint IMC national focal points responsible for data recording and coordination across different aspects.

General observations

- African trainees placed greater emphasis on the economic benefits of mangroves, such as eco-tourism and timber supply.

- Almost all trainees recommended the creation of a comprehensive knowledge management platform, supported by professional equipment and expert teams.

- Many highlighted the critical role of decision-makers and suggested further efforts to raise awareness of both conservation and sustainable use.

Key Recommendations

- Integrated Mangrove Data Platform: Collect and consolidate national data on mangrove extent, biodiversity, and wetlands, with updates every 2–3 years. Develop a comprehensive knowledge platform combining online databases and regional sharing centers, supported by expert teams and cross-border exchanges.

- Capacity Building and Professional Training: Expand hands-on training programs in mangrove conservation and restoration monitoring, and promote international and regional technical exchanges to enhance professional skills.

- Technical Support and Coordination: Establish regional branches of the center and rotate technical staff assignments to provide on-the-ground support. Ensure diversity in the Secretariat to bring in innovative perspectives.

- Financial Support and Funding: Strengthen implementation of the center's founding agreement, explore sustainable development strategies for mangrove ecosystems, diversify funding sources, and create an international mangrove conservation fund to support long-term research and protection projects.

- Blue Carbon Market Development: Compile standardized methods, prepare measurement and assessment manuals, and initiate specialized blue carbon trading markets while exploring innovative financing mechanisms.

- Integrating Ecological and Economic Value: Encourage broad participation by enterprises and society, with government policy support to mobilize public engagement through eco-tourism, specialty product development, and carbon markets.

- Raising Public Awareness and Education: Promote mangrove conservation courses at all school levels, increase public understanding, disseminate scientific knowledge, and encourage active community and public involvement.

The outcomes of these group work sessions provided valuable input for the workshop's final recommendations and created a foundation for ongoing collaboration among participants. Many participants expressed appreciation for the opportunity to engage in substantive discussions with peers facing similar challenges and indicated their intention to maintain contact and explore collaborative opportunities upon returning to their home countries.

Photo 17 : Group discussion, future priorities for International Mangrove Center

7. Cultural Experiences and Field Visits

As part of the IMC Workshop, participants not only engaged in intensive learning and technical sessions on mangrove conservation and restoration, but also had the opportunity to immerse themselves in rich cultural experiences and field visits. These activities offered a unique perspective on the connection between environmental protection, cultural heritage, and modern development in China.

Field trips were central to the workshop, providing participants with valuable opportunities to connect theoretical learning with practical experience. Visits were organized to representative sites in Shenzhen and Hainan, including the Futian and Dongzhaigang National Nature Reserves, Shenzhen Bay Park, and the Hainan International Blue Carbon Research Center. These excursions highlighted the diversity of approaches applied in mangrove conservation and restoration, from urban mangrove management in Shenzhen to large-scale restoration and research initiatives in Hainan.

Participants were able to observe first-hand how ecological protection can be effectively integrated with urban planning, socioeconomic development, ecotourism, and public awareness campaigns. Complementary visits to institutions such as the Shenzhen Urban

Planning Museum and the Hainan Provincial Planning Exhibition Hall provided a broader perspective on how environmental objectives are embedded within regional development strategies. Through these immersive experiences, participants deepened their understanding of the ecological, economic, and cultural significance of mangroves and recognized the value of combining conservation efforts with scientific research, community participation, and innovative policy measures. Many participants expressed the wish that future workshops extend the duration of field visits to allow for more detailed study and exchange.

Chinese Tea Culture Class

Participants attended a class on Chinese tea culture, an important element of China's intangible heritage. The session highlighted the philosophy of harmony, balance, and respect for nature embedded in traditional tea practices. Beyond tasting a variety of teas, the class illustrated how cultural traditions can nurture mindfulness and a deeper appreciation of natural resources.

Shenzhen – A Window of Modern Development for Harmony Between Man and Nature

A visit to Shenzhen showcased the city as a model of modern development that integrates economic growth with ecological balance. Participants observed how urban planning in Shenzhen emphasizes green spaces, sustainable infrastructure, and the coexistence of urban life with natural ecosystems, positioning the city as a global example of harmonious development.

Photo 2: Visit Shenzhen Museum of Contemporary Art and Urban Planning, China

Riverine Wetland Restoration and Scientific and Technological Development

The group explored ongoing efforts in riverine wetland restoration, where advanced science and technology are applied to rehabilitate degraded ecosystems. This visit underlined the role of research, innovation, and integrated management in restoring wetlands, as well as their importance in biodiversity conservation, water purification, and climate resilience.

Hainan Province Planning Exhibition Hall

In Hainan, participants visited the Planning Exhibition Hall, which presented the province's ambitious strategies for sustainable development. The exhibition offered insights into Hainan's ecological zoning, conservation policies, and forward-looking vision to balance economic opportunities with the protection of its unique natural environment.

Figure 3: Visit Hainan Province Planning Exhibition Hall, China

Yanoda Tropical Rainforest Park

The final cultural experience took place at Yanoda Tropical Rainforest Park, where participants discovered the beauty and ecological richness of China's tropical rainforests. The visit provided a deeper understanding of rainforest ecosystems, their biodiversity, and the importance of protecting these habitats in the face of global environmental challenges.

Field Visits

Guangdong Shenzhen Futian National Nature Mangrove Reserve (Ramsar Site of Futian)

The first field visit was to the Futian Mangrove Ramsar Site in Shenzhen, a flagship location for international wetland conservation. Participants observed the protection measures in place for one of the world's most urban mangrove sites, as well as its role in supporting migratory bird species along the East Asian–Australasian Flyway.

Baguang Exhibition Hall & Baguang Heritiera Wetland Park

The second visit took participants to the Baguang Exhibition Hall and the Baguang Heritiera Wetland Park. The exhibition showcased the history, ecological importance, and restoration efforts of the area, while the wetland park demonstrated practical management approaches, including community involvement and habitat restoration techniques.

Futian Mangrove Eco-Park

At the Futian Mangrove Eco-Park, participants explored innovative educational initiatives designed to raise public awareness of mangrove ecosystems. The park combines ecological conservation with recreational functions, offering a model of how environmental education and eco-tourism can reinforce conservation goals.

Photo 18 : Visit Futian Mangrove Eco-Park Park

On-Site Teaching

Xinying Mangrove Eco-Restoration Blue Carbon Project Site

The first on-site teaching session introduced participants to the Blue Carbon Project at Xinying, where restoration efforts not only rehabilitate mangrove habitats but also contribute to climate change mitigation through carbon sequestration. The visit emphasized the dual benefits of mangroves for biodiversity and climate action.

Photo 4: Visit Xinying Mangrove Eco-Restoration Blue Carbon Project Site

Dongzhaigang National Nature Reserve

At Dongzhaigang, China's first national mangrove nature reserve, participants learned about large-scale conservation strategies, species monitoring, and habitat protection. The reserve serves as a cornerstone of mangrove conservation in Hainan Province, offering lessons on long-term ecological management.

Hainan Qinglan Harbor Mangrove Provincial Nature Reserve

The Qinglan Harbor site highlighted provincial-level conservation efforts. Participants studied restoration techniques and management practices that balance local livelihoods with ecosystem protection, demonstrating the importance of policy and governance at the regional scale.

Hainan Lingshui Mangrove National Wetland Park

The session at Lingshui showcased how wetland parks can serve as hubs for eco-tourism, education, and scientific research. Participants observed how the park integrates community participation while safeguarding biodiversity and providing ecosystem services.

Urban Development and Mangrove Conservation – Sanya Coral Reef National Nature Reserve & Sanya River National Wetland Park

The final on-site teaching experience focused on the challenges and opportunities of balancing urban expansion with conservation. In Sanya, participants examined the interplay between coral reef and mangrove ecosystems, and how urban wetland parks can mitigate ecological pressures while enriching urban resilience.

The field visits and on-site teaching sessions of the IMC Workshop provided participants with a comprehensive understanding of mangrove conservation in practice. From Ramsar-listed wetlands to national and provincial reserves, and from blue carbon projects to urban wetland parks, the experiences illustrated the multifaceted approaches China employs to safeguard its mangroves. The integration of science, education, governance, and community participation stood out as key lessons for global mangrove conservation efforts.

Photo 19 : Visit Sanya Coral Reef National Nature Reserve, China

Through these cultural and field experiences, the IMC Workshop provided participants with a holistic understanding of conservation. Beyond technical discussions on mangrove restoration, the visits demonstrated how China combines cultural traditions, scientific innovation, and modern development to foster harmony between people and nature. These experiences enriched the workshop by linking theory with practice and culture with conservation.

8. Evaluation and feedback

The workshop was met with very positive evaluations from participants, who praised the thoughtful balance of lectures, field activities, cultural exchanges, and peer learning. The organizational arrangements, particularly the quality of accommodation, meals, and transportation, were commended for their attention to detail and efficiency. Participants emphasized that the combination of expert-led lectures with opportunities to share case studies from their own countries created an atmosphere of genuine international exchange and collaboration. They also appreciated the cultural and creative products provided, including IMC-branded materials and USB drives containing lecture content, which served both practical purposes and lasting reminders of their experience in China.

At the same time, several constructive suggestions were offered to further enhance the effectiveness of future programs. Participants highlighted the importance of allowing more rest time upon arrival, especially given the long international journeys and time zone differences. They also suggested improving language support, noting the value of bilingual or multilingual interpretation during field visits to ensure inclusivity for non-English speakers. Another recurring recommendation was to extend the time available for interactive discussions and question-and-answer sessions, thereby enabling deeper reflection and knowledge sharing.

9. Conclusions

On the morning of August 7, 2024, the closing ceremony for the first session of the 2024 International Mangrove Center Workshop on Mangrove Conservation and Restoration was held at the Sanya Phoenix Kailai Hotel. Attendees included Chen Jingjin, Executive Vice Mayor of Sanya; Representative of the Shenzhen Municipal Bureau of Ocean Development; Chen Kang, Deputy Director of the Hainan Provincial Forestry Bureau; and Bao Daming, Director General of IMC Secretariat. During the ceremony, attendees collectively viewed a documentary short film of the workshop, revisiting the highlights of the two-week learning experience. Subsequently, Mr. Virak SON, a representative of the Cambodian participants, Mayor Chen Jingjin, and Director Bao Daming delivered speeches. They expressed sincere affirmation and congratulations on the successful completion of all tasks and achievements of this session, and expressed hope to strengthen exchanges and cooperation with various countries to jointly promote greater effectiveness in mangrove conservation and restoration efforts. The two-week seminar concluded successfully as all 23 participants received their certificates of completion, uniformly printed by the Center, and took commemorative group photos.

The workshop successfully achieved its objectives of strengthening international collaboration, advancing technical knowledge, and showcasing China's achievements in mangrove conservation and restoration. It demonstrated the shared responsibility of all nations to protect and restore mangrove ecosystems, while highlighting the possibility of integrating conservation with scientific research, urban development, cultural heritage, and community engagement.

Participants concluded that the workshop provided not only an opportunity to enhance their professional skills but also a platform to build meaningful networks and partnerships. They left with a renewed commitment to applying the lessons learned in their home countries and to promoting international cooperation in this field.

Looking ahead, it is recommended that future workshops seek to refine the balance between classroom lectures, field instruction, and cultural activities in order to maximize learning outcomes. Efforts should also be made to ensure the consistent availability of bilingual or multilingual materials and guides at all sites, thereby improving accessibility for all participants. Greater attention to contingency planning is also advised, particularly to respond effectively to weather events or other unexpected challenges. Finally, participants strongly encouraged the International Mangrove Center to hold similar workshops on a regular basis and to consider expanding the program to other member countries, which would allow for broader exposure to diverse conservation practices and foster stronger global cooperation.

Photo 20 : IMC Certificate Awarding Ceremony

Annex

Annex 1 : List of participants with contact details

No.	Name	Nation	Gender	Position / Organization
1	Julien Noël RAKOTOARISOA	Madagascar	Male	Ministry of Environment and Sustainable Development, NFP of Mangrove Management
2	Andoniaina NARISOA	Madagascar	Female	Ministry of Environment and Sustainable Development,NFP
3	Virak SON	Cambodia	Male	Department of Fresh Water Wetlands Conservation， General Directorate of Natural Protected Area Deputy Officer
4	Sokmean MENG	Cambodia	Male	Department of Coastal Zone and Marine Conservation， General Directorate of Natural Protected Area Officer
5	Peng Peng	China	Male	Director, APFNet Coordination Center, National Forestry and Grassland Administration
6	Wu Tong	China	Male	Guangdong Neilingding Futian National Nature Reserve Administration Bureau
7	Faya Nestor KONDIANO	Guinea	Male	Chef de Division Faune et Protection de la Nature，NFP
8	Levi Z PIAH	Liberia	Male	Environmental Protection Agency of Liberia, NFP
9	Milton MUUSHA	Zimbabwe	Male	Environmental Management Agency, Provincial Environmental Manager
10	Jean Fortune NTOUNA KAMBANGOYE	Gabon	Male	Ministry of Water and Forest General Management of Aquatics Ecosystems, Deputy General Manager
11	Samuel Ibrahim KOBBA	Sierra Leone	Male	Conservation Trust Fund, Resource Mobilization Manager
12	Wai Nyein Aye	Myanmar	Female	Ministry of Natural Resources and Environmental Conservation, Forest Department, Watershed Management Division,Staff Officer
13	Sidonia	Mozambiqu	Female	Ministry of Environment, Head of

No.	Name	Nation	Gender	Position / Organization
	Muamina Bacar Cardoso MUHORRO GUEZE	e		Natural Resources Management Division/Ramsar National Focal Point，Ministry of Land and Environment
14	Veronica Argelis GONZALEZ QUINTERO	Panama	Female	Ministry of Environment, Forestry Engineer
15	SUCHART YAMPRASAI	Thailand	Male	Department of Marine and Coastal Resources, Forestry Technical, Professional level
16	Athoumani HOUSSAMA	Comoros	Male	Mitsamiouli-Ndroud National Park, Technique Assistant
17	Pinthong SALEUMSAY	Laos	Male	Department of Water Resources, Technical official
18	AKM Showkat Alam MOZUMDER	Bangladesh	Male	Ministry of Environment, Forest and Climate Change, Deputy Secretary
19	Maria Rebeca PACHECO DE RAMOS	Venezuela	Female	Ministry for the People´s Power for Ecosocialism, Coordinator of Territorial Planning and Coastal Zones
20	Foalalo Mapuilesua-Fiu	Samoa	Female	Ministry of Natural Resources and Environment/Forestry Division，forestry officer
21	Kashif Khan DURRANI	Pakistan	Male	Forest and Wildlife Department of Sindh, Ministry of Climate Change,

No.	Name	Nation	Gender	Position / Organization
				Pakistan，Divisional Forest Officer
22	Ali Ahmed F M F BERBASH	Libya	Male	Ministry of Environment, Head of Protected Area Section
23	Arzoumbila PEDABGA	The Burkina Faso	Male	Secratariat Permanet du Conseil National pour le Developpement Durable, Charge de Programme Communication, enforcement des capacites, education, sensibilisation et participation

Annex 2 : Agenda

Date	Day		Time	Activities	Lecturer/Moderator/Institute	Location
July 25th	Thu		Whole day	Arrival &Registration		Shenzhen Guohui Hotel
July 26th	Fri		09:00-09:20	Opening Ceremony	Mr. BAO Daming, Director General, Provisional Secretariat, International Mangrove Center	Shenzhen Hall, Shenzhen Guohui Hotel *Dress code: Business Casual or Traditional*
			09:20-09:30	Group Photo	Mr. JIANG Yi, Program Officer, National Academy of Forestry and Grassland Administration (NAFGA), China	Shenzhen Hall, Shenzhen Guohui Hotel
			09:30-10:30	Lecture 1: The Status, Challenges and Actions of Mangroves in China	Dr. YUAN Jiming, Director General, Department of Wetland Management, National Forestry and Grassland Administration (NFGA), China	Shenzhen Hall, Shenzhen Guohui Hotel
			10:30-11:00	Tea Break		Shenzhen Hall, Shenzhen Guohui Hotel
			11:00-12:00	Lecture 2: The Implementation of the Convention on Wetlands and	Dr. XIA Jun, Director General, Department of International Cooperation, NFGA, China	Shenzhen Hall, Shenzhen Guohui Hotel

July 26th	Fri			International Cooperation on Mangrove Conservation		
			12:10-13:00	Welcome Banquet	Mr. JIANG Yi, Program Officer, NAFGA, China	Longhua Hall, Shenzhen Guohui Hotel
			14:00-15:30	Lecture 3: Introduction to China and the Chinese Culture	Mr. LIU Chunyan, Director General, NAFGA, China	Qianhai Hall, Shenzhen Guohui Hotel
			15:30-15:50	Tea Break		Qianhai Hall, Shenzhen Guohui Hotel
			15:50-17:30	Cultural Experience 1: Chinese Tea Culture Class	Ms. WAN Li, National Senior Tea Master, China	Qianhai Hall, Shenzhen Guohui Hotel
			17:30-18:00	Team Building: Notice, Ice breaking and Guidelines for Living in China	Mr. JIANG Yi, Program Officer, NAFGA, China	Qianhai Hall, Shenzhen Guohui Hotel
			19:00-22:00	Discover Mangroves		Shenzhen City
July 27th	Sat		9:00-10:30	Lecture 4: Introduction to Mangrove Ecosystem and Restoration Practice	Prof. WANG Wenqing, Xiamen University, China	Qianhai Hall, Shenzhen Guohui Hotel

			10:30-11:30	Lecture 5: Science, Technology and Innovation for Sustainable Mangrove Restoration	Prof. FAN Hangqing, Guangxi Academy of Marine Sciences (Guangxi Mangrove Research Center), China	Qianhai Hall, Shenzhen Guohui Hotel
			11:30-12:00	Discussion 1: Case and Experience Sharing on Mangrove Conservation (Trainees from three countries)	Prof. FAN Hangqing, Guangxi Academy of Marine Sciences (Guangxi Mangrove Research Center), China	Qianhai Hall, Shenzhen Guohui Hotel
			14:00-17:00	Cultural Experience 2: Shenzhen-A Window of Modern Development for Harmony Between Man and Nature	Commentator from Shenzhen Finance Center, China Ms Yuan Qiufeng, Director of Shenzhen Museum of Contemporary Art and Urban Planning, China	Shenzhen Finance Center & Shenzhen Museum of Contemporary Art and Urban Planning
			19:00-20:10	Enjoy the Civic Center Light Show		Civic Center
July 28th	Sun		9:00-10:30	Lecture 6: Pollution, Wastewater Treatment and Bioremediation	Prof. Nora Fung-yee TAM, City University of Hong Kong, China	Qianhai Hall, Shenzhen Guohui Hotel
			10:30-11:30	Lecture 7: Ecological Monitoring and Evaluation of Mangrove	Prof. LI Ruili, Peking University Shenzhen Graduate School, China	Qianhai Hall, Shenzhen Guohui Hotel
			11:30-12:00	Discussion 2: Case and Experience Sharing on Mangrove Conservation (Trainees from three	Prof. LI Ruili, Peking University Shenzhen Graduate School, China	Qianhai Hall, Shenzhen Guohui Hotel

				countries)		
			14:00-17:00	Field Visit 1: Guangdong Shenzhen Futian Mangrove Ramsar Site	Dr. YANG Qiong, Dr. XU Hualin Scientist of Futian Mangrove Site, China	Neilingding Futian National Nature Reserve
July 29th	Mon		9:00-10:30	Lecture 8: Mangrove Conservation and Alien Species	Prof. ZHANG Yihui, Xiamen University, China	Qianhai Hall, Shenzhen Guohui Hotel
			10:30-11:30	Lecture 9: Mangrove Conservation and Climate Change	Prof. LIN Guanghui, Tsinghua University, China	Qianhai Hall, Shenzhen Guohui Hotel
			11:30-12:00	Discussion 3: Case and Experience Sharing on Mangrove Conservation (Trainees from three countries)	Prof. LIN Guanghui, Tsinghua University, China	Qianhai Hall, Shenzhen Guohui Hotel
			14:00-17:00	Field Visit 2: Baguang Exhibition Hall & Baguang Heritiera Wetland Park	Ms. OU Wei, Moderator, China	Shenzhen Baguang & Baguang Heritiera Wetland Park
July 30th	Tue		9:00-10:30	Lecture 10: CEPA in South-East Asia	Prof. A. Aldrie Amir, Universiti Kebangsaan Malaysia, Malaysia	Qianhai Hall, Shenzhen Guohui Hotel

			10:30-11:30	Lecture 11: Mangrove Conservation in Mai Po	Dr. WEN Xianji, Director of Mai Po Nature Reserve and Flyway Program, WWF-Hong Kong, China	Qianhai Hall, Shenzhen Guohui Hotel
			11:30-12:00	Discussion 4: Case and Experience Sharing on Mangrove Conservation (Trainees from three countries)	Dr. WEN Xianji, Director of Mai Po Nature Reserve and Flyway Program, WWF-Hong Kong, China	Qianhai Hall, Shenzhen Guohui Hotel
			14:00-17:00	Cultural Experience 3: Riverine Wetland Restoration and Scientific and Technological Development	Ms. JIN Jingwan, Official of the Park, China	Shenzhen Bay Park & Shenzhen Talent Park & Dasha River Ecological Corridor
July 31st	Wed		9:00-10:30	Lecture 12: Monitoring and Protection of Migratory Birds in Mangrove Wetlands	Prof. ZHOU Haichao, Shenzhen University, China	Qianhai Hall, Shenzhen Guohui Hotel
			10:30-12:00	Discussion 5: Case and Experience Sharing on Mangrove Conservation (Trainees from nine countries)	Prof. ZHOU Haichao, Shenzhen University, China	Qianhai Hall, Shenzhen Guohui Hotel

			14:00-17:00	Field Visit 3: Futian Mangrove Eco-Park Park	Ms. SUN Lili, Founder and Deputy Board Chairwoman, Mangrove Conservation Foundation, Director of Futian Mangrove Eco-Park, China	Futian Mangrove Eco-Park Park
Aug 1st	Thu		9:00-10:30	Lecture 13: Mangrove Ecological Character Maintenance	Prof. LYU Cai, Beijing Forestry University, China	Qianhai Hall, Shenzhen Guohui Hotel
			10:30-12:00	Panel Discussion 1: Priorities and Challenges in Mangrove Conservation and Restoration	Prof. LYU Cai, Beijing Forestry University, China	Qianhai Hall, Shenzhen Guohui Hotel
			14:00-17:00	Personal Arrangement	Mr. JIANG Yi, Program Officer, NAFGA, China	Shenzhen City
Aug 2nd	Fri		9:00-12:00	From Shenzhen to Haikou	Mr. JIANG Yi, Program Officer, NAFGA, China	Haikou City
			14:00-14:30	Welcome Reception	Mr. CHEN Kang, Deputy Director General, Forestry Department of Hainan Province, China	Haikou City

			14:30-17:00	Cultural Experience 4: Hainan Province Planning Exhibition Hall	Ms. WANG Feifei, Hainan Province Planning Exhibition Hall, China	Hainan Province Planning Exhibition Hall
Aug 3rd	Sat		8:00-10:00	From Haikou to Danzhou		Danzhou City
			10:00-12:00	On-Site Teaching 1: Xinying Mangrove Eco-Restoration Blue Carbon Project Site	Prof. LYU Shuguo, Hainan International Blue Carbon Research Center, China	Blue Carbon Project Site
			13:30-15:30	From Danzhou to Dongzhaigang National Nature Reserve		Dongzhaigang National Nature Reserve
			15:30-17:30	On-Site Teaching 2: Dongzhaigang National Nature Reserve	Mr. FENG Erhui, Dongzhaigang National Nature Reserve, China	Dongzhaigang National Nature Reserve
Aug 4th	Sun		8:30-10:00	From Haikou to Wenchang		Wenchang City
			10:00-12:00	On-Site Teaching 3: Hainan Qinglan Harbor Mangrove Provincial Nature Reserve	Mr. FU Yonggang, Hainan Qinglan Harbor Mangrove Provincial Nature Reserve, China	Qinglan Harbor Mangrove Provincial Nature Reserve
			14:00-17:00	From Wenchang to Lingshui		Lingshui County

Aug 5th	Mon		9:00-12:00	On-Site Teaching 4: Hainan Lingshui Mangrove National Wetland Park	Ms. FAN Ruofei, Hainan Lingshui Mangrove National Wetland Park, China	Lingshui Mangrove National Wetland Park
			14:00-17:00	From Lingshui to Sanya		Sanya City
Aug 6th	Tue		9:00-12:00	On-Site Teaching 5: Urban Development and Mangrove Conservation - Sanya Coral Reef National Nature Reserve & Sanya River National Wetland Park	Mr. LI Changqing, Mr. ZHANG Xin, Sanya Coral Reef National Nature Reserve, China Mr. ZENG Dehua, Sanya River National Wetland Park, China	Sanya Coral Reef National Nature Reserve & Sanya River National Wetland Park
			14:00-17:00	Cultural Experience 5: Yanoda Tropical Rainforest Park	Ms. HUANG Rong, Yanoda Tropical Rainforest Park, China	Yanoda Tropical Rainforest Park
Aug 7th	Wed		9:00-11:30	Panel Discussion 2: Needs of Mangrove Restoration Research and Pilot Project	Prof. LEI Guangchun, Beijing Forestry University, China	Phoenix A Hall, Phoenix Waterside Gloria Resort Sanya Hotel
			11:30-12:00	Closing Ceremony	Mr. JIANG Yi, Program Officer, NAFGA, China	Phoenix A Hall, Phoenix Waterside Gloria Resort Sanya Hotel **Dress code: Business Casual or Traditional*

			14:00-17:00	Personal Arrangement	Mr. JIANG Yi, Program Officer, NAFGA, China	Sanya City
			18:30-20:00	Farewell Dinner	Mr. JIANG Yi, Program Officer, NAFGA, China	Phoenix Waterside Gloria Resort Sanya Hotel
Aug 8th	Thu		All Day	Departure		Sanya City

Annex 3 : Biography of speakers

1. Dr. YUAN Jiming

Director General, Department of Wetland Management, National Forestry and Grassland Administration (NFGA), China

Dr. YUAN Jiming holds a pivotal leadership role in China's national wetland conservation efforts. As the Director General of the Department of Wetland Management within the NFGA—the national authority responsible for implementing the Ramsar Convention in China—he is at the forefront of policy development, national wetland park planning, and the execution of major conservation initiatives. His work is critical for achieving China's ambitious ecological civilization goals, including the recent designation of significant new Ramsar sites. Dr. YUAN oversees the management of China's wetland resources, balancing ecological protection with sustainable development, and plays a key role in guiding the country's contributions to global wetland conservation targets.

2. Dr. XIA Jun

Director General, Department of International Cooperation, NFGA; Chairperson, Standing Committee of the Ramsar Convention on Wetlands

Dr. XIA Jun is a prominent figure in international environmental governance. As the Director General of International Cooperation for the NFGA, he manages China's multilateral environmental engagements. His significance was elevated globally when he was elected as the **Chairperson of the Standing Committee of the Ramsar Convention on Wetlands**, a position of considerable influence that guides the convention's strategic direction between COP meetings. In this role, Dr. XIA is instrumental in fostering global consensus on wetland issues, overseeing the convention's budget, and implementing decisions made by the Conference of the Parties. His leadership underscores China's growing commitment and influence in global environmental diplomacy.

3. Mr. LIU Chunyan

President, Chinese Academy of Forestry (CAF), NFGA

Mr. LIU Chunyan leads one of China's most prestigious research institutions the Chinese Academy of Forestry (CAF). The CAF is a comprehensive research organization under the NFGA, dedicated to forestry and grassland scientific innovation, policy support, and technological development. As President, he guides a vast network of scientists and researchers working on critical issues, including wetland ecology, desertification control, and biodiversity conservation. His leadership is essential for bridging scientific research with national policy, ensuring that China's conservation strategies are informed by cutting-edge science. The CAF's work provides the technical foundation for many of China's large-scale ecological restoration projects.

4. Ms. WAN Li

National Senior Tea Master of China

Ms. WAN Li is a distinguished custodian of Chinese intangible cultural heritage. The title "National Senior Tea Master" is a recognition of the highest skill and deep cultural knowledge in the art of Chinese tea ceremony (*Gongfu Cha*). She is not only an expert in the brewing and appreciation of tea but also a cultural ambassador who understands the profound philosophy, history, and etiquette embedded within the practice. Her class will offer a immersive experience into a tradition that embodies harmony, respect, and refinement—core values that resonate with the principles of environmental conservation and living in balance with nature.

5. Professor WANG Wenqing

Professor and Doctoral Advisor, College of the Environment and Ecology, Xiamen University

A leading authority on mangrove ecosystems in China, Prof. WANG Wenqing's research is highly applied, focusing on the practical challenges of coastal wetland restoration. His work on mangrove wetland ecology and the screening of salt-tolerant plant species is directly relevant to combating coastal erosion and rehabilitating degraded shorelines. Based at Xiamen University, located near significant mangrove habitats, his team has been instrumental in developing effective techniques for mangrove afforestation and restoration, contributing valuable data and methodologies that are applied along China's southern coastline.

6. Professor FAN Hangqing
Director, Guangxi Mangrove Research Center, Academy of Marine Sciences; Director, Guangxi Key Lab of Mangrove Conservation and Utilization

Prof. FAN Hangqing is a cornerstone of mangrove research and conservation in the Beibu Gulf region, a global hotspot for mangrove diversity. As the director of the premier mangrove research institution in Guangxi, he oversees both fundamental research and its practical application. Prof. Fan's leadership is crucial for the "Mangrove Blue Carbon" initiatives in China, quantifying the carbon sequestration potential of these ecosystems and advocating for their protection as a nature-based solution to climate change.

7. Professor TAM Nora Fung Yee
Emeritus Professor, Department of Chemistry, City University of Hong Kong; Member, State Key Laboratory of Marine Pollution

With a career spanning over 25 years, Prof. TAM is an internationally recognized pioneer in bioremediation and mangrove microbial ecology. Her unique expertise lies at the intersection of environmental chemistry, microbiology, and ecology. She has conducted groundbreaking research on using microorganisms to degrade pollutants (bioremediation) in mangrove sediments and on the impacts of wastewater on mangrove health. Her work provides a critical scientific basis for managing polluted coastal environments and understanding the complex biochemical processes that sustain mangrove ecosystems.

8. Professor LI Ruili
Researcher, Shenzhen Graduate School; Executive Director, Mangrove Engineering Technology Research Center of Guangdong Province
Prof. LI Ruili bridges high-level academic research with technological innovation. Her role as Executive Director of the Mangrove Engineering Technology Research Center highlights her focus on developing practical engineering solutions for mangrove conservation. Her work on "smart water ecology" in the Greater Bay Area involves using advanced sensors, remote sensing, and data analytics to monitor mangrove health, water quality, and biodiversity in real-time. This high-tech approach is essential for the adaptive management of vulnerable coastal ecosystems in one of the world's most urbanized regions.

9. Professor ZHANG Yihui
Distinguished Professor, College of the Environment and Ecology, Xiamen University

Prof. ZHANG Yihui is an expert in community ecology, particularly the dynamic interactions at ecological boundaries, such as those between mangroves and the invasive cordgrass *Spartina alterniflora*. This invasive species is a major threat to mangrove ecosystems in China. As an experimental ecologist, he employs sophisticated field manipulations to understand how climate change and human activities alter these coastal communities. His research provides critical insights for managing invasive species and predicting how mangrove ecosystems will respond to future environmental changes.

10. Professor LIN Guanghui
Professor, Department of Earth System Science, Tsinghua University

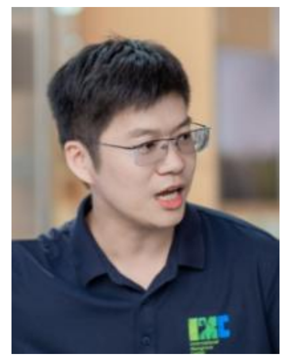
Prof. LIN Guanghui brings a macro-scale, earth system perspective to mangrove research. His work integrates ecology with biogeochemistry, examining the role of mangroves and other wetlands in global carbon, nitrogen, and water cycles. This approach is vital for quantifying the ecosystem services provided by mangroves, such as their significant "blue carbon" storage capacity. By studying these processes, his research at Tsinghua University helps to model the feedback between wetland ecosystems and climate change, informing both national and international climate policy.

11. Dr. A. Aldrie Amir
Senior Lecturer and Research Fellow, Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia; Commissioner, IUCN SSC Mangrove Specialist Group

Dr. Aldrie Amir is a key thought leader in mangrove conservation in Southeast Asia. His work at LESTARI focuses on the crucial link between science, policy, and community engagement (CEPA - Communication, Capacity Building, Education, Participation, and Awareness). As a commissioner for the IUCN's Mangrove Specialist Group, he contributes to global assessments of mangrove species' extinction risk. His role as coordinator of the Malaysian Mangrove Research Alliance and Network (MyMangrove) demonstrates his commitment to fostering collaborative research and conservation action across the region.

12. Dr. WEN Xianji
Head of Wetland Management, WWF-Hong Kong

Dr. WEN Xianji is the chief guardian of the iconic Mai Po Marshes, a Ramsar site of international importance in the heart of the Pearl River Delta. With over two decades of experience, he manages one of the most challenging conservation sites in Asia, balancing the habitat needs of migratory waterbirds (including the endangered Black-faced Spoonbill) with the immense pressures of urban development. His work includes innovative habitat management, a highly respected Wetland Management Training Programme that builds capacity across Asia, and scientific research that informs the wise use of wetlands.



13. Professor ZHOU Haichao
Professor, College of Life Sciences and Oceanography, Shenzhen University

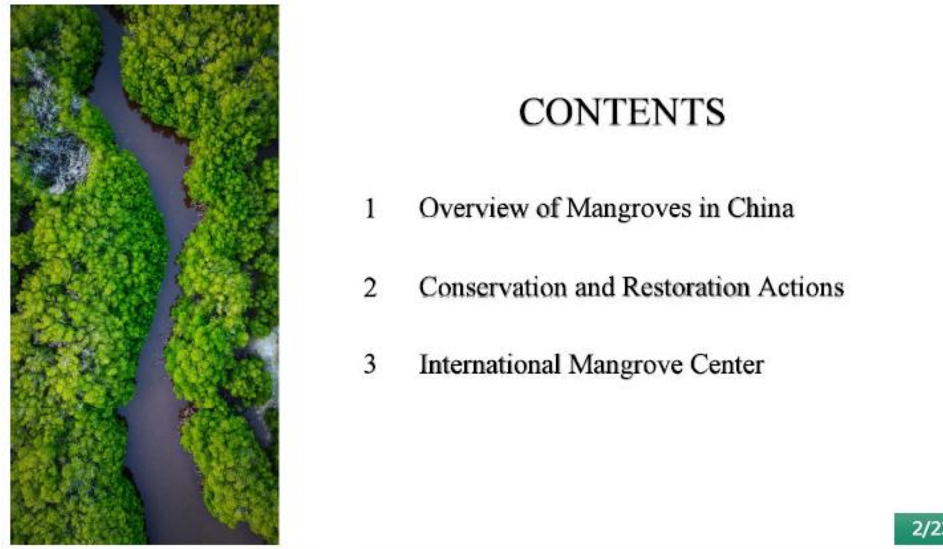
Prof. ZHOU Haichao's research delves into the intricate biogeochemical processes within mangrove wetlands. He has a specific focus on the cycling of nutrients and pollutants, and the ecological role of mangrove. His work is fundamental to understanding how mangroves act as natural water filters, improving water quality in coastal areas. This research is directly applicable to the conservation of migratory birds, as the health of the mangrove food web—supported by these chemical processes—directly impacts the bird populations that depend on these habitats.

14. Professor LYU Cai
Professor, School of Ecology and Nature Conservation, Beijing Forestry University

Prof. LYU Cai is an expert in aquatic and conservation ecology. His lecture on "Mangrove Ecological Character Maintenance" will address a core concept of the Ramsar Convention: the maintenance of a wetland's essential ecological features. This involves defining the key biological, physical, and chemical components of a mangrove system and developing management strategies to ensure its health and long-term viability. His perspective is essential for moving beyond simple restoration to the sustainable, long-term management required to ensure mangrove ecosystems continue to function and provide services for future generations.

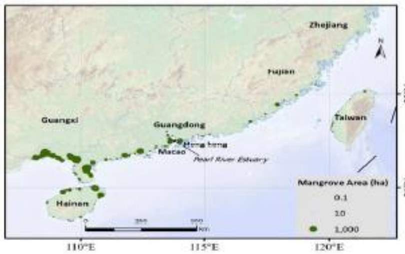
Annex 4 :Keynote lecture slides

- **Lecture 1: Conservation of mangrove in China**

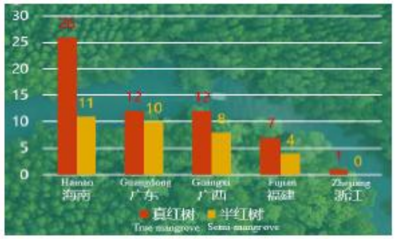


Mangroves distribution in China

In the mainland of China (excluding Hong Kong, Macau, and Taiwan), mangroves are distributed across 5 provinces and regions: **Hainan province, Guangdong province, Fujian province, Zhejiang province, and Guangxi autonomous region.**



area（ ha ）



species

5/23

National Land Inventory

carried out from 2018 to 2021. It recorded 27,100 hectares of mangroves distributed in the mainland of China, with 97% located in Guangdong, Guangxi, and Hainan.

6/23

Trend and driving factors of mangroves area change in China

Compared with 2002, the area increased 7,200 hectares. China has become one of the few countries in the world with a net increase in mangrove area over the past 20 years.

Loss drivers

- Aquaculture
- Urbanization
- Timber harvesting
- Natural degradation

Measures facilitating increase of mangroves:

- Protected areas
- Coastal shelterbelt project
- Blue Bay Remediation Action
- Mangrove Conservation and Restoration Action Plan, etc

7/23

Protected areas

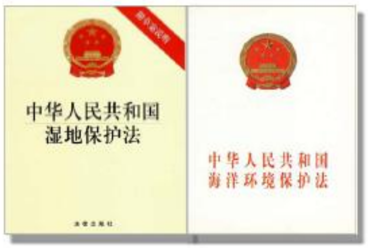
68% of mangroves are distributed in 96 protected areas such as nature reserve, wetland park, and marine park (10 nature reserves at national level, and 7 are Ramsar Sites)

8/23

Laws and Regulations

National level:

- Wetland Conservation Law
- Marine Environment Conservation Law



Local Level:

- Mangroves Conservation Regulation (Hainan)
- Mangroves Conservation Regulation (Guangxi)
- Wetland Conservation Regulation (Guangdong)
- Wetland Conservation Regulation (Fujian)
- Marine Area Utilization Management Regulation (Zhejiang)

9/23

Summary of Part 1

- National Priority
- Distribution and change of area over the past 70 years.
- Protected areas
- Legislation

10/23

Part 2. Conservation and Restoration Actions

11/23

Mangrove Conservation and Restoration Action Plan (2020-2025)

Long-term Goals

- Strictly protect existing mangroves and conduct ecological restoration scientifically;
- Expand the area of mangrove forests and improve biodiversity;
- Overall improvement of mangrove ecosystem quality and comprehensive enhance the supply capacity of ecological products.

Specific Objectives

By 2025, to replant 9,050 hectares of mangroves and to restore 9,750 hectares of existing mangrove forests

12/23

7 key actions with 19 tasks

Action 1: Overall conservation of mangroves

- Prioritely protect mangrove ecosystems;
- Strictly control land use conversion.

Action 2: Management of protected areas

- Optimize the boundary of existing, and establish new protected areas;
- Stop aquaculture activities in protected areas;
- Improve capacity building of protected areas.

13/23

Action 3: Strengthen planning for mangrove restoration

- Overall plan for mangrove conservation and restoration;
- Put conservation and restoration tasks in place.

Tasks for provinces by 2025

Province	Replanting area (ha)	(%)
Zhejiang	200	2.21
Fujian	350	3.87
Guangdong	5500	60.77
Guangxi	1000	11.05
Hainan	2000	22.10
Total	**9050**	**100.00**

Province	Restoration area (ha)	(%)
Zhejiang	0	0.00
Fujian	550	5.64
Guangdong	2500	25.64
Guangxi	3500	35.90
Hainan	3200	32.82
Total	**9750**	**100.0**

14/23

Action 4: Ecological restoration of mangroves

- Replant mangroves with scientific methods;
- Restore degraded mangroves;
- Protect rare and endangered mangrove species;
- Enhance post-planting management;
- Control harmful organisms (Strive to achieve a *S. alterniflora* removal rate of over 90% by 2025)
- Ensure supply of mangrove seedlings.

15/23

Action 5: Improvement of scientific supports for mangroves

- Carry out scientific and technological breakthrough projects;
- Improve research facilities and professional standards.

16/23

Action 6: Monitoring and assessment

- Improve monitoring capabilities;
- Track and assess the whole mangrove restoration process.

17/23

Action 7: Improvement of legislation

- Promote legislation for mangrove protection and restoration;
- Improve local regimes for mangrove protection and restoration.

18/23

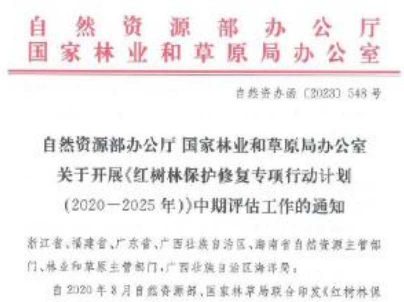
Guarantee Measures

- Strengthen organizational leadership
- Financial and policy supports
- Encourage social capital into conservation and restoration
- Enhance CEPA and international cooperation

19/23

Mid-term Assessment

By 2023, 52% of replantation and 49% of restoration have been completed.


自然资源部办公厅
国家林业和草原局办公室

自然资办函〔2023〕548号

自然资源部办公厅 国家林业和草原局办公室
关于开展《红树林保护修复专项行动计划
（2020—2025年）》中期评估工作的通知

浙江省、福建省、广东省、广西壮族自治区、海南省自然资源主管部门、林业和草原主管部门，广西壮族自治区海洋局：

自2020年8月自然资源部、国家林草局联合印发《红树林保

Replantation

Province	Target(ha)	Completion(ha)	Completion rate
Zhejiang	200	147.68	73.84%
Fujian	350	907.52	259.29%
Guangdong	5500	1821.16	33.11%
Guangxi	1000	457.81	45.78%
Hainan	2000	1322.07	66.10%
Total	**9050**	**4656.24**	**51.45%**

Restoration

Province	Target(ha)	Completion(ha)	Completion rate
Zhejiang	—	44.28	—
Fujian	550	920.77	167.41%
Guangdong	2500	1834.47	73.38%
Guangxi	3500	1455.95	41.60%
Hainan	3200	496.642	15.52%
Total	**9750**	**4752.112**	**48.74%**

20/23

Part 3. International Mangrove Center (IMC)

21/23

Ramsar Regional Initiative

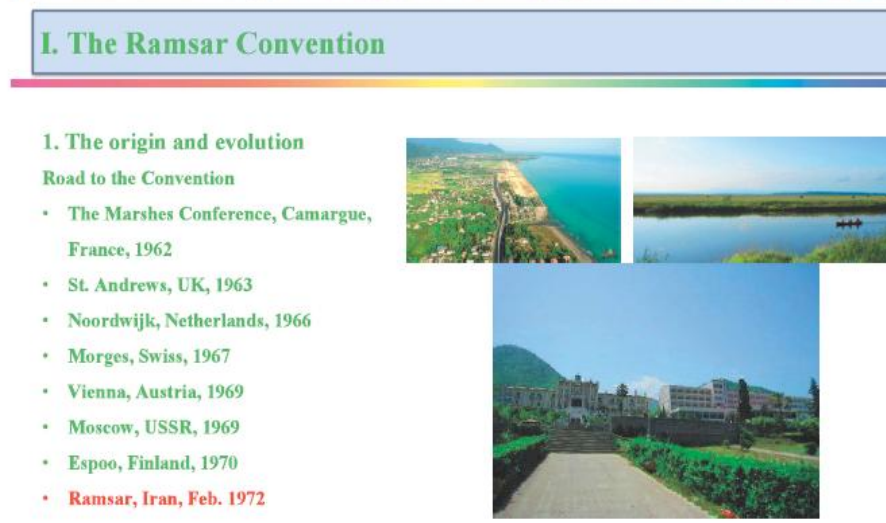
- President Xi Jinping proposed to build International Mangrove Center in Shenzhen at COP14 in 2022.
- The COP14 **Resolution XIV.19** welcomes the focus of the International Mangrove Center as the conservation, restoration, and wise use of mangroves and coastal blue carbon ecosystems;
- **Decision SC62-22**: The Standing Committee endorsed the International Mangrove Center as a new Ramsar Regional Initiative within the framework of the Convention

President Xi Jinping on COP14

Sketch of the Chinese Mangrove Museum (Center)

22/23

- **Lecture2: Ramsar Convention and China**



I. The Ramsar Convention

2. The Convention

Ramsar
CONVENTION ON WETLANDS
CONVENTION SUR LES ZONES HUMIDES
CONVENCIÓN SOBRE LOS HUMEDALES
(Ramsar, Iran, 1971)

Convention on Wetlands of International Importance especially as Waterfowl Habitat

Mission

The conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.

I. The Ramsar Convention

3. Actions taken by contracting parties

Three Pillars of action

- Wise use of all wetlands
- International Cooperation
- Wetlands of Int'l Importance, designation and management

I. The Ramsar Convention

5. The Bodies

COP
The Conference of Contracting Parties
The Standing Committee

STRP
The science and technical review panel

CEPA
The oversight panel on Communication, Education and Public Awareness

Management Subgroup

Financial Subgroup

Strategy Subgroup

Other Subgroups

The Secretariat
Secretary General

II. Ramsar implementation in China


中华人民共和国国务院

国函〔1992〕1号

国务院关于决定加入《关于特别是作为水禽栖息地的国际重要湿地公约》的批复

林业部、外交部：

国务院决定，我国加入《关于特别是作为水禽栖息地的国际重要湿地公约》。加入该公约的通知手续由外交部办理。执行该公约的具体事宜，由林业部负责组织、协调。有关交纳会费问题，按照国家有关规定办理。

一九九二年一月二日

主题词：外事 公约 批复

2. Accession and institutional setup

- January 3rd 1992, China's instrument of accession to UNESCO, depository of the Convention
- July 31 1992, China's entry into force (the 67th contracting party)
- 2005, Ramsar Management Authority established in China
- 2007, National Ramsar Committee formed to coordinate implementation efforts
- 2018, Department of Wetland Management set up in National Forestry & Grassland Administration

II. Ramsar implementation in China

4. Legal framework

- *The Wetlands Protection Law* introduced 1 June 2022

China "adopts the principle of protection in priority, strict management, systematic control, science-based restoration and wise use in wetland protection, so as to play multiple ecological functions of wetland ecosystem in conserving water, regulating climate, improving environment and conserving biodiversity"

- 28 of the 31 provinces on mainland China have released provincial regulations on wetlands

中国湿地保护规划
（2022—2030年）

二〇二二年五月

II. Ramsar implementation in China

5. National programs and financial input

- National Programs launched, including wetland conservation & restoration and mangrove conservation
- Central investment for infrastructure construction and restoration at RMB 600m/y
- Central investment at RMB 2b/y for
  1. subsidies for wetland conservation & restoration
  2. PES
  3. subsidies for converting farmland to wetland

II. Ramsar implementation in China

5. National programs and financial input

National Wetland Conservation Plan (2022-2030) identified 6 Key tasks

1. Total wetland area under control	2. Glassified management	3. Conservation and restoration programs
4. Wetland monitoring	5. Research & technical support	6. International cooperation

II. Ramsar implementation in China

6. Wetland inventory and monitoring

3 national inventories (1995-2003, 2009-2013, 2017-2021)

Monitoring of wetlands of international importance

ECOLOGICAL CONDITION OF CHINA'S WETLANDS OF INTERNATIONAL IMPORTANCE (RAMSAR SITES)

Ramsar Convention on Wetlands Management Office of People's Republic of China

December 2018

II. Ramsar implementation in China

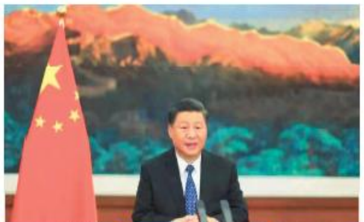
7. CEPA

Full participation of target groups

- Conservation network in Yangtze River, Yellow River and coastal areas
- World Wetland Day
- Natural education, science popularization
- Educational models for primary people
- Training courses

II. Ramsar implementation in China

8. International Cooperation



COP 14

- Nov. 5-13, 2022, hybrid mode in Wuhan & Geneva
- Chinese President Xi delivers the opening
- Wetlands Actions for People and Nature
- 142 contracting parties, international organizations, 950 plus participants
- Ramsar Post-2025 Strategic Plan
- Wuhan Declaration
- Establishing International Mangrove Centre (IMC) in Shenzhen, China

COP14 2022

III. International Cooperation on Mangrove & the IMC

1. Global mangrove ecosystems

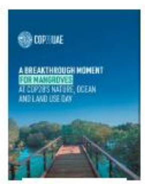
Mangrove ecosystems are exceptional in their ability to provide essential ecosystem services to people, **including coastal disaster risk reduction, carbon sequestration and long-term storage**, and ecological support for **fisheries and biodiversity**.

- Store almost **11 billion** tons of carbon, which is almost three times the amount of carbon stored by tropical forests of the same size.
- Protect **15.4 million** people and **USD 65 billion** worth of property per year from coastal disasters. In 2050, this could rise to 15.5 million and USD 118 billion because of population growth and rise in property values.
- Support **126 million** fishing days per year, providing a key source of food for human populations living near coasts and beyond, along with valuable employment provided by millions of fisheries-related jobs.

III. International Cooperation on Mangrove & the IMC

3. Global efforts in mangrove conservation

The Regional Initiative for the Integral Management and Wise Use of Mangroves and Coral Reefs/Ramsar Convention (2009)
Initiated by Ramsar to develop a Regional Strategy and Action Plan for the conservation, management, and wise use of mangroves and coral reefs, members countries include Brazil, Costa Rica, Mexico, Venezuela, etc.



Global Mangrove Alliance (2018)
GMA is coordinated by CI, IUCN, TNC, WI, & WWF. Its target is to increase the global area of mangrove habitat 20% over current extent by the year 2030.

MANGROVE ALLIANCE CLIMATE

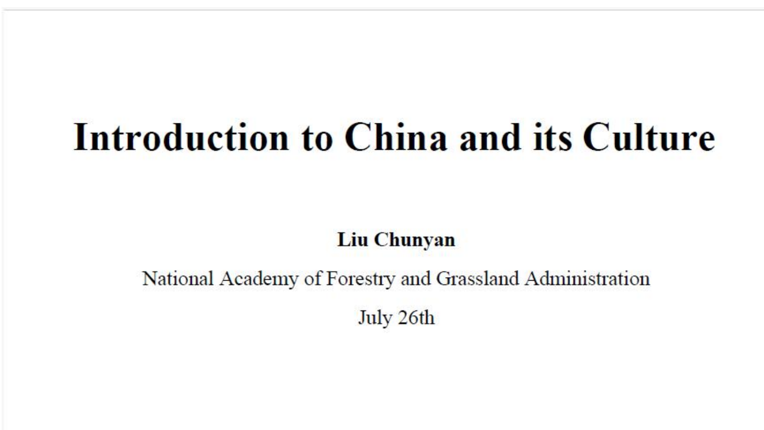
Mangrove Alliance for Climate (2022)
An initiative by the UAE in partnership with Indonesia at the UNFCCC COP 27. The members commit to plant, rehabilitate, and restore mangroves within their country; as well as supporting others to do the same.

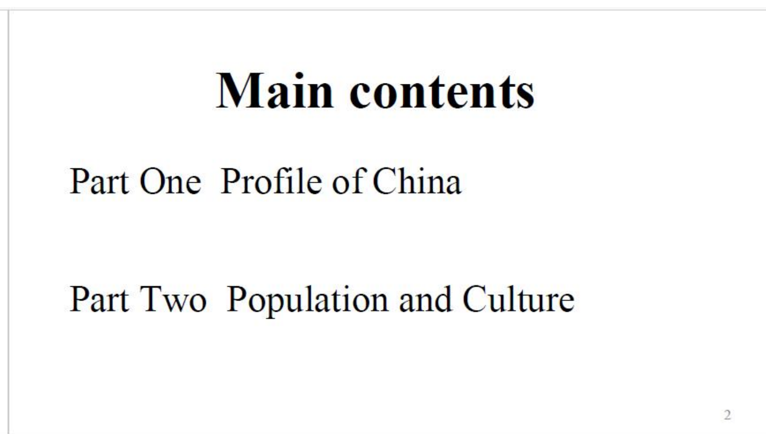
III. International Cooperation on Mangrove & the IMC

4. Mangrove conservation & restoration in China

- Special Action Plan for Mangrove Conservation and Restoration (2020-2025)
- Regulations on Mangrove Conservation by Guangxi and Hainan provinces
- Mangrove Ecological Restoration Guidelines
- 10 national mangrove nature reserves and 7 mangrove Ramsar sites designated in mainland China

- **Lecture 3: Introduction to China and its culture**





Part One Profile of China

I. Geography
II. History
III. Political system
IV. Economy
V. Diplomacy

3

II. China's history

China is one of the ancient civilizations in the world, and the only country among the four ancient civilizations (ancient Egypt, ancient India, and ancient Babylon) with uninterrupted civilization. According to the latest achievements of the "Exploration of Civilization" project, the recorded history of China is over 5800 years. In the long process of historical evolution, the Chinese people have created brilliant historical and cultural heritage.

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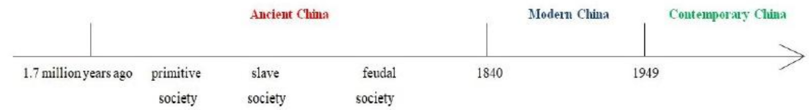
(2) Historical periods



There are three historical periods in China's history: ancient times, modern times, and contemporary times.

20

3. Land and water resources

(1) Land types There are different land types in China including cultivated land, forest land, grassland, deserts, wetland and so on. Cultivated land is principally in east China, grassland in north and west China and forest land in northeastern and southwestern China, wetland in different areas.






(2) Terrain Mountains accounts for 33% of China's territory, plateaus for 26%, basins for 19%, hills for 10% , and plains for 12% . China also has abundant island resources.

8

Ancient China

China's ancient history and dynasties oriented from 1.7 million years ago, ended in 1840AD, before the First Opium War.

The ancient history includes: Primitive society, Slavery society, Feudal society.

21

Historic sites

There are 26 dynasties in China's ancient history.

China's long history has left many cultural relics, such as the Terra Cotta Warriors, the Great Wall, the Forbidden City, and Mogao Grottoes.

22

Modern China

From 1840 (the First Opium War) - 1949 (the founding of PRC), the history of the semi-colonial and semi-feudal society.

The first Opium War 1840

23

Contemporary China

From 1949 (the founding of PRC) till now, the socialist revolution and construction period

Founding of People's Republic of China 1949

24

IV. China's political system

The strong leadership of the Communist Party of China(CPC) is the key to China's great achievements

The CPC has in the people its roots, its lifeblood and its source of strength. It puts people first and is committed to delivering a better life for the people

25

Adhering to "Two Establishments" and "Two Upholds"

- The establishment of both Xi Jinping's core position on the Party Central Committee and in the Party as a whole and the guiding role of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era ("Two Establishments").

- Boost our consciousness of the need to maintain political integrity, think in big-picture terms, follow the leadership core, and keep in alignment with the central Party leadership ("Four Consciousnesses"), stay confident in the path, the theory, the system, and the culture of socialism with Chinese characteristics ("Four Confidents"), and firmly uphold Xi Jinping's core position on the Party Central Committee and in the Party as a whole and uphold the Central Committee's authority and its centralized, unified leadership ("Two Upholds").

26

the "Two Establishments" and "Two Upholds" are the most significant political achievements of the Party in the new era drawing upon historical experience and that they are the fundamental guarantee for achieving the goals and tasks of the new journey to fully build a modern socialist China.

27

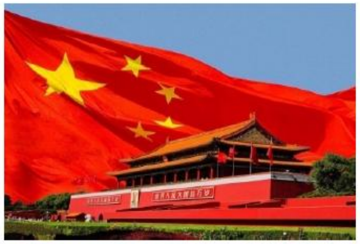
China's achievements

- the Communist Party of China has led the country to create miracles.
- China has become a mainstay of global economic growth.
- Foreign trade develops steadily and rapidly.
- Chinese people's per capita disposable income increased more than a hundredfold.
- China is among the countries with a relatively complete academic system.
- China has realized the transformation from a country of population to a country of human resources.
- "Poverty Alleviation: China's Experience and Contribution."

28

IV. China's political system

- The basic political structure: under the leadership of the Communist Party of China, the systems of People's Congress, Multi-party Cooperation and Political Consultation, and Regional Autonomy for Ethnic Minorities are adopted.



29

CPC was established in 1921 and led the Chinese people win the war of resistance against Japanese agression and establish socialism system.

30

- Just like many other parties, the CPC has gone through some ups and downs throughout its journey. But it had to live through many unusual challenges, including isolation, a huge population, and several unjust wars with the successive superpowers.

31

1. The Communist Party of China(CPC)

- The basic political structure: under the leadership of the Communist Party of China, the systems of People's Congress, Multi-party Cooperation and Political Consultation, and Regional Autonomy for Ethnic Minorities are adopted.

32

(2)The number of CPC members

- At the initial period of founding, the number of CPC member was 58.
- By the end of 2022, the total number exceeded 98m, has now become the largest political party in the world.
- The total number is estimated to exceed 100 billion by the end of July, 2024.

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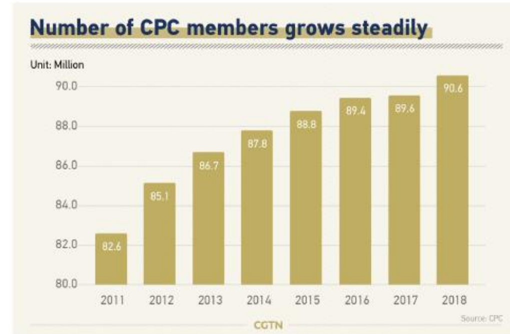


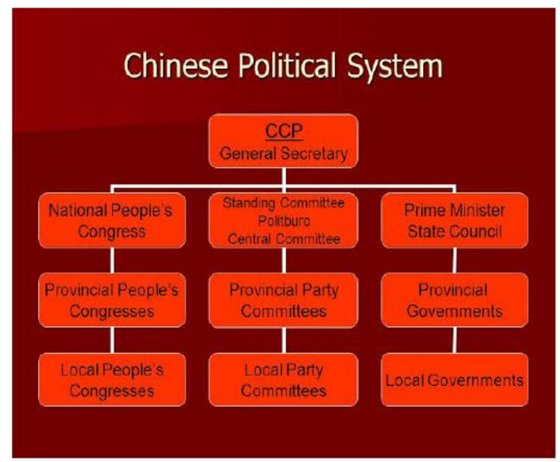
by the end of 2023, the CPC member was 99.185 million

34

2. People's congress system

- The people's congress is an important part of the system of socialism with Chinese characteristics and the fundamental political system.

35



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The working system of People's Congress

- According to the Constitution of the People's Republic of China, all State power belongs to the people. The National People's Congress (NPC) and the local people's congresses at various levels are the bodies through which the people exercise State power.

(1) The National People's Congress and the local people's congresses are created through democratic election and are responsible to the people and subject to their oversight.

(2) All administrative, supervisory, adjudicatory, and procuratorial organs of the state are created by the people's congresses and shall be responsible to them and subject to their oversight.

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(3) The people's congresses at all levels are constituted through democratic elections, and are responsible to the people and subject to their supervision.

(4) Deputies to the people's congresses at all levels shall maintain close contact with the electors of their original constituencies or their original electoral units and with the people, listen to and reflect their views and demands, endeavor to serve the people and be subject to supervision by the people.

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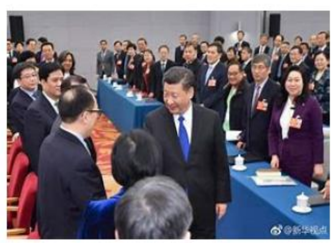
3.Multi-party Cooperation and Political Consultation

- The CPC is the only ruling party in China and the rest 8 democratic parties, led by the CPC, participate in the state affairs.



39

Two sessions

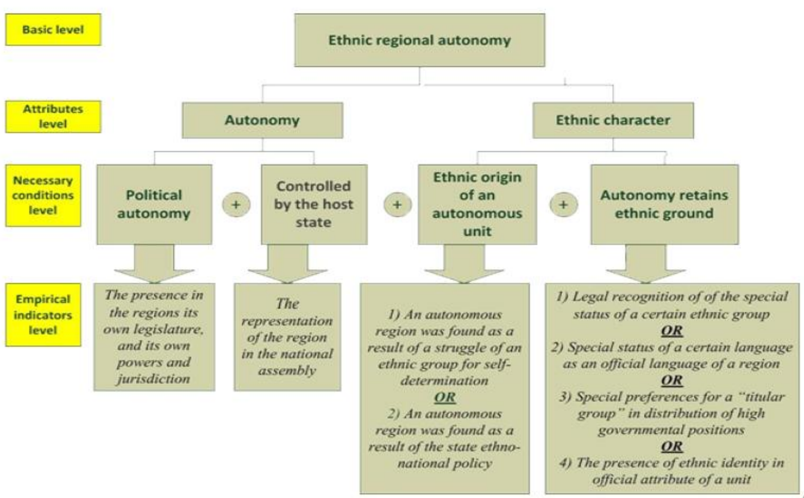
- The "two sessions" is not a specific institutional name. The term "two sessions" refers to the yearly plenary meetings of the National People's Congress (NPC) - China's top legislative body and the National Committee of the Chinese People's Political Consultative Conference (CPPCC) - the top political advisory body.
- They are held every year, beginning in 1978. Since the sessions basically coincide and are very important to the operation of the country, they are called "two sessions" for short.

40

The organs of Self-Government of National Autonomous Areas

- The organs of self-government of national autonomous areas are the people's congresses and people's governments of autonomous regions, autonomous prefectures and autonomous counties.
- In the people's congress of an autonomous region, autonomous prefecture or autonomous county, in addition to the deputies of the nationality exercising regional autonomy in the administrative area, the other nationalities inhabiting the area are also entitled to appropriate representation.
- The chairman of an autonomous region, the prefect of an autonomous prefecture or the head of an autonomous county shall be a citizen of the nationality exercising regional autonomy in the area concerned.

42



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5. China's administrative system

(1) Classification

China's administrative units are currently based on a three-tier system, dividing the nation into provinces, counties and townships:

- The country is divided into provinces, autonomous regions and municipalities directly under the Central Government;
- A province or an autonomous region is subdivided into autonomous prefectures, counties, autonomous counties and cities;
- A county or an autonomous county is subdivided into townships, ethnic townships and towns.

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- Municipalities directly under the Central Government and large cities are subdivided into districts and counties;
- Autonomous prefectures are subdivided into counties, autonomous counties and cities.
- Autonomous regions, autonomous prefectures and autonomous counties are all ethnic autonomous areas.
- The Constitution specifically empowers the state to establish special administrative regions when necessary.
- A special administrative region is a local administrative area directly under the Central Government.

45

V. China's economy

1.Reform and openning up

Deng Xiaoping
(1904-1997)

The CPC has steered China to such massive growth and development by introducing its major economic reforms, known as the reform and opening-up policy, in 1978.

During the past 40 years, China has experienced tremendous development in all major sectors including manufacturing, international trade, transport infrastructure and smart city solutions. These changes have pivotal importance that has not only impacted the lives of Chinese citizens but also proved beneficial for foreigners.

47

Shenzhen before and after the policy

48

China's poverty alleviation

- China has since lifted more than 700 million people out of poverty, which is over 70 percent of the total global poverty reduction during the time. Thus it shook off abject poverty one decade before the deadline set by the UN by 2030.

49

VI. China's diplomacy

1. Basic tenets

- Maintaining world peace and promoting common development are the purposes of China's foreign policy
- The five principles of peaceful coexistence are the basic norms of China's foreign relations.
- Independence is the basic position of China's foreign policy.
- Strengthening solidarity and cooperation with third world countries is the basic foothold of China's foreign policy.

50

2. Major country diplomacy with Chinese characteristics

A Community with Shared Future for Humanity

- To build a community with a shared future for humanity calls for concrete actions. China has advocated that the international community promote a common approach to partnership, the security landscape, economic development, cultural exchanges and eco-environmental conservation.

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Part Two Population and Culture

I. Population & Ethnic Groups
II. Chinese Culture

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I. China's population and Ethnic group

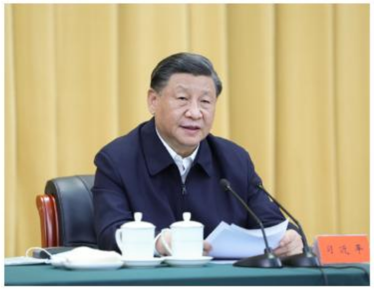
Chinese culture is inclusive and develops in a long history. In the process of historical development, not only have numerous local schools of thought emerged, but also foreign cultures have been constantly introduced. Different schools of thought and cultures have absorbed and integrated into each other in contradictions and conflicts, gradually establishing a basic pattern of Confucianism as the main body, with Confucianism, Buddhism, and Taoism each holding its own unique banner, while also working together to complement each other and apply it to society.

54

2. Ethnic Groups

Ethnic groups China is a unified country with 56 ethnic groups with the han people accounting for 91.11% of the total population

II. Chinese Culture



President Xi Jinping attends the Meeting on Cultural Inheritance and Development, June 2, 2023

Given the profound foundations of our time-honored 5,000-year-old civilization, the only path for pioneering and developing Chinese socialism is to integrate the basic tenets of Marxism with China's specific realities and the best of its traditional culture (two integrations)

Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era was established on the basis of upholding the "two integrations" and serves as a shining example for this concept.

63

Xi Jinping Thought on Culture

Xi Jinping Thought on Culture was put forward for the first time in 2023, marking a pivotal ideological development after the 20th National Congress of the Communist Party of China (CPC).
The Thought bears immense importance in the pursuit of a stronger China and the realization of national rejuvenation.

64

It proposes a people-centered development philosophy. In addition, it adheres to Marxist principles regarding the relationship between human and nature and draws on Chinese wisdom concerning the environment, including the ideas of humanity being an integral part of nature and all things living side by side.
It espouses the concept of harmony between humanity and nature, thus giving shape to Xi Jinping's thought on ecological conservation.
Furthermore, it adheres to Marxist ideas on world history and carries forward the broad-minded vision advocated in traditional Chinese culture, which includes seeking prosperity for all and

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Over the past decade, guided by the concept of building a community with a shared future for mankind, China has promoted dialogue and exchange among different civilizations, jointly creating a garden of diverse and harmonious world civilizations.

The 9th Silk Road International Arts Festival

The International Tourism Alliance of Silk Road Cities

66

Chinese culture is inclusive and develops in a long history. In the process of historical development, not only have numerous local schools of thought emerged, but also foreign cultures have been constantly introduced. Different schools of thought and cultures have absorbed and integrated into each other in contradictions and conflicts, gradually establishing a basic pattern of Confucianism as the main body, with Confucianism, Buddhism, and Taoism each holding its own unique banner, while also working together to complement each other and apply it to society.

Confucius

benevolence, righteousness, courtesy and trustworthiness

Laotzu

non-intervention, follow the nature

Buddha

compassion, karma

68

Confucianism emphasizes benevolence and filial piety, requiring humans to hold awe for all things in nature and to maintain the harmonious order of the universe. Taoism focuses on pursuing the realm of natural non-action, integrating with nature, seeking harmony and unity between nature and human, and advocating that human should conform to the way of nature, abandon impatience and utilitarianism, and pursue inner tranquility and self-transcendence. Buddhism emphasizes letting go of desires, pursuing inner peace and transcendence, advocating compassion, paying attention to the suffering of all beings, and promoting coexistence with nature to achieve harmonious coexistence between human and nature.

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2.Specific forms of Chinese Culture

2.1 Opera and Quyi arts

Chinese opera is one of the three ancient dramas in the world (including Chinese opera, Greek tragicomedy, and Indian Sanskrit opera), with over 300 genres including Peking Opera, Kunqu Opera, Yue Opera, and Yu Opera. Peking Opera is the most influential. Peking Opera, also known as Peking Opera or National Opera, is divided into four types of characters: male roles, female roles, painted roles and clowns--on stage. It has four skills: singing, speaking, acting and acrobatic fighting.

70

赤壁 The Red Cliffs

71

Quyi arts

Quyi is a general term for various "talking and singing arts". It is a unique art form that has evolved over a long period of development from folk oral literature and singing arts. According to incomplete statistics, there are about 400 different types of quyi performed by various ethnic groups in China.

Quyi, as a performing art, uses "oral talking and singing" to narrate stories, portray characters, express thoughts and emotions, and reflect social life. Just as the essential characteristic of opera art is "performing stories through singing and dancing," the fundamental feature of quyi art can be described as "narrating stories through oral talking and singing."

72

苏州评弹Suzhou Pingdan

73

2.2 Music and dance

Chinese music specifically refers to Chinese instrumental music and Chinese vocal music, with a history that can be traced back to the Yellow Emperor era. From Confucius' transmission of the Six Arts to modern Western music, Chinese music has continued to enrich and develop in the process of absorbing foreign musical elements. China is known as the "land of rites and music," and ancient music played a significant role and held an important position in personality cultivation, cultural life, and national etiquette.

战国时期曾侯乙编钟
Zeng Houyi Chime Bells

74

Music

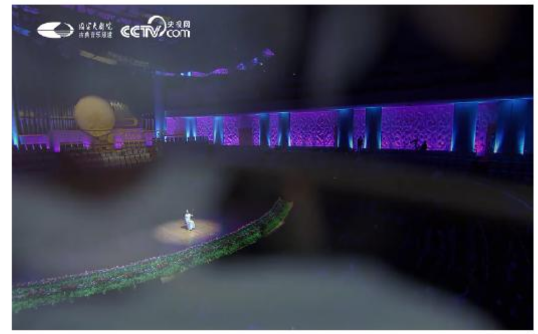
Guzheng

Pipa

Erhu

75

二泉映月 Moon Reflected in Second Spring



76

Dance

It can be said that China has had a history of dance for as many years as it has had civilization. Chinese traditional dance is rich in variety and form, containing abundant cultural connotations and ethnic characteristics. Classical dance is one of the main forms of Chinese dance, which has formed a unique artistic style through thousands of years of development and inheritance. It mainly includes Han and Tang dances, court dances, and more. Ethnic and folk dances refer to the dances of various ethnic groups in China in aspects such as production labor, living customs, religious beliefs, etc., fully demonstrating the unique customs and cultural traditions of various ethnic groups in China.

77

《霓裳羽衣舞》The Dance of Rainbow Skirt and Feathered Robe

78

Chinese calligraphy

Calligraphy is a unique traditional art in China, mainly composed of writing Chinese characters with a brush, as well as pen calligraphy and finger writing. There are five main styles of Chinese calligraphy: seal script, clerical script, regular script, running script, and cursive script.

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Calligraphy Practice

80

Poetry and rhymes, as well as classics, histories, philosophical works, and collected works,

Poetry and rhymes are the treasures of ancient Chinese literature. With refined language, profound artistic conception, and rich emotions, they express the unique perceptions of ancient literati on themes such as life, nature, love, friendship, home, and country. Poetry, songs, and rhymes emphasize rhythm, parallelism, and the creation of artistic conception, embodying the essence of ancient Chinese literary art."
From the simplicity and freshness of the "Book of Songs" to the prosperity and splendor of Tang poetry, and further to the graceful delicacy of Song lyrics, poetry and songs have carried the development process of ancient Chinese literature and reflected the social styles and humanistic spirits of different historical periods.

Li Bai, 701—762

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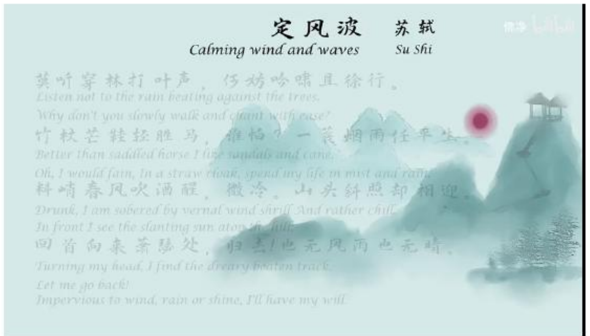
The collection of classics, histories, philosophical works, and collected works constitutes the core of ancient Chinese academic culture. The classics section includes Confucian classics such as the "Book of Songs", "Book of History", "Book of Rites", "I Ching", and "Spring and Autumn Annals", which are important carriers of mainstream thought and moral norms in ancient Chinese society. The histories section includes various historical works such as "Records of the Grand Historian", "History of the Han Dynasty", and "History of the Later Han Dynasty", which record the social development, changes, and historical events of ancient China, serving as important materials for studying ancient Chinese history. The philosophical works section covers the writings of various schools of thought such as "The Analects of Confucius", "Mencius", "Laozi", "Zhuangzi", etc., representing different ideological schools and academic viewpoints in ancient China.

Sima Qian, 145B.C.--?

82

定风波(Calming Wind and Waves)



83

2.5Architecture

- The total number of world heritage sites amounts to 1,122, distributed in 167 countries around the world, with 39 dual world cultural and natural heritage sites, 213 world natural heritage sites and 869 world cultural heritage sites. China has 57 world cultural and natural heritage sites on the World Heritage List, including 39 world cultural heritage sites, 4 dual world cultural and natural heritage sites and 14 world natural heritage sites.

84

2.6 Crafts

- In the long process of social development, China's bronze vessels, ceramics, silk, embroidery, lacquerware, jade articles, enamel, gold and silver products, and various sculptures and handicrafts have successively achieved remarkable achievements. The historically famous "Silk Road" and "Maritime Ceramic Road" fully reflect the high development of Chinese arts and crafts and their impact on Chinese culture and even world culture. Among them, ceramic products are the most representative. Their technological and artistic achievements have spread to various countries around the world and profoundly influenced the development of their ceramics and culture, earning China the reputation as the "Land of Ceramics".

89

There are numerous categories of Chinese arts and crafts, divided into more than ten major categories, hundreds of subcategories, and tens of thousands of varieties, with countless colors and designs. The main categories include ceramic handicrafts, sculpture handicrafts, jade, brocade, embroidery, printing and dyeing handicrafts, lace, weaving handicrafts, weaving handicrafts, carpets and tapestries, lacquerware, metal handicrafts, craft paintings, jewelry, etc.

90

Among ethnic minority handicrafts, famous practical items include: Mongolian saddle, waist knife, and inlaid products; Brocade weaving of different styles in various counties, including Dai, Zhuang, Tujia, Miao, Dong, Li, etc; Carpets of Uyghur and Tibetan ethnic groups; Uyghur hats and musical instruments; Cross stitch and silver jewelry of the Miao and Dong ethnic groups; Wax dyeing of the Miao and Buyi ethnic groups; The patchwork of the Kazakh people; Yi ethnic lacquerware, etc.

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III. Chinese martial arts

Chinese martial arts is a rich and full cultural carrier, reflecting Chinese wisdom in every move, embodying Chinese spirit in every fist and every movement, and concealing Chinese civilization in every skill and theory.

Chinese martial arts emphasizes the balance of strength and softness, with both internal and external cultivation. It has a robust and beautiful appearance, as well as an elegant and profound connotation.

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Shaolin Sect: It is a martial arts sect with the widest range and the most varieties of boxing in Chinese martial arts, with over 700 martial arts routines. It is named after Songshan Shaolin Temple in Henan Province, China, where it originated. It is also known as "martial arts Zen" because it incorporates Zen into martial arts and emphasizes both martial arts training and Zen meditation.

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Wudang Sect: In Chinese martial arts circles, there is a saying that goes "Shaolin is the external school, Wudang is the internal school." The Wudang Sect is named after Wudang Mountain, which is located in Jun County, Hubei Province, where it originated.

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Emei Sect: Together with the Shaolin Sect and the Wudang Sect, it is known as one of the three major schools of Chinese martial arts, and it is also a very extensive sect. It originated from Emei Mountain in Sichuan Province, China, and was formed in the Ming Dynasty. Its techniques are between the masculine style of Shaolin and the feminine style of Wudang, combining both softness and hardness, emphasizing both internal and external training, and utilizing both long and short techniques. It integrates the strengths of various martial arts schools such as Southern Fist, Shaolin, and Wudang.

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Video: Three Section Cudgel

96

IV.Festivals and customs

4.1 Etiquettes

Chinese traditional culture is renowned for its long history, profound connotations, and diverse artistic forms. One of its core characteristics is the high emphasis on ceremonies and etiquette. Ceremonies and etiquette permeate every aspect of Chinese traditional culture, from family to society, from religion to politics, omnipresent. They are not only seen as a code of conduct but also carry moral values, social order, and the maintenance of interpersonal relationships. Through the study and inheritance of ceremonies and etiquette, we can gain a deep understanding of the essence of Chinese traditional culture and experience the respect and care between people.

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China is a country that has inherited etiquette for thousands of years. During the Yin and Zhou dynasties more than 3000 years ago, the Zhou Duke established a system of ritual and music, and proposed the program of ritual governance. To understand traditional Chinese culture, it is necessary to understand Chinese etiquette culture. It should be said that when the history of the Chinese nation opened its first page, etiquette accompanied human activities and primitive religions. The etiquette system was formulated to handle the three major relationships between people and gods, people and ghosts, and people and people.

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In the excellent traditional Chinese culture, rituals and etiquette play an important role. Ritual is a sacred activity that expresses respect for significant events and traditional customs through standardized procedures and unique symbols. Etiquette emphasizes the norms and respect of personal behavior, reflecting the unique expression of culture.

In traditional Chinese culture, etiquette is regarded as a necessary social way and behavioral norm. It involves interpersonal communication, social interaction, and rituals in various fields. Etiquette occupies an important position in traditional Chinese culture and runs through all aspects of people's lives.

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Traditional Chinese culture, with rituals and etiquette as its core, is a unique set of social behavioral norms and normative systems. It originated in ancient China and has undergone thousands of years of inheritance and development. Ritual holds a very important position and profound significance in traditional Chinese culture. From major turning points in personal life such as weddings, funerals, and celebrations to major national events such as politics and military, rituals occupy a crucial position. Ritual is not only a carrier of conveying appearance and emotions, but also an important means of conveying values, moral norms, and social order.

100

Ancient etiquette includes a wide range of contents and forms, such as political system, court code, worship of heaven and earth, praying for floods and droughts, school imperial examinations, military campaigns, administrative division, building and tomb construction, as well as clothing, food, housing, transportation, weddings, funerals, weddings, and speech, all of which are related to etiquette. It is almost a vast concept that includes all national political, economic, military, and cultural laws and regulations, as well as personal ethical and moral cultivation and behavioral norms. Until modern times, the scope of etiquette gradually narrowed down, and generally only had the meaning of etiquette and ritual.

101

Tiananmen Square Flag Raising Ceremony

102

4.2 Important festivals

Chinese traditional festivals are an important part of the long history and culture of the Chinese nation, with diverse forms and rich content. The formation of traditional festivals is a process of long-term accumulation and cohesion of the historical and cultural heritage of a nation or country.

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The origin and inheritance development of ancient traditional festivals is a cultural process that gradually forms and improves human society, and is a product of the evolution and development of human civilization. According to the research results of modern anthropology and archaeology, the two most primitive beliefs of humans are: the belief in heaven and earth, and the belief in ancestors.

The ancient traditional festivals of the Chinese nation cover humanistic and natural cultural content such as primitive beliefs, sacrificial culture, astronomy and calendar, and the principles of change and numerology, containing profound and rich cultural connotations. The traditional Chinese festivals that have developed from the ancient ancestors not only clearly record the rich and colorful social and cultural content of the Chinese nation's ancestors, but also accumulate profound historical and cultural connotations.

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The emergence of traditional festivals reflects the Chinese nation's understanding and respect for nature, contains profound historical and humanistic sentiments, and has rich cultural connotations and spiritual cores. Through various forms, the Chinese nation expresses its values and thoughts, morality and ethics, behavior and norms, aesthetics and tastes during festivals, and also embodies people's positive aspirations and persistent pursuit of a happy life for thousands of years.

China is a country of etiquette, and rituals express the Chinese people's recognition of the importance and value of things. Festivals without a sense of ceremony are difficult for people to psychologically identify and comply with the festival, and rituals themselves are an important way for people to participate. A series of sequentially unfolding programs represent the layered display of festival cultural connotations, and also involve the soul in the process of aesthetic appreciation.

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Spring Festival
also known as the Lunar New Year or the Chinese New Year. The Spring Festival has a long history and evolved from the ancient era of praying for the beginning of the year and offering sacrifices. In traditional agricultural societies, the beginning of the Spring Festival is of great significance. Starting with a hundred festivals, the Spring Festival is the most solemn traditional festival of the Chinese nation. It not only embodies the ideological beliefs, ideal wishes, life entertainment, and cultural psychology of the Chinese nation, but also serves as a display of blessings, food, and entertainment activities.

106

Yuanxiao Festival

also known as the Lantern Festivalalls on the 15th day of the first lunar month every year and is one of the traditional festivals in China. The first month is the first month of the lunar calendar. The 15th day of the first month is the first full moon night of the year, so the 15th day of the first month is called "Yuanxiao (Filled round balls made of glutinous rice-flour for Lantern Festival) Festival". Since ancient times, the custom of Yuanxiaoas been dominated by the warm and festive custom of watching lanterns.

107

Loong Head Up

also known as Spring Farming Festival, Agricultural Festival,etc., is a traditional Chinese folk festival. Loong refers to the seven constellations of the Eastern Canglong in the twenty-eight constellations. At the beginning of the Mao month in mid spring (Douzhi due east), the "Loong Horn Star" rises from the eastern horizon, hence the name "Loong Head".

108

Qingming Festival

also known as Qingqing Festival, Xingqing Festival, March Festival, Ancestral Worship Festival, etc., is celebrated at the turn of mid spring and late spring. The Qingming Festival originated from the ancestral beliefs and spring festival customs of ancient times, and has both natural and cultural connotations. It is not only a natural solar term, but also a traditional festival.

109

Loong Boat Festival

The ancients have always advocated the path of righteousness and righteousness. The Dragon Boat Festival, also known as Zhongzheng, refers to the noon hour on this day, which is the highest point in the middle. The Loong Boat Festival originated from the worship of celestial phenomena and evolved from dragon worship in ancient times. The Dragon Boat Festival is an auspicious day of "flying dragons in the sky". People hold some celebration activities at the Dragon Boat Festival, especially the activity elements corresponding to the dragon, such as offering sacrifices to the dragon and ancestors, picking up the Loong Boat, etc., or do some activities to pray for good fortune and ward off evil spirits on this auspicious day.

110

Qixi Festival

Also known as the Double Seventh Festival, it is named "Qixi" because worship activities are held in the evening of July 7th. Through historical development, Qixi has been endowed with the beautiful love legend of "Niulang and Zhinv" (Cowherd and Weaver Girl). Because it has been endowed with connotations related to love, it has become a festival symbolizing love and is thus considered the most romantic traditional festival in China. In modern times, it has even acquired the cultural meaning of "Chinese Valentine's Day".

111

Zhongyuan Festival

also known as the "Ghost Festival", has main customs such as ancestor worship, floating river lanterns, honoring deceased spirits, burning paper money, and sacrificing to the earth god. Its origin can be traced back to ancient times' ancestor worship and related seasonal sacrifices.

112

Mid-Autumn Festival

also known as the Reunion Festival, originates from the worship of celestial phenomena and evolved from the ancient autumn moon sacrifice. Since ancient times, the Mid-Autumn Festival has been associated with customs such as moon worship, moon gazing, eating mooncakes, playing with lanterns, admiring osmanthus flowers, and drinking osmanthus wine, which have persisted and spread for a long time. Eating mooncakes has become an essential custom for celebrating the Mid-Autumn Festival across China. On this day, people eat mooncakes to symbolize "reunion".

113

Lower Yuan Festival

In northern China, the Cold Clothes Festival, along with the Qingming Festival in spring and the Zhongyuan Festival on July 15th, are collectively known as the three major "Ghost Festivals" in China. The Cold Clothes Festival is popular in northern China, where many people will offer sacrifices and sweep tombs on this day to commemorate their deceased loved ones, which is called "sending cold clothes".

114

Winter Solstice Festival

embodies both natural and cultural significance. It is not only an important solar term in the twenty-four solar terms but also a traditional ancestral worship festival in Chinese folk culture. The Winter Solstice is one of the four seasons and eight solar terms and is regarded as a major festival in winter. In ancient times, there was a saying among the people that "the Winter Solstice is as significant as the New Year." Customs during the Winter Solstice vary in content or details depending on the region.

115

New Year's Eve

marks the final night of the year, signifying the end of the old year and the beginning of a new one. It is a day for removing the old and welcoming the new, for family reunion, and for sacrificing to ancestors. Together with the Qingming Festival, the Zhongyuan Festival (July 15th), and the Double Ninth Festival, New Year's Eve is one of the major traditional Chinese festivals for ancestral worship.

116

Spring Festival Gala

The Spring Festival Gala is a comprehensive cultural show organized by China Central Television (CCTV) on the night of Chinese New Year's Eve to celebrate the Lunar New Year. The first CCTV Spring Festival Gala was officially launched in 1983, and as of 2024, it has been held 42 times. The gala features a variety of performances, including songs, dances, crosstalk (comic dialogue), skits, operas, martial arts, magic, acrobatics, musicals, and micro-films.

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Spring Festival Gala

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V. Food culture

5.1 Chinese food

Chinese cuisine is famous worldwide and is one of China's business cards. Color, aroma, taste, and shape are the four major standards of Chinese cuisine. Traditional Chinese cuisine uses chopsticks as a tool for eating. For thousands of years, people have continuously summarized and formed the eight major cuisines of Chinese cuisine, namely the Shandong, Sichuan, Guangdong, Fujian, Jiangsu, Zhejiang, Hunan, and Anhui schools.

119

5.2 Chinese tea

China is the homeland of tea and the birthplace of tea culture. Chinese tea culture has a long and profound history, with a discovery and utilization spanning over 4,700 years. It has remained vibrant and widespread globally. Chinese tea culture encompasses not only the material cultural aspect but also a profound spiritual dimension. The "Tea Classic" by Lu Yu, the Tea Sage of the Tang Dynasty, sounded the clarion call of Chinese tea culture in history. Since then, the spirit of tea has permeated the imperial court and society, deeply influencing Chinese poetry, painting, calligraphy, religion, and medicine. Over thousands of years, China has accumulated not only a substantial material culture related to tea planting and production but also a rich spiritual culture associated with tea, which is the unique tea culture of China.

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Tea has medicinal effects in promoting health and treating illnesses, and it also offers aesthetic pleasure that can cultivate one's sentiments. Enjoying tea and entertaining guests are elegant forms of entertainment and social activities for Chinese people. Visiting teahouses and attending tea parties are social group activities related to tea art for Chinese people.

China's tea varieties are also diverse, classified into green tea, black tea, oolong tea, white tea, yellow tea, dark tea, and so on.

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5.3 Alcoholic beverage culture

It has a long and rich history in China, with many literati and scholars writing works to evaluate and appreciate fine wines, leaving behind numerous legends and anecdotes related to drinking, poetry, painting, health preservation, banquets, farewell gatherings, and the divine spirit of wine. The works and deeds of historical figures such as Li Bai and Wang Xizhi are closely related to alcohol. As a special cultural carrier, alcohol holds a unique position in human interactions.

122

According to ancient records, the invention of alcohol was quite accidental. Once, Du Kang placed leftover rice in an empty mulberry tree stump. After a long time, the rice naturally fermented, emitting a fragrant aroma and producing a liquid. Du Kang tasted it and found it sweet and delicious. Inspired by this, Du Kang invented alcohol.

123

Drinking at banquets is not only a social etiquette but also a way for friends to express their feelings. The drinking etiquette in China reflects respect for the drinkers. There are fixed seating arrangements for the host and guests, as well as a specific order for offering toasts.

The fun of drinking is abundant in drinking games, which are purely cultural elements integrated into alcohol, representing the cultural essence of alcohol culture. As early as the Spring and Autumn Period and the Warring States Period more than two thousand years ago, drinking games emerged at banquets in the Yellow River basin. Drinking games can be divided into vulgar games and elegant games. Guessing fingers is a representative of vulgar games, while elegant games, also known as literary games, are typically popular among people with richer cultural knowledge. They mainly include word games, riddle games, and dice games.

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VI. Technological innovations

In addition to historical relics, ancient China also had countless technological inventions. There were the Four Great Inventions in ancient China, namely paper, Movable type, gunpowder and compass, which greatly promoted the development of politics, economy and culture in ancient China. They spread to the West through various channels, and exerted great influence on the development of world civilization.

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Paper

Paper was invented by Cai Lun in 105 AD (during the Eastern Han Dynasty). It was made from bark, hemp, rags, and old fishing nets, which is convenient for people to write and promoted cultural dissemination.

126

Movable type printing

Printing in ancient China can be traced back to the 6th century AD. Engraving printing was invented in the Tang Dynasty. Bi Sheng invented movable type printing, marking the birth of movable type printing. He was the world's first inventor, about 400 years ahead of Western lead movable type printing.

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Gunpowder

The invention and use of gunpowder can be traced back to 2000 years ago. In the Spring and Autumn period, China had already used gunpowder for civilian and people's livelihood applications. China's gunpowder has advanced the process of world history. Gunpowder shook the feudal rule of Western Europe and was one of the important impetus to the European Renaissance and Religious Reform.

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Compass

The invention of the compass can be traced back to the Warring States period (2500 years ago), greatly promoting the development of navigation and writing a glorious page in the history of world navigation.

129

Traditional Chinese Medicine

Traditional Chinese Medicine (TCM). TCM emphasizes "observation, listening, inquiry, and palpation," viewing the human body as a unity of qi (vital energy), form, and spirit. It is also a great invention in Chinese tradition and has made significant contributions to humanity throughout history. In addition to TCM, there are also ethnic medical systems in China such as Tibetan medicine, Zhuang medicine, Miao medicine, Mongolian medicine, Uyghur medicine, Korean medicine, and Dai medicine.

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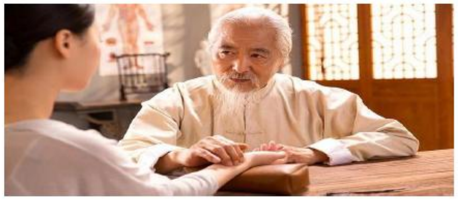
TCM is a discipline that studies human physiology, pathology, pharmacology, and their relationship with the natural environment from a dynamic and holistic perspective, guided by the theories of yin-yang and the five elements. With yin-yang and the five elements as its theoretical foundation, TCM views the human body as a unity of qi (vital energy), form, and spirit. Through the methods of observation, listening, inquiry, and palpation, combined with the four diagnostic methods, TCM explores the cause, nature, and location of diseases, analyzes the pathogenesis and changes in the internal organs, meridians and collaterals, qi, blood, and body fluids, judges the growth and decline of pathogenic and healthy factors, and then determines the disease name and summarizes the syndrome type. Based on the principle of syndrome differentiation and treatment, TCM formulates treatment methods such as "inducing sweating, inducing vomiting, purgation, harmonization, warming, clearing, tonifying, and eliminating," and uses various therapeutic means such as Chinese herbal medicine, moxibustion, acupuncture, massage, cupping, qigong (breathing exercises), and dietary therapy to restore the body's yin-yang balance and promote recovery.

131

TCM has a complete theoretical system, with its uniqueness lying in the holistic view of "the unity of heaven and man" and "the correspondence between heaven and man," as well as syndrome differentiation and treatment. Its main characteristics include: (1) It believes that human beings are an integral part of nature, composed of two major categories of substances: yin and yang. The yin and yang qi are both opposite and interdependent, and are constantly in motion and change. In a normal physiological state, they are in a dynamic balance. Once this dynamic balance is disrupted, it manifests as a pathological state. When treating diseases and correcting the imbalance of yin and yang, TCM does not adopt an isolated and static approach to viewing problems. Instead, it emphasizes a dynamic perspective, known as the "constant motion view."



132

(2) It believes that human beings and nature are a unified whole, embodying the concepts of "the unity of heaven and man" and "the correspondence between heaven and man." The laws of human life activities, the occurrence of diseases, and other aspects are closely related to various changes in nature (such as seasonal climate, regional differences, day and night, etc.). Different natural environments and varying degrees of human adaptation to these environments result in distinct physical characteristics and patterns of disease occurrence. Therefore, when diagnosing and treating the same disease, emphasis is placed on considering the time, location, and individual differences, rather than applying a uniform approach.

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(3) It believes that all tissues and organs in the human body coexist within a unified whole, and they are interconnected and mutually influence each other, both physiologically and pathologically. Therefore, it never views a physiological or pathological phenomenon in isolation, such as treating only the head for a headache or only the foot for a foot pain. Instead, it approaches the treatment and prevention of diseases from a holistic perspective, with a strong emphasis on the "holistic view."

134

On November 16, 2010, the application for Chinese acupuncture to be included in the World Intangible Cultural Heritage succeeded.

135

1.Huangdi Neijing (the Yellow Emperor's Inner Canon)

Huangdi Neijing is the earliest and most influential medical book in China, revered by later generations as the "Ancestor of Medicine.". It emphasizes the principle of prevention, advocating for treating diseases before they occur rather than after they have manifested.

136

2. Bian Que

Bian Que (407 BCE - 310 BCE), originally named Qin Yueren, was a renowned physician during the Warring States period. He is credited as the founder of pulse diagnosis in TCM. In his practice, Bian Que applied the four diagnostic methods: Looking (at their tongues and their outside appearances), Listening (to their voice and breathing patterns), Inquiring (about their symptoms), and Taking (their pulse)

137

3. Hua Tuo

Hua Tuo was a renowned physician at the end of the Han dynasty. He was proficient in internal medicine, surgery, gynecology, pediatrics, and acupuncture. Hua Tuo was the first to use general anesthesia in surgical procedures, earning him the titles of "Saint of Surgery" and "Father of Surgery" from later generations. Hua Tuo also developed a set of therapeutic exercises, which mimics the movements of the monkey, deer, bear, tiger, and bird, designed to promote health and vitality in the elderly and infirm.

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4. Zhang Zhongjing

Zhang Zhongjing was a great clinical physician at the end of the Han Dynasty. He authored the medical masterpiece "Treatise on Cold Damage and Miscellaneous Diseases" (Shang Han Za Bing Lun). Zhang Zhongjing classified diseases into six categories, known as the "Six Channels" (Liu Jing). Based on factors such as the body's resistance to disease and the progression and severity of the illness, he summarized the characteristics of symptoms and the locations of pathological changes.

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Thank you for your attention!

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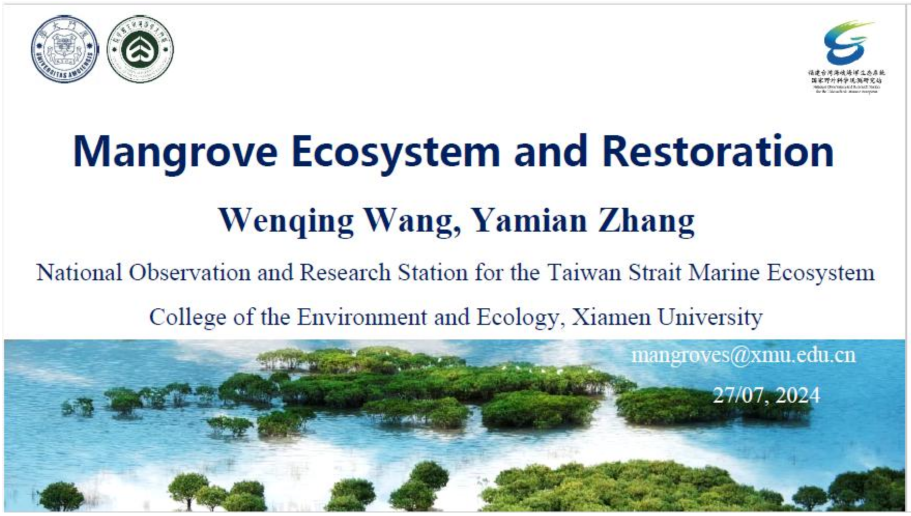
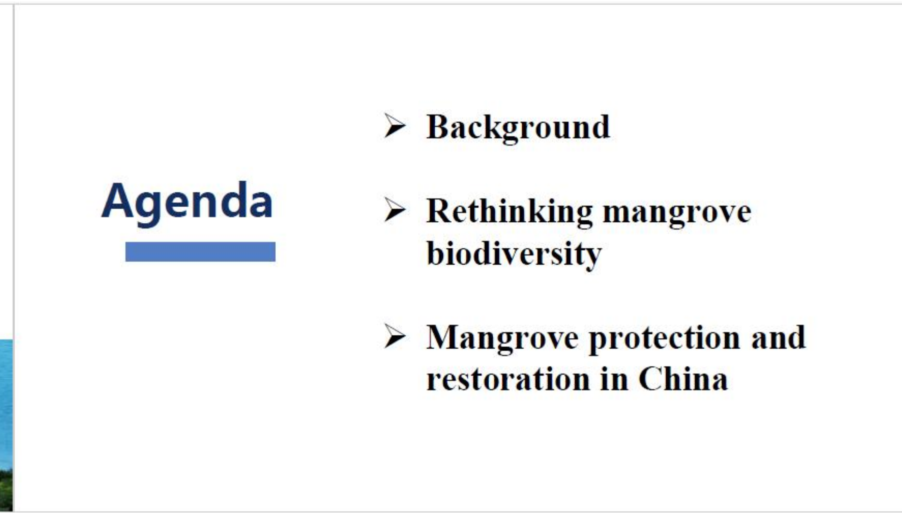
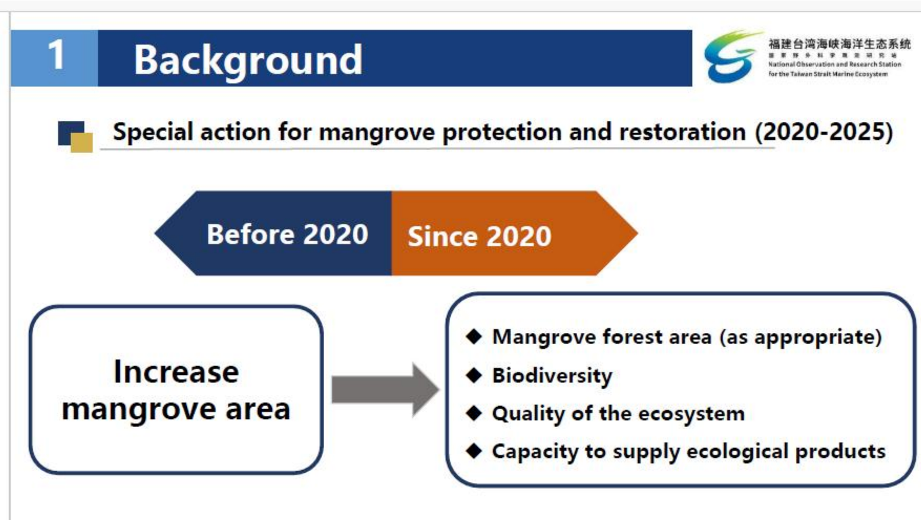
- **Lecture 4: Mangrove Ecosystem and Restoration**






1 Background
Special action for mangrove protection and restoration (2020-2025)
(Promulgated in August, 2020)
Afforestation: 9050 ha
Degradated mangrove forest restoration: 9750 ha
Coastal shelterbelt system construction project plan (2016-2025)
(Promulgated in May, 2017)
Afforestation: 48650 ha


1 Background
Special action for mangrove protection and restoration (2020-2025)
Before 2020
Since 2020
Increase mangrove area
Mangrove forest area (as appropriate)
Biodiversity
Quality of the ecosystem
Capacity to supply ecological products

Agenda

- Background
- Rethinking mangrove biodiversity
- Mangrove protection and restoration in China

2 Rethinking mangrove biodiversity

福建台湾海峡海洋生态系统 National Observation and Research Station for the Taiwan Strait Marine Ecosystem

Mangroves are low biodiversity

Mangrove area and true mangrove species diversity (Luther et al., 2009)

Region	Mangrove area (km^2)	Mangrove genera	Mangrove species
Atlantic-Caribbean-Eastern pacific	68000		
Eastern Pacific	12000	4	7
West Atlantic-Caribbean	32000	3	6
Western Africa	24000	3	5
Indo-West Pacific	83000		
East Africa	8000	8	9
Indo-Malaysia	60000	17	39
Australasia	15000	16	35

2 Rethinking mangrove biodiversity

福建台湾海峡海洋生态系统 National Observation and Research Station for the Taiwan Strait Marine Ecosystem

Mangroves are low biodiversity

- Mangrove forest in Guangxi, China
- Total area: 230 ha
- 1 mangrove species: *Avicennia marina*

2 Rethinking mangrove biodiversity

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National Observation and Research Station for the Taiwan Strait Marine Ecosystem

Mangroves species distribution in China

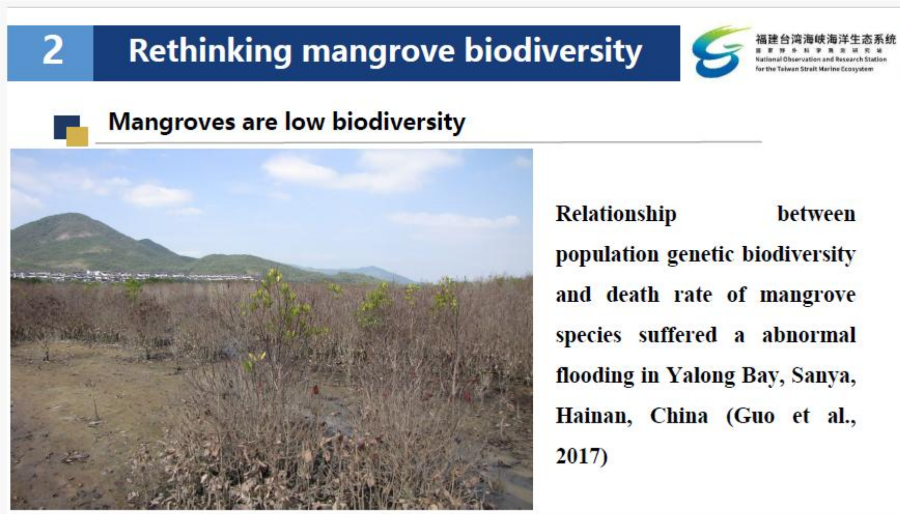
	Fujian	Guangdong	Guangxi	Hainan	Hong Kong	Macau	Taiwan	IUCN
Kandelia obovata	√	√	√	√	√	√	√	LC
Bruguiera gymnorhiza	√	√	√	√	√		Ex	LC
Bruguiera sexangula				√				NT
B. s. var. *rhynchopetala*	√			√				VU
Rhizophora stylosa		√	√	√	Ex		√	LC
Rhizophora apiculata				√				VU
R. lamarkii				√				CR
Ceriops tagal			Ex	√			Ex	LC
Pemphis acidula				√			√	EN
Sonneratia caseolaris				√				NT
S. × gulngai				√				EN
S. × *hainanensis*				√				CR
Sonneratia ovata				√				CR
Sonneratia alba				√				LC

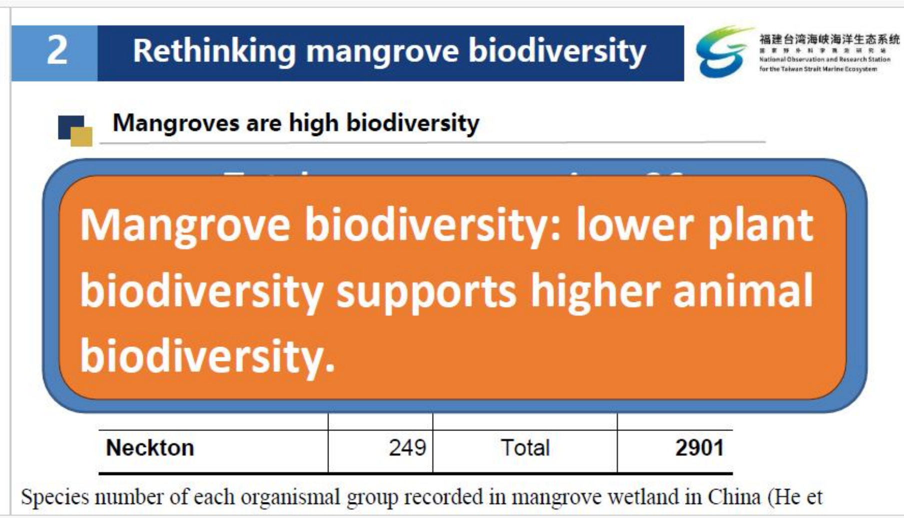
2 Rethinking mangrove biodiversity

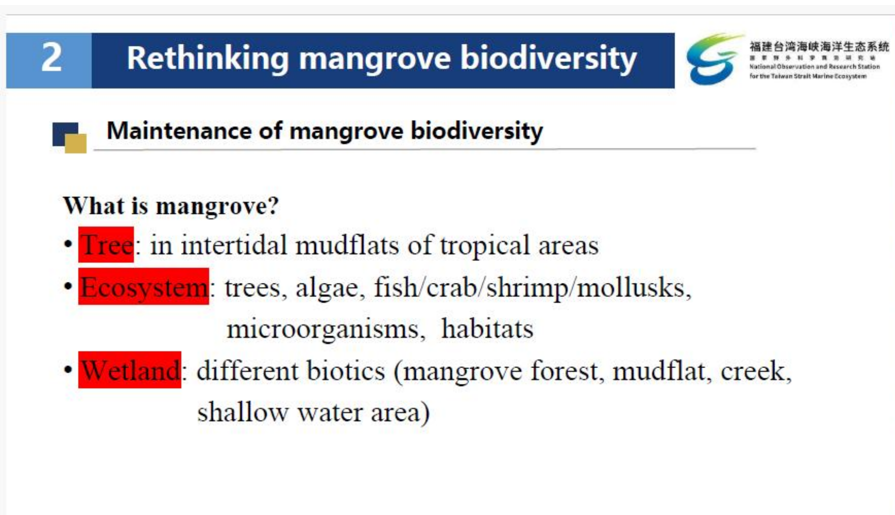
福建台湾海峡海洋生态系统
National Observation and Research Station for the Taiwan Strait Marine Ecosystem

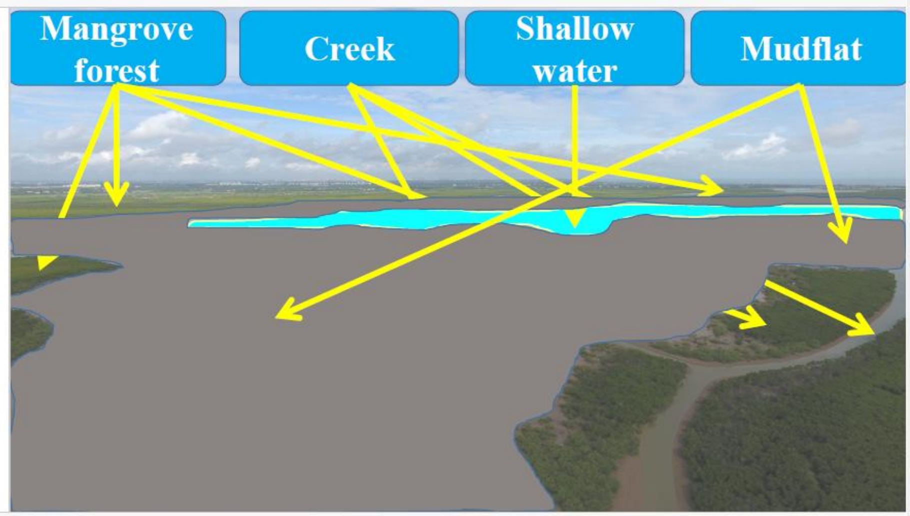
Mangroves species distribution in China

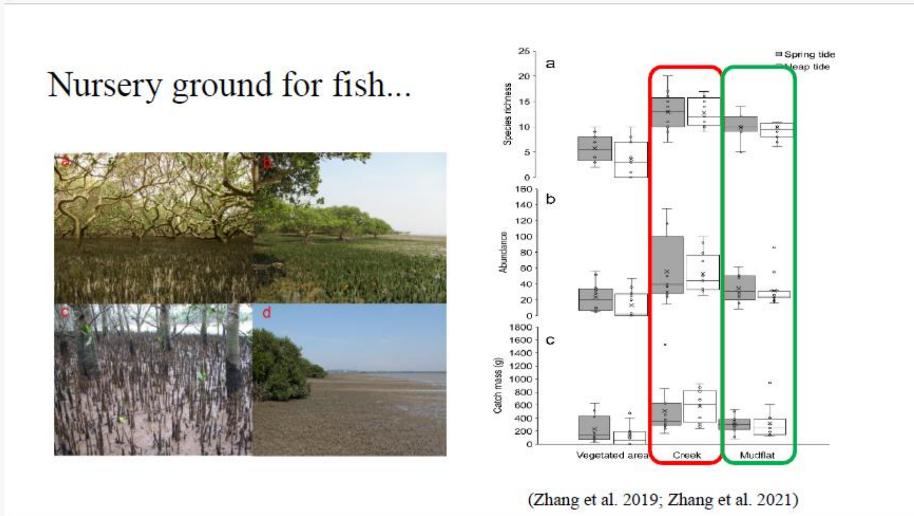
	Fujian	Guangdong	Guangxi	Hainan	Hong Kong	Macau	Taiwan	IUCN
Xylocarpus granatum				√				VU
Lumnitzera racemosa		√	√	√	√		√	LC
Lumnitzera littorea				√				CR
Acanthus ilicifolius	√	√	√	√	√	√	√	LC
Acanthus ebracteatus		√	√	√				EN
Scyphiphora hydrophyllacea				√				EN
Acrostichum aureum	Ex	√	√	√	√	√	√	LC
Acrostichum speciosum		√		√				EN
Nypa fruticans				√				VU
Avicennia marina	√	√	√	√	√	√	√	LC
Aegiceras corniculatum	√	√	√	√	√	√	√	LC
Excoecaria agallocha	Ex	√	√	√	√		√	LC

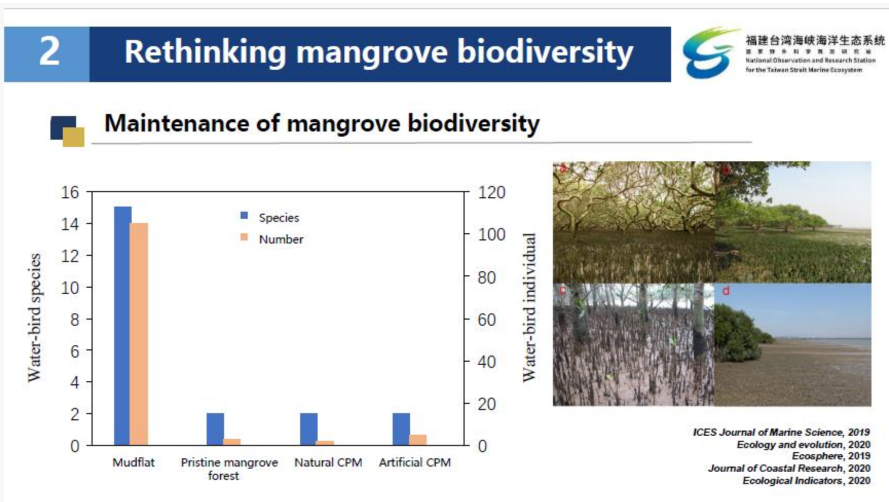

2
Rethinking mangrove biodiversity
福建台湾海峡海洋生态系统
Mangroves are low biodiversity
Relationship between population genetic biodiversity and death rate of mangrove species suffered a abnormal flooding in Yalong Bay, Sanya, Hainan, China (Guo et al., 2017)

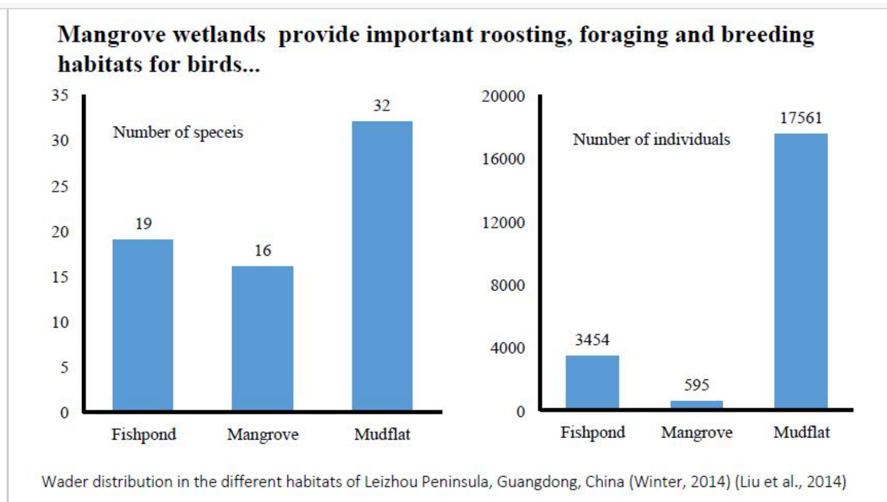

2
Rethinking mangrove biodiversity
福建台湾海峡海洋生态系统
Mangroves are high biodiversity
Mangrove biodiversity: lower plant biodiversity supports higher animal biodiversity.
Neckton 249 Total 2901
Species number of each organismal group recorded in mangrove wetland in China (He et


2
Rethinking mangrove biodiversity
福建台湾海峡海洋生态系统
Maintenance of mangrove biodiversity
What is mangrove?
• Tree: in intertidal mudflats of tropical areas
• Ecosystem: trees, algae, fish/crab/shrimp/mollusks, microorganisms, habitats
• Wetland: different biotics (mangrove forest, mudflat, creek, shallow water area)


Mangrove forest
Creek
Shallow water
Mudflat


Nursery ground for fish...
Spring tide
Neap tide
a
b
c
Species richness
Abundance
Catch mass (g)
Vegetated area
Creek
Mudflat
(Zhang et al. 2019; Zhang et al. 2021)


2
Rethinking mangrove biodiversity
Maintenance of mangrove biodiversity
Species
Number
Water-bird species
Water-bird individual
Mudflat
Pristine mangrove forest
Natural CPM
Artificial CPM
ICES Journal of Marine Science, 2019
Ecology and evolution, 2020
Ecosphere, 2019
Journal of Coastal Research, 2020
Ecological Indicators, 2020


Mangrove wetlands provide important roosting, foraging and breeding habitats for birds...
Number of speceis
19
16
32
Number of individuals
3454
595
17561
Fishpond
Mangrove
Mudflat
Wader distribution in the different habitats of Leizhou Peninsula, Guangdong, China (Winter, 2014) (Liu et al., 2014)

2 Rethinking mangrove biodiversity

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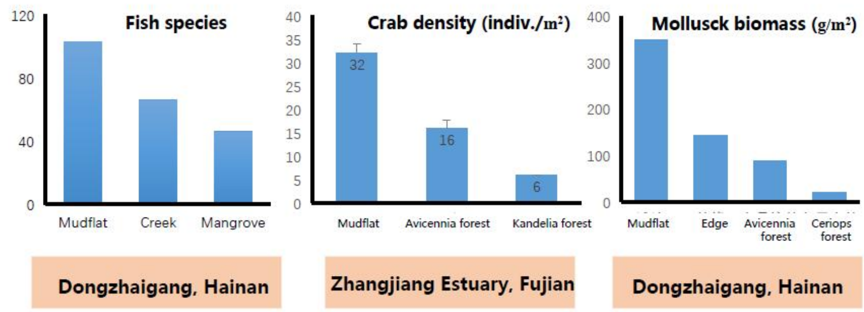
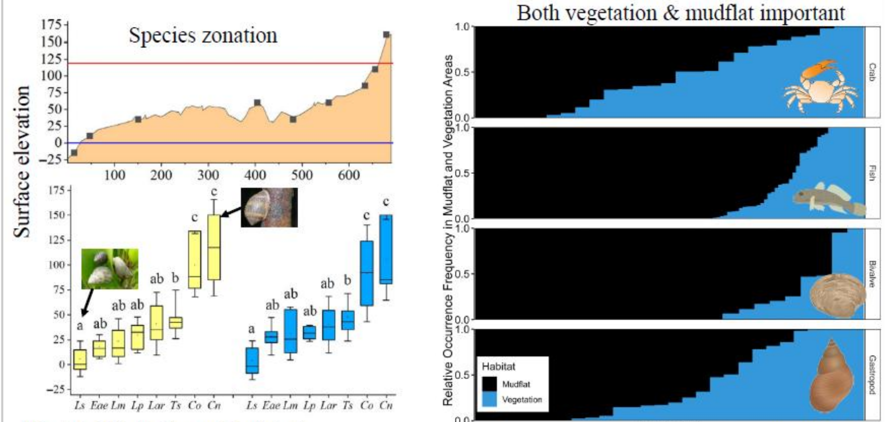
Maintenance of mangrove biodiversity



Diverse habitats for biodiversity



(Ma et al. 2020, *Ecology and Evolution*)

(Zhang, unpublished)

2 Rethinking mangrove biodiversity

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Take home message

- Lower plant diversity supports higher animal diversity;
- Different parts (forest area, creek, mudflat, shallow water area) support different biotics;
- Mangrove wetland = mangrove forest+creek+mudflat+shallow water area.

Agenda

- Background
- Rethinking mangrove biodiversity
- Mangrove protection and restoration in China

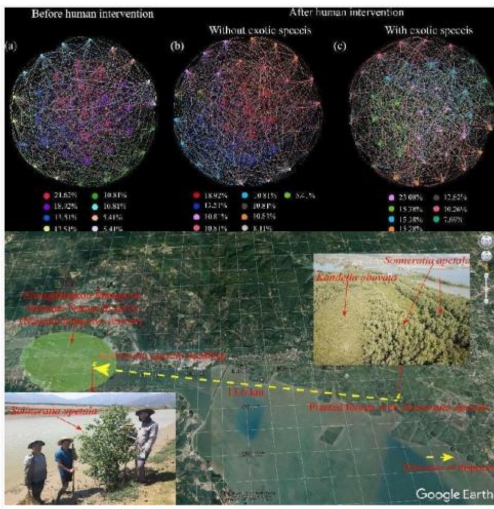
3 Mangrove restoration in China

Mangrove afforestation plan in China

Promulgation time	Department	Time	Goal (hm²)	Actual performance
2001	State Forestry Administration	2001-2010	60000	~13% (2023)
2016	State Oceanic Administration	2016-2020	2500	?
2017	State Forestry Administration	2016-2025	48650	?

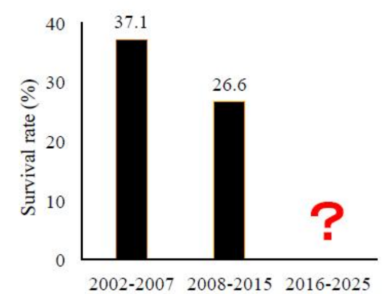
Mudflat afforestation project at Lingshui, Hainan

Mudflat afforestation project at Lingshui, Hainan



- Increased the species diversity of local mangrove and changed the latitude pattern of alpha diversity.
- Resulted in the homogenization of mangrove plant community.
- Reduced the complexity and stability of the biogeographic network of mangrove communities（Chen et al., 2021, 2022）.

➢ Restoration through planting mangrove seedlings on mudflats has been the priority for mangrove protection in the past two decades



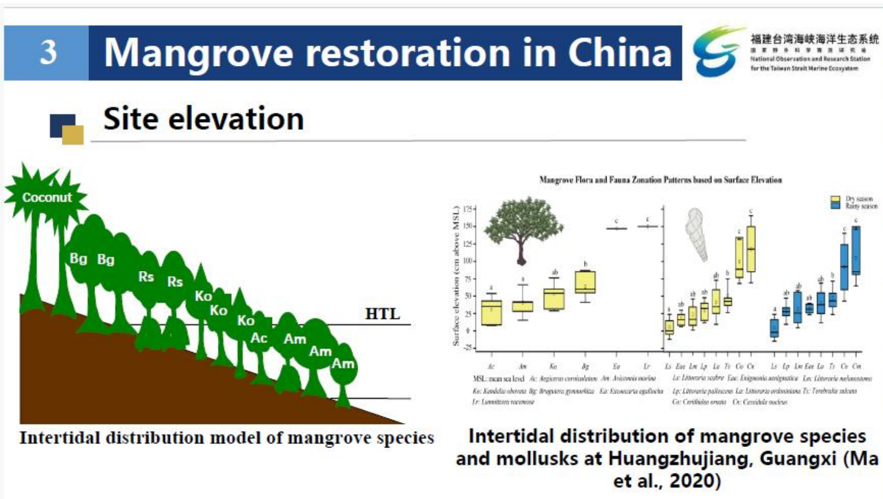
Changes of the survival rate of mangrove seedlings in Guangxi, China (Fan & Mo, 2018)

Disadvantages:

- ◆ Higher cost
- ◆ Higher technical difficulty
- ◆ Fewer species
- ◆ Lower survival rate
- ◆ Lower carbon storage rate
- ◆ Encroachment of waterbird habitat
- ◆ Limited ecological benefits


3
Mangrove restoration in China
Special action for mangrove protection and restoration (2020-2025)
Before 2020
Since 2020
Increase mangrove area
◆ Mangrove forest area (as appropriate)
◆ Biodiversity
◆ Quality of the ecosystem
◆ Capacity to supply ecological products


3
Mangrove restoration in China
• More mangrove species used (rare or endangered species).
• Higher survival rate of mangrove seedlings.
• Ecosystem functions: biodiversity, blue carbon, disaster prevention and mitigation, stability, sustainable development, ⋯.


3
Mangrove restoration in China
Site elevation
Coconut
Bg
Rs
Ko
Ac
Am
HTL
Intertidal distribution model of mangrove species
Mangrove Flora and Fauna Zonation Patterns based on Surface Elevation
Intertidal distribution of mangrove species and mollusks at Huangzhujiang, Guangxi (Ma et al., 2020)


3
Mangrove restoration in China
福建台湾海峡海洋生态系统
National Observation and Research Station for the Taiwan Strait Marine Ecosystem


3
Mangrove restoration in China
福建台湾海峡海洋生态系统
National Observation and Research Station for the Taiwan Strait Marine Ecosystem
Site elevation
Reason for the low survival rate: insufficient site elevation.
The lower the site elevation and the higher the water salinity, the more serious the barnacle damage.
The determination of the critical elevation of mangrove forest is the key to the success of mangrove forestation.


3
Mangrove restoration in China
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Site elevation

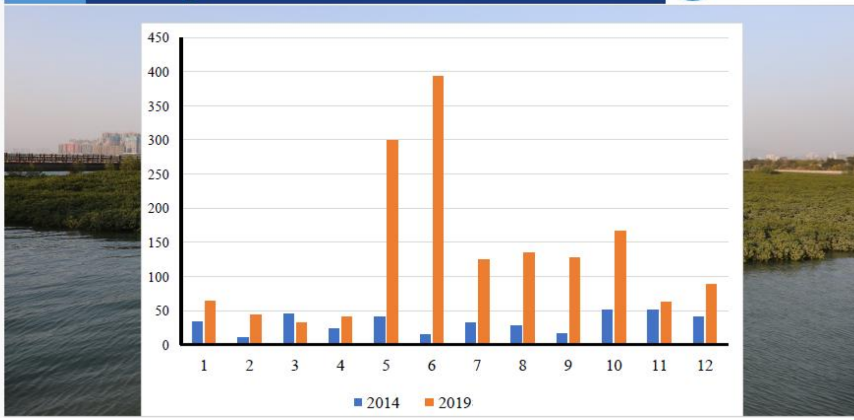

3
Mangrove restoration in China
福建台湾海峡海洋生态系统
National Observation and Research Station for the Taiwan Strait Marine Ecosystem
Site elevation


3
Mangrove restoration in China
Site elevation
Insufficient elevation


3
Mangrove restoration in China
Site elevation
Too high!!!

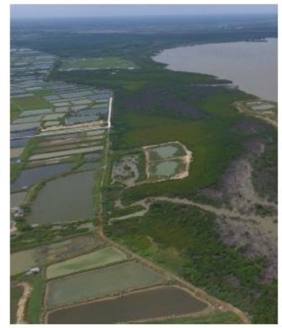

3
Mangrove restoration in China
Seedling raising

3 Mangrove restoration in China



3 Mangrove restoration in China

Mangrove restoration in abandoned acquaculture ponds



- Aquaculture expansion is the key driver of mangrove lose (Alongi 2002, 2019);
- Numeral disadvantages of mudflat afforestation.

Abandoned fish ponds in southern China in 2014 (Fan et al., 2017)

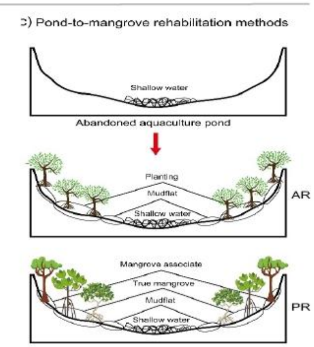
Province	Total area of fish pond in use (ha)	Total area of fish pond (ha)	Vacancy rate (%)
Zhejiang	32 025	45 750	30
Fujian	29 949	46 075	35
Guangdong	72 641	85 460	15
Guangxi	20 307	46 152	56
Hainan	12 665	16 887	25
Total	167 587	240 324	30.3

3 Mangrove restoration in China

Mangrove restoration in abandoned acquaculture ponds

Disadvantages:
- Higher cost
- Higher administrative costs
- Higher ecological benefits
- No standard

Advantages:
- Higher technical difficulty
- Higher survival rate
- More species
- Higher carbon storage rate



3 Mangrove restoration in China

Standard system for mangrove restoration

- Occupation and local standards: 16 items
- Seeding raising, site selection, water, soil, planting, pest control, invasive plant control, check and accept
- National standard: in preparing

3 Mangrove restoration in China

Biodiversity conservation-based mangrove restoration

- Mangrove forest ≠ mangrove wetland
- Mangrove wetland =mangrove forest + mudflat+ creek + shallow water area
- Mangrove forest management → Mangrove ecosystem management
- Mudflat afforestation → Mangrove restoration in abandoned acquaculture ponds
- Leave more than 40% of the mudflats blank
- More mangrove species (rare or endangered species)

3 Mangrove restoration in China

Take home message

- Lower plant biodiversity supports higher animal biodiversity
- Mangrove biodiversity maintenance: mangrove forest + mudflat + creek+ shallow water area
- Leave more than 40% of the mudflats blank
- "Mangrove+": mangrove afforestation + ecotourism + ecological breeding + blue carbon


Thanks!

- **Lecture 5: Conversion of the aged Shrimp ponds to mangrove eco-farm (factory) in China**

Technological innovation to promote sustainable restoration of mangroves:

Conversion of the aged shrimp ponds to mangrove eco-farm (factory) in China

Hangqing Fan

Guangxi Key Lab of Mangrove Conservation and Utilization
Guangxi Academy of Marine Sciences (Guangxi Mangrove Research Center)
Beihai, Guangxi, China.

1. Background

There are about 240, 000ha coastal shrimp ponds along the southeast coast of China, approximately 10% (24, 000 ha) of them were derived from mangroves in the history.

In order to protect the coastal environment, China is gradually eliminating the traditional shrimp pond and encouraging conversion of the aged shrimp ponds to mangroves.

Aiming to provide livelihood and promote community development during mangrove restoration, the eco-farm(factory) was researched and demonstrated.

The mangroves occupied by shrimp ponds in Guangxi province, China

2. Scientific mechanism and design

Definition of "Aged Shrimp Pond Mangrove Blue Carbon Eco-farm(factory)"

Optimizing the existing pond embankment and sluice gate, creating tidal ditch and varied habitats, to realize the coordination of mangrove restoration, breeding, aquatic enrichment, pollution reduction and entertainment.

Scientific objectives

- To balance the contradiction between the need for relatively stable water for swimming animals and the need of periodic change in water level for mangroves.
- To establish multi-species breeding models based on varied ecological niches.
- To raise carbon sink and reduce breeding pollution.

General method

- Excavating shelter ditch for cultivation, and using the substrate to create mangrove habitat.
- Controlling essential water level through sluice gate to ensure the safety of aquaculture.
- The intensive breeding suspended particles should be filtered and used as fertilizer to nurse mangrove seedlings and bio-baits for carnivores.

Design of Pattern1: Mangroves + Ditch for aquatic enrichment+ Shrimp pond

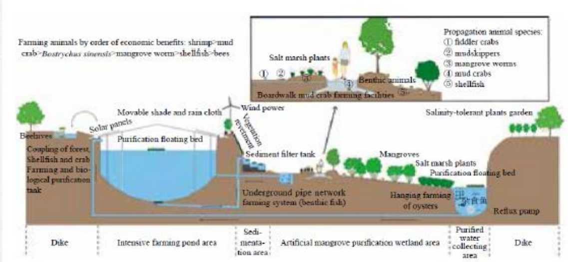


Figure 6-11 Basic Structure and Process Diagram of a Shrimp Pond Conversed Mangrove Ecological Farm

Design of Pattern 2: Mangrove + Ditch for aquatic enrichment+ Racetrack cultivation

3. Construction of the eco-farm

Location: Beihai, Guangxi, China

Coast: Open sea, not estuarine

Use of land: Salt industry, later shrimp pond

Substrate: Sand

Salinity: >25

Area: 4.80 ha, of which 2.33 ha for mangrove wetland experiment

Eco-farm under construction

Changes of the eco-farm landscape

Bird view of the eco-farm in 2023

4. Result

4.1 Restoration of vegetable in shrimp pond

30.02% wetland area was successfully restored to true mangroves in four years, and the embankment was covered by associate mangroves and coastal plants in 1~2 year.

Plant species used in restoration

No.	Embankment plant	Wetland plant
1	*Heritiera littoralis*	*Kandelia obovata*
2	*Hibiscus tiliaceus*	*Rhizophora stylosa*
3	*Thespesia populnea*	*Bruguiera gymnorrhiza*
4	*Pongamia pinnata*	*Avicennia marina*
5	*Cerbera manghas*	*Aegiceras corniculatum*
6	*Syzygium hancei*	
7	*Pandanus tectorius*	
8	*Dodonaea viscosa*	
9	*Scaevola sericea*	
10	*Pluchea indica*	
11	*Volkameria inermis*	
12	*Canavalia rosea*	
13	*Ipomoea pes-caprae*	
14	*Sesuvium portulacastrum*	
15	*Myoporum bontioides*	

4.2 Cultivation and enrichment

Twelve economically valuable species of artificial seedling were cultivated, and nine species of wild fish were enriched in the ditches.

No.	Swimming species	Seedling
1	*Mugil cephalus*	Artificial
2	*Sparus latus*	
3	*Trachinotus ovatus*	
4	*Scatophagus argus*	
5	*Litopenaeus vannamei*	
6	*Penaeus monodon*	
7	*Epinephelus fuscoguttatus*♀×*Epinephelus lanceolatus*♂	
8	*Therapon jarbua*	
9	*Scylla paramamosain*	
10	*Siganus canaliculatus*	
11	*Bostrychus sinensis*	
12	*Oreochromis niloticus*	
13	*Sillago sihama*	Wild
14	*Elops saurus*	
15	*Sparus macrocephalus*	
16	*Osteomugil strongylocephalus*	
17	*Glossogobius olivaceus*	
18	*Metapenaeus ensis*	
19	*Penaeus penicillatus*	
20	*Konosirus punctatus*	
21	*Gerres filamentosus*	

4.3 Pollution reduction

Compared with the 17 traditional shrimp ponds in Guangxi province， the eco-farm reduced emission of total N by 53.09%, and total P by 24.89%.

Evaluation of pollution reduction by eco-farm compared with the traditional shrimp ponds in Guangxi province

Season	Content of TN（mg/L）	Content of TP（mg/L）
Eco-farm in Spring	8.6	0.38
	7.99	0.36
	5.47	0.33
Eco-farm in Wenter	2.27	0.36
	1.99	0.37
	2.32	0.40
Mean of eco-farm	4.77	0.37
Mean of traditinal shrimp pond	10.17	0.49
Reduction by eco-farm (%)	53.09	24.89

4.4 Effect and benefit

1) Success rate of shrimp farming

During the period of 2019 to 2021, mean success rate of *Penaeus vannamei* breeding was 58.33% for the eco-farm, and 27.03% for the 315 traditional shrimp ponds adjacent to eco-farm site, with an increase of 1.16 times.

2) Benefit

The annual economic benefit of eco-farm is 12000.0USD /ha, slightly more than that of the traditional shrimp pond. According to the government criteria, the annual value of mangrove trees is 256,758.6 USD/ha, while the traditional shrimp pond is zero. Therefore, the comprehensive benefit of eco-farm is 268.758 USD/ha, which is 25.98 times that of the traditional shrimp pond.

Comparison of the benefit between eco-farm and traditional shrimp pond((USD/ha.a^{-1})

Type of farming	Economic output	Ecological value	Total
Eco-farm(A)	12,000.0	256,758.6	268,758.6
Tradinational shrimp pond(B)	10,344.8	0	10,344.8
A/B			25.98

Note: 1 USD=7.25 CNY;
The Value Calculation Criteria of Guangxi Mangrove Trees (2021 edition) issued by the Forestry Bureau of Guangxi Zhuang Autonomous Region

3) Social influence

A part of public education activities at eco-farm site

A part of government advanced workshop activities relative to mangrove blue carbon eco-farm

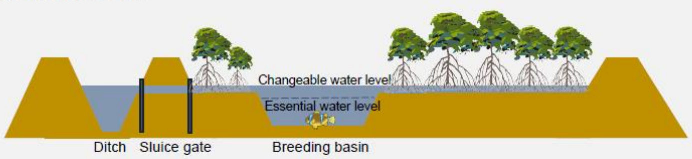
5. Lessons learnt

5.1 Shrimp ponds that suitable to create mangrove eco-farm

The shrimp pond bottom should not be lower than the elevation of the adjacent mud flat, and should not be higher than the "Mean high tidal level -0.5m".

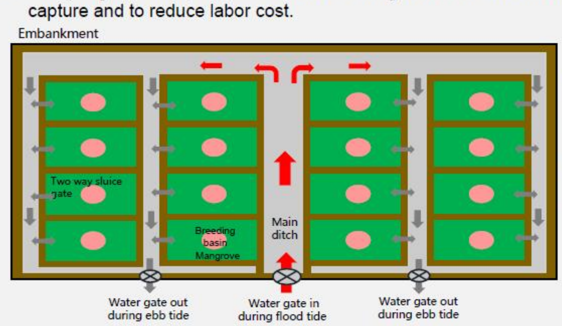
5.2 Breeding model

In order to gain high quality products and reduce the costs, "breeding basin " will take the place of prior pond and racetrack breeding model. The depth of ditch should range from 1.5m to 2.0 m.



5.3 Water system

- One-way flow, high-throughput, pulse and controllable tidal stream system like heart is critical to the success of large-scale eco-farms.
- Excepting tour sites, the ditch should be straightened to smooth the streams, to facilitate capture and to reduce labor cost.

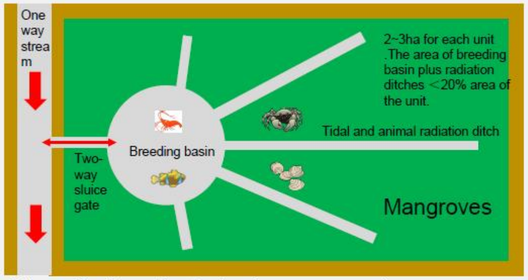


Two ways
Water diffuse exchange with low environ. capacity.

One way
Water thorough exchange with higher environ. capacity.

5.4 Area ratio of aquaculture to mangrove wetland excluding ditches

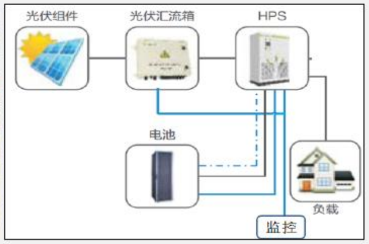
- Area of partial shrimp ponds / Aera of mangrove wetland should be ＜1:5.
- Area of racetrack breeding / Aera of mangrove wetland should be ＜3%.
- The breeding seedling density of eco-farm should be less than traditional pond by at least 40%.



Schematic of breeding basin of mangrove eco-farm

5.5 Encourage use of solar energy

Use solar energy to supplement the energy consumption of production, living and tourism facilities, and reduce the running costs and carbon emissions.



5.6 Sustainability

- Increasing the ecological premium of products is the key to maintain the eco-farm operation.
- In order to balance the income and expenditure, It deserves a great concern that company should be involved in eco-farm management.
- Community participation benefits the building and running of eco-farm.

In cooperation with the capitals, we established Shenzhen Zhonghe Mangrove Science and Technology Co., Ltd., striving to open up a new track of mangrove serving community economy.

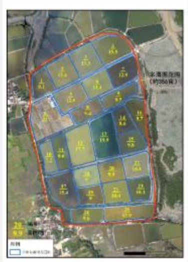
Technical cooperation signing ceremony between Guangxi Academy of Sciences and Shenzhen Zhonghe Mangrove Technology Co., LTD. in July 2023

The business of the company will cover mangrove restoration, blue carbon trade, ecological breeding, leisure tourism, health and care products, training and public education , as well as international cooperation.

The business blueprint of Zhonghe Co., Ltd

The two initiatives of the company in Guangxi province have been approved and are being under planning and construction. A project at Putian in Fujian province is waiting for confirmation.

Fangchenggang

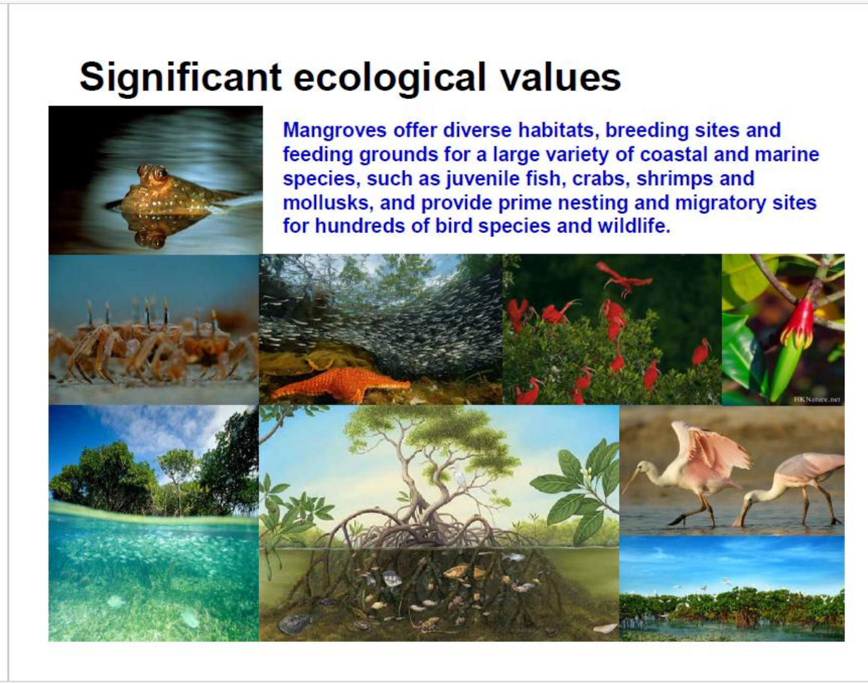


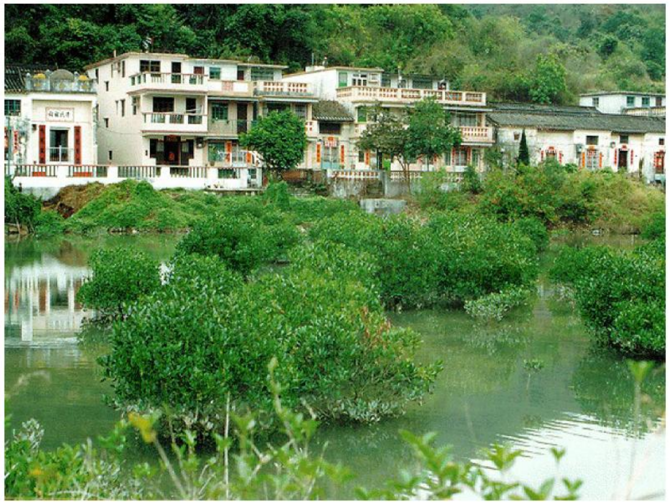
Beihai

Welcome to visit our eco-farms

THANKS

- **Lecture 6: Mangrove pollution, Wastewater Treatment and Bioremediation**





Benefits of sewage discharge

- **Domestic sewage, discharge from agriculture and aquaculture**
- **Rich in nutrients, including nitrogen and phosphorus**
- **Essential for plant growth in nutrient-limited mangrove environments, enhance primary productivity and microbial activities**

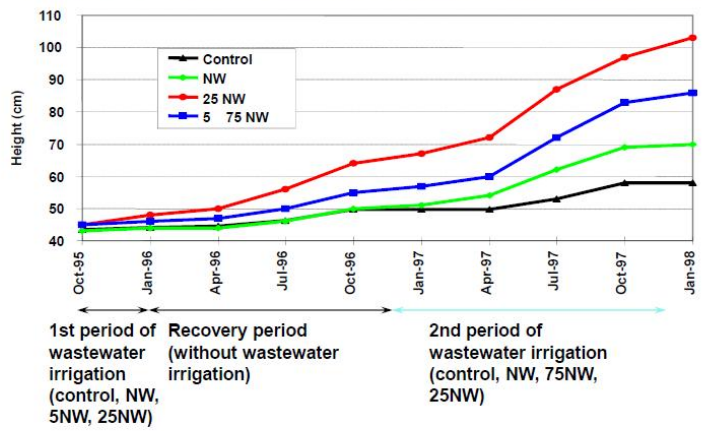
6

Mangrove Microcosms

Computerized tide-tanks with tidal flushing

Sewage of different strengths

Height of *K. obovata* received municipal sewage



% increases in population sizes of N-bacteria due to sewage addition

Bacterial groups	NW to microcosm with *Kandelia*
Ammonium oxidizers	20.5
Nitrite oxidizers	22.6
Denitrifiers	24.4

Beneficial effects of municipal wastewater

- **Increases in biomass and density of dominant species: beneficial effects**
- **No change in plant community structure, litter production and decomposition**
- **Stimulate more production of bacteria, algae and benthic diatoms although community structure may be similar**

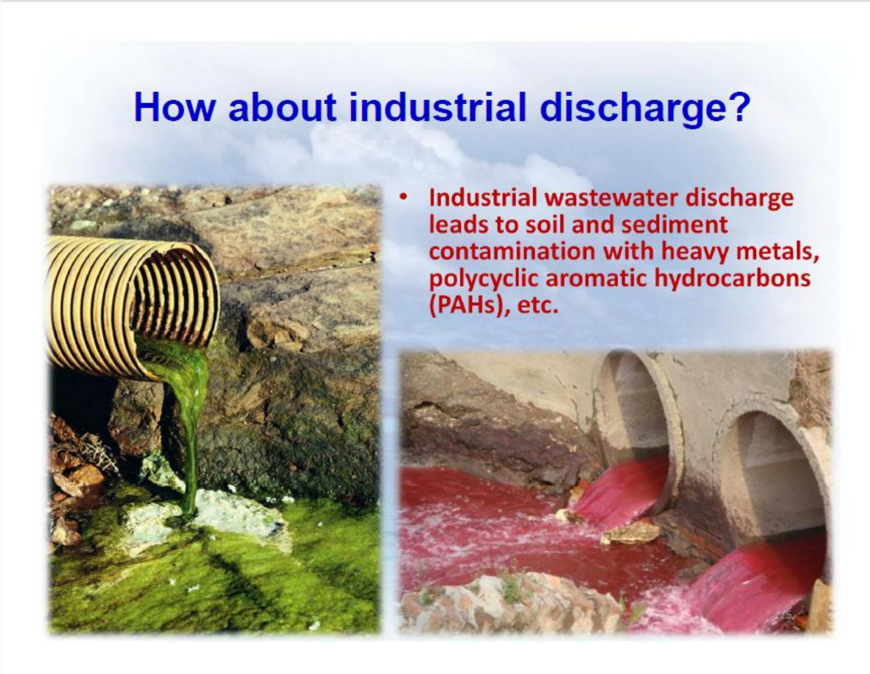
Mangrove plants well established with sewage discharge

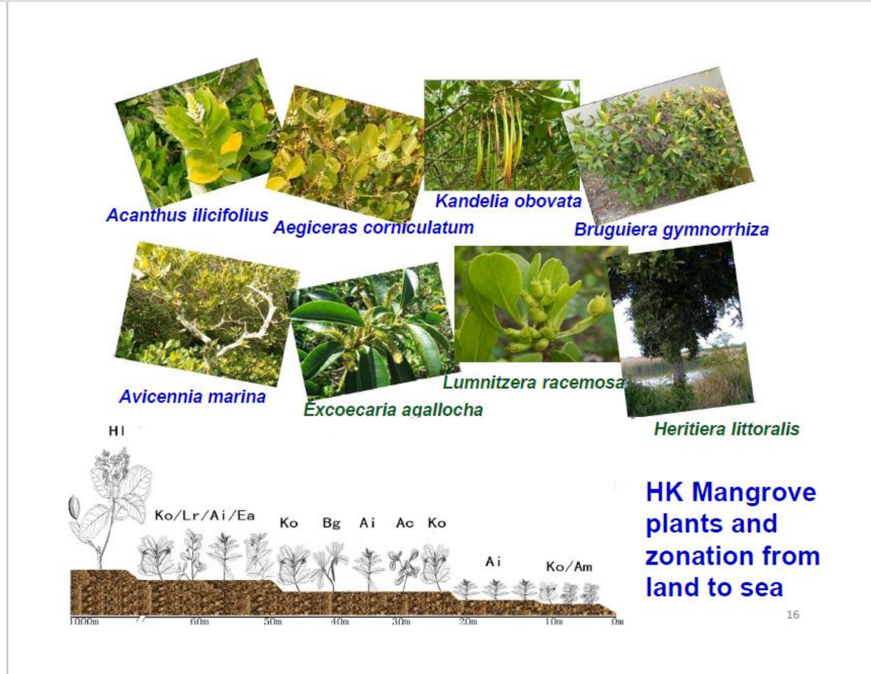
Close-up showing vigorous growth of *Aegiceras corniculatum* and unplanted control 10 years after construction

Average effluent conc (mg/L) and removal % in 10-year treatment in Futian

Species	COD	BOD_5	TN	NH_3-N	TP	SP
Influent	119.03	53.02	16.17	13.53	1.61	1.26
S. caseolaris	43.35 64.9%	13.38 75.5%	8.56 53.6%	6.87 52.6%	0.65 65.0%	0.45 69.2%
A. corniculatum	37.75 67.8%	13.61 74.1%	7.98 55.1%	6.00 58.4%	0.45 74.5%	0.32 76.9%
K. candel	41.98 62.8%	13.75 73.8%	8.25 50.0%	7.27 45.2%	0.64 62.2%	0.47 64.8%

- Treatment performance satisfactory
- >70% of samples meeting the discharge standard for COD (60 mg/L), BOD (20 mg/L), TN and NH_3 (15 mg/L), >40% for TP (<0.5 mg/L)


How about industrial discharge?
• Industrial wastewater discharge leads to soil and sediment contamination with heavy metals, polycyclic aromatic hydrocarbons (PAHs), etc.


Acanthus ilicifolius
Aegiceras corniculatum
Kandelia obovata
Bruguiera gymnorrhiza
Avicennia marina
Excoecaria agallocha
Lumnitzera racemosa
Heritiera littoralis
Hl
Ko/Lr/Ai/Ea
Ko
Bg
Ai
Ac
Ko
Ai
Ko/Am
HK Mangrove plants and zonation from land to sea
16

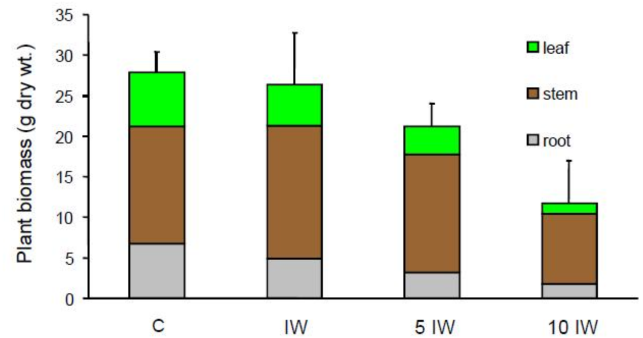
Tolerance of mangrove plants to heavy metals

(No. survival / total No. of plants)

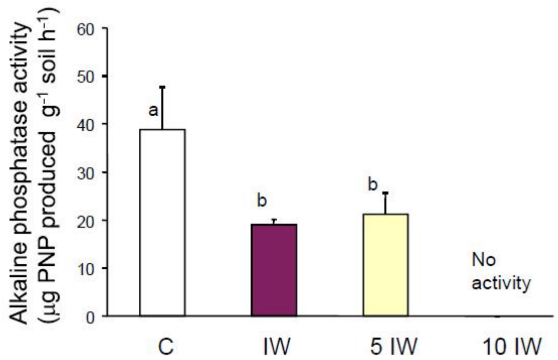
	A. ilicifolius	*A. marina*	*A.corniculatum*	*B. gymnorrhiza*
Control	12/12	12/12	12/12	12/12
T1	6/12	12/12	12/12	12/12
T2	3/12	9/12	9/12	12/12
T3	0/12	9/12	6/12	9/12
T4	0/12	6/12	3/12	6/12

T1: 50, 50 and 100 mg/kg Cu, Pb and Zn, respectively; T2: 2 times of T1; T3: 4 times of T1; T4: 6 times of T1

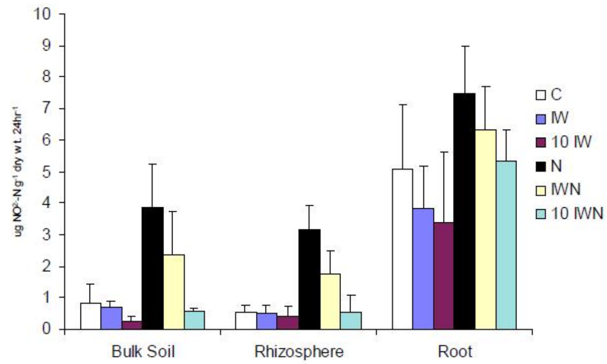
Effects of electroplating effluent on mangrove *K. obovata*



Inhibition of alkaline phosphatase activity by strong electroplating effluent



Nitrification activity ($\mu g\ NO_2^-$-N g^{-1} dry weight day^{-1})



Mangroves are efficient in removing heavy metals from industrial wastewater

Fe^{3+}, Zn^{2+}, Pb^{2+}, Cr^{6+} → More than <u>99%</u> were removed from strong industrial wastewater and concentrations in effluent all met discharge standard in HK

Cu^{2+}, Cd^{2+} → <u>100%</u> were removed by the three mangrove species

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Fate of contaminants

- Heavy metals: >90% heavy metals in wastewater are retained in sediment/soil, and their concentrations are proportional to contaminant levels in wastewater
- Plant uptake is relatively low (most are <6%, max 10%)

Heavy metals conc. ($\mu g\ g^{-1}$ dw)	Background	C	IW	5 IW	10 IW
Total Cu	3.94 ± 2.62	4.22 ± 1.49	22.68 ± 0.09	118.46 ± 37.20	172.02 ± 6.34
Total Zn	16.06 ± 1.20	17.19 ± 2.83	51.93 ± 3.50	232.75 ± 50.70	389.09 ± 43.64
Total Cd	ND	1.30 ± 0.55	1.97 ± 1.71	7.92 ± 3.37	12.81 ± 1.72
Total Cr	9.94 ± 2.81	6.28 ± 0.63	13.99 ± 0.60	42.18 ± 9.15	74.95 ± 3.43
Total Ni	ND	ND	17.37 ± 0.50	114.35 ± 8.45	211.27 ± 23.50

ND: Not detected as the concentration is below the detection limit of AAS.

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Plant uptake of heavy metals (%)

Heavy metals	Industrial wastewater (IW)		10 x IW	
	Ko	Bg	Ko	Bg
Cu	0.93	1.12	0.46	1.69
Zn	0.51	2.93	0.74	2.69
Cd	0	2.95	0.41	3.01
Cr	1.18	5.45	1.58	4.99
Ni	0.38	3.31	0.70	3.01

Total uptake of heavy metals: <6%

Effects of industrial wastewater rich in heavy metals

- Heavy metals are effectively remove by mangroves with little discharge to surrounding water
- Mainly accumulated in roots and little translocation
- Reduces plant growth and biomass, bacterial and enzyme activity
- Change community structure of animals and algae, with tolerant species become dominant
- How about POPs in wastewater (PAHs and PBDEs)??

PAHs: persistent organic pollutants (POPs), toxic and carcinogenic

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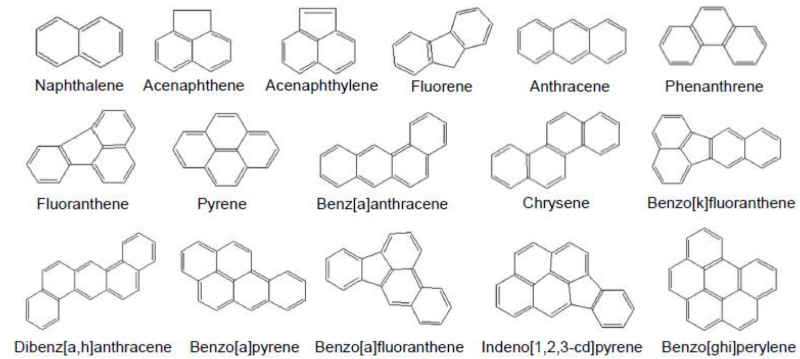
PAHs (Polycyclic Aromatic Hydrocarbons)

16 USEPA priority pollutants, with different number of rings and molecular weights



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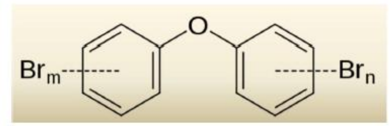
PAHs Concentrations in Mangrove Sediment

Mangrove sediments	Total PAHs (ng g^{-1} dw)
Ma Wan	1058.37±363.38
Mai Po	556.94±224.49 (hot spot: 4680)
Sai Keng	429.15±117.95 (hot spot: 1811)
Sheung Pak Lai	334.16±264.69
Yi O	311.10±94.74
Ho Chung	258.85±70.26 (hot spot: 11098)
Kei Ling Ha	169.41±51.92
Puerto Rico	1820 (hot spot: 6000)
Caribbean Island	502 (hot spot: 1657)

Marine sediment:
- Hong Kong (553 ng g^{-1})
- Pearl River Estuary (2196 ng g^{-1})
- South China Sea (146 ng g^{-1})
- Xiamen Harbor (367 ng g^{-1})

Mangrove sediments are seriously contaminated by PAHs, even Mai Po RAMSAR, important world wetland

Another POPs: PBDEs (Polybrominated Diphenyl Ethers)



209 congeners: numerous combinations of number and position of bromine atoms on the two phenyl rings, e.g. BDE-47 (4 Br), BDE-99, BDE-153, BDE-209 (10 Br)

Highly hydrophobic and strongly adsorbed onto sediment

Penta- and octa-BDE have been banned in Europe since 2004 and in the State of California, USA since 2008,
The production of deca-BDE has only been ceased in 2013
Still serious problem because of their long-term usage and new productions with recycled PBDE-containing materials and disposal of e-waste

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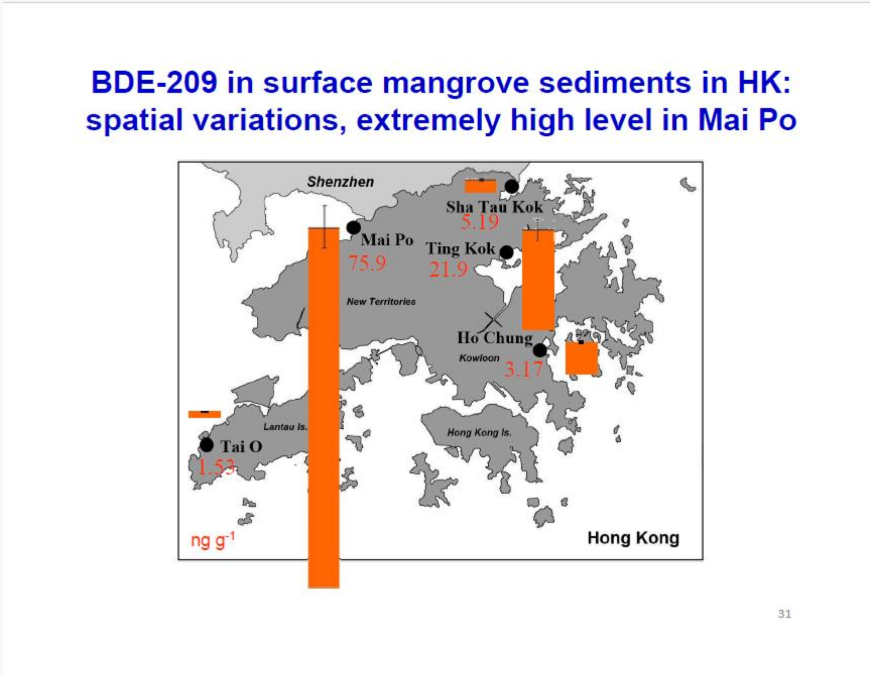
E-waste illegally dumped and piled up in villages (heavy metals, Polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), etc.)

Commonly used brominated flame retardants (BFR), widely found in:

- textiles
- foams
- furniture
- rubber
- electronic components
- construction materials
- automobiles
- airplanes

Release to environment during manufacture, use, and disposal


BDE-209 in surface mangrove sediments in HK: spatial variations, extremely high level in Mai Po
Shenzhen
Sha Tau Kok
5.19
Mai Po
75.9
Ting Kok
21.9
New Territories
Ho Chung
Kowloon
3.17
Lantau Is.
Tai O
1.53
Hong Kong Is.
ng g-1
Hong Kong
31


Plastic and microplastic

Microplastic pollution in mangroves

Table 1
Abundance, dominant shape and polymer type of microplastics in mangrove sediments (d.w.: dry weight; N.P.: not provided; N.A.: not analyzed).

Location	Sampling depth	Analytical procedure	Abundance (items/kg sediment)	Dominant shape (%)	Dominant polymer type (%)	Reference
Futian Mangrove (interior)	10 cm	$ZnCl_2$ Density separation + digestion + FT-IR & μFTIR	1920 ± 509	Fiber (78.79 ± 4.59)	PET (43.83 ± 6.12)	This study
Mai Po Mangrove (interior)	10 cm		1110 ± 195	Fiber (84.97 ± 5.03)	PET (38.10 ± 6.93)	This study
Sonneratia caseolaris (interior)	10 cm		4754 ± 416	Fiber (88.90 ± 3.17)	PET (54.19 ± 2.14)	This study
Kandelia obovata (interior)	10 cm		4627 ± 425	Fiber (76.39 ± 3.75)	PET (45.36 ± 3.09)	This study
S. apetala (interior)	10 cm		3548 ± 638	Fiber (75.48 ± 0.49)	PET (46.47 ± 1.12)	This study
Futian Mangrove	10 cm	$ZnCl_2$ Density separation + digestion + FTIR & ATR-FTIR	1200 ± 98 to 4007 ± 152 d.w.	N.A.	PS (N.A.)	Duan et al. (2020)
Qinzhou Bay Mangrove, South China	2 cm	$CaCl_2$ Density separation + digestion + ATR-FTIR & SEM-EDS	42.9 ± 26.8	Fragment (94)	PS (> 98)	Li et al. (2018)
Maowei Sea Mangrove, South China	N.P.	Digestion + Potassium formate aqueous Density separation + Micro-Raman	520 ± 8 to 940 ± 17	N.A.	PET (47.5–79.2)	Li et al. (2019)
Shenzhen Mangrove, South China	2 cm	NaCl & NaI Density separation I & II + ATR-FTIR, μ-FTIR & SEM	157.0	N.A.	PS (75.2)	Zhou et al. (2020)
Futian Mangrove, South China	5 cm	$ZnCl_2$Density separation + digestion + Micro-Raman & SEM-EDS	980–3100 d.w.	Fiber (N.A.)	PP (75.2–84.7)	Li et al. (2020)
Mangrove in Pearl River Estuary	5 cm	Digestion + NaCl Density separation + μ-FTIR	100–7900 d.w.	Fiber (>69.7)	PE (36)	Zuo et al. (2020)
Persian Gulf mangrove	5 cm	NaCl & NaI I & II Density separation + FTIR & SEM-EDS	19.5–34.5 d.w.	Fiber (>56)	N.A.	Naji et al. (2019)
Ciénaga Grande de Santa Marta mangrove	N.P.	Water Density separation + ATR-FTIR	31–2863 d.w.	Films (N.A.)	N.A.	Garcés-Ordóñez et al. (2019)
Singapore's coastal mangrove	3–4 cm	NaCl Density separation + ATR-FTIR	36.8 ± 23.6 d.w.	Fibers (72.0)	N.A.	Nor and Obbard (2014)

Duan et al. 2021 STE Vol 767

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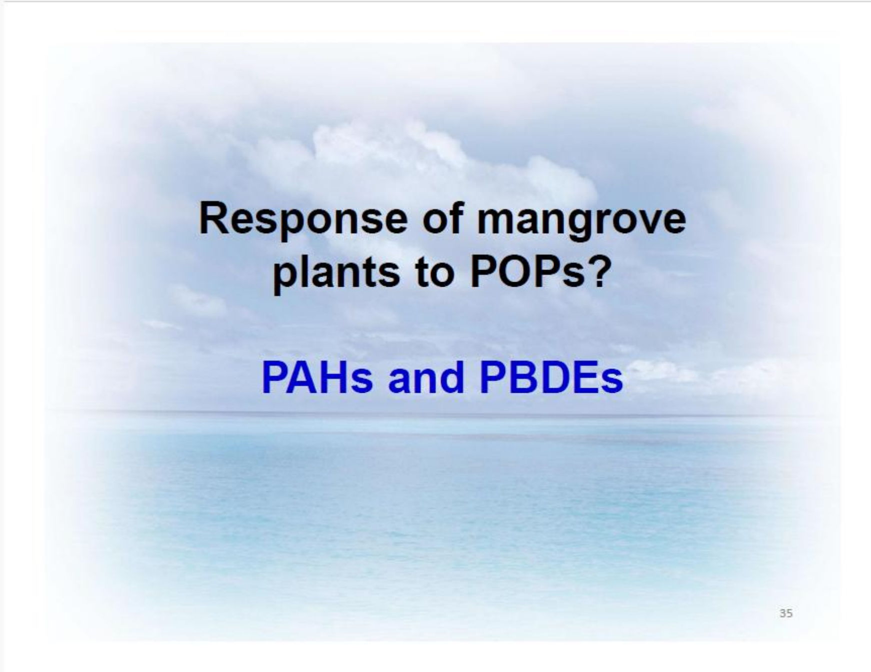
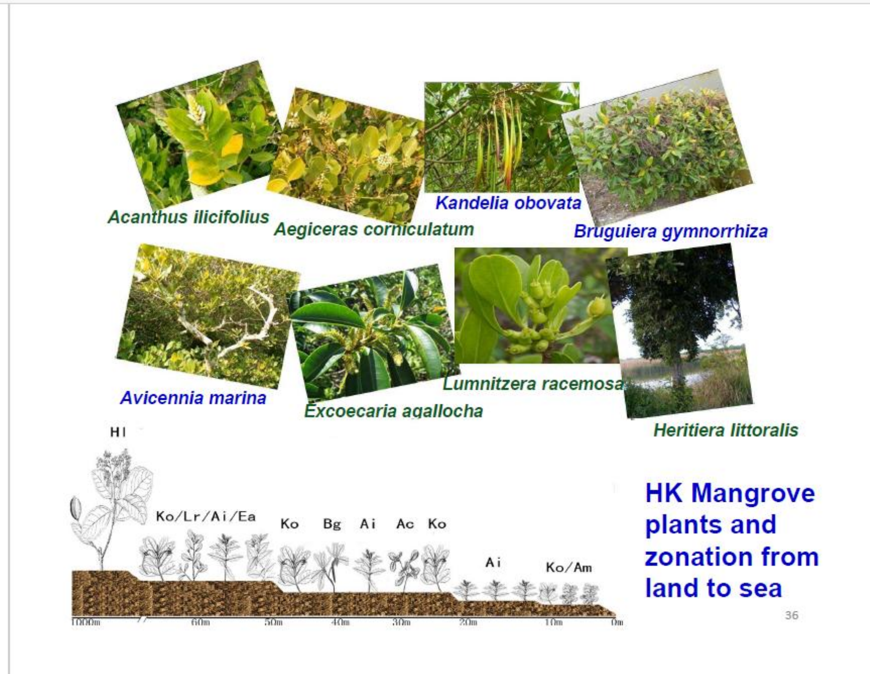
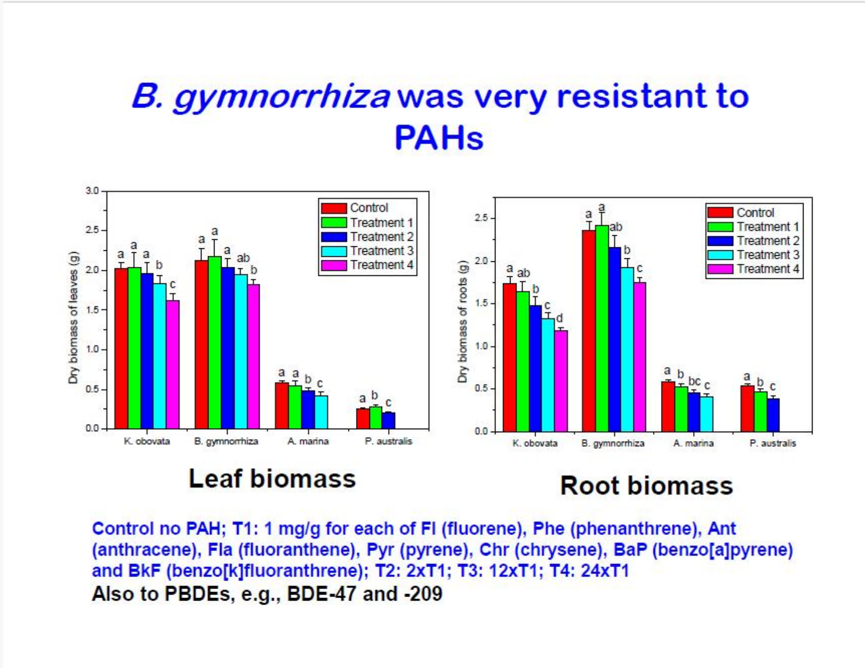
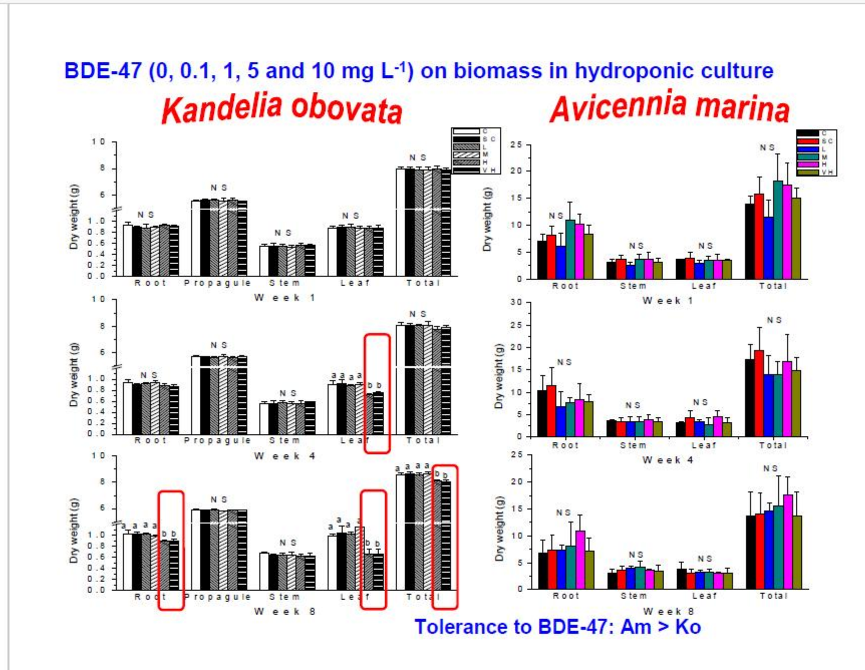
Mangroves are sink of pollutants


Response of mangrove plants to POPs?
PAHs and PBDEs
35


Acanthus ilicifolius
Aegiceras corniculatum
Kandelia obovata
Bruguiera gymnorrhiza
Avicennia marina
Excoecaria agallocha
Lumnitzera racemosa
Heritiera littoralis
Hl
Ko/Lr/Ai/Ea
Ko
Bg
Ai
Ac
Ko
Ai
Ko/Am
HK Mangrove plants and zonation from land to sea
36


B. gymnorrhiza was very resistant to PAHs
Control
Treatment 1
Treatment 2
Treatment 3
Treatment 4
Dry biomass of leaves (g)
Dry biomass of roots (g)
K. obovata
B. gymnorrhiza
A. marina
P. australis
Leaf biomass
Root biomass
Control no PAH; T1: 1 mg/g for each of Fl (fluorene), Phe (phenanthrene), Ant (anthracene), Fla (fluoranthene), Pyr (pyrene), Chr (chrysene), BaP (benzo[a]pyrene) and BkF (benzo[k]fluoranthrene); T2: 2xT1; T3: 12xT1; T4: 24xT1
Also to PBDEs, e.g., BDE-47 and -209


BDE-47 (0, 0.1, 1, 5 and 10 mg L-1) on biomass in hydroponic culture
Kandelia obovata
Avicennia marina
Dry weight (g)
Root
Propagule
Stem
Leaf
Total
Week 1
Week 4
Week 8
Tolerance to BDE-47: Am > Ko

Mangrove tolerance to toxic POPs

- Most mangrove plant species are more tolerant to PAHs than other wetland plants, e.g. *Phragmites australis* (common reeds)
- Within mangrove group, tolerance varies among species, most tolerant species is *Bruguiera gymnorrhiza*, followed by *Kandelia obovata*, and *Avicennia marina* is most sensitive
- But *A. marina* is more tolerant to PBDEs
- Species-specific




Why mangrove plants can tolerate toxic POPs?

- Inter-tidal location and adapt to stressed environment
  - Fluctuating salinity (0 to 35 ppt)
  - Various oxygen levels (aerobic, anoxic, anaerobic)
  - Wet and dry condition
- Extensive root system and large root biomass
- Specialized root systems
- High concentrations of tannins and polyphenols
- Activities of antioxidant enzymes

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Biomass ratio of aboveground to belowground

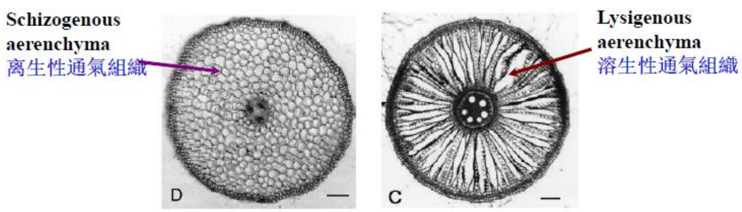
Genus and species	Tidal position in Hong Kong	Biomass ratio
Aegiceras corniculatum	Mostly outer (seaward) mangrove fringe	1.47
Acanthus ilicifolius	Littoral region, upper and middle reaches of estuarine rivers	0.91
Avicennia marina	Foreshore and seaward region, pioneer species	0.91
Bruguiera gymnorrhiza	Middle but also extends into the transitional landward	0.45
Excoecaria agallocha	Back mangrove, near terrestrial fringe	1.67
Heritiera littoralis	Back mangrove, forest edge	1.62
Kandelia obovata	All areas	0.22
Lumnitzera racemosa	Back mangrove, more landward	3.04

Specialized root systems (1)

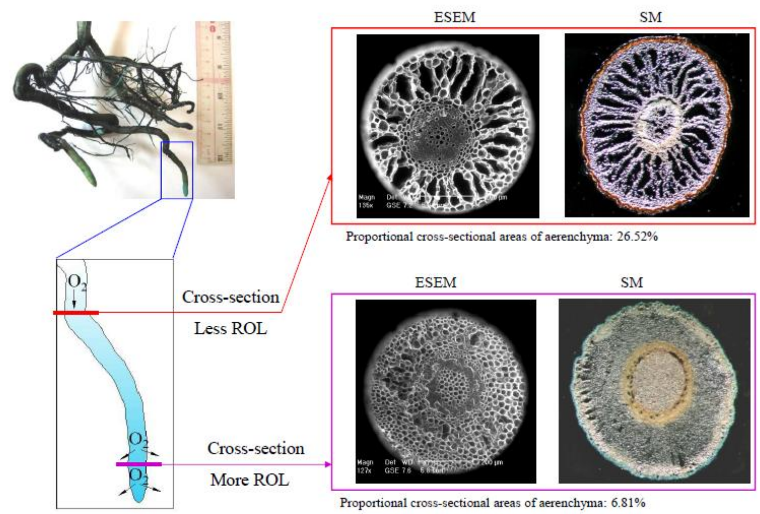
- **Pneumatophores and knee joint for aeration**

Specialized root systems (2)

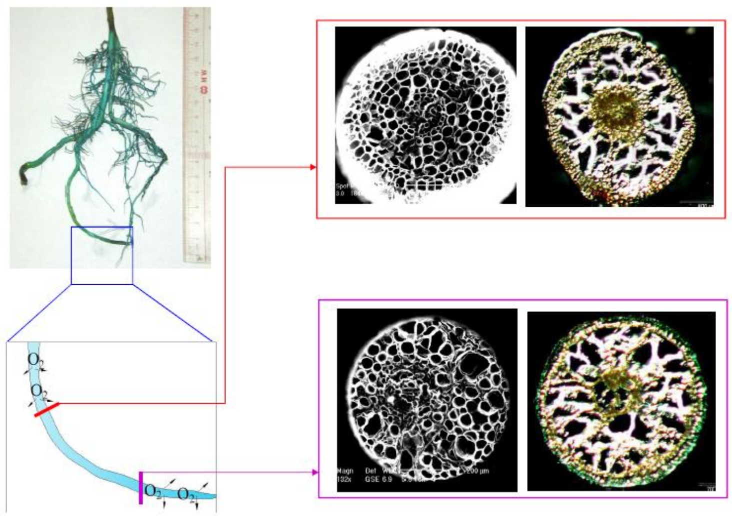
- **Extensive aerenchyma: spongy tissue with large air spaces or cavities, mainly exist in root cortex**
- **Able to transfer oxygen from aerial parts to root tips and rhizosphere, maintain aerobic pockets in anoxic sediment by releasing excess oxygen from roots (radial oxygen loss) for oxidation and detoxification**
- **Form iron plaque**



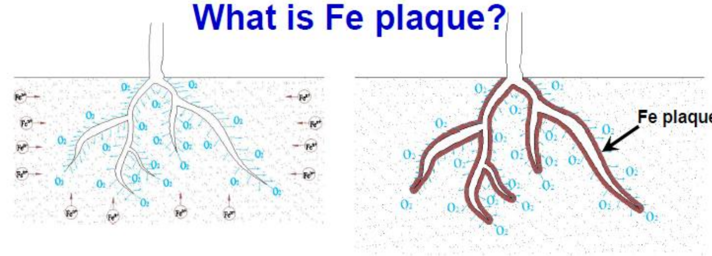
Root anatomy of *Bruguiera gymnorrhiza*



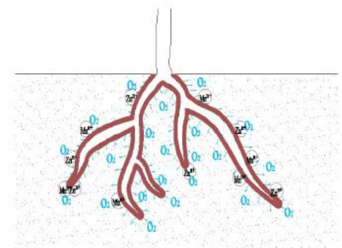
Root of *Acanthus ilicifolius*



What is Fe plaque?

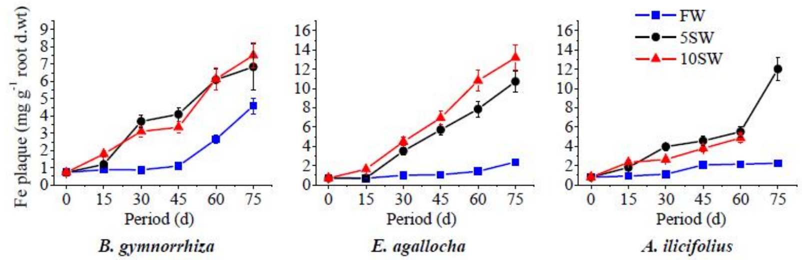


- **ROL induces a partial precipitation of Fe under oxidized forms on root surfaces, creating Fe-rich root coatings, generally called Fe plaque**
- **Fe plaque is a mixture of crystalline and amorphous ferric hydroxides goethite and lepidocrocite**
- **More ROL around the rhizosphere may induce more Fe plaque formed on root surface to immobilize pollutants**



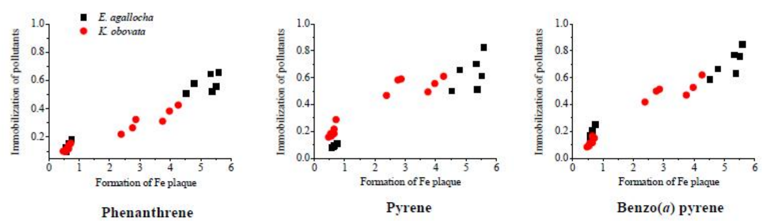
Without Fe plaque on root surface

With Fe plaque on root surface



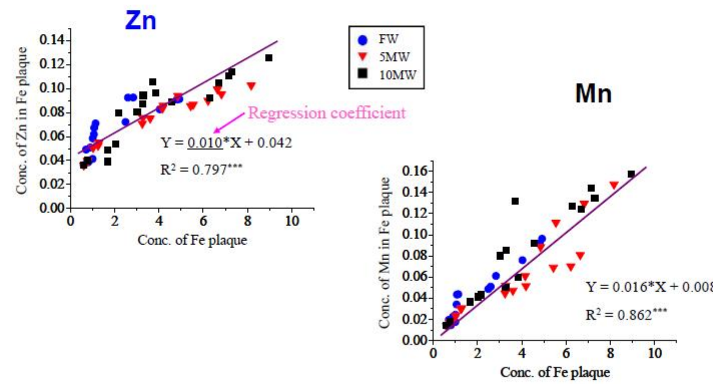
Fe plaque formed on root surface could be induced by pollutants but varied among mangrove species

FW: Fresh Water, 5SW: Medium Synthetic Wastewater, 10SW: Strong Synthetic Wastewater



Relationship between the formation of Fe plaque on root surface and immobilization of PAHs in Fe plaque

Positive relationships also found between Fe plaque and immobilization of PBDEs, e.g. BDE-47, -99, -100, -153, -154, -209



Relationship between concentration of Fe plaque (mg/g dw) on root surface of *B. gymnorrhiza* and Zn and Mn immobilized in Fe plaque

Same for Cr, Ni, Pb, Cu and Cd, also for other mangrove plants

Specialized root system, such as ROL leading to formation of Fe plaque to:

Immobilize toxic contaminants

Reduce their uptake in mangrove plants, especially the sensitive plant parts such as leaves: total plant uptake is small

e.g., Uptake of PBDEs: <1% (exclude immobilized on Fe plaque)

Specialized root systems (3)

- **Root exudates:** Low molecular weight organic acids, e.g., lactic, benzoic, succinic, maleic, oxalic, malic and citric acids, are released by mangrove plants, provide carbon sources for microorganisms
- **Root surface: support diverse groups of POP-resistant and POP-degrading microbes**

Correlation coefficients between organic acids and BDE-47,99,209 concentrations in rhizosphere sediment

PBDE	Lactic	Oxalic	Benzoic	Maleic	Succinic	Malic	Citric
BDE-47	-0.135	0.135	-0.135	-0.287	-0.413*	-0.207	-0.435*
BDE-99	0.138	0.442*	-0.215	-0.406*	-0.630**	-0.233	-0.603**
BDE-209	-.346	-.208	.065	-.212	.014	.274	-.271

**. Correlation is significant at the 0.01 level
*. Correlation is significant at the 0.05 level

Oxidative stress and anti-oxidative defense

- Toxic contaminants such as PAHs and PBDEs often produce reactive oxygen species (ROS)
  - Free radicals: Superoxide radical ($O_2^{\cdot -}$), hydroxyl radical ($OH\cdot$) and peroxyl radical ($RO_2\cdot$)
  - Non free radicals: Hydrogen peroxide (H_2O_2)
- Pose oxidative stress
- Plants develop anti-oxidative defense system

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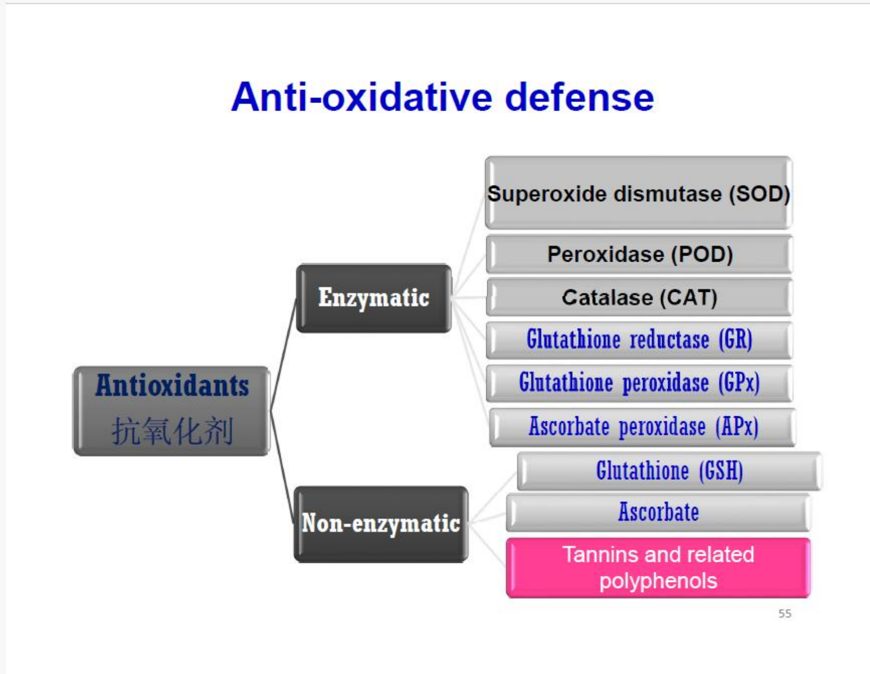
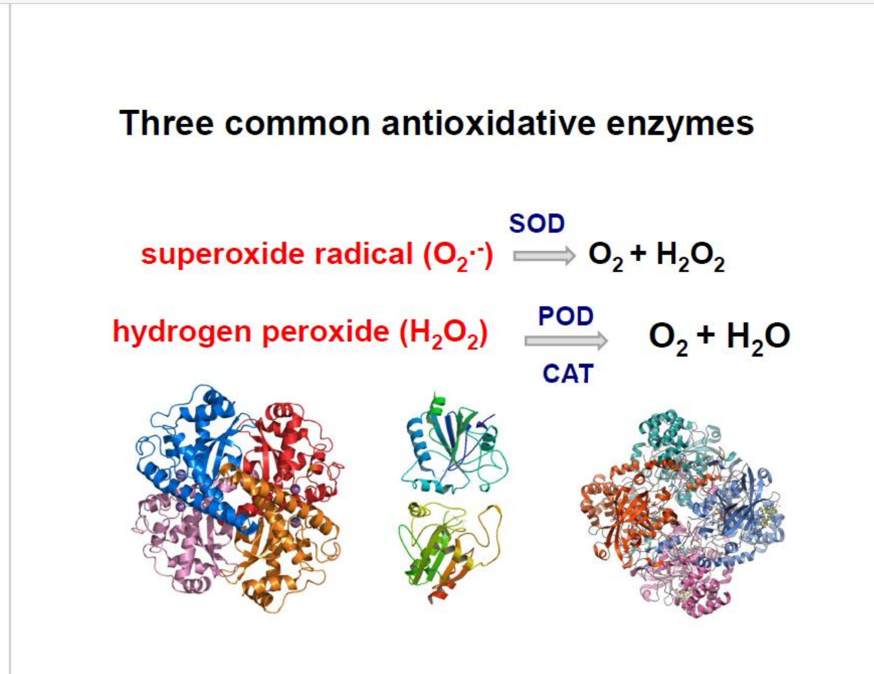
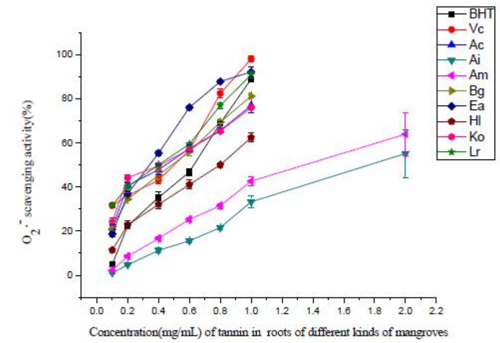

Anti-oxidative defense
Antioxidants
抗氧化剂
Enzymatic
Superoxide dismutase (SOD)
Peroxidase (POD)
Catalase (CAT)
Glutathione reductase (GR)
Glutathione peroxidase (GPx)
Ascorbate peroxidase (APx)
Non-enzymatic
Glutathione (GSH)
Ascorbate
Tannins and related polyphenols
55


Three common antioxidative enzymes
superoxide radical ($O_2^{\cdot -}$) $\xrightarrow{SOD}$ $O_2 + H_2O_2$
hydrogen peroxide (H_2O_2) $\xrightarrow[CAT]{POD}$ $O_2 + H_2O$

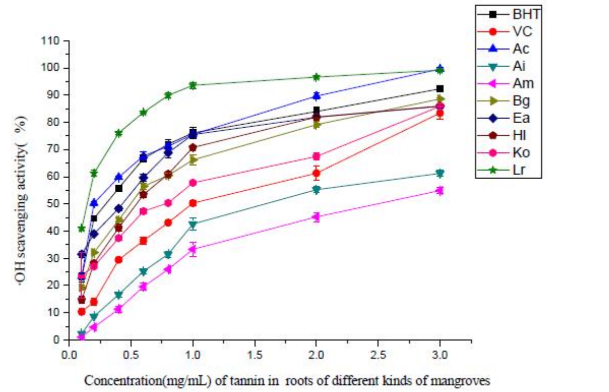
Superoxide radical scavenging activity



	BHT	Vc	Ac	Ai	Am	Bg	Ea	Hl	Ko	Lr
EC_{50}	0.629	0.510	0.447	1.771	1.360	0.488	0.343	0.802	0.414	0.404

Ea > Lr > Ko > Ac > Bg > Vc (ascorbic acid) > BHT (butylated hydroxytoluene) > Hl > Am > Ai

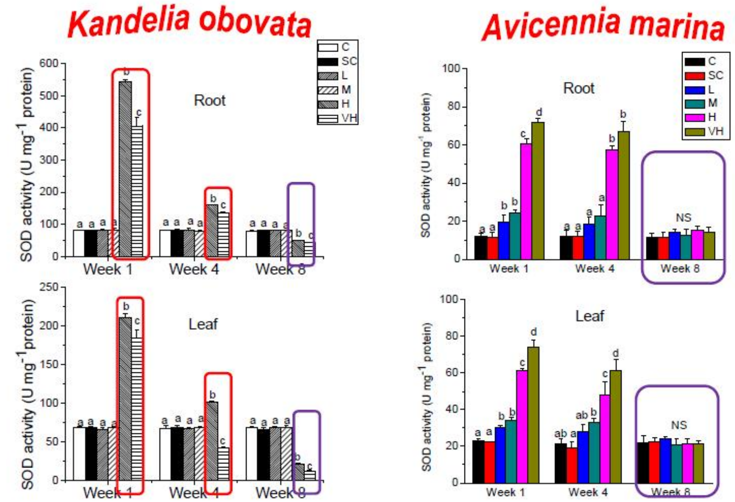
Hydroxyl radical scavenging activity



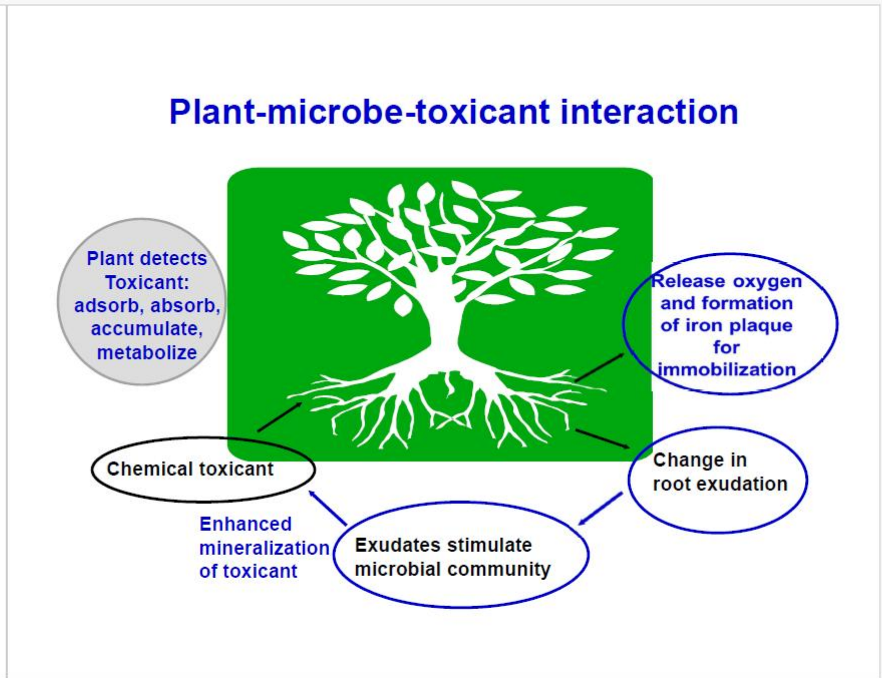
	BHT	Vc	Ac	Ai	Am	Bg	Ea	Hl	Ko	Lr
EC_{50}	0.289	0.998	0.205	1.588	2.495	0.495	0.436	0.536	0.799	0.150

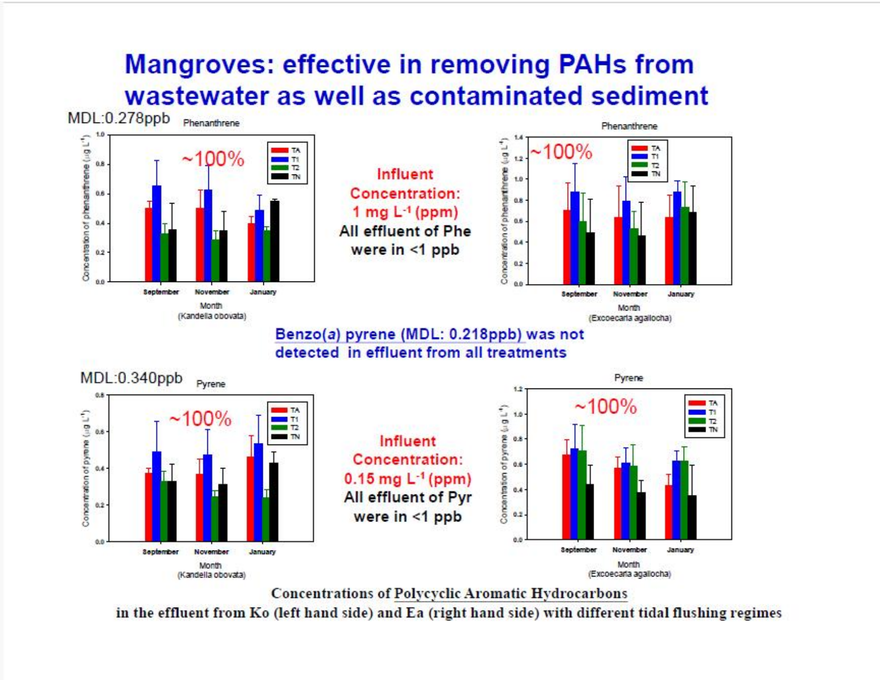
Lr > Ac > BHT > Ea > Bg > Hl > Ko > Vc > Ai > Am

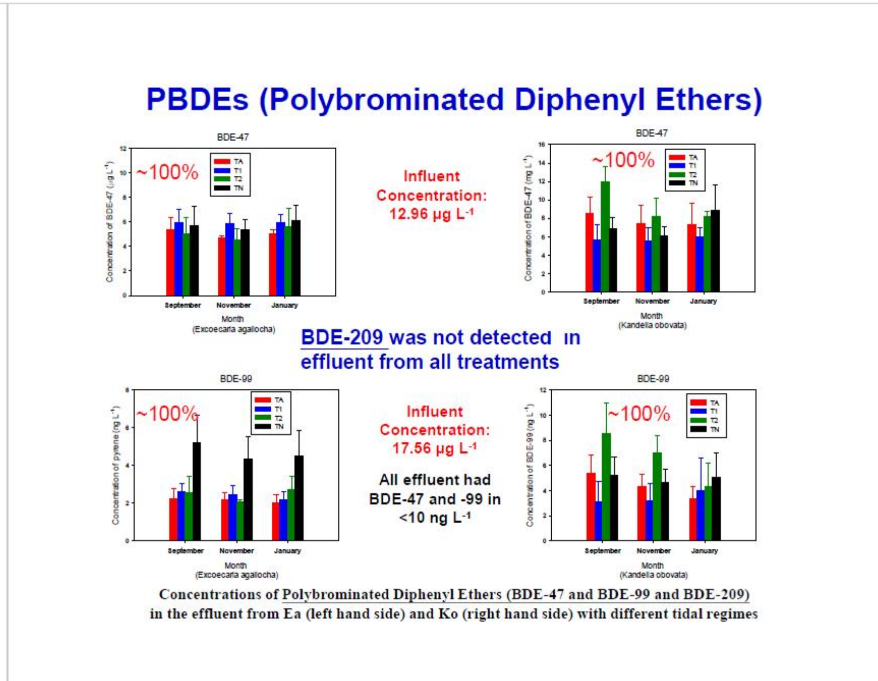
Anti-oxidative enzymes activity could be induced by pollutants: BDE-47 on SOD in hydroponic culture

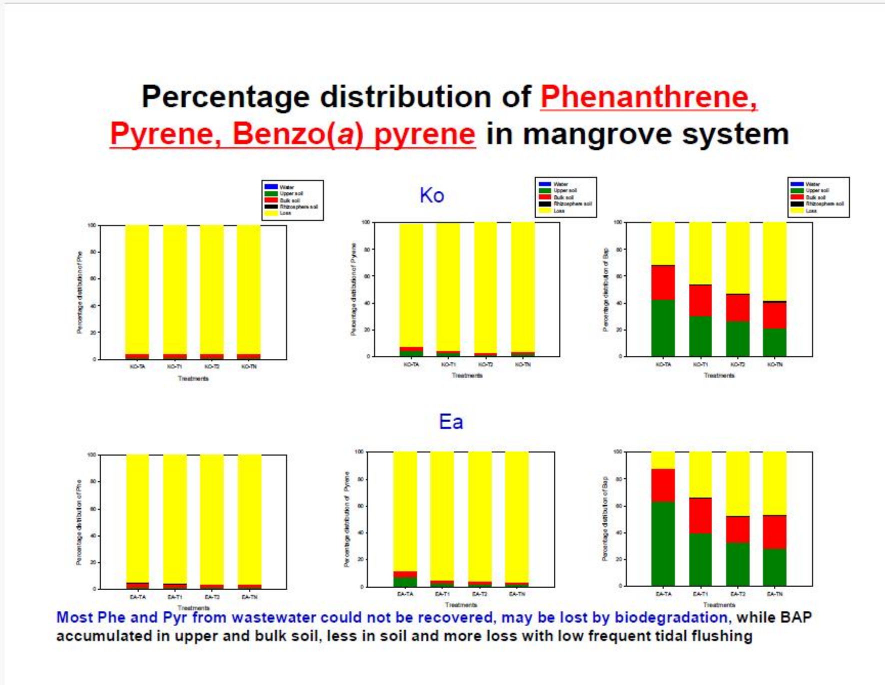


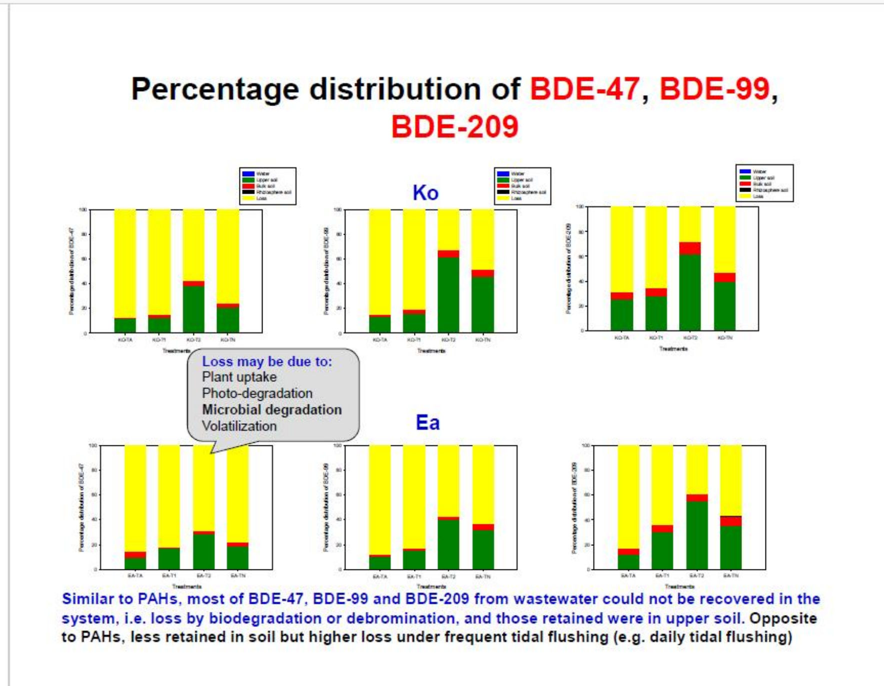

Can mangroves remove and detoxify POPs?
61


Plant-microbe-toxicant interaction
Plant detects Toxicant: adsorb, absorb, accumulate, metabolize
Release oxygen and formation of iron plaque for immobilization
Chemical toxicant
Change in root exudation
Enhanced mineralization of toxicant
Exudates stimulate microbial community


Mangroves: effective in removing PAHs from wastewater as well as contaminated sediment
MDL:0.278ppb
Phenanthrene
~100%
Influent Concentration: 1 mg L-1 (ppm)
All effluent of Phe were in <1 ppb
Phenanthrene
~100%
Month (Kandelia obovata)
Month (Excoecaria agallocha)
Benzo(a) pyrene (MDL: 0.218ppb) was not detected in effluent from all treatments
MDL:0.340ppb
Pyrene
~100%
Influent Concentration: 0.15 mg L-1 (ppm)
All effluent of Pyr were in <1 ppb
Pyrene
~100%
Month (Kandelia obovata)
Month (Excoecaria agallocha)
Concentrations of Polycyclic Aromatic Hydrocarbons
in the effluent from Ko (left hand side) and Ea (right hand side) with different tidal flushing regimes


PBDEs (Polybrominated Diphenyl Ethers)
BDE-47
~100%
Influent Concentration: 12.96 µg L-1
BDE-47
~100%
Month (Excoecaria agallocha)
Month (Kandelia obovata)
BDE-209 was not detected in effluent from all treatments
BDE-99
~100%
Influent Concentration: 17.56 µg L-1
All effluent had BDE-47 and -99 in <10 ng L-1
BDE-99
~100%
Month (Excoecaria agallocha)
Month (Kandelia obovata)
Concentrations of Polybrominated Diphenyl Ethers (BDE-47 and BDE-99 and BDE-209)
in the effluent from Ea (left hand side) and Ko (right hand side) with different tidal regimes


Percentage distribution of Phenanthrene, Pyrene, Benzo(a) pyrene in mangrove system
Ko
Ea
Most Phe and Pyr from wastewater could not be recovered, may be lost by biodegradation, while BAP accumulated in upper and bulk soil, less in soil and more loss with low frequent tidal flushing


Percentage distribution of BDE-47, BDE-99, BDE-209
Ko
Loss may be due to:
Plant uptake
Photo-degradation
Microbial degradation
Volatilization
Ea
Similar to PAHs, most of BDE-47, BDE-99 and BDE-209 from wastewater could not be recovered in the system, i.e. loss by biodegradation or debromination, and those retained were in upper soil. Opposite to PAHs, less retained in soil but higher loss under frequent tidal flushing (e.g. daily tidal flushing)

PAHs and PBDEs in wastewater cannot be detected in effluent

Plant uptake is minimal

Some retain in sediment / soil

But

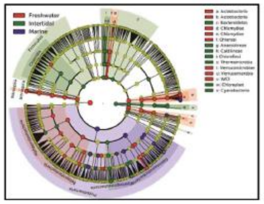
Most are lost from the system (>80%), esp. PAH with less rings (Phe) and PBDEs with less bromine atoms (BDE-47)

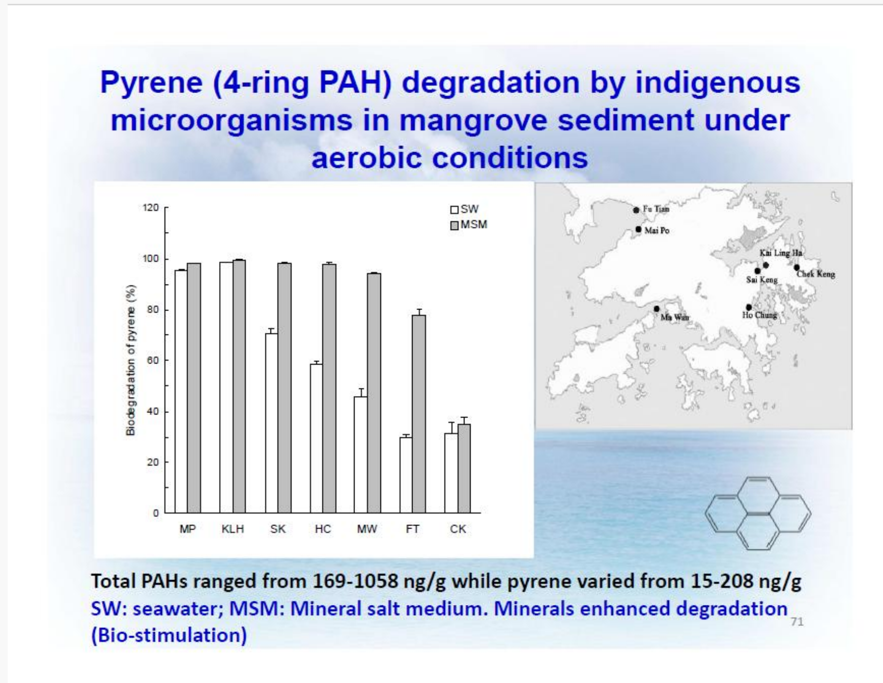
- How PAHs / PBDEs lost from the mangrove system (>80%)
  - Volatilization (little for highly brominated BDE congeners and also PAHs with large molecular size)
  - Photo-degradation (not much in sediment)
  - Microbial degradation (bioremediation): more important

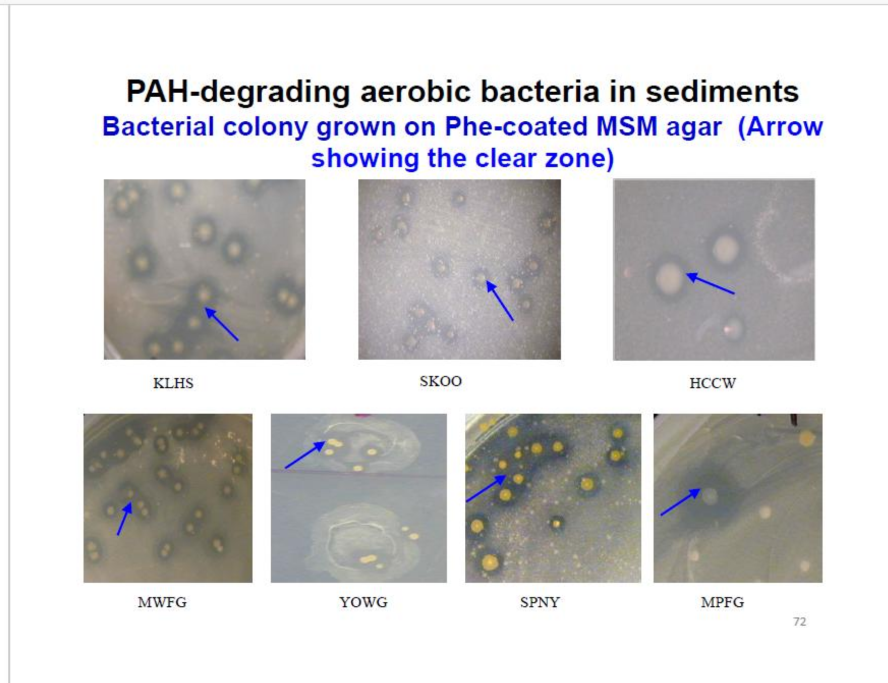
- **Mangroves: aerobic and anaerobic processes for microorganisms to break down organic pollutants**
- **Intrinsic degradation or natural attenuation**
- **Both reduced and oxidized environments strongly influence soil chemistry**
- **Intrinsic relationship between redox potential (Eh) and metabolic activities of microbes in sediment and root surface (rhizosphere)**

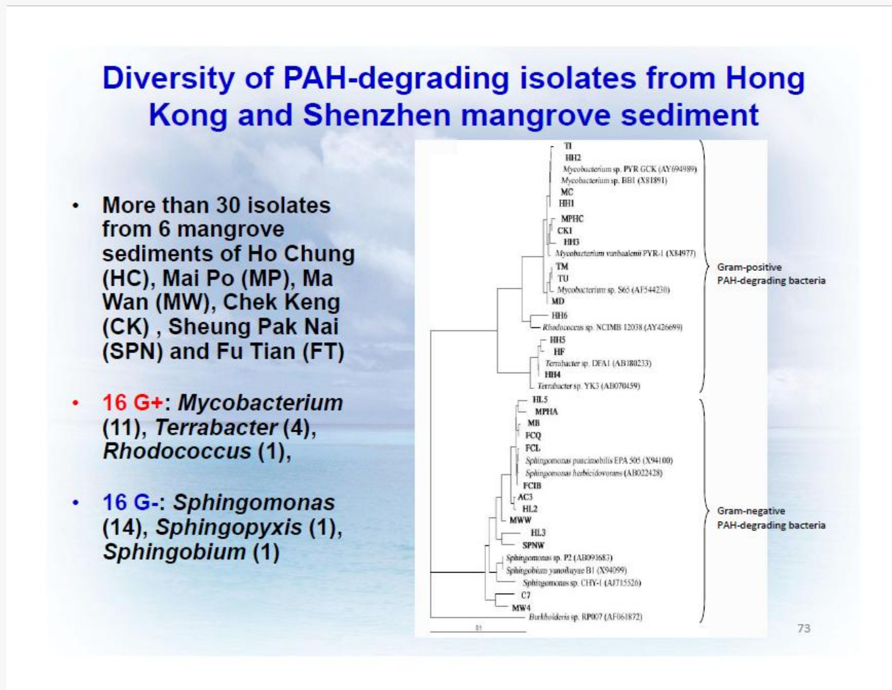
Root for microbes

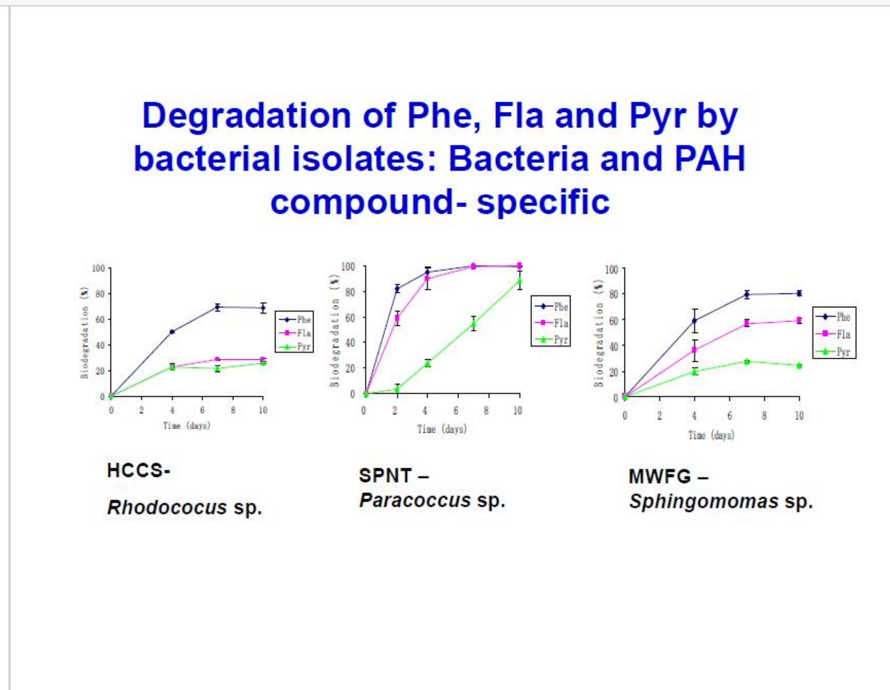
- **Root surface: support diverse groups of POP-resistant and POP-degrading microbes**
- **Root exudates: Low molecular weight organic acids, e.g., lactic, benzoic, succinic, maleic, oxalic, malic and citric acids, are released by mangrove plants, provide carbon sources for microorganisms**
- **Microorganisms in mangrove root and sediment have intrinsic degrading potential**




Pyrene (4-ring PAH) degradation by indigenous microorganisms in mangrove sediment under aerobic conditions
SW
MSM
Biodegradation of pyrene (%)
120
100
80
60
40
20
0
MP
KLH
SK
HC
MW
FT
CK
Fu Tian
Mai Po
Kai Ling Ha
Chek Keng
Sai Keng
Ho Chung
Ma Wan
Total PAHs ranged from 169-1058 ng/g while pyrene varied from 15-208 ng/g
SW: seawater; MSM: Mineral salt medium. Minerals enhanced degradation (Bio-stimulation)
71

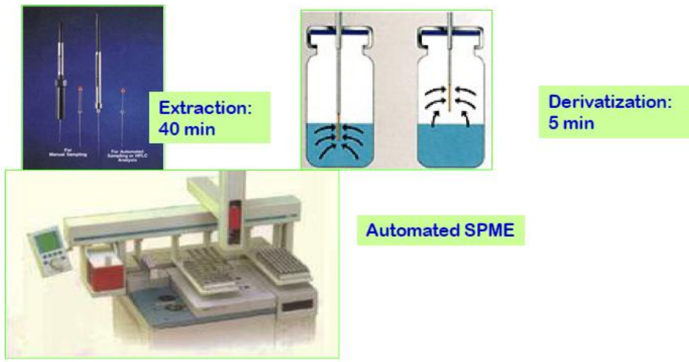

PAH-degrading aerobic bacteria in sediments
Bacterial colony grown on Phe-coated MSM agar (Arrow showing the clear zone)
KLHS
SKOO
HCCW
MWFG
YOWG
SPNY
MPFG
72


Diversity of PAH-degrading isolates from Hong Kong and Shenzhen mangrove sediment
• More than 30 isolates from 6 mangrove sediments of Ho Chung (HC), Mai Po (MP), Ma Wan (MW), Chek Keng (CK) , Sheung Pak Nai (SPN) and Fu Tian (FT)
• 16 G+: Mycobacterium (11), Terrabacter (4), Rhodococcus (1),
• 16 G-: Sphingomonas (14), Sphingopyxis (1), Sphingobium (1)
Gram-positive PAH-degrading bacteria
Gram-negative PAH-degrading bacteria
73

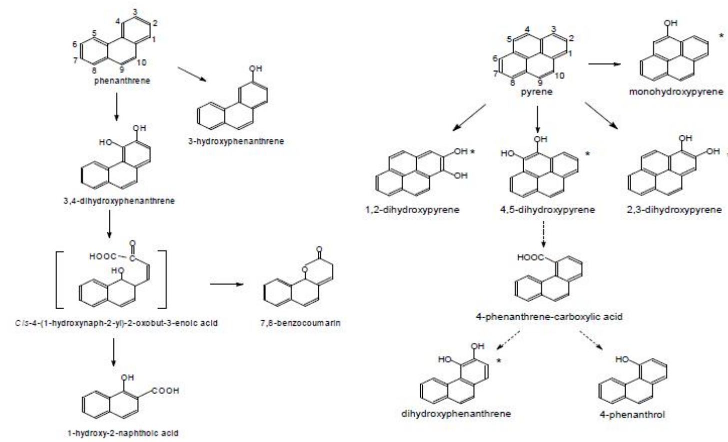

Degradation of Phe, Fla and Pyr by bacterial isolates: Bacteria and PAH compound- specific
Biodegradation (%)
Time (days)
Phe
Fla
Pyr
HCCS-
Rhodococus sp.
SPNT –
Paracoccus sp.
MWFG –
Sphingomomas sp.

SPME: Solid-phase microextraction

SPME-GC-MS for analysis of metabolites of PAHs produced at different time during biodegradation



Proposed degradation pathway of Phe and Pyr by Isolates (ring opening)



Degrading microorganisms

- Mangrove sediment/soil: diverse groups of indigenous degrading microorganisms
- Will bacterial community shift and induce more degraders in contaminated environments?

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PAH-degrading bacterial strains isolated from control (T0) and contaminated slurries (T4-T6)

Strain	Sources*				Bacterial name (similarity %)
	T0	T4	T5	T6	
SKDOP	D0	D0	D0	D0	*Pseudomonas abikonensis* (98)
SAFY	-n	D15	D15	D15	*Sphingobium yanoikuyae* (97)
SKET	-n	-n	-n	D15	*Sphingomonas adhaesiva* (97)
SCFL	-n	-n	-n	D15	*Sphingobium yanoikuyae* (98)
SASS	-n	D30	D30	D30	*Sphingopyxis composta* (97)
SBSW	-n	-n	D30	D30	*Mycobacterium chlorophenolicum* (100)
SKEW	-n	-n	-n	D30	*Mycobacterium farcinogenes* (99)
SCSH	-n	D30	D30	D30	*Mycobacterium parafortuitum* (98)
SKEY	-n	-n	D30	D30	*Mycobacterium austroafricanum* (99)
SCSO	-n	-n	-n	D30	*Sphingomonas cloacae* (97)

*D0: at the beginning of the experimental period; D15: after 15-day exposure time
D30: after 30-day exposure time; -n: no bacterial strain was isolated

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Induction of degrading microorganisms

- Bacterial community structure could be shifted to induce more degraders in contaminated environments, e.g.
  - Dominant bacteria changed with exposure of PAHs, from *Pseudomonas* sp. → Sphingomonads → *Mycobacterium* sp.
  - More diverse *Mycobacterium* are found in slurries with more PAH contamination

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PAHs biodegradation was easier under aerobic conditions because of hydroxylation by dioxygenase genes

But

Relatively slow under anaerobic environments: enhanced by biostimulation with electron acceptors

How about another POP, PBDEs?

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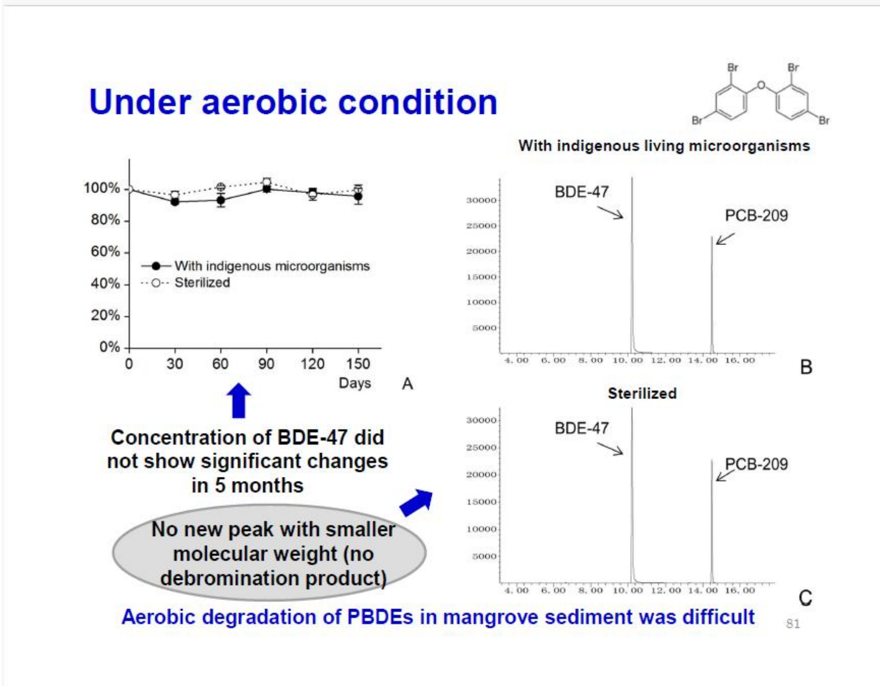
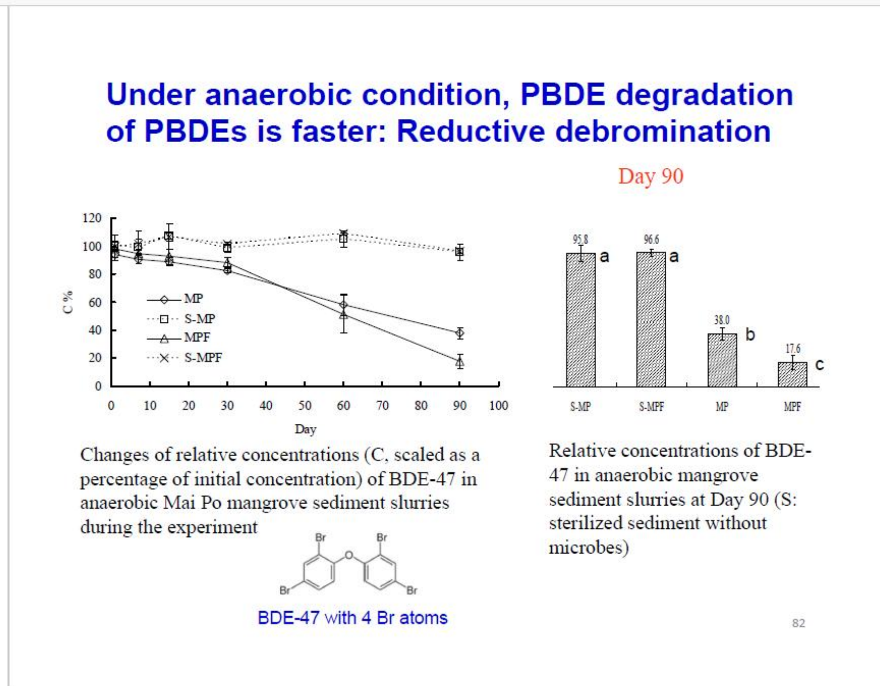
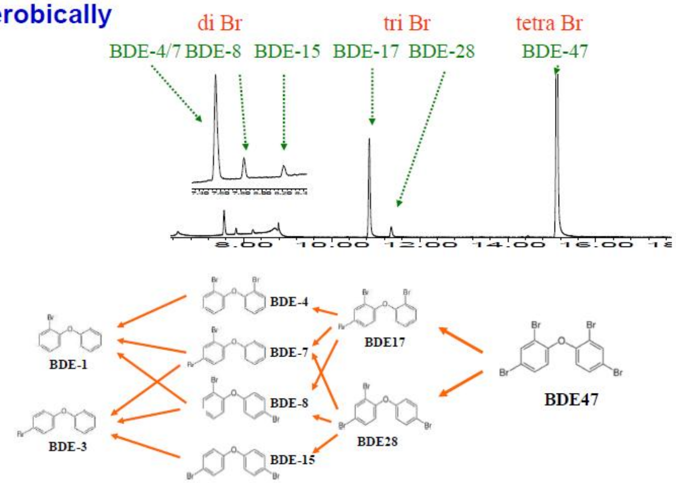

Under aerobic condition
With indigenous living microorganisms
Br
Br
Br
Br
100%
80%
60%
40%
20%
0%
0
30
60
90
120
150
Days
A
With indigenous microorganisms
Sterilized
BDE-47
PCB-209
B
Sterilized
BDE-47
PCB-209
C
Concentration of BDE-47 did not show significant changes in 5 months
No new peak with smaller molecular weight (no debromination product)
Aerobic degradation of PBDEs in mangrove sediment was difficult
81


Under anaerobic condition, PBDE degradation of PBDEs is faster: Reductive debromination
Day 90
C %
Day
MP
S-MP
MPF
S-MPF
95.8
96.6
38.0
17.6
a
a
b
c
Changes of relative concentrations (C, scaled as a percentage of initial concentration) of BDE-47 in anaerobic Mai Po mangrove sediment slurries during the experiment
Relative concentrations of BDE-47 in anaerobic mangrove sediment slurries at Day 90 (S: sterilized sediment without microbes)
BDE-47 with 4 Br atoms
82

BDE-47 in mangrove sediment could be debrominated anaerobically



PBDE-related microbial groups

- **Based on 16S rDNA gene copies from qPCR, PBDE-related groups for anaerobic debromination were detected:**
  - ***Dehalobacter (Dhb)***
  - ***Dehalococcoides (Dhc)***
  - ***Dehalogenimonas (Dhg)***
- **Debrominated product from BDE-47 such as BDE-15 might be further degraded under aerobic conditions:**
  - **Dioxygenases genes (*Bph*) for aerobic degradation of PBDEs were also detected**

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Shift in microbial community structure (Same as in PAH bioremediation)

- Temporal shift in microbial community
- e.g., transformation of BDE-153 in mangrove sediment:
  - Initial rapid debromination of BDE-153 to penta- and tetra-BDEs by Delta-proteobacteria and Chloroflexi (e.g., *Dehalococcoides*)
  - Further debrominated into di and tri-BDEs by α-proteobacteria
  - Leading to nearly complete debromination of BDE-153

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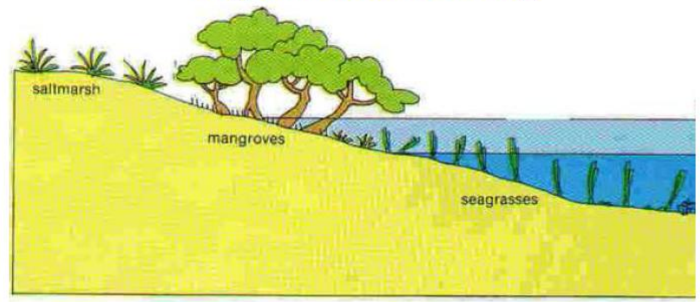
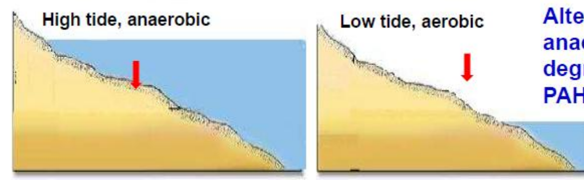
Mangrove wetlands: inter-tidal with regular tidal flushing





Alternating aerobic-anaerobic favor degradation of both PAHs and PBDEs

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Greenhouse experiment: fate of mixed PBDEs discharged from wastewater under different tidal regimes

- *Kandlia obovata* (Ko) *and* *Excoecaria agallocha* (Ea: landward)
- Tidal regimes:
  - Everyday flooding (Te)
  - Every two days flooding (To)
  - Every two weeks flooding (the first and 15th of each month) (Tt)
  - No Tidal flooding (Tn)
- Concentrations of dominant PBDE congeners in artificial wastewater:
  - BDE-47: 10.94 ppb
  - BDE-99: 16.86 ppb
  - BDE-100: 3.34 ppb
  - BDE-153: 1.56 ppb
  - BDE-154: 1.21 ppb
  - BDE-209: 18.77 ppb
- This experiment lasted 8 months

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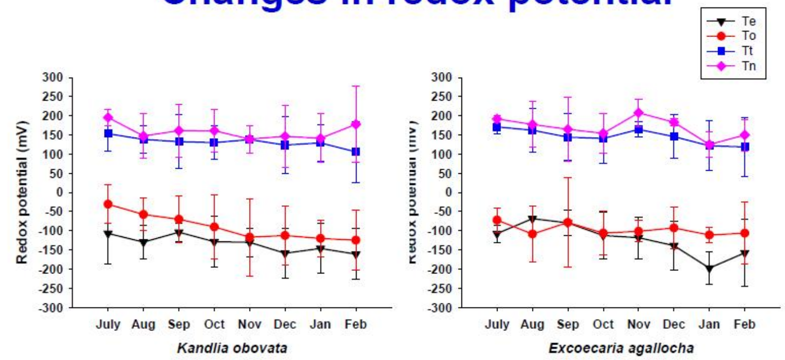
Changes in redox potential



In sediment (0-3cm) during 8-month wastewater discharge

Te: Everyday tidal flooding
To: One-day with / One-day without tidal flooding
Tt: Every two week tidal flooding
Tn: No tidal flooding

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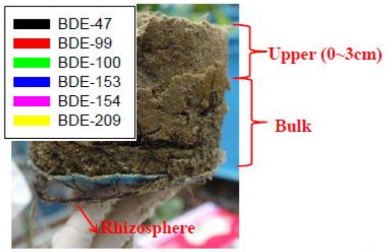
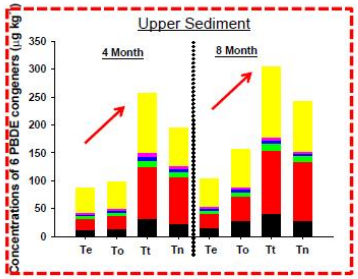
PBDEs in mangrove sediments (Ko)



Upper sediment accumulated more PBDEs than bulk (10 times more), and least accumulation in rhizosphere sediments
Difference among tidal regimes followed the same trend in all three sediment types

Te: Everyday;
To: Every two days;
Tt: Every two weeks;
Tn: No tidal flooding



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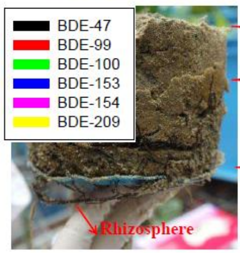
Tidal regime effect

- **Wastewater-borne PBDEs accumulate in sediments: highest in upper surface, followed by bulk and least in rhizosphere sediment**
- **At month 8, more accumulation of total PBDEs in Tn (no tidal) and Tt (every 2 weeks) than in Te (every day) and To (every 2 days)**
- **BDE-209: Te < To < Tt ≈ Tn (more accumulation in less frequent tidal flooding, more aerobic, not favor anaerobic debromination)**
- **Tidal flushing regime significantly affect accumulation and transformation (debromination) of PBDEs**

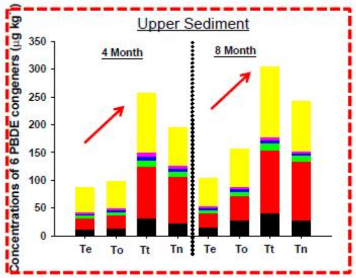
90

PBDEs in mangrove sediments (Ko)



Upper sediment accumulated more PBDEs than bulk (10 times more), and least accumulation in rhizosphere sediments
Difference among tidal regimes followed the same trend in all three sediment types

Te: Everyday;
To: Every two days;
Tt: Every two weeks;
Tn: No tidal flooding



89

Tidal regime effect

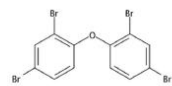
- **Wastewater-borne PBDEs accumulate in sediments: highest in upper surface, followed by bulk and least in rhizosphere sediment**
- **At month 8, more accumulation of total PBDEs in Tn (no tidal) and Tt (every 2 weeks) than in Te (every day) and To (every 2 days)**
- **BDE-209: Te < To < Tt ≈ Tn (more accumulation in less frequent tidal flooding, more aerobic, not favor anaerobic debromination)**
- **Tidal flushing regime significantly affect accumulation and transformation (debromination) of PBDEs**

90

More on tidal regime: single PBDE and higher contamination

- **3 tidal regimes**
  - **1:1d: 1-day high tide and 1-day low tide**
  - **1:1w: 1-week high tide and 1-week low tide**
  - **2:2w: 2-week high tide and 2-week low tide**

- **Single BDE (BDE-47) at 1 μg/g spiking level (simulated severe contamination in sediments in South China)**



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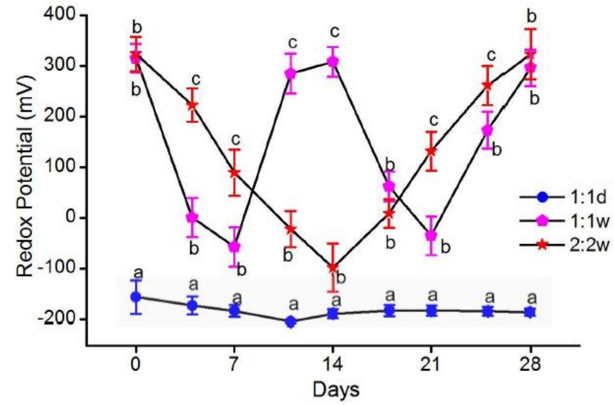
Changes of redox potential (Eh, mV) in sediment during 28 days



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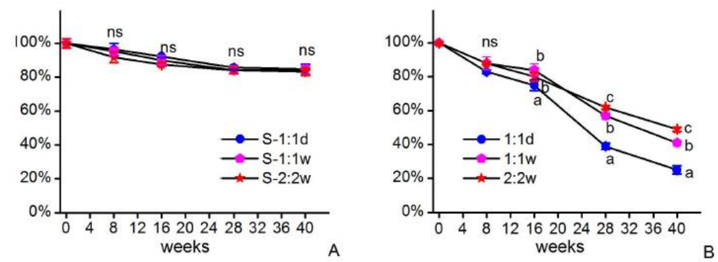
Degradation of BDE-47 in different tidal regimes



Abiotic loss of BDE-47 in the sterilized controls was around 20%.

1:1d regime (75.2%)
>
1:1w regime (58.8%)
>
2:2w regime (51.4%)

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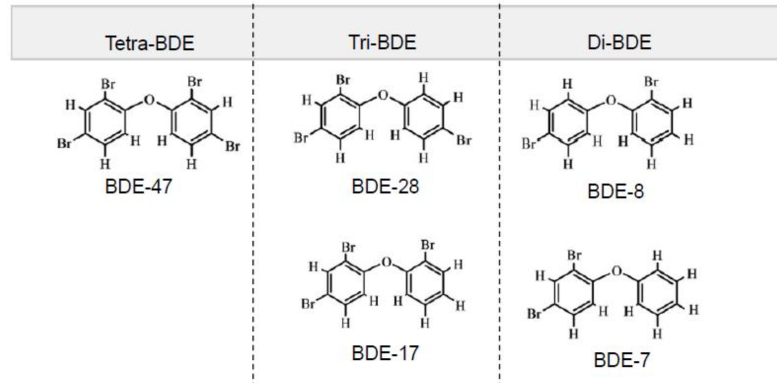
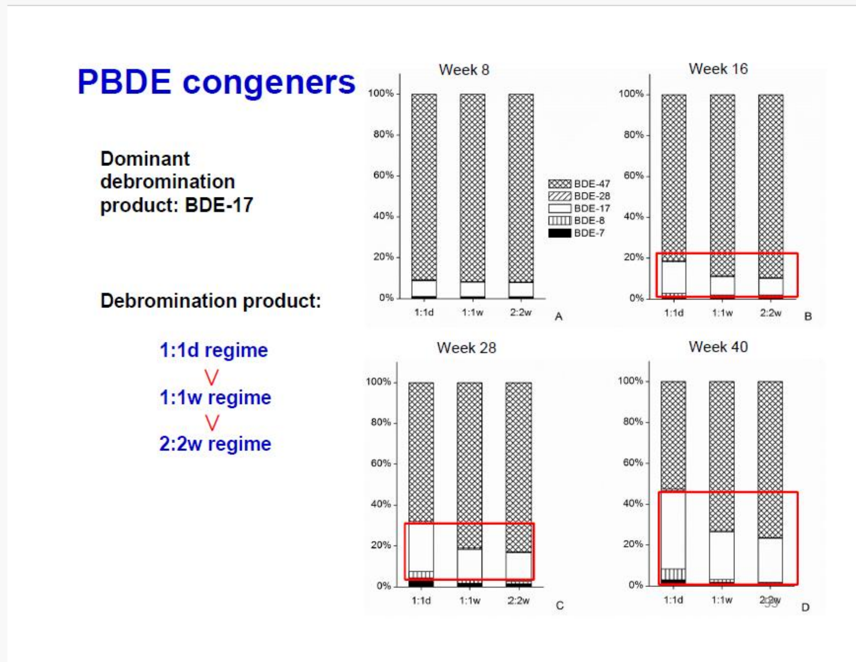
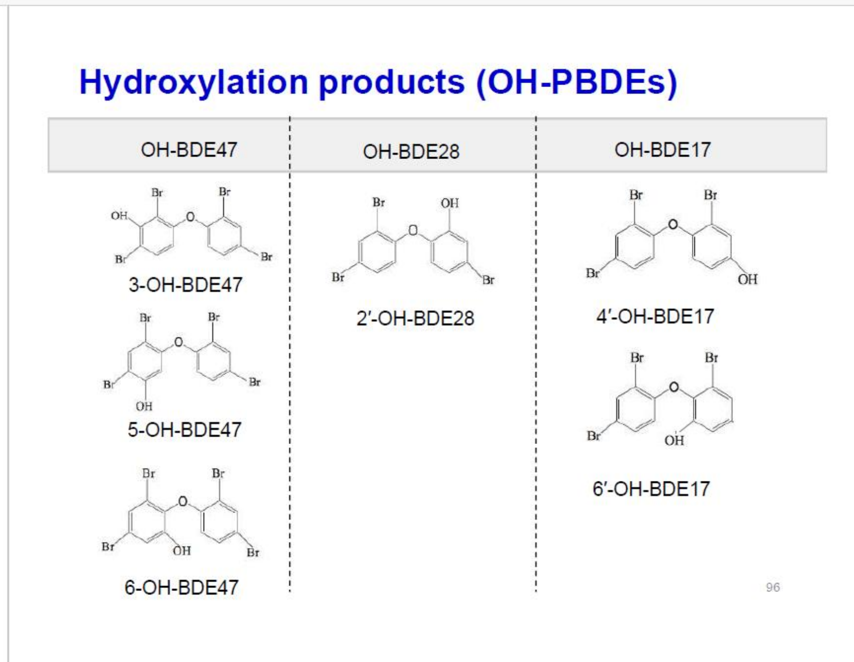
PBDE congeners



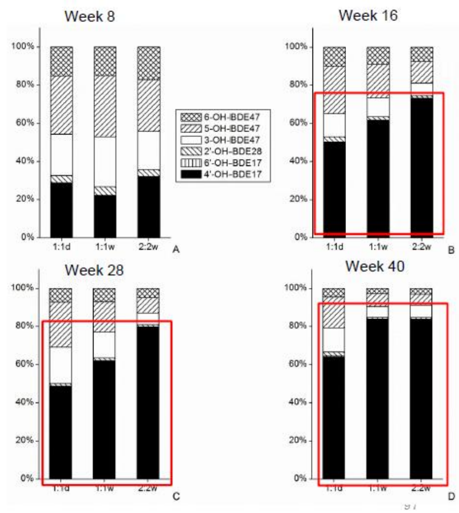
94


PBDE congeners
Dominant debromination product: BDE-17
Debromination product:
1:1d regime
>
1:1w regime
>
2:2w regime
Week 8
Week 16
Week 28
Week 40
BDE-47
BDE-28
BDE-17
BDE-8
BDE-7
100%
80%
60%
40%
20%
0%
1:1d
1:1w
2:2w
A
B
C
D


Hydroxylation products (OH-PBDEs)
OH-BDE47
OH-BDE28
OH-BDE17
3-OH-BDE47
5-OH-BDE47
6-OH-BDE47
2′-OH-BDE28
4′-OH-BDE17
6′-OH-BDE17
96

Hydroxylation products (OH-PBDEs)

2:2w regime
V
1:1w regime
V
1:1d regime



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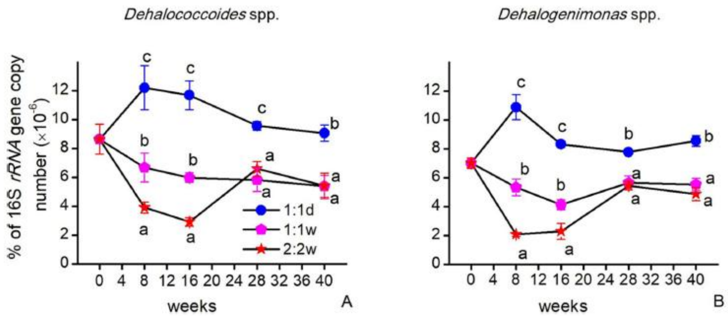
Percentages of BDE-47, debromination products (de-PBDEs) and hydroxylation products (OH-PBDEs) in sediments of different treatments at Week 40

	Sterilized control			Non-sterilized		
	1:1d	1:1w	2:2w	1:1d	1:1w	2:2w
BDE-47	80.73	80.26	79.26	26.76	44.48	52.5
De-PBDEs	ND	ND	ND	24.28	16.49	16.25
OH-PBDEs	0.29	0.24	0.19	0.99	2.38	2.11
% not recovered	18.37	18.87	19.87	47.36	36.03	28.50

<0.5% of BDE-47 in tidal water
In sterilized control without any microbes, 80% BDE-47 remained
In sediment with indigenous microbes, more than half BDE-47 transformed, mostly in debrominated PBDEs, while only 1-2% hydroxylated (very difficult process: molecular size and hydrophobicity and ortho-position of Br atom)
Tidal regime significantly affected BDE-47 degradation and removal

98

Relative abundances of *Dehalococcoides* spp. (A) and *Dehalogenimonas* spp. (B) 16S rRNA genes in sediments under different tidal regimes during 40-week experiment

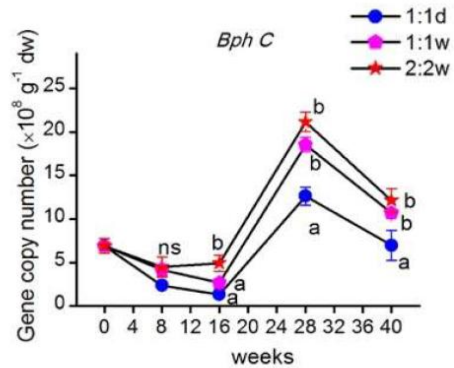


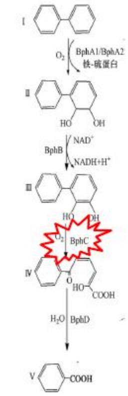
Dehalococcoides spp. > *Dehalogenimonas* spp.

1:1d regime > 1:1w regime ≈ 2:2w regime

99

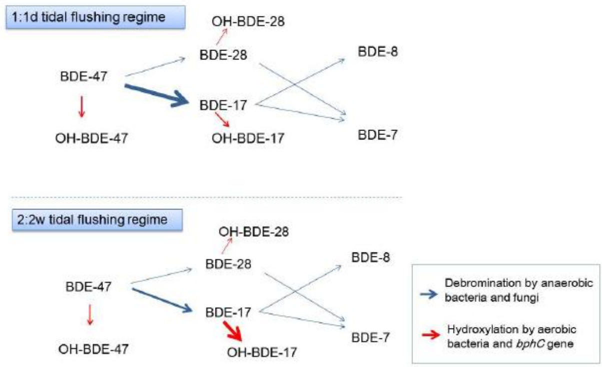
Bph **gene: encoding biphenyl dioxygenase enzyme responsible for ring-cleavage of less brominated PBDEs**





2:2w regime ≈ 1:1w regime > 1:1d regime

Effect of tidal regime with alternating aerobic-anaerobic condition



Removal and degradation pathways of BDE-47 under alternating anaerobic-aerobic conditions

101

Take Home Messages

- **Mangroves: sinks of pollutants**
- **Mangrove plants have tolerance: Specialized root systems: radial oxygen loss (ROL), iron (Fe) plaque formation, anti-oxidative defense system**
- **Toxic pollutants such as heavy metals, polycyclic aromatic hydrocarbons (PAHs) and polybrominated diphenyl ethers (PBDEs) are immobilized in sediment, with relatively minimal plant uptake and translocation**
- **Mangrove sediments harbor diverse microbial (bacterial) communities**
- **High potential to degrade or remove POPs, such as PAHs and PBDEs**
- **Contamination induces relevant degraders and shift bacterial community structure**

Take home messages

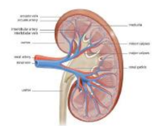
- Tidal flushing in mangrove wetlands creates alternating anaerobic-aerobic conditions
- Anaerobic: negative redox potential favors reductive debromination, produce less brominated congeners (de-PBDEs)
- Aerobic: oxidation and hydroxylation with ring opening for PAHs and PBDEs

- Cost-effective and environmental friendly constructed wetland technology for wastewater treatment and bioremediation of contaminated environments

103

Mangrove: Green kidney

- Nature's kidney in coastal environments: perform kidney-like functions
- Store and assimilate nutrients and useful chemicals
- Transform contaminants or toxic pollutants to less harmful materials
- Remove harmful materials from water, dilute and filter pollutants from industrial and agricultural discharges, contaminated soil/sediment
- Retain water on land, prevents flooding in wet years and drought in dry years



104

Tolerance and purification abilities of mangroves are not unlimited, just like our kidney

We all protect our kidney!

Any failure: kidney transplant

BUT

No transplant of mangrove ecosystem!!

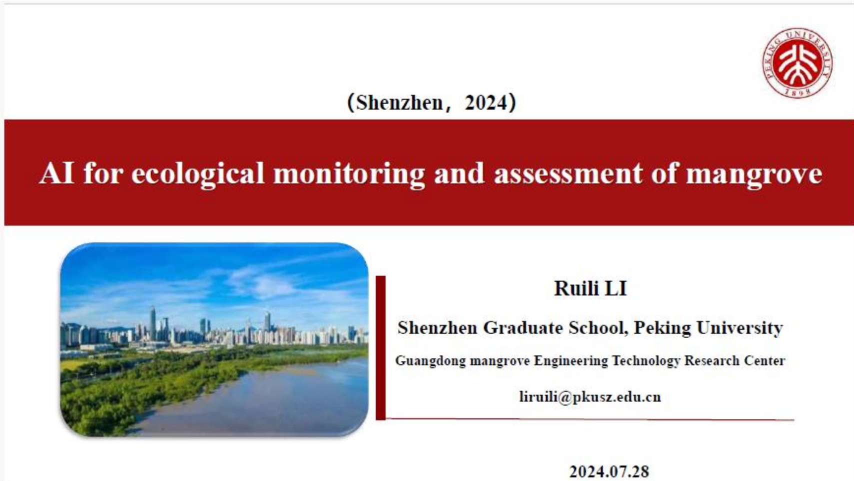
Hope we all protect our green kidney: the mangroves!!!

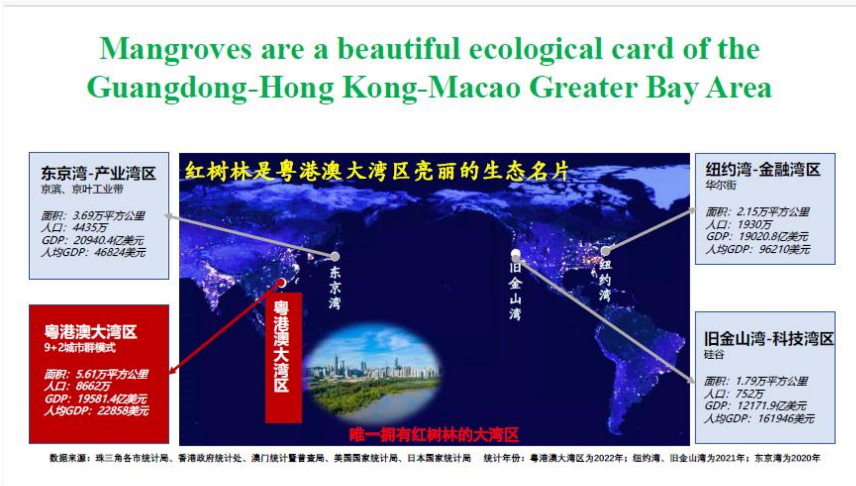
105

Thank you

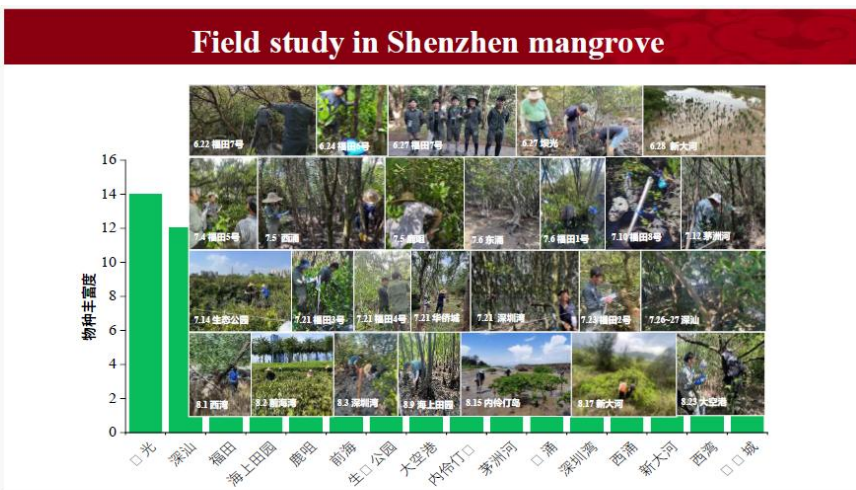
E-mail: bhntam@cityu.edu.hk

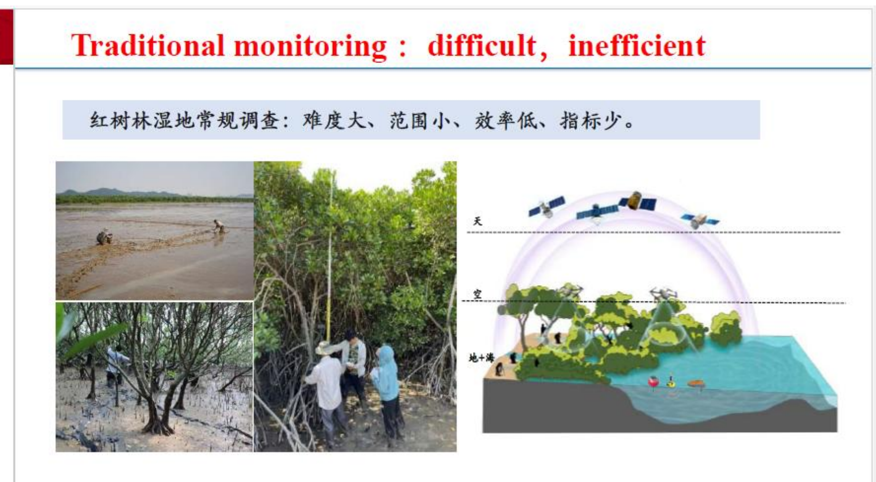
- **Lecture 7: Ecological monitoring and assessment of mangrove**



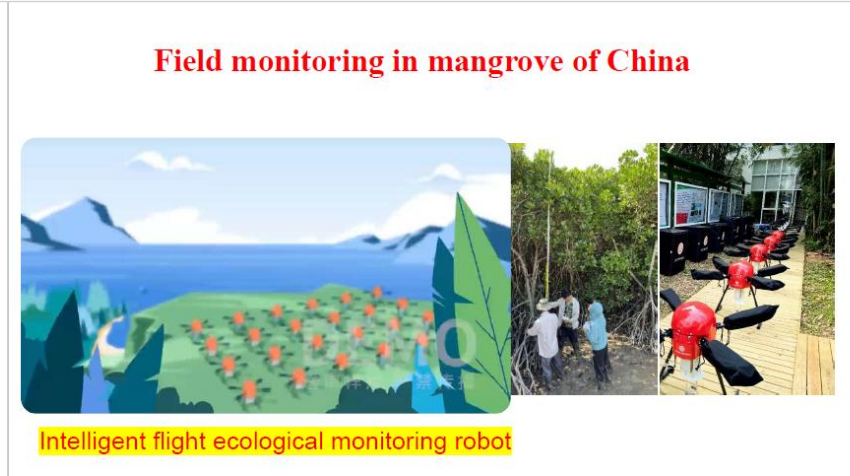

Mangroves are a beautiful ecological card of the Guangdong-Hong Kong-Macao Greater Bay Area
红树林是粤港澳大湾区亮丽的生态名片
东京湾-产业湾区
京滨、京叶工业带
面积：3.69万平方公里
人口：4435万
GDP：20940.4亿美元
人均GDP：46824美元
粤港澳大湾区
9+2城市群模式
面积：5.61万平方公里
人口：8662万
GDP：19581.4亿美元
人均GDP：22858美元
纽约湾-金融湾区
华尔街
面积：2.15万平方公里
人口：1930万
GDP：19020.8亿美元
人均GDP：96210美元
旧金山湾-科技湾区
硅谷
面积：1.79万平方公里
人口：752万
GDP：12171.9亿美元
人均GDP：161946美元
东京湾
旧金山湾
纽约湾
粤港澳大湾区
唯一拥有红树林的大湾区

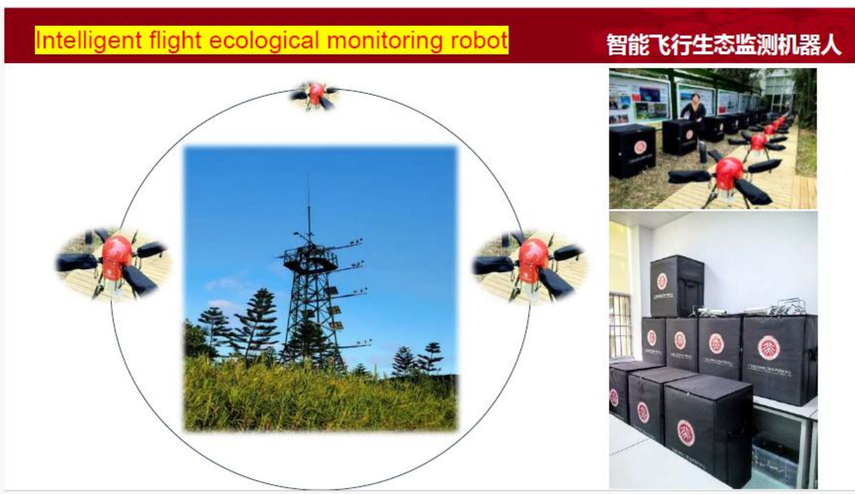

Field study in Shenzhen mangrove
深圳（含深汕）
全市域红树林
(135个样方)
深汕特别合作区
深圳


Field study in Shenzhen mangrove
物种丰富度
16
14
12
10
8
6
4
2
0


Traditional monitoring： difficult，inefficient
红树林湿地常规调查：难度大、范围小、效率低、指标少。
天
空
地+海


Field monitoring in mangrove of China
中国红树林保护区分布图
全国
大样地调查
深圳
全国生态资源调查（地面+无人机）

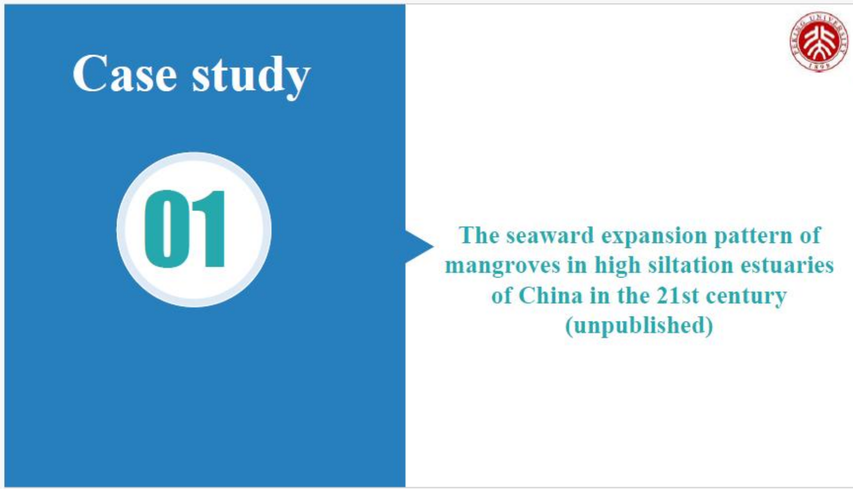

Field monitoring in mangrove of China
Intelligent flight ecological monitoring robot

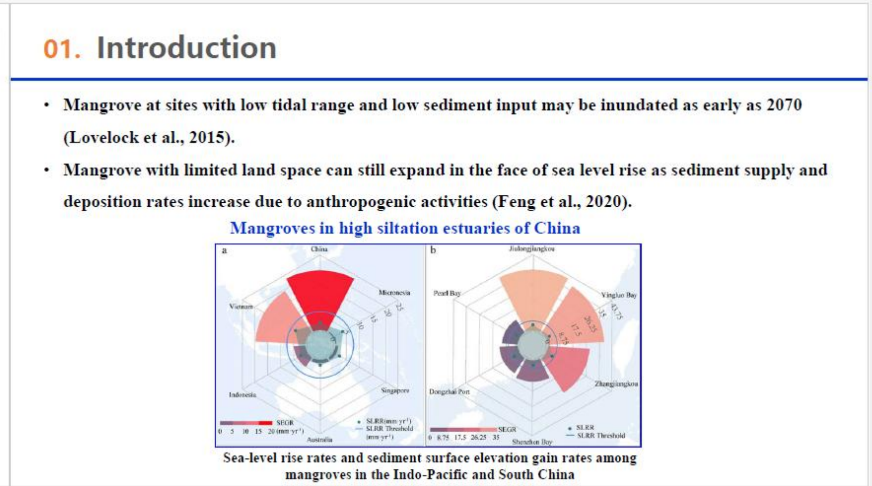

Intelligent flight ecological monitoring robot
智能飞行生态监测机器人

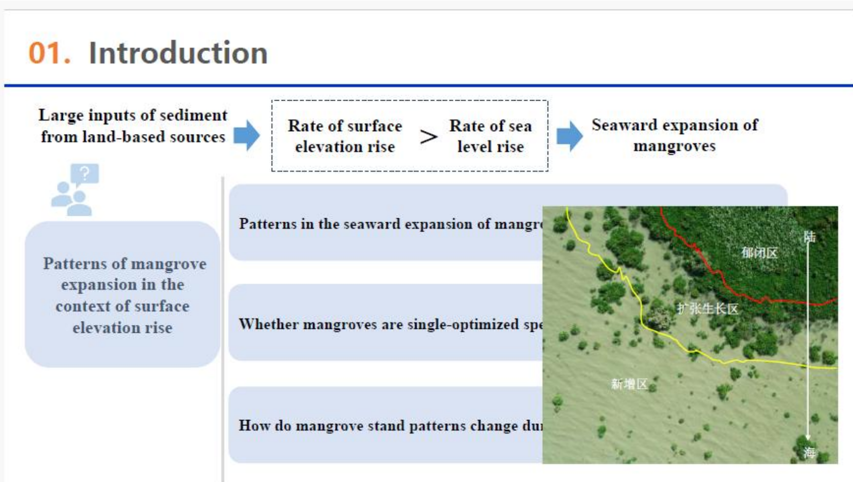

已建成的站点信息（深圳）

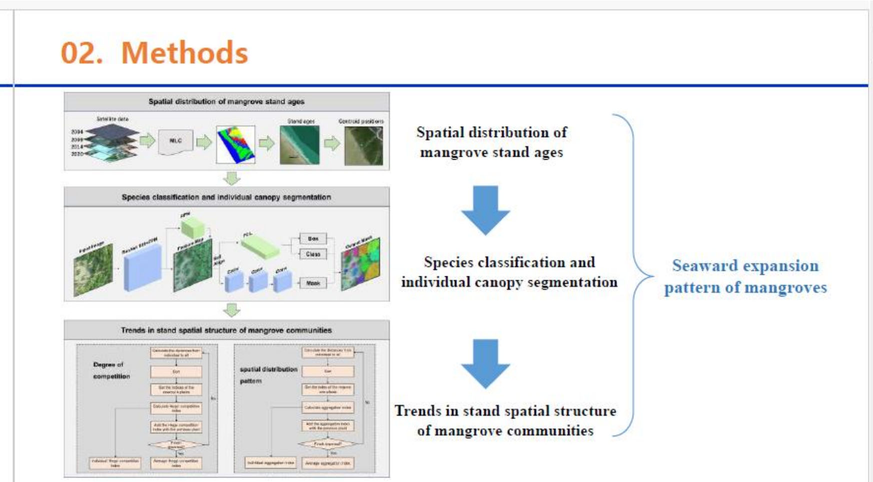
类型	名称
通量塔	红树林通量观测系统（福田，深圳）
通量塔	红树林通量观测系统（东涌，深圳）
通量塔	红树林通量观测系统（宝安，深圳）
涡度系统	北大深圳校园的涡度系统（南山，深圳）

深汕特别合作区
深圳
宝安海上田园通量塔
（2023.10）
观测红树林模拟湿地
观测城市陆地植被
北大深圳校园
涡度系统
（2024）
福田红树林生态公园南区
通量塔
东涌红树林湿
地公园通量塔

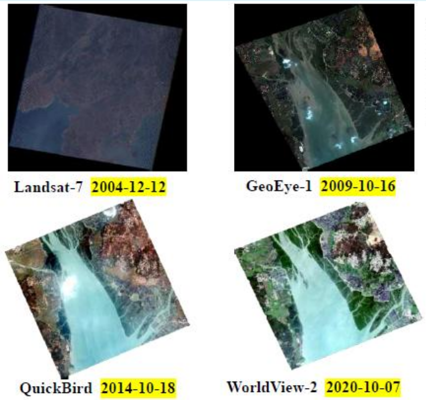

Case study
01
The seaward expansion pattern of mangroves in high siltation estuaries of China in the 21st century (unpublished)

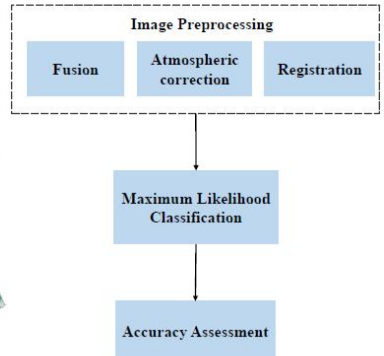

01. Introduction
Mangrove at sites with low tidal range and low sediment input may be inundated as early as 2070 (Lovelock et al., 2015).
Mangrove with limited land space can still expand in the face of sea level rise as sediment supply and deposition rates increase due to anthropogenic activities (Feng et al., 2020).
Mangroves in high siltation estuaries of China
Sea-level rise rates and sediment surface elevation gain rates among mangroves in the Indo-Pacific and South China


01. Introduction
Large inputs of sediment from land-based sources
Rate of surface elevation rise
>
Rate of sea level rise
Seaward expansion of mangroves
Patterns of mangrove expansion in the context of surface elevation rise
Patterns in the seaward expansion of mangr
Whether mangroves are single-optimized sp
How do mangrove stand patterns change du
郁闭区
扩张生长区
新增区
陆
海

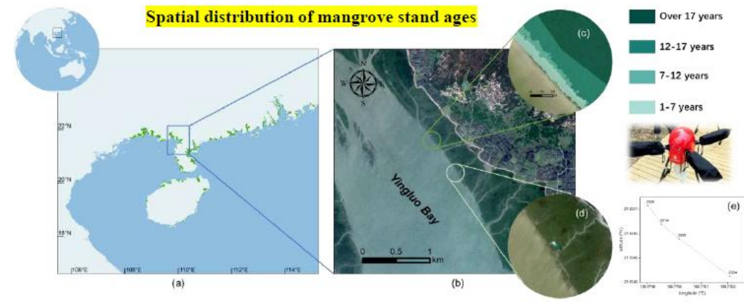

02. Methods
Spatial distribution of mangrove stand ages
Species classification and individual canopy segmentation
Trends in stand spatial structure of mangrove communities
Spatial distribution of mangrove stand ages
Species classification and individual canopy segmentation
Trends in stand spatial structure of mangrove communities
Seaward expansion pattern of mangroves

02. Methods



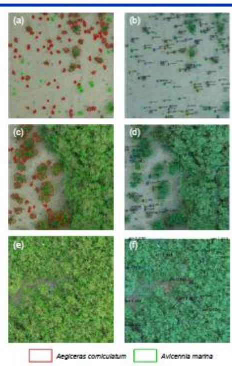


03. Results and Discussion



(a) Mangrove distribution in South China; (b) Location of the study area; (c) The stand age distribution of mangrove naturally expanding seaward, with colors representing mangrove plants of different stand ages; (d) Spatial variation of the centroid of mangrove from 2004 to 2020; (e) Changes of the centroid longitude and latitude position of mangrove from 2004 to 2020.

03. Results and Discussion

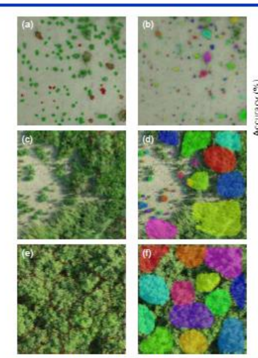


Species identification results. (a, c, e) Labeled images in LabelMe software; (b, d, f) Species identification results output by Mask R-CNN network.

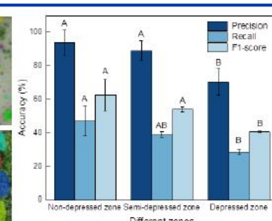
Predicted types	Truth types: *Avicennia marina*	*Aegiceras corniculatum*	*Sonneratia apetala*	User's accuracy (%)
Avicennia marina	317	19	20	89.04
Aegiceras corniculatum	16	263	0	94.27
Sonneratia apetala	30	10	97	70.80
Producer's accuracy (%)	87.33	90.07	82.91	—

➢ User's and producer's accuracies for the three main species were above 70%, resulting in an overall accuracy (OA) of 87.69%

03. Results and Discussion

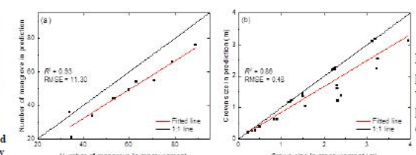


Individual canopy segmentation results. (a, c, e) Labeled images in LabelMe software; (b, d, f) Individual canopy segmentation results output by Mask R-CNN network.



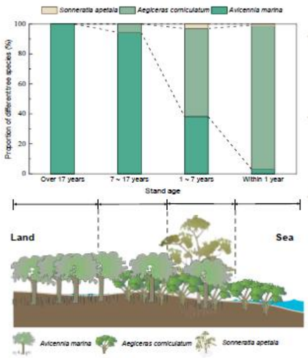
Accuracy evaluation of individual canopy segmentation. Mean ± SD. Different capital letters indicate significant differences among different zones for the same accuracy index ($P < 0.05$).

➢ The obtained Precision values are all above 70%, indicating that the individual canopy segmentation achieved good accuracy



Fitting curve between predicted and true values of mangrove plant counts (a) and crown size (b).

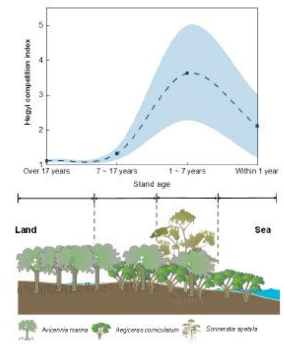
03. Results and Discussion



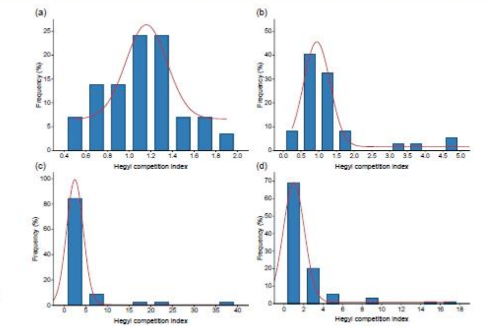
Proportion of the number of each mangrove species for different stand ages

- Mangrove communities aged 7-17 years still exhibited a dominance of *Avicennia marina*, but the overall proportion of *Aegiceras corniculatum* increased.
- As the stand age decreased to 1-7 years, the dominance of *Avicennia marina* decreased, while the dominance of *Aegiceras corniculatum* significantly increased.
- Furthermore, in mangrove communities aged 1 to 7 years, the dominance of *Aegiceras corniculatum* started to increase, while the dominance of *Avicennia marina* decreased. The dominance of different species within the community changes as the mangroves expand seaward, with *Aegiceras corniculatum* becoming increasingly prominent in younger stands.

03. Results and Discussion

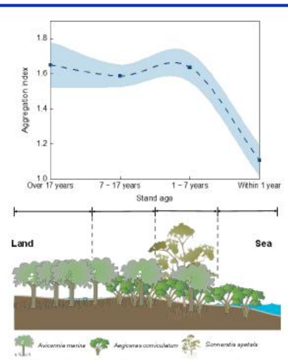


Mean Hegyi competition index of mangrove for different stand ages.

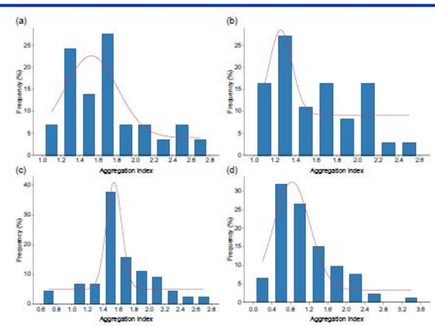


Frequency of Hegyi competition index of mangrove for different stand ages. The solid red lines are Gauss fitted curves. (a) Over 17 years of stand age; (b) 7 ~ 17 years of stand age; (c) 1 ~ 7 years of stand age; (d) Within 1 year of stand age.

03. Results and Discussion

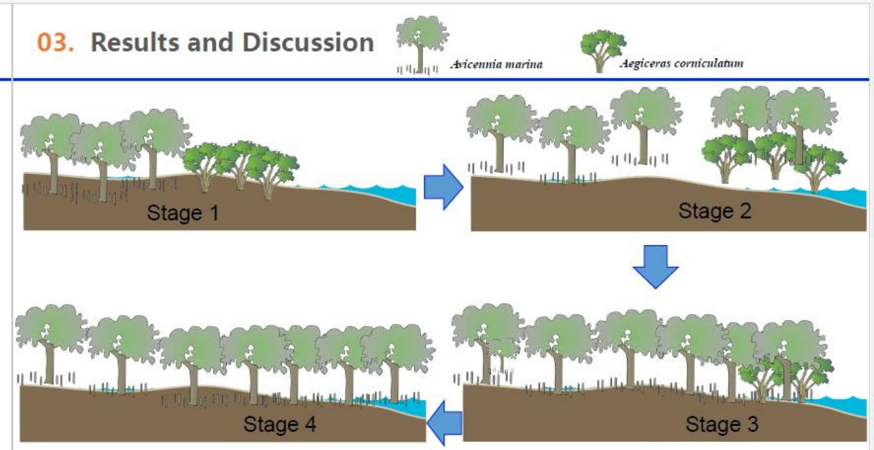


Mean clumping index of mangrove for different forest ages. Mean ± SD.



Frequency of index of clumping of mangrove for different stand ages. The solid red lines are Gauss fitted curves. (a) Over 17 years of stand age; (b) 7 ~ 17 years of stand age; (c) 1 ~ 7 years of stand age; (d) Within 1 year of stand age.

03. Results and Discussion



The seaward expansion pattern of mangroves

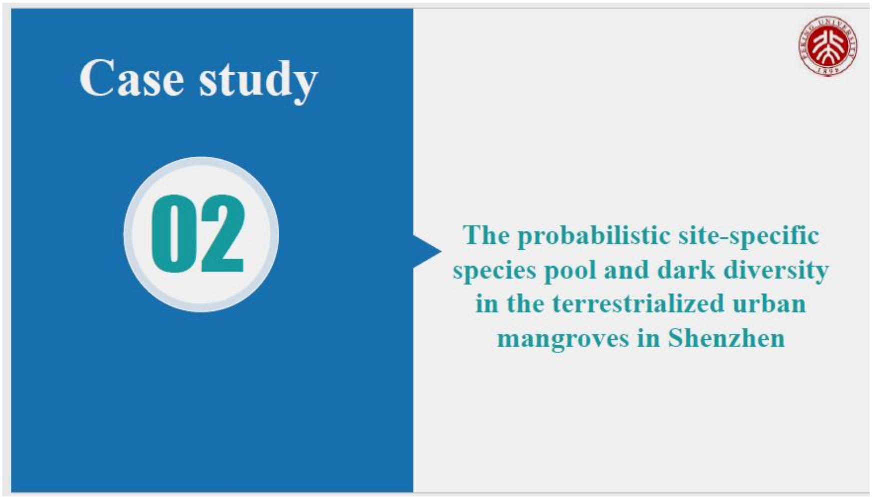

Case study
02
The probabilistic site-specific species pool and dark diversity in the terrestrialized urban mangroves in Shenzhen

Fig.1 Evaluation of mangrove forest capacity to cope with sea-level rise and terrestrialization trend of mangrove wetlands in South China.

Comparison of sea-level rise rates (SLRR, $mm \cdot yr^{-1}$) and sediment surface elevation gain rates (SEGR, $mm \cdot yr^{-1}$) among mangroves in the Indo-Pacific a) and North Indo-Pacific, South China b). The SLRR threshold of mangrove survival was 6.1 $mm \cdot yr^{-1}$ (Saintilan et al., 2020). The data on surface elevation gain in Indo-Pacific mangroves were collected from a previous study (Lovelock et al., 2015). The data for mangroves in South China was measured using the surface elevation table–marker horizon methodology. c) Represents the terrestrialization index of the main mangroves in South China, including Jiulongjiangkou (JLJK), Zhangjiangkou (ZJK), Shenzhen Bay (SZB), Dongzhaigang (DZP), Yingluo Bay (YLB) and Pearl Bay (PB).

The color lines in c) consist of the color sectors in b), indicating the locations of the urban mangroves. d) Shows the mangrove landscape and habitat in Shenzhen Bay, which had the highest terrestrialization index.

目前，中国红树林潮滩高程抬升速度远远大于海平面上升速度；

陆地化趋势将持续增加至2070年。此后，至2100年，随着海水冲刷和泥沙沉降减少，陆地化趋势将减弱。

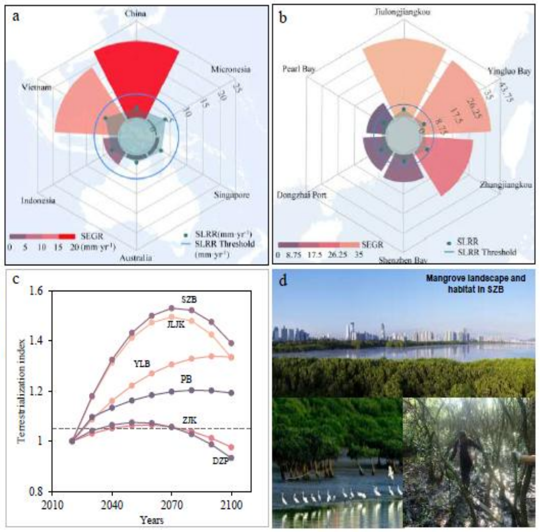


Fig.2 Plant diversity and distribution probability in a typical terrestrialized urban mangrove forest.

a) Observed diversity,
b) distribution probability of 6 typical species
c) dark diversity
d) community completeness in the studied forest.

深圳湾城市红树林，作为将来陆地化程度最高的红树林，未来群落结构将经历很大的演变。

6种物种均不会本地灭绝，老鼠簕分布概率最高；群落结构较为完整，可容纳潜在物种少于3种。

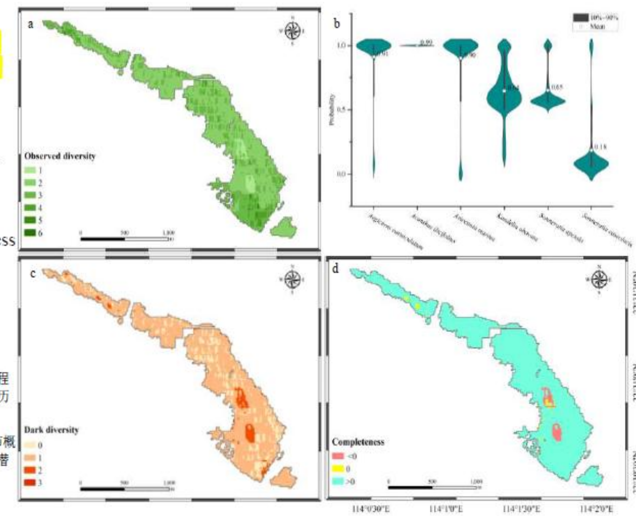


Fig. 3. Probabilistic site-specific species pool in the terrestrialized urban mangrove.

Light to dark green colors indicate the survival probability for observed species from low to high. Light to dark orange colors indicate their potential distribution ability in new areas. The species photos were collected from "Flora Reipublicae Popularis Sinicae" (http://www.iplant.cn/frps).

未来白骨壤有很大潜力取代当前优势种秋茄，秋茄的分布面积将缩减85.48%，白骨壤的分布面积将扩增67.19%。

未来群落下层仍将被老鼠簕群落覆盖，覆盖度将高达94.17%以上。

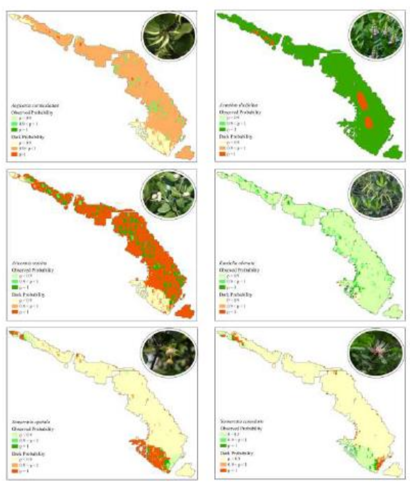


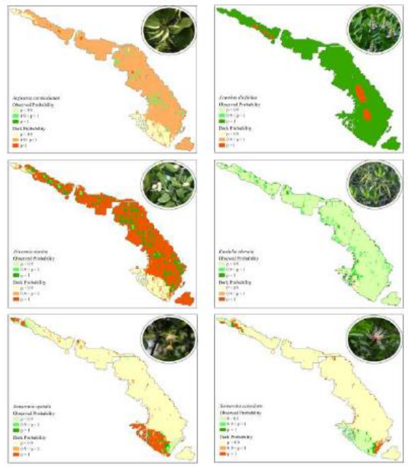
Table 1 Potential distribution area portion changes for the six mangrove species.

	Distribution area portion for					
	Ac	Ai	Am	Ko	Sa	Sc
Area decrement in in-situ sites with						
probability = 0	0	94.17	16.47	2.92	1.73	1.3
0 < probability <= 0.1	3.98	0.35	1.75	10.11	0.69	1.3
probability>0.1	0.1	0.12	0.22	**85.48**	4.35	11.51
Area extension to ex-situ sites with						
probability = 1	0.49	5.36	**67.19**	0.16	9.4	2.29
probability from 0.9 to 1	**82.48**	0	3.92	0.08	3.57	1.85
probability <0.9	12.95	0	10.46	1.24	80.26	81.75

Ac, *Aegiceras corniculatum*; Ai, *Acanthus ilicifolius*; Am, *Avicennia marina*; Ko, *Kandelia obovata*; Sa, *Sonneratia apetala*; Sc, *Sonneratia caseolaris*. The values in bold indicate the high potential of decrement in in-situ sites or extension to ex-situ sites.

Fig. 3. Probabilistic site-specific species pool in the terrestrialized urban mangrove.

Light to dark green colors indicate the survival probability for observed species from low to high. Light to dark orange colors indicate their potential distribution ability in new areas. The species photos were collected from "Flora Reipublicae Popularis Sinicae" (http://www.iplant.cn/frps).



未来白骨壤有很大潜力取代当前优势种秋茄，秋茄的分布面积将缩减85.48%，白骨壤的分布面积将扩增67.19%。

未来群落下层仍将被老鼠簕群落覆盖，覆盖度将高达94.17%以上。

Table 1 Potential distribution area portion changes for the six mangrove species.

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probability>0.1	0.1	0.12	0.22	**85.48**	4.35	11.51
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probability = 1	0.49	5.36	**67.19**	0.16	9.4	2.29
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Ac, *Aegiceras corniculatum*; Ai, *Acanthus ilicifolius*; Am, *Avicennia marina*; Ko, *Kandelia obovata*; Sa, *Sonneratia apetala*; Sc, *Sonneratia caseolaris*. The values in bold indicate the high potential of decrement in in-situ sites or extension to ex-situ sites.

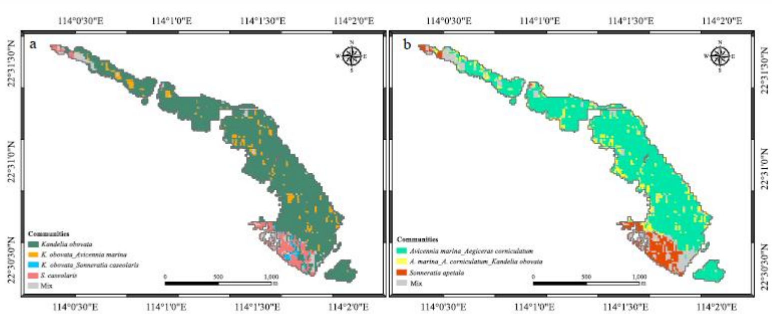


Fig. 4. Changes in community structure in the terrestrialized urban mangrove forest. a) Shows the current community types. b) Shows the community's potential changes. The different colors represent the different communities.

未来研究区域的红树林群落结构有很大潜力变得比现在更复杂。白骨壤-桐花树群落有很高概率取代当前占优势的秋茄单一群落。

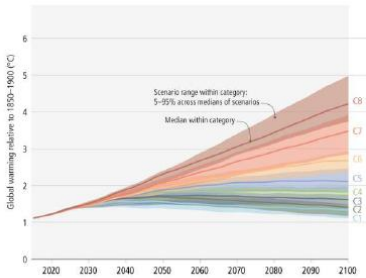
Case study

03

Case study 3

Subtropical mangroves shift northward to the Yangtze Estuary under future climate change

01. Introduction



All simulation scenarios estimate the level of global warming (IPCC, AR6).

1850-1900	2100
ssp126	1.5°C~1.8 °C
ssp245	2.4°C~2.9 °C
ssp370	2.8°C~3.9 °C
ssp585	3.7°C~5.0 °C

- It is currently widely accepted that low temperatures are the main factor limiting the high-latitude distribution of mangrove plants (Michael, 2017).
- Global warming has created opportunities for the northward migration of mangroves (Cavanaugh, 2013).
- Cold spells and their synergistic effects with other factors may also limit the expansion of mangroves to higher latitudes (Ward, 2016).

02. Materials

Environmental climate data

Table 1 Model bioclimatic indicators. (a) The set of environmental indicators used in the final model for *K. obovata*. (b) The environmental indicators used in the final model for *A. marina* and *A. corniculatum*.

Variable	Description	Units
BIO1	Annual mean temperature	℃
BIO2[(a,b)]	Mean diurnal range (mean of monthly (max temp - min temp))	℃
BIO3[(a,b)]	Isothermality (BIO2/BIO7) (×100)	unitless
BIO4	Temperature seasonality (standard deviation ×100)	unitless
BIO5[(a,b)]	Maximum temperature of the warmest month	℃
BIO6	Minimum temperature of the coldest month	℃
BIO7	Temperature annual range (BIO5-BIO6)	℃
BIO8	Mean temperature of wettest quarter	℃
BIO9	Mean temperature of driest quarter	℃
BIO10	Mean temperature of warmest quarter	℃
BIO11	Mean temperature of coldest quarter	℃
BIO12	Annual precipitation	mm
BIO13[(b)]	Precipitation of the wettest month	mm
BIO14[(a,b)]	Precipitation of the driest month	mm
BIO15[(a,b)]	Precipitation seasonality (coefficient of variation)	mm
BIO16	Precipitation of the wettest quarter	mm
BIO17	Precipitation of the driest quarter	mm
BIO18[(a)]	Precipitation of the warmest quarter	mm
BIO19	Precipitation of the coldest quarter	mm
BIO20	Accumulated temperature ($\sum_{i=1}^{n} T > 10°C$)	℃
BIO21[(a,b)]	The average annual number of days below 10℃	Day
BIO22	Cooling rate at winter ($\Delta T/\Delta t$)	℃/Day

Current Climate Environmental Data (2000-2020)
- National Centre for Atmospheric Science (NCAS), UK
- Earth System Science Data Federation (ESSDF)

Future Climate Data (2021-2100)
- WorldClim Global Climate Database
- Includes four scenarios: SSP126, SSP245, SSP370, SSP585

Collinearity Analysis
- Select climate indicators with a correlation lower than 0.8 to form different model ensembles.

02. Methods

MaxEnt Model

Model Construction and Training Fitting

Constraints

MaxEnt

Known species' multidimensional environmental conditions

The most entropic among countless probability distributions that meet the constraints

Construct an algorithm aimed at maximizing entropy to project known multidimensional environmental constraints onto different times and spaces, achieving potential distribution

Climate Environmental Indicator Set, 17 Regularization Multipliers, 5 Types of Environmental Variables

Multiple Model Combinations

Model Selection and Validation

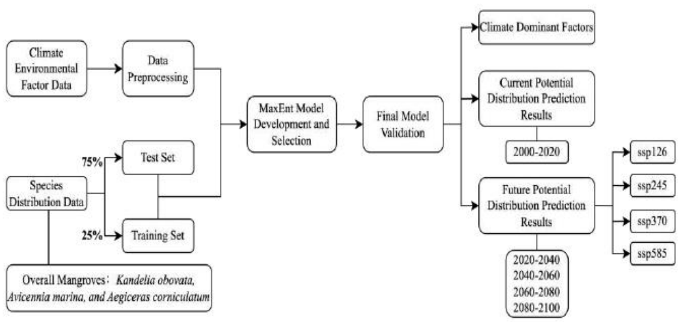
- **AUC Statistical Significance (Partial ROC ≤ 0.05)**
- **Omission Rate ≤ 5%**
- **delta_AICc value < 2**

The Optimal Final Model

Final Validation with Additional Points

02. Methods

Technical Route



03. Results and Discussion

3.1 Main factors influencing mangrove distribution

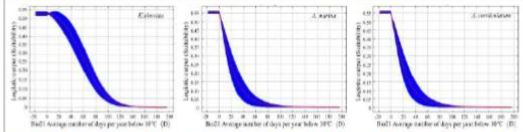


Fig. 2. Response curves of the average annual number of days below 10 °C (BIO21) in the species distribution model

Table 2 The top three factors were affecting the distribution model of subtropical mangroves.

	Variable	Description	Percent contribution(%)
Kandelia obovata	BIO21	The average annual number of days below 10℃	51.3
	BIO5	Maximum temperature of the warmest month	24.9
	BIO2	Mean diurnal range	9.2
Avicennia marina	BIO21	The average annual number of days below 10℃	85.4
	BIO5	Maximum temperature of the warmest month	4.9
	BIO2	Mean diurnal range	4.9
Aegiceras corniculatum	BIO21	The average annual number of days below 10℃	88
	BIO5	Maximum temperature of the warmest month	4.8
	BIO2	Mean diurnal range	3

1. **Model Performance**

- High accuracy confirmed with AUC values above 0.85 for K. obovata, A. marina, and A. corniculatum, indicating robust predictive capability of the models.Key Climatic Factors.

2. **Climatic Impact**

- The average annual number of days below 10°C (BIO21) emerged as the primary limiting factor for the distribution of subtropical mangroves, particularly for ***A. marina*** and ***A. corniculatum***, demonstrating the significant impact of low temperatures on these species.

03. Results and Discussion

3.3 Future changes in the northern boundary of subtropical native mangrove

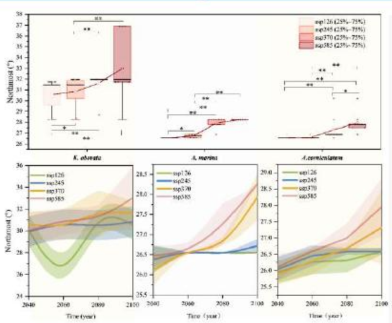


Fig. 6. Future changes of northmost subtropical native mangrove habitats

- ***K. obovata***: Expands northward, surpassing 30°N by 2100 under high-emission scenarios, with notable expansion from 2060 to 2100 under SSP585.
- ***A. marina***: Less cold tolerant, remains below 30°N but shows significant northward shifts under high emissions, increasing its northernmost boundary by about 1.68°N from the 2040s to the 2100s.
- ***A. corniculatum***: Similar to A. marina in cold tolerance and shifts, with a 1.84°N increase under high emissions from the 2040s to 2100s.
- **General Trends:** Minimal changes under low emissions, with significant and consistent northward movements under high emissions from 2060 onwards.

04. Conclusions

1. **Climatic Factors:**

- Annual cold days (<10°C) are key to subtropical mangroves' distribution.
- Precipitation has a lesser impact.

2. **Habitat Shifts:**

- Under SSP126/SSP245: Minor northward shifts for *A. marina* and *A. corniculatum*.
- Under SSP370/SSP585: K. obovata moves to the Yangtze estuary (31.9°N); A. marina and A. corniculatum reach Ningde (26.8°N).

3. **Restoration & Afforestation:**

- *K. obovata*: Suitable restoration areas in Yueqing Bay, Ningbo Bay, Zhoushan Islands.
- *A. marina* and *A. corniculatum*: Afforestation recommended in Fuzhou and Ningde coasts; northern Fujian unsuitable.

4. **Conservation Guidance:**

- The shifts offer crucial insights for coastal management and conservation planning.


北京大学深圳研究生院
北京大学深圳校区是扎根粤港澳大湾区的国际校区


在北京大学发展布局下的定位
P K U S H E N Z H E N
北京：学院路校区（医学部）
布局医学基础研究，以及生命医学健康领域的交叉学科
北京：昌平新校区
重点布局和建设新工科，并考虑与新工科结合的理科类学科、医学类学科和人文社科
北京：燕园校区（校本部）
主要布局文理基础研究
北京：昌平 200 号
集中开展军民融合研究、现代农学和科研设施平台建设
北京：怀柔科学城
布局重大科技设施平台、医学中心和全新的研究型医院等
深圳：深圳研究生院
问题导向、南北联动、AI牵引、创新融合
打造贯通基础研究-技术攻关-应用示范-产业转化的交叉生态


北京大学 深圳研究生院
Peking University Shenzhen Graduate School
基 本 概 况
2001年1月，北京大学与深圳市人民政府签署《合作创办北京大学深圳校区协议书》，共同创办北京大学深圳研究生院，作为北京大学唯一一所异地办学的国际化校区。
办学目标
建设世界一流国际化校区
校区办学方针
前沿领域、交叉学科、应用学术、国际标准。
发展原则
与校本部差异化发展，学科互补；面向深圳，服务广东，辐射华南，为地方经济发展服务。
培养目标
专业知识、综合素质、国际视野、社会责任。
PKU


北京大学 深圳研究生院
Peking University Shenzhen Graduate School
八大学院及学科布局
问题导向、聚力攻关
立足服务区域经济社会发展需求，瞄准深圳产业转型升级所需
学科布局
信息工程学院
化学生物学与生物技术学院
环境与能源学院
城市规划与设计学院
新材料学院
汇丰商学院
国际法学院
人文社会科学学院
新一代电子信息
生命健康与生物医药
生态文明&应急环保
城市设计&国土空间规划
新材料&新能源&绿色低碳
国际金融中心建设
法治示范城市建设
文化创意
区域产业需求
PKU


国家战略　湾区名片
2017年，广西北海：一定要尊重科学、落实责任，把红树林保护好。
2022年，广东深圳：在深圳建立“国际红树林中心”。
2023年，广东湛江：红树林保护，我在厦门工作的时候就亲自抓。
党的十八大后，我有过几次指示。这是国宝啊，一定要保护好。
红树林是粤港澳大湾区亮丽的生态名片
红树林生态系统


积极响应　组织科研
北大红树林一张图
2023年
建市
省级红树林保护区
国家级红树林保护区
1979年
1984年
1988年
1993年
2021年
2022年
深港治理深圳河工程环评项
广东省红树林工程技术研究
生态环境与资源效率研究实
1月
2月
3月
4月
5月
7月
9月
10月
11月
2024年
北大红树林学科启动
广东省科学技术奖
红树林国家政协提案
市校共建国际红树林中心
红树林保护合作国际研讨会
国际红树林保护高级论坛
《湿地公约》审议通过
广东省水生态与红树林创新团队
国家环境保护科学技术奖
中国红树林博物馆
2022年11月5日
习主席宣布在深圳建立“国际红树林中心”
广东省冲补强重点学科“滨海红树林保护与生态修复”
广东省水生态与红树林创新团队


AI牵引　创新融合
未来红树林
国际红树林中心
中国大型红树林苗圃基地
红树林生态小镇
红树林健康产业中心
红树林生态公园
红树林产业
产学研官协同发展
红树林工程技术研究中心
国际红树林实验教学AI中心
全球顶级生态环境数据共享中心
全球红树林数字孪生AI中心
红树林
重要科技奖项
CNS期刊论文
红树林国家工程技术研究中心
国际红树林生态超级站
全球布局
全球大数据


Thanks!
PKU

- **Lecture 8: Mangrove conservation and alien species**

Mangrove conservation and alien species

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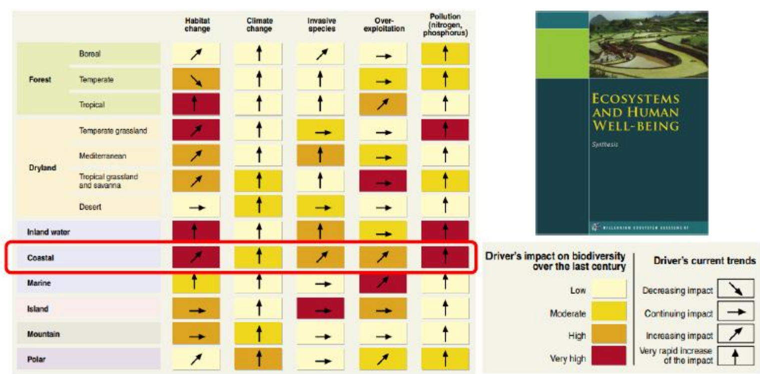
2024/07/29, Shenzhen

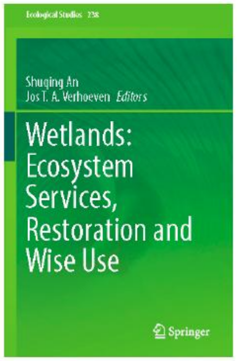
Outline

1. **Overview**
2. **Research**
3. **Management**

Main direct drivers of change in biodiversity and ecosystems



(Millennium Ecosystem Assessment, 2005)



(An & Verhoeven, 2019)

Part II Wetland Mechanisms, Threats, Conservation and Management

5 Invasive Plants in Coastal Wetlands: Patterns and Mechanisms
Luzhen Chen

Table 5.1 Invasive vascular plants in coastal areas

Life form/name	Native range	Introduced range	Growing habitats	Source
Tree				
Annona glabra	Tropical America	Australia	Mangrove and salt marsh	a
Bruguiera gymnorrhiza	Indo-Pacific	USA	Mangroves	b
Lumnitzera racemosa	Indo-Pacific	USA	Mangroves	b
Melaleuca quinquenervia	Australia	Florida in the USA	Brackish	c
Rhizophora mangle	Tropical America	Pacific Islands	Mangroves	b
Sonneratia apetala	India/Bangladesh	China	Mangroves	d
Terminalia catappa	Asia/ Africa/Australia	Latin America/Caribbean Islands	Brackish	b
Thespesia populnea	Asia	North America/Caribbean Islands	Mangrove associate	b
Triadica sebifera	Eastern Asia	Southern and Eastern USA	Brackish	e

9 trees

[a]Duke (2006)
[b]Richardson and Rejmánek (2011)
[c]Turner et al. (1998)
[d]GRIIS (Global Register of Introduced and Invasive Species, http://www.griis.org)
[e]Conner et al. (2014)
[f]Pathikonda et al. (2008)
[g]Chambers et al. (1999)
[h]Woo and Zedler (2002)
[i]Zan et al. (2000)

Chen. (2019) *Invasive Plants in Coastal Wetlands: Patterns and Mechanisms*

Life form/name	Native range	Introduced range	Growing habitats	Source
Shrub				
Nypa fruticans	Indo-Pacific	Pacific Islands/Caribbean Islands /West Africa	Mangroves	d
Pluchea carolinensis	Latin America/West Indies /Florida of USA	Pacific Islands	Mangrove associate	b
Pluchea indica	Asia/Australia	Pacific Islands	Mangrove associate	b
Rosa rugosa	Asia	Northern Europe/USA	Dunes coast	b
Scaevola taccada	Asia/Middle East / Pacific Islands	Center America	Brackish	b
Tamarix chinensis	China	North America /South America/South Africa	Salt marsh	b
Vine				
Mikania micrantha	Center America/ South America	Tropical Asia	Brackish	i

6 shrubs

1 vine

Life form/name	Native range	Introduced range	Growing habitats	Source
Herb				
Ammophila arenaria	Europe	Canada/ Chile/South Africa	Dunes coast	d
Aster squamatus	Central and South America	Mediterranean	Salt marsh	d
Cycloloma atriplicifolium	–	Albania	Salt marsh	d
Cymodocea nodosa	–	Turkey	Seagrass	d
Halophila stipulacea	Western Indian Ocean	Mediterranean	Seagrass	d
Iris pseudacorus	Europe	North America	Brackish	f
Phragmites australis	Some limited area in USA	Eastern USA/Gulf of Mexico	Salt marsh	g
Rhaponticum repens	Europe	China/Western USA	Brackish	d
Spartina alterniflora	Atlantic coast of USA	East Asia/Western USA/UK /New Zealand	Salt marsh	d
Spartina anglica	Europe	Ireland/Australia/ French	Salt marsh	d
Spartina densiflora	South America	Mediterranean	Salt marsh	d
Spartina × townsendii	Western Europe	Ireland	Salt marsh	d
Spartina pectinata	USA	Ireland	Salt marsh	d
Typha × glauca	Asia	North America	Salt marsh	h

14 grasses

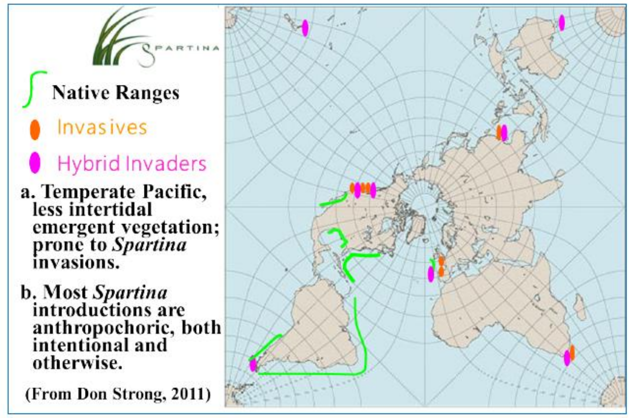
Table 5.5 Invasive mangrove species in the world (according to the database of Richardson and Rejmánek 2011; and Global Register of Introduced and Invasive Species, http://www.griis.org)

Name	Invasive regions/time	Purpose
Mangroves		
Bruguiera gymnorrhiza	Hawaii (1902) and Florida (1940), USA	Stabilization/ornamental
Lumnitzera racemosa	Florida, USA (1960s–1970s)	Stabilization/erosion control
Nypa fruticans	West Africa/Pacific Islands/Caribbean Islands (the 1990s)	Ornamental
Rhizophora mangle	Pacific Islands	Stabilization/erosion control
Sonneratia apetala[a]	China (1985)	Afforestation
Mangrove associates		
Pluchea carolinensis	Pacific Islands	Ornamental
Pluchea indica	Pacific Islands	Ornamental
Thespesia populnea	North America/Caribbean Islands	Ornamental

[a]The invasiveness of this species is still being tested, as discussed in the following paragraphs

Chen. (2019) *Invasive Plants in Coastal Wetlands: Patterns and Mechanisms*

Global invasion of *Spartina*

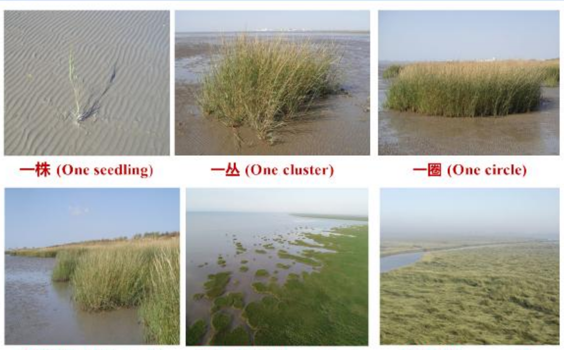


a. Temperate Pacific, less intertidal emergent vegetation; prone to *Spartina* invasions.

b. Most *Spartina* introductions are anthropochoric, both intentional and otherwise.

(From Don Strong, 2011)

互花米草入侵滩涂的过程 (*Spartina* invading mudflat)



一株 (One seedling) 一丛 (One cluster) 一圈 (One circle)

多群 (Multiple circle) 多片 (Multiple patches) 全占 (All occupied)

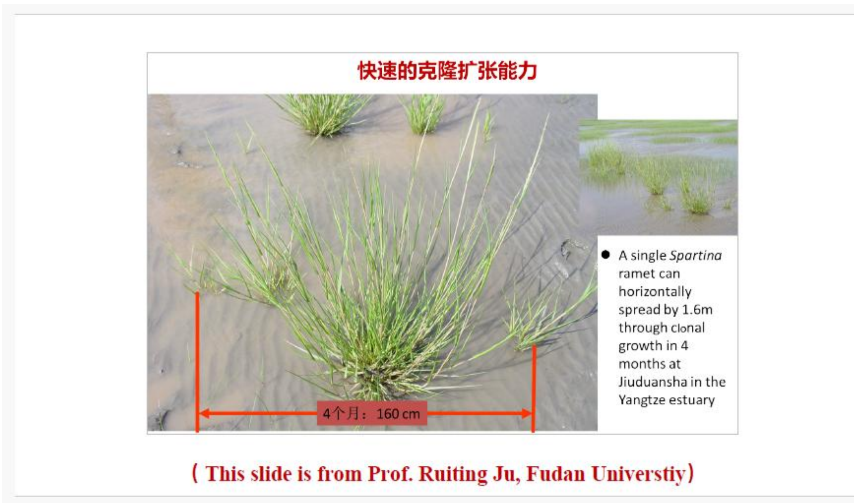
（This slide is from Prof. Ruiting Ju, Fudan Universtiy）

●巨大繁殖能力，导致高r对策

- Two modes of reproduction, with high r
- Up to 700 seeds produced per ramet

- Successful sexual reproduction in China

（This slide is from Prof. Ruiting Ju, Fudan Universtiy）


快速的克隆扩张能力
4个月：160 cm
A single *Spartina* ramet can horizontally spread by 1.6m through clonal growth in 4 months at Jiuduansha in the Yangtze estuary
(This slide is from Prof. Ruiting Ju, Fudan Universtiy)


Spartina alterniflora
Avicennia germinans
Louisiana, USA (Saintilan *et al*, 2009)
Queensland, Australia
New Zealand
(Saintilan *et al*, 2009)

Fast expansion of *Spartina* in mangroves

Outline

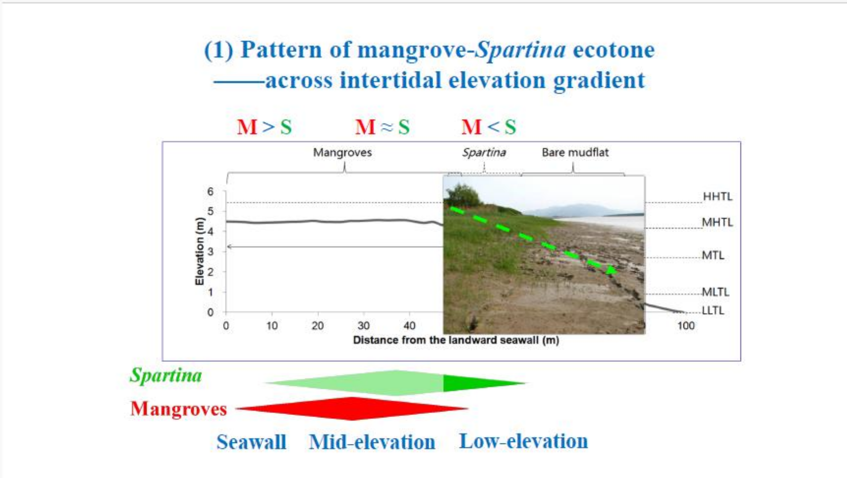
1. Overview
2. **Research**
3. Management

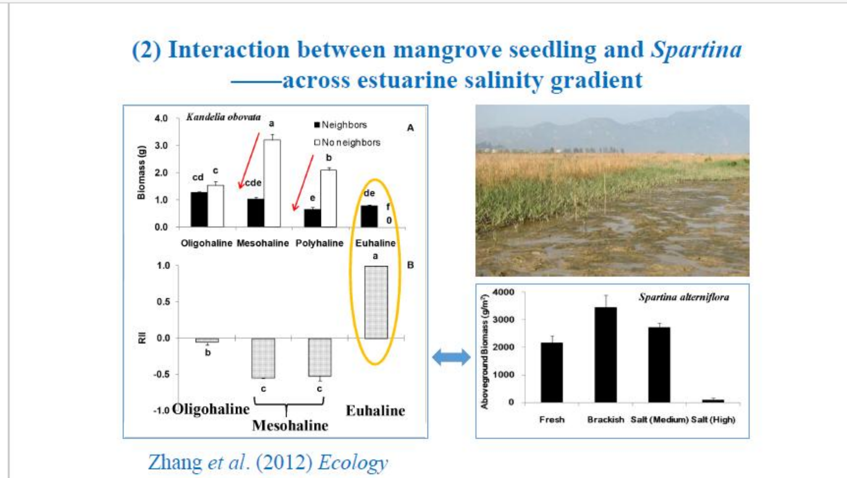
Question 1

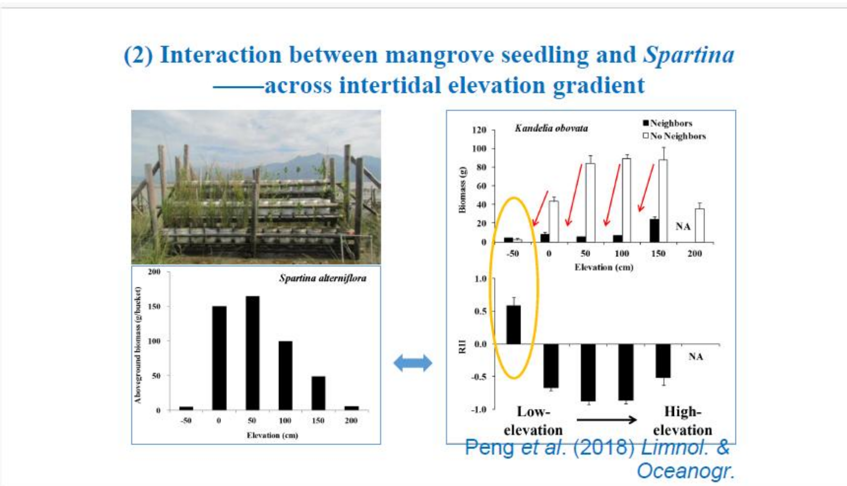
What are the current growth and genetic patterns of *Spartina alterniflora*?

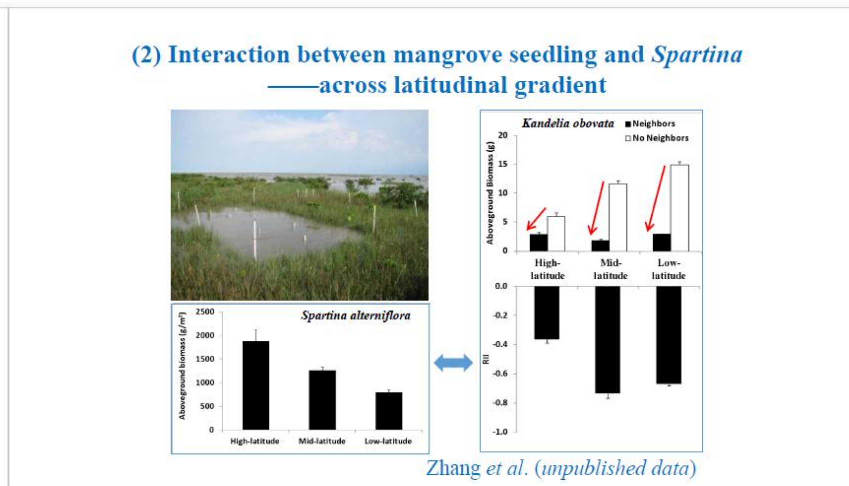
Question 2

What are the distribution and growth patterns of mangrove-*Spartina* ecotone in southeast China?

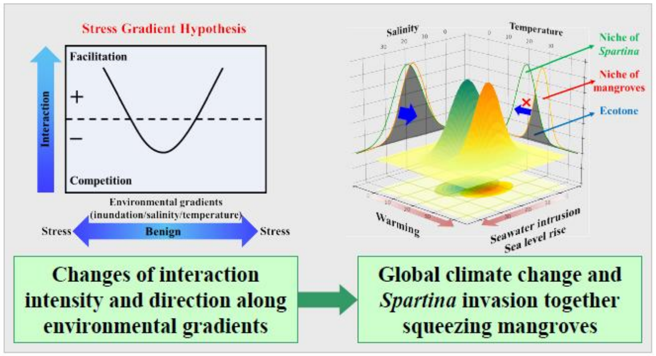

(1) Pattern of mangrove-Spartina ecotone
——across intertidal elevation gradient
M > S
M ≈ S
M < S
Mangroves
Spartina
Bare mudflat
Elevation (m)
HHTL
MHTL
MTL
MLTL
LLTL
Distance from the landward seawall (m)
Spartina
Mangroves
Seawall
Mid-elevation
Low-elevation


(2) Interaction between mangrove seedling and Spartina
——across estuarine salinity gradient
Kandelia obovata
Neighbors
No neighbors
Biomass (g)
Oligohaline
Mesohaline
Polyhaline
Euhaline
RII
Oligohaline
Mesohaline
Euhaline
Spartina alterniflora
Aboveground Biomass (g/m²)
Fresh
Brackish
Salt (Medium)
Salt (High)
Zhang et al. (2012) Ecology


(2) Interaction between mangrove seedling and Spartina
——across intertidal elevation gradient
Spartina alterniflora
Aboveground biomass (g/bucket)
Elevation (cm)
Kandelia obovata
Neighbors
No Neighbors
Biomass (g)
Elevation (cm)
NA
RII
Low-
elevation
High-
elevation
Peng et al. (2018) Limnol. &
Oceanogr.


(2) Interaction between mangrove seedling and Spartina
——across latitudinal gradient
Spartina alterniflora
Aboveground biomass (g/m²)
High-latitude
Mid-latitude
Low-latitude
Kandelia obovata
Neighbors
No Neighbors
Aboveground Biomass (g)
High-
latitude
Mid-
latitude
Low-
latitude
RII
Zhang et al. (unpublished data)

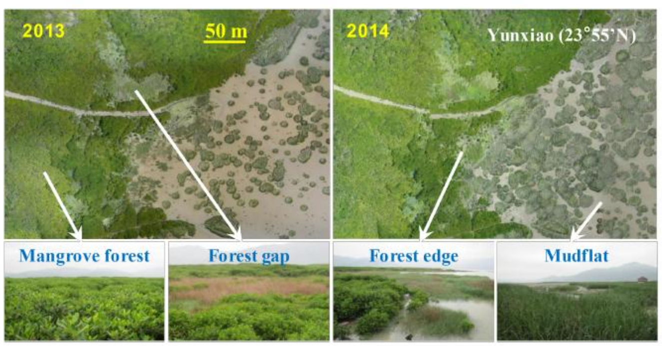
Answer to Question 2



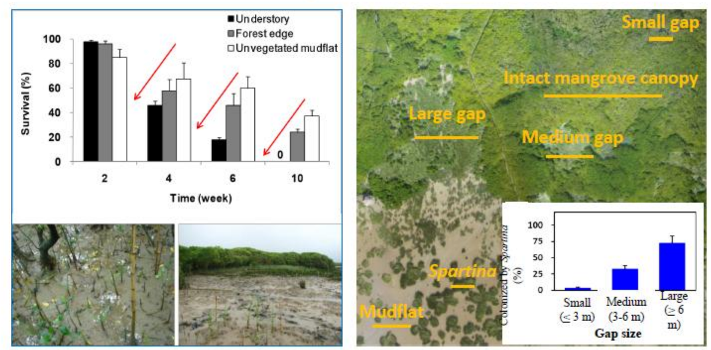
Question 3

How does invasion of *Spartina alterniflora* affect the mangrove ecosystems in China?

Interaction between adult mangrove and *Spartina*
——*Spartina* can not invading into intact mangrove forests



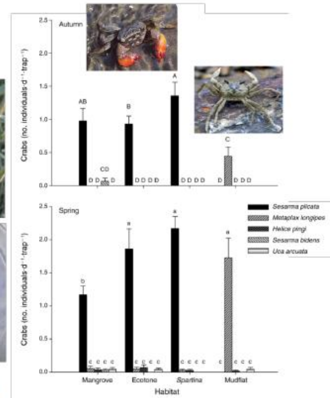
(1) Plant-plant interaction:



Zhang *et al.* (2012) *Ecology*

(2) Plant-animal interaction: crab

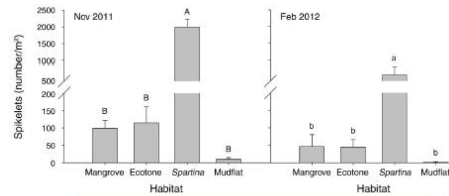
- Field survey

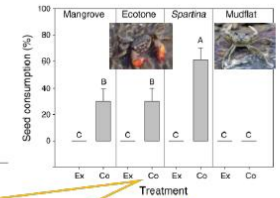


Li *et al.* (2014) *Ecology*

(2) Plant-animal interaction: crab

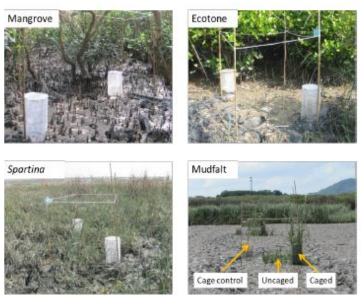
- Seed bank
- Seed predation

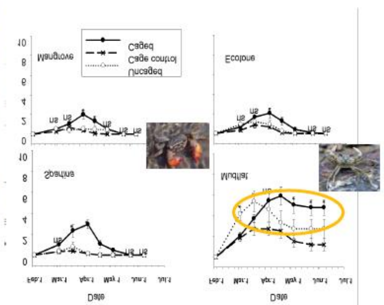




(2) Plant-animal interaction: crab

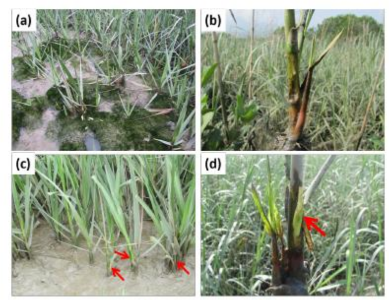
- Herbivory on seedling

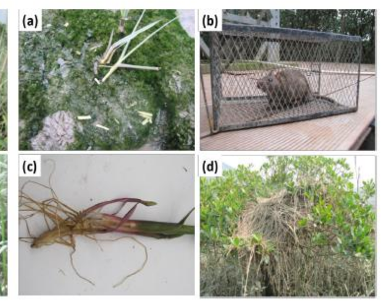




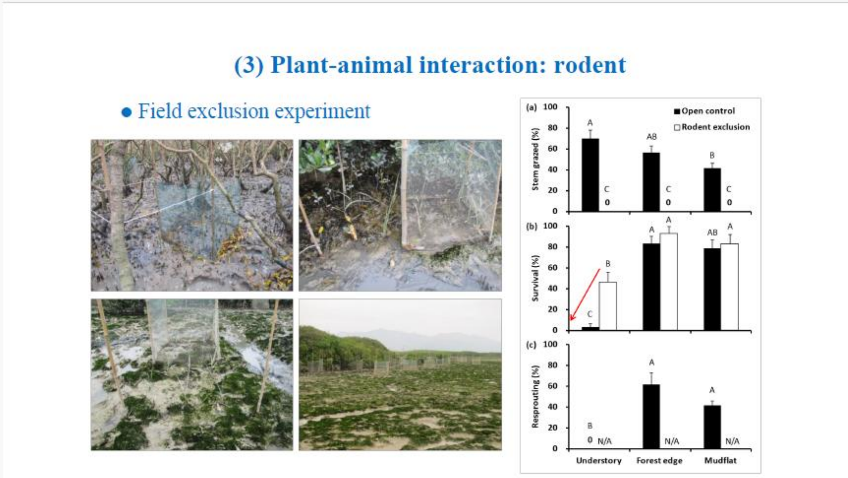
(3) Plant-animal interaction: rodent

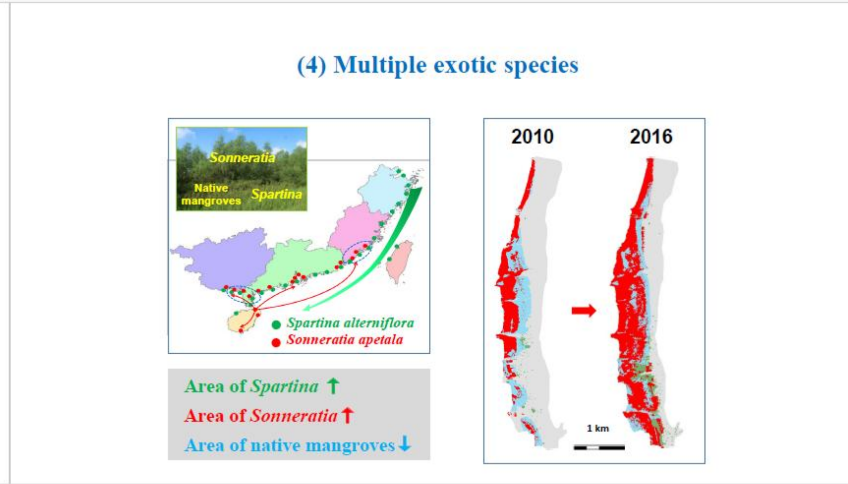
- Ramet grazing
- Rodent activities

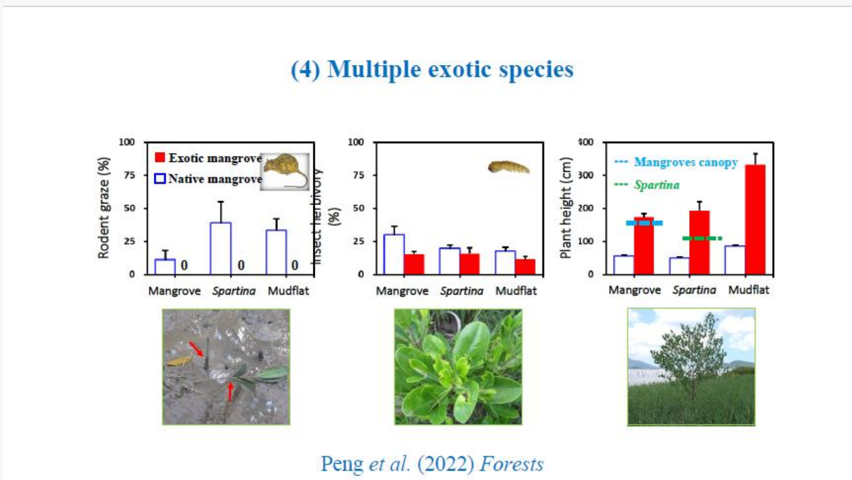


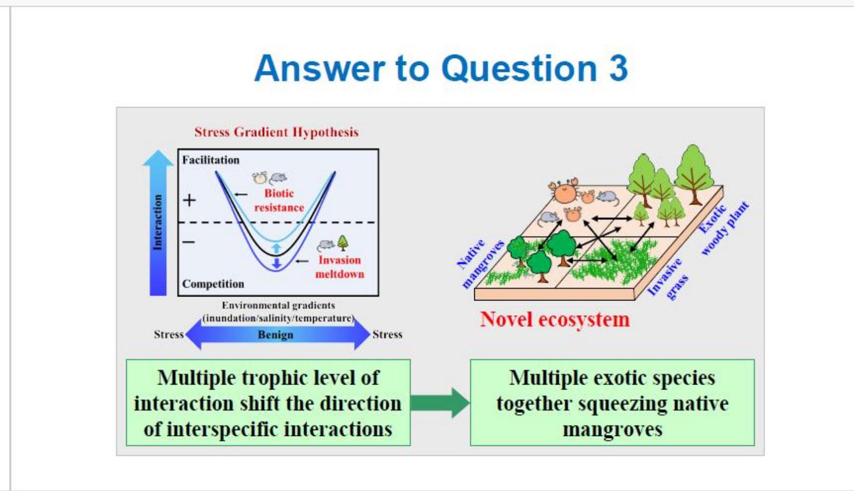


Zhang *et al.* (2018) *Ecology*


(3) Plant-animal interaction: rodent
• Field exclusion experiment
■ Open control
□ Rodent exclusion
Stem grazed (%)
Survival (%)
Resprouting (%)
N/A
Understory
Forest edge
Mudflat


(4) Multiple exotic species
Sonneratia
Native mangroves
Spartina
● Spartina alterniflora
● Sonneratia apetala
Area of Spartina ↑
Area of Sonneratia ↑
Area of native mangroves ↓
2010
2016
1 km


(4) Multiple exotic species
■ Exotic mangrove
□ Native mangrove
Rodent graze (%)
Insect herbivory (%)
Plant height (cm)
--- Mangroves canopy
--- Spartina
Mangrove
Spartina
Mudflat
Peng et al. (2022) Forests


Answer to Question 3
Stress Gradient Hypothesis
Facilitation
Competition
Interaction
Biotic resistance
Invasion meltdown
Environmental gradients (inundation/salinity/temperature)
Stress
Benign
Stress
Native mangroves
Exotic woody plant
Invasive grass
Novel ecosystem
Multiple trophic level of interaction shift the direction of interspecific interactions
Multiple exotic species together squeezing native mangroves

Summary

***Spartina* performance:**

- Genetic and environment shaped the growth and adaptation
- Niche overlap with mangroves in southeast China
- Powerfully suppressed native mangrove seedlings

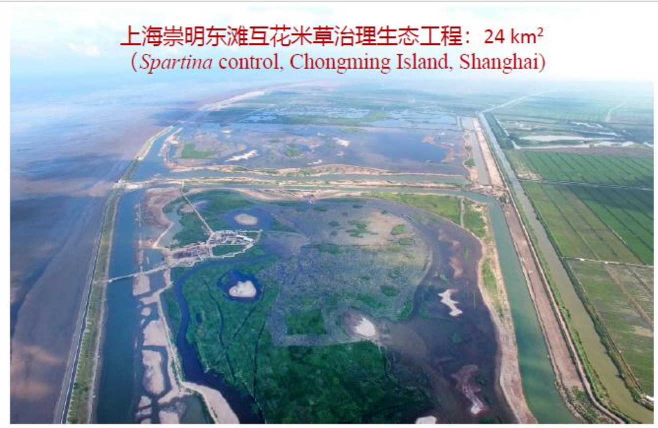
Mangroves resistance:

- Plant competition
- Crab herbivory
- Rodent grazing

Outline

1. Overview
2. Research
3. **Management**

(This slide is from Prof. Don Strong, UC Davis)



(This slide is from Prof. Ruiting Ju, Fudan Universtiy)

NEWS | IN DEPTH

ENVIRONMENT

China battles alien weed at unprecedented scale

"Mammoth" plan to control a coastal invader would benefit migratory birds

By Erik Stokstad

Along its 18,000 kilometers of coastline, China has been taken over by a green invader. Smooth cordgrass (*Spartina alterniflora*) grows tall and thick across tidal mudflats, depriving endangered migratory birds of habitat, clogging shipping channels, and ruining clam farms. Now, China aims to beat back 90% of the weed by 2025. "This is a mammoth undertaking," says Steven Pennings, a coastal ecologist at the University of Houston. "It's audacious."

The nationwide effort, launched last month, "is by far the largest action plan for wetland invasive species control in China and even in the world," says Bo Li, an invasion ecologist at Fudan and Yunnan universities who was not involved in creating the plan. It won't be simple or cheap, costing hundreds of millions of dollars, Li estimates. And schemes to dig up, drown, or poison the weed all have side effects. "It's going to be really difficult," says Sam Reynolds, a biologist at the University of Cambridge.

Spartina, native to eastern North America, was brought to China starting in 1979 to stabilize tidal mudflats and turn them into land for agriculture or development. The plan

from gathering food, Crockford says.

China has already launched smaller scale *Spartina* control projects. Li was involved in a well-known success at the Chongming Dongtan National Nature Reserve. After *Spartina* was planted there in 2001, it ruined habitat for dozens of fish species and migratory birds. To remove the weed, engineers built a seawall and flooded the wetland to drown the grass. By 2018, the project had eliminated 95% of the *Spartina* in 2400 hectares, and native plants and bird populations began to recover. But the price tag was steep: about $150 million, largely for erecting the sea-

Spartina has invaded. None of the possible methods is a sure thing. Releasing insects that eat weeds, a technique called biocontrol, has worked against other plants, but so far researchers have not found anything that can be used against *Spartina* in China. Other techniques have limitations. Flooding, for instance, can starve the sediment of oxygen, which can kill worms and other animals that live in it. Baoshan Cui, an expert in wetland protection and restoration at Beijing Normal University, says waterlogging causes more problems than other strategies, so it should be avoided. But backhoes and other construction equipment, which can drive onto firm mudflats to dig up and bury *Spartina*, compact the mudflats, disturbing the habitat of sediment-dwelling creatures. And herbicides have rarely been used against *Spartina* in China.

Researchers who reviewed 116 studies of *Spartina* control—all of them much smaller than China's plan—found that physical controls such as digging and burying are highly effective in the short term, but the weed grows back. Herbicides worked very well at controlling *Spartina*, but only when applied year after year. Overall, combined methods worked best, Reynolds and other researchers conclude in a preprint. Shengyu Wang of

China is scaling up small projects to remove *Spartina alterniflora*, such as this one in Qingdao, which dug up the weed over 1312 hectares and buried it.

Stokstad (2023) *Science*

Key challenges:

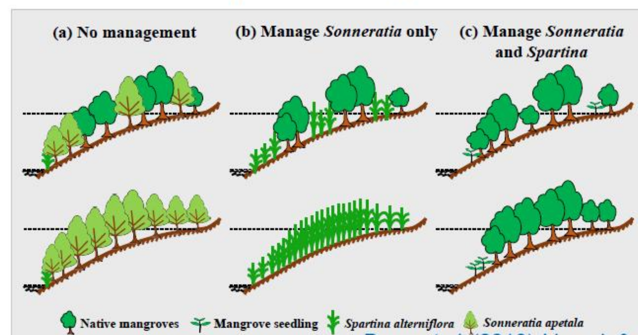
- prevent regrowth
- variety habitats
- combined methods

Dilemma: eliminate *Spartina* vs protect mangroves

Dig up and bury

Plantation mangrove seedlings

Take home messages
—— management of biological invasion



Peng *et al.* (2018) *Limnol. & Oceanogr.*

Conclusions and prospections

Research:

- Long-term observation and field manipulate experiment
- Traits of native mangrove species and adaptation
- Theory on coastal biological invasions

Practice:

- Combined methods of alien species control
- Afforestation of native mangrove species
- Ecosystem service and function

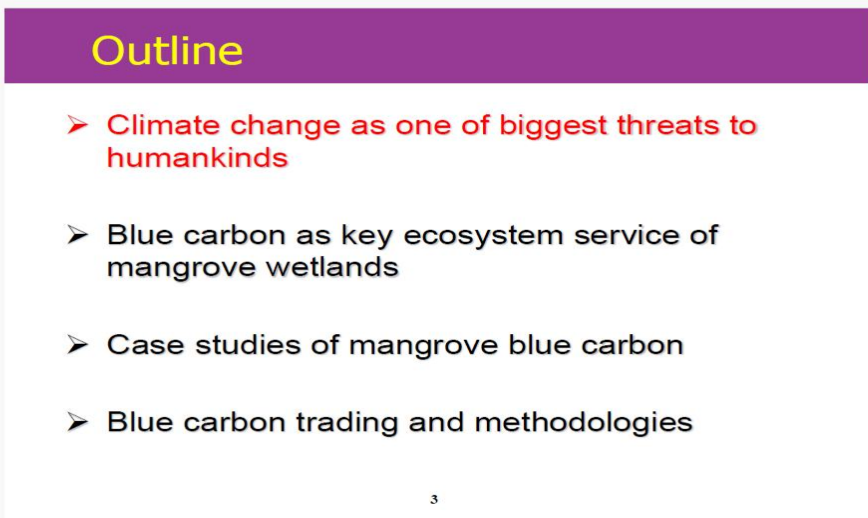
Acknowledgements

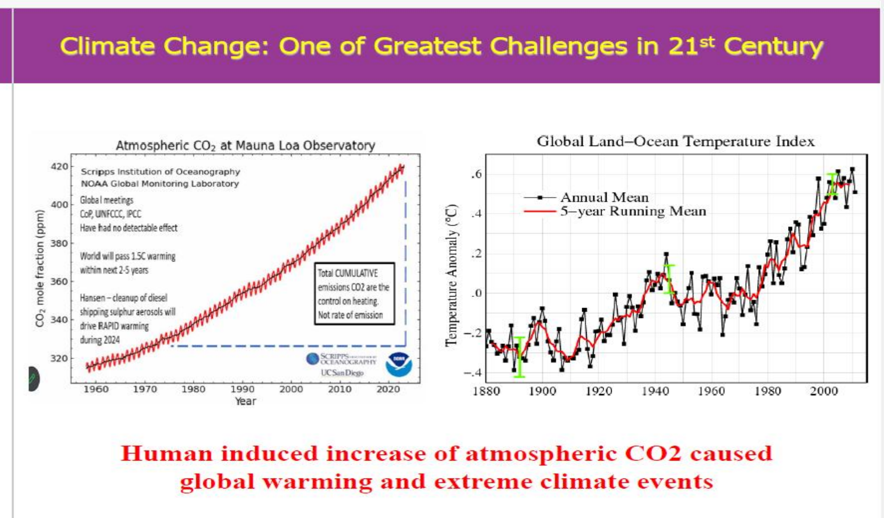
NSFC
National Natural Science Foundation of China

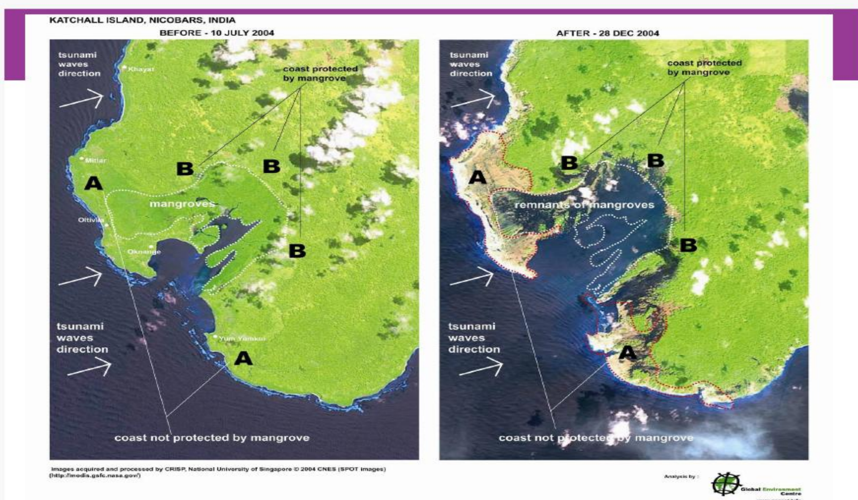
Donald Strong (UC Davis)

Steven Pennings (UH)

- **Lecture 9: Mangrove Conservation and Climate Change**

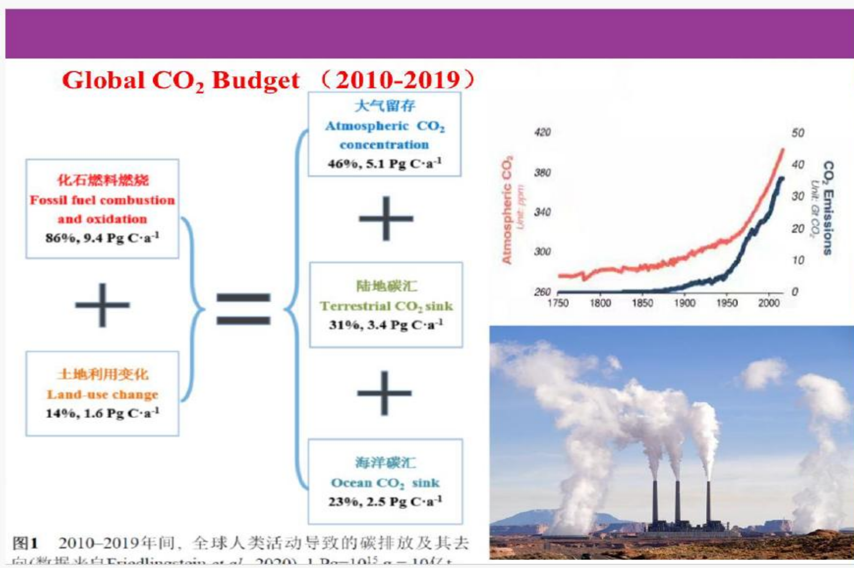


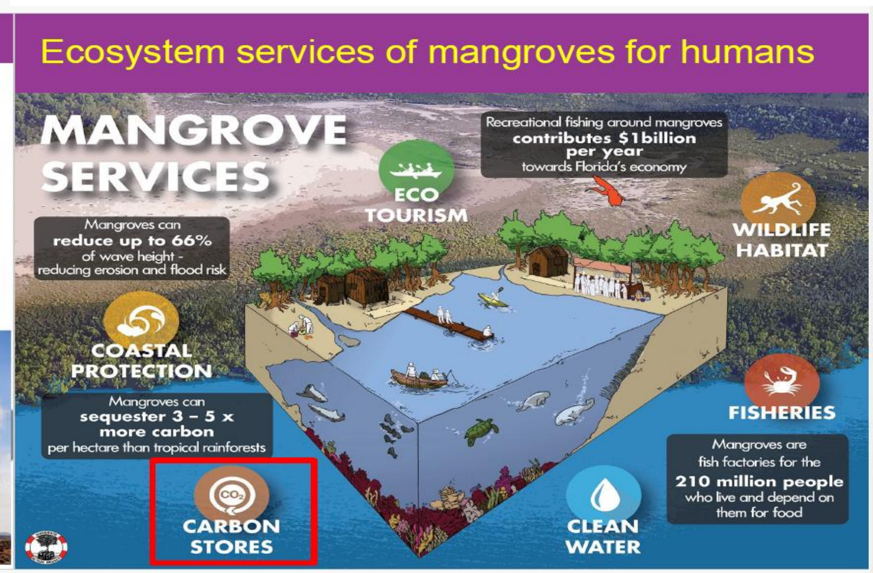




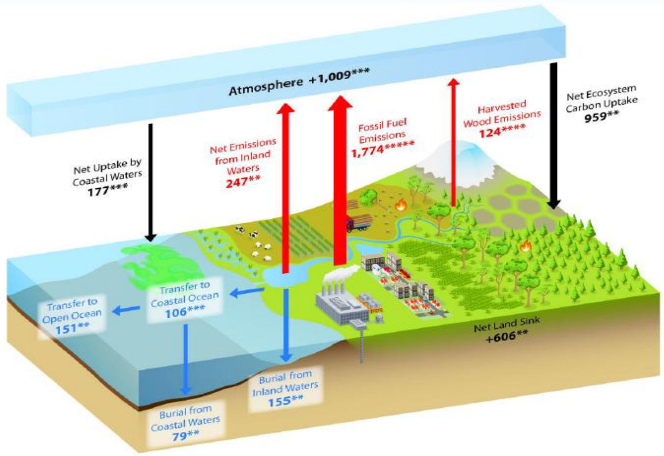
The 2004 tsunami broken a long boat jetty in to pieces, while mangroves intact without damage in Parangipettai, south east India


Public Interest
Source: The Star newspaper, Malaysia
Focus 31
Save mangroves to fight tsunamis
GLOBAL TRENDS
By Martin Khor
Nation 21
Mangroves can protect coasts
Tsunami Aftermath
Natural barriers against tsunamis


Global CO_2 Budget （2010-2019）
化石燃料燃烧
Fossil fuel combustion and oxidation
86%, 9.4 Pg C·a⁻¹
土地利用变化
Land-use change
14%, 1.6 Pg C·a⁻¹
大气留存
Atmospheric CO_2 concentration
46%, 5.1 Pg C·a⁻¹
陆地碳汇
Terrestrial CO_2 sink
31%, 3.4 Pg C·a⁻¹
海洋碳汇
Ocean CO_2 sink
23%, 2.5 Pg C·a⁻¹
Atmospheric CO_2
CO_2 Emissions
1750 1800 1850 1900 1950 2000
图1 2010–2019年间，全球人类活动导致的碳排放及其去


Ecosystem services of mangroves for humans
MANGROVE SERVICES
ECO TOURISM
Recreational fishing around mangroves contributes $1billion per year towards Florida's economy
WILDLIFE HABITAT
Mangroves can reduce up to 66% of wave height - reducing erosion and flood risk
COASTAL PROTECTION
Mangroves can sequester 3 – 5 x more carbon per hectare than tropical rainforests
FISHERIES
Mangroves are fish factories for the 210 million people who live and depend on them for food
CARBON STORES
CLEAN WATER

Global Carbon Cycle



Key definitions

- **Carbon sink**: a natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period.
- **Carbon sequestration**: the process by which carbon sinks remove carbon dioxide (CO_2) from the atmosphere
- **Carbon source**: the process, activity and mechanism for the release of CO2 into the atmosphere.

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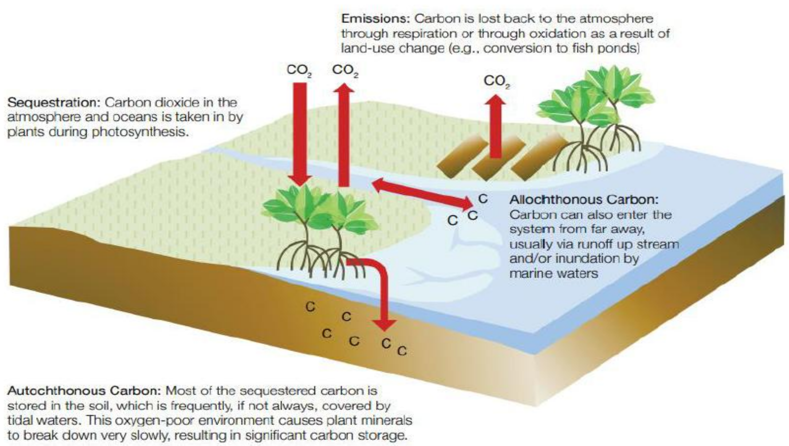
Key definitions



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Key definitions

- **Carbon Pool** – Carbon pools refer to carbon reservoirs such as soil, vegetation, water, and the atmosphere that absorb and release carbon. together carbon pools make up a carbon stock.
- **Carbon Stock** – A carbon stock is the total amount of organic carbon stored in a blue carbon ecosystem of a known size. A carbon stock is the sum of one or more carbon pools.
- **Soil Organic Carbon** – the term soil organic carbon refers to the carbon component of the soil organic matter. the amount of soil organic carbon depends on soil texture, climate, vegetation and historical and current land use/management.
- **Emission Factors** – A term used to describe changes in the carbon content of a pre-deffned area due to change in land coverage and use (i.e., conversion from mangroves to shrimp ponds) or changes within a land use type (i.e., nutrient enrichment of seagrass).

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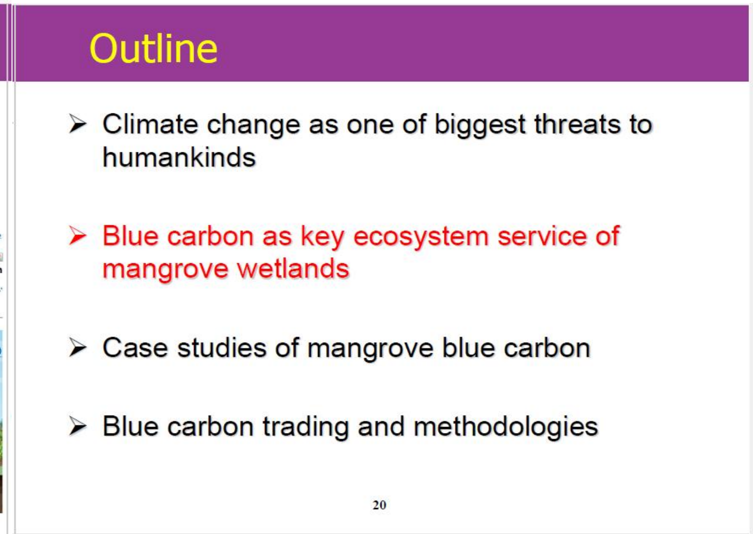
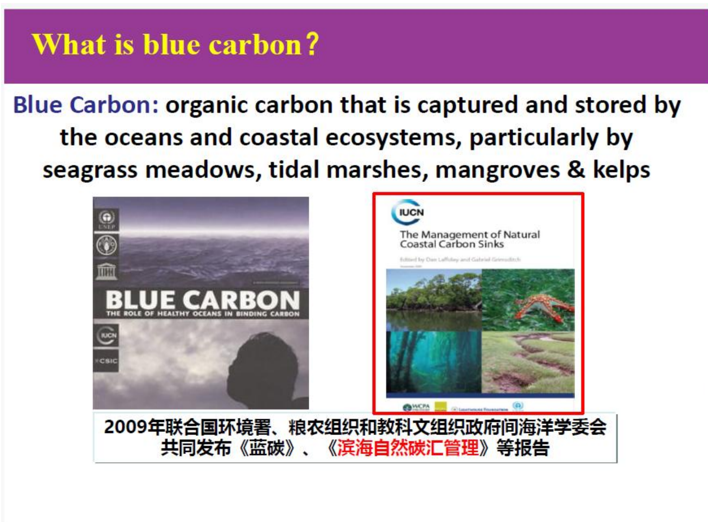
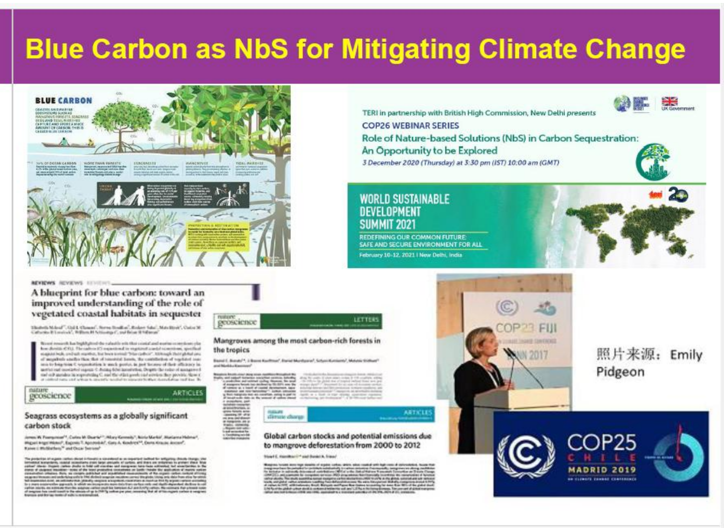
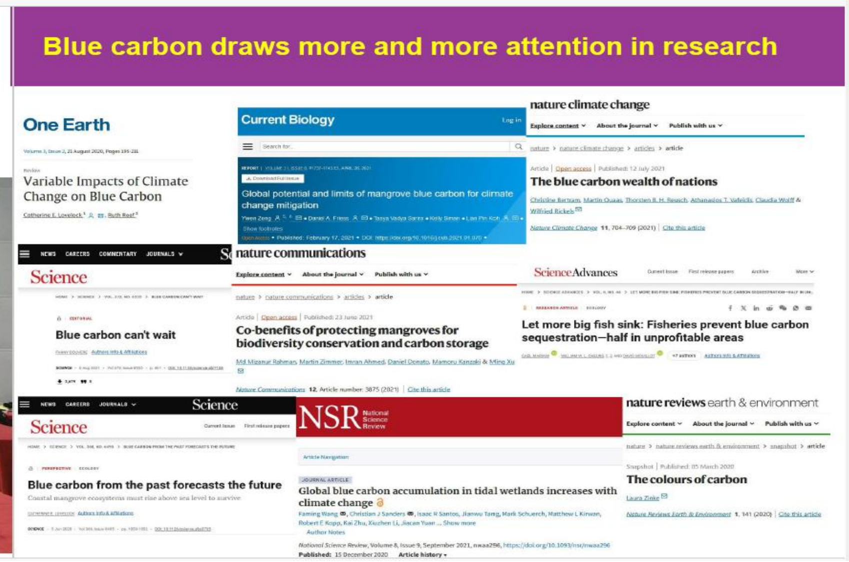
Conserve and restore coastal wetlands for blue C as carbon neutrality techniques
The Innovation
Review
Technologies and perspectives for achieving carbon neutrality
Coastal blue carbon in China as a nature-based solution toward carbon neutrality
GRAPHICAL ABSTRACT
17

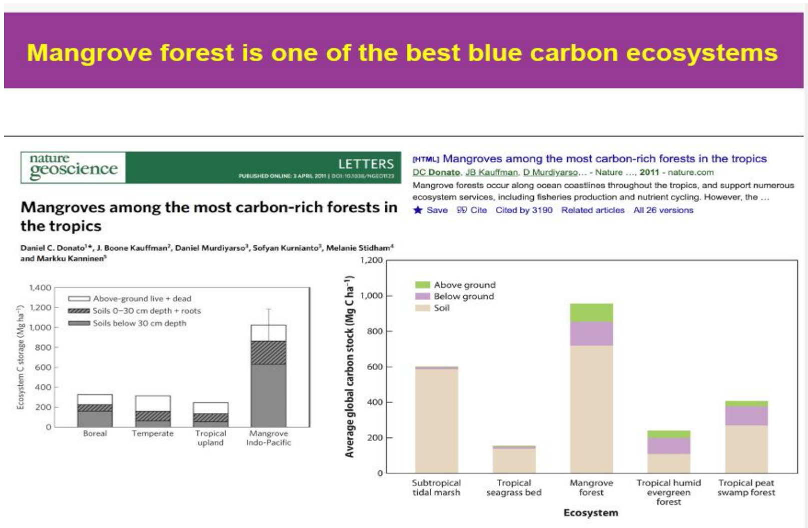

Outline
➢ Climate change as one of biggest threats to humankinds
➢ Blue carbon as key ecosystem service of mangrove wetlands
➢ Case studies of mangrove blue carbon
➢ Blue carbon trading and methodologies
20

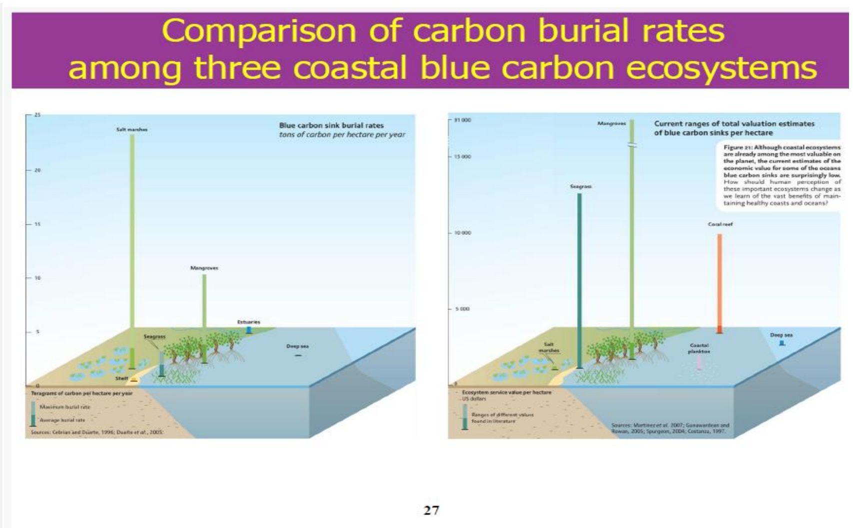

What is blue carbon?
Blue Carbon: organic carbon that is captured and stored by the oceans and coastal ecosystems, particularly by seagrass meadows, tidal marshes, mangroves & kelps
BLUE CARBON
THE ROLE OF HEALTHY OCEANS IN BINDING CARBON
IUCN
The Management of Natural Coastal Carbon Sinks
2009年联合国环境署、粮农组织和教科文组织政府间海洋学委会
共同发布《蓝碳》、《滨海自然碳汇管理》等报告


Blue Carbon as NbS for Mitigating Climate Change
BLUE CARBON
TERI in partnership with British High Commission, New Delhi presents
COP26 WEBINAR SERIES
Role of Nature-based Solutions (NbS) in Carbon Sequestration:
An Opportunity to be Explored
3 December 2020 (Thursday) at 3:30 pm (IST) 10:00 am (GMT)
WORLD SUSTAINABLE DEVELOPMENT SUMMIT 2021
REDEFINING OUR COMMON FUTURE: SAFE AND SECURE ENVIRONMENT FOR ALL
February 10-12, 2021 | New Delhi, India
A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequester
Mangroves among the most carbon-rich forests in the tropics
Seagrass ecosystems as a globally significant carbon stock
Global carbon stocks and potential emissions due to mangrove deforestation from 2000 to 2012
COP23 FIJI
COP25 CHILE MADRID 2019
照片来源：Emily Pidgeon


2nd International Symposium: Effects of Climate Change on the World's Oceans
Monday, May 14 - W3
Workshop 3 (W3)
Coastal Blue Carbon: Mitigation opportunities and vulnerability to change
Co-Convenors:
Ik Kyo Chung (PNU, Korea)
Gabriel Grimsditch (UNEP)
Jerker Tamelander (UNEP)
BLUE CARBON


Blue carbon draws more and more attention in research
One Earth
Variable Impacts of Climate Change on Blue Carbon
Current Biology
Global potential and limits of mangrove blue carbon for climate change mitigation
nature climate change
The blue carbon wealth of nations
Science
Blue carbon can't wait
nature communications
Co-benefits of protecting mangroves for biodiversity conservation and carbon storage
Science Advances
Let more big fish sink: Fisheries prevent blue carbon sequestration—half in unprofitable areas
Science
Blue carbon from the past forecasts the future
NSR
Global blue carbon accumulation in tidal wetlands increases with climate change
nature reviews earth & environment
The colours of carbon


Mangrove forest is one of the best blue carbon ecosystems
nature geoscience
LETTERS
Mangroves among the most carbon-rich forests in the tropics
Daniel C. Donato, J. Boone Kauffman, Daniel Murdiyarso, Sofyan Kurnianto, Melanie Stidham and Markku Kanninen
[HTML] Mangroves among the most carbon-rich forests in the tropics
DC Donato, JB Kauffman, D Murdiyarso... - Nature ..., 2011 - nature.com
Mangrove forests occur along ocean coastlines throughout the tropics, and support numerous ecosystem services, including fisheries production and nutrient cycling. However, the ...
Save Cite Cited by 3190 Related articles All 26 versions
Above-ground live + dead
Soils 0–30 cm depth + roots
Soils below 30 cm depth
Ecosystem C storage (Mg ha⁻¹)
Boreal
Temperate
Tropical upland
Mangrove Indo-Pacific
Above ground
Below ground
Soil
Average global carbon stock (Mg C ha⁻¹)
Subtropical tidal marsh
Tropical seagrass bed
Mangrove forest
Tropical humid evergreen forest
Tropical peat swamp forest
Ecosystem


Comparison of carbon burial rates
among three coastal blue carbon ecosystems
Blue carbon sink burial rates
tons of carbon per hectare per year
Current ranges of total valuation estimates of blue carbon sinks per hectare
27

Indus Delta Blue Carbon: Net CO_2 Removals

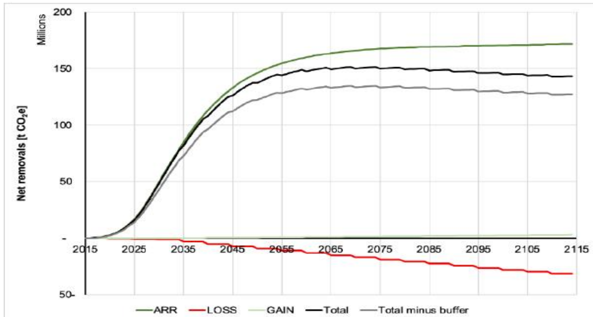


Figure 26. Summary of net GHG emissions in t CO_2e since the project start date in 2015. ARR: Net GHG removals as a result of mangrove reforestation; LOSS: Carbon loss in biomass and soil as a result of erosion due to sea level rise; GAIN: Net removals as a result of mangrove establishment in new mangrove habitats due to sea level rise.

Outline

- ➢ Climate change as one of biggest threats to humankinds
- ➢ Blue carbon as key ecosystem service of mangrove wetlands
- ➢ Case studies of mangrove blue carbon
- ➢ Blue carbon trading and methodologies

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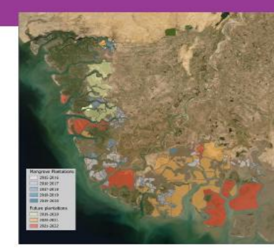
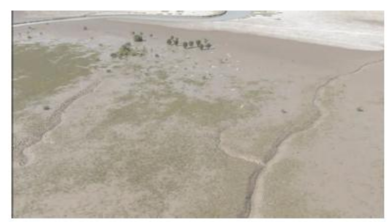
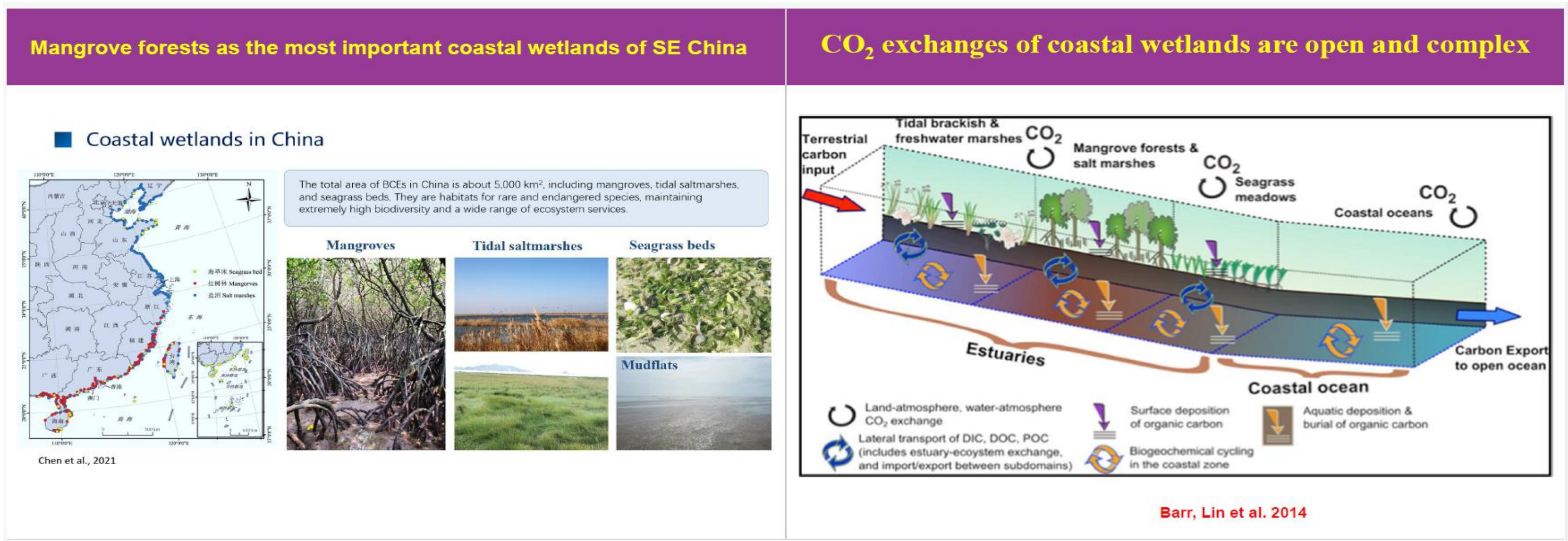
Example： Indus Delta Blue Carbon Project

Indus Delta BC Project

- ◆ Restoration of 224,997 ha of mangroves
  75,000 ha already planted
- ◆ 60 year long project: 2015 - 2075
- ◆ Approximately 1 BILLION mangroves planted over 12 years
- ◆ Estimated 140 million t CO_2e removals over 60 years
- ◆ Applied Landsat, SRTM, field survey and calibration.






Mangrove forests as the most important coastal wetlands of SE China
Coastal wetlands in China
The total area of BCEs in China is about 5,000 km², including mangroves, tidal saltmarshes, and seagrass beds. They are habitats for rare and endangered species, maintaining extremely high biodiversity and a wide range of ecosystem services.
Mangroves
Tidal saltmarshes
Seagrass beds
Mudflats
Chen et al., 2021
CO₂ exchanges of coastal wetlands are open and complex
Terrestrial carbon input
Tidal brackish & freshwater marshes
CO₂
Mangrove forests & salt marshes
CO₂
Seagrass meadows
CO₂
Coastal oceans
Estuaries
Coastal ocean
Carbon Export to open ocean
Land-atmosphere, water-atmosphere CO₂ exchange
Lateral transport of DIC, DOC, POC (includes estuary-ecoystem exchange, and import/export between subdomains)
Surface deposition of organic carbon
Biogeochemical cycling in the coastal zone
Aquatic deposition & burial of organic carbon
Barr, Lin et al. 2014

Key techniques for measuring blue carbon

- **Stock Difference Method – this method estimates the difference in carbon stocks measured at two points in time and results in tier 3 estimates.**
- **Gain-loss Method – this method estimates the difference in carbon stocks based on emissions factors for speciffc activities (e.g., plantings, drainage, rewetting, deforestation) derived from the scientiffc literature and country activity data and results in tier 1 and 2 estimates.**
- **Flux Method – this method estimates the effux between the soil and vegetation and the atmosphere/water column through direct measurements or by modeling and results in tier 2 and 3 estimates.**

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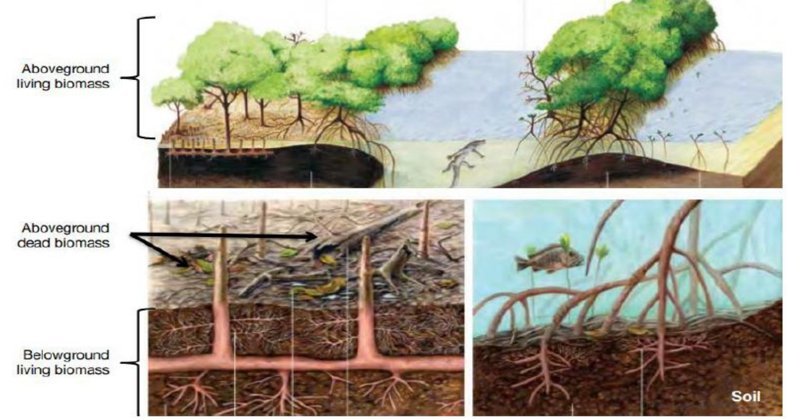
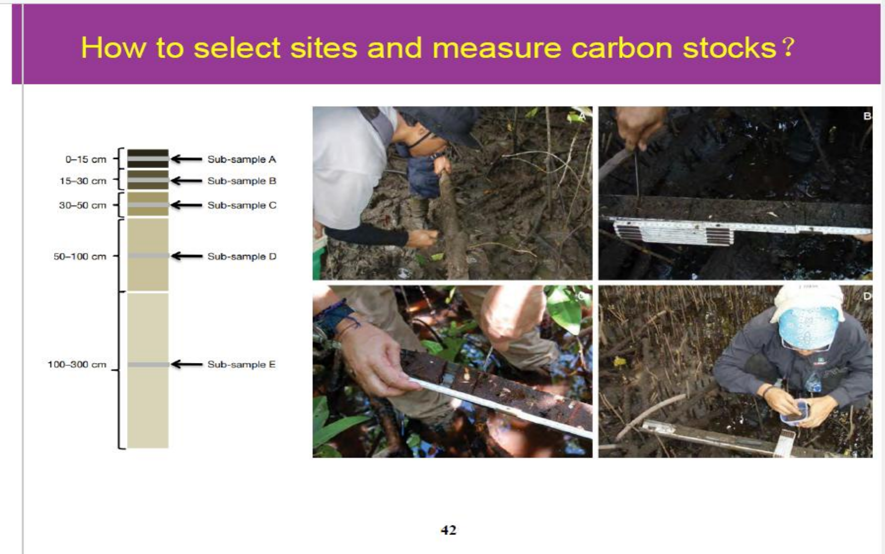
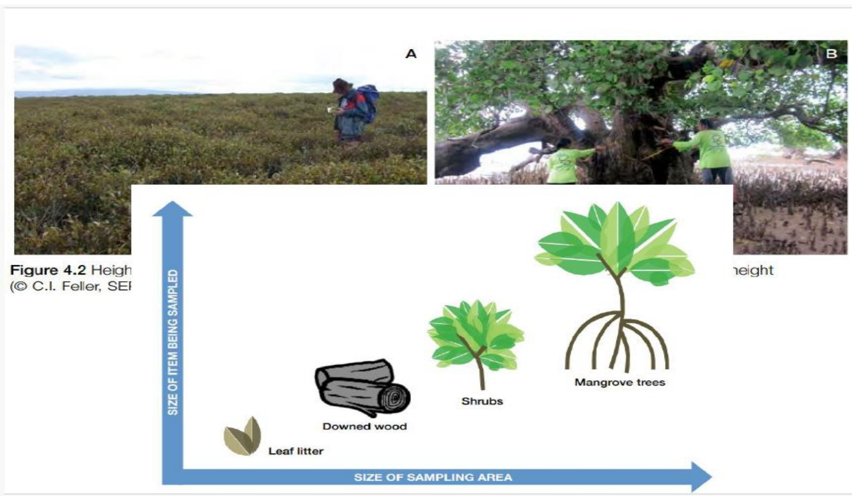
How to select sites and measure carbon stocks？

How to select sites and measure carbon stocks？




A
B
C
D
Figure 4.1 Classification of mangroves. (A) Oceanic fringing mangroves (© Enrico Marone, CI), (B) Riverine or estuarine mangroves (© Ginny Farmer, CI), (C) Basin mangroves (© Colin Foster, CI), and (D) Dwarf or scrub mangroves (© Catherine Lovelock, UQ.)


How to select sites and measure carbon stocks？
0–15 cm
15–30 cm
30–50 cm
50–100 cm
100–300 cm
Sub-sample A
Sub-sample B
Sub-sample C
Sub-sample D
Sub-sample E
B
D
42


A
B
Figure 4.2 Heigh
(© C.I. Feller, SEI
eight
SIZE OF ITEM BEING SAMPLED
Mangrove trees
Shrubs
Downed wood
Leaf litter
SIZE OF SAMPLING AREA

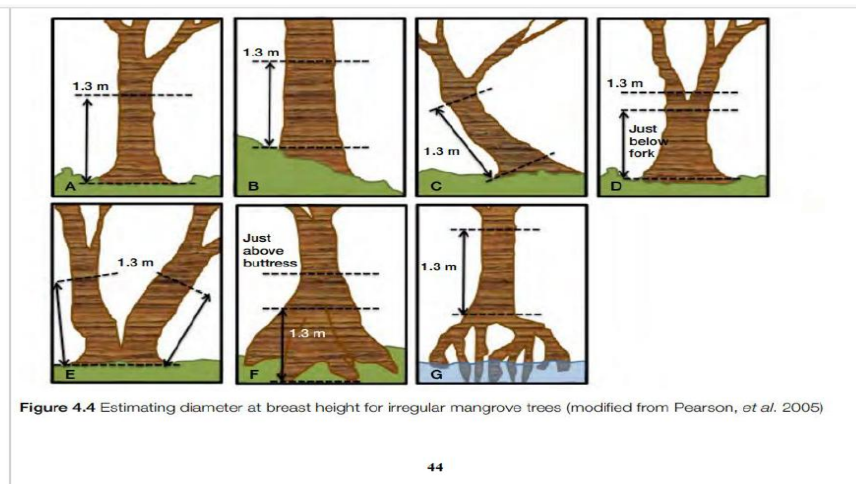

1.3 m
1.3 m
1.3 m
1.3 m
Just below fork
A
B
C
D
1.3 m
Just above buttress
1.3 m
1.3 m
E
F
G
Figure 4.4 Estimating diameter at breast height for irregular mangrove trees (modified from Pearson, et al. 2005)
44

Figure 4.10 Pneumatophores. (A) Measuring pneumatophore height, (B) Pneumatophores can be measured n or next to microplots. These microplots can be the same plots used to sample litter (described below). © Boone Kauffman, OSU)

45

Examples

- How much carbon is stored in the biomass and top 1 m of soil in 564 hectares of mangrove forests on your project site?
- And how does that relate to CO_2 emissions if all the organic carbon in the upper 1 m of sediment is oxidized to carbon dioxide?

Total Carbon (MgC/ha) * Area (ha) = Tier 1 total carbon stock for the project site (Mg)

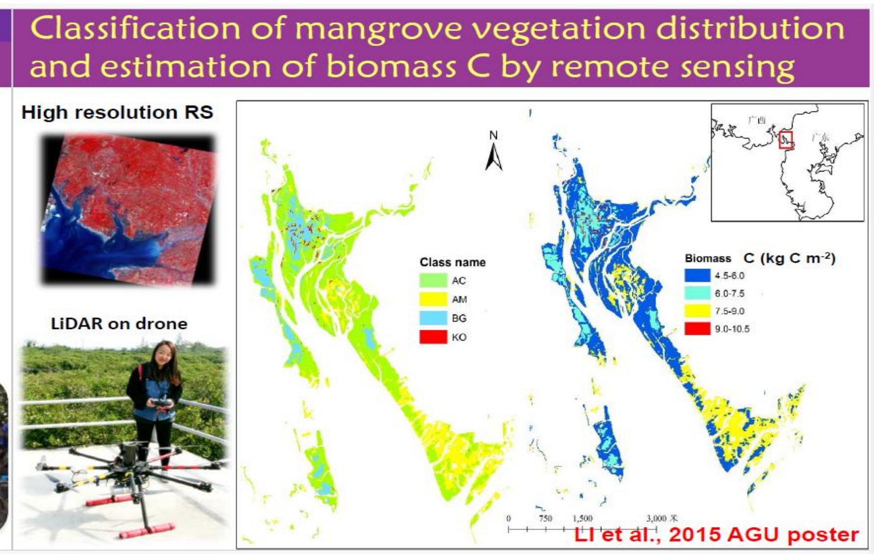
- Where Total Carbon = the mean carbon stock for a given ecosystem (from **Table 1.2**)
- Area = the area of the ecosystem being investigated

Total potential CO_2 emissions per hectare (Mg CO_2/ha) = Conversion factor for the CO_2 that can be produced from the carbon present in the system * carbon in the system

- Conversion factor = 3.67, the ratio of the molecular weights of CO_2 (44) and carbon (12)
- Carbon in the system = the mean carbon stock for a given ecosystem

Answer to the second question

- *217,704 Mg of Blue Carbon * 3.67 = 798,974 Mg CO_2 in the study area*



Key techniques for measuring blue carbon

- **Stock Difference Method – this method estimates the difference in carbon stocks measured at two points in time and results in tier 3 estimates.**
- **Gain-loss Method – this method estimates the difference in carbon stocks based on emissions factors for speciffc activities (e.g., plantings, drainage, rewetting, deforestation) derived from the scientiffc literature and country activity data and results in tier 1 and 2 estimates.**
- **Flux Method – this method estimates the effux between the soil and vegetation and the atmosphere/water column through direct measurements or by modeling and results in tier 2 and 3 estimates.**

51

FOR EXAMPLE

- Measurements taken from a 1,000 ha salt marsh site in 2002 (T1) estimated the total carbon stock to be 34,667 Mg C.
- In 2007: 200 ha were drained resulting in an emissions rate = 7.9 Mg C/ha/yr (IPCC 2013, **Table 4.13**, p. 31)
- In 2010: 50 ha were rewetted resulting in an emissions rate = -0.91 Mg C/ha/yr (IPCC 2013, **Table 4.12**, p. 29)
- Second assessment conducted in 2012 (T2)
- Assuming all else remained the same carbon stock change can be estimated as follows:
  - (200 ha * 7.9 Mg C/ha/yr) * (2010-2007) = 4,740 Mg C
  - (150 ha * 7.9 Mg C/ha/yr) * (2012-2010) = 2,370 Mg C
  - (50 ha * -0.91 Mg C/ha/yr) * (2012-2010) = -91 Mg C
- Total carbon difference = 4,740 Mg C + 2,370 Mg C + -91 Mg C = 7,019 Mg C lost
- Associated CO_2 emissions = 7,019 Mg C * 3.67 (conversion factor) = 25,739 Mg CO_2

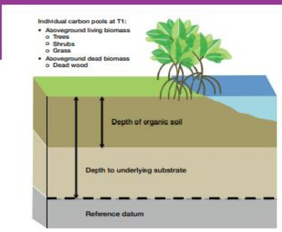


Figure 5.1 Establishing a soil volume reference datum

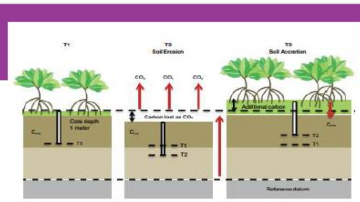
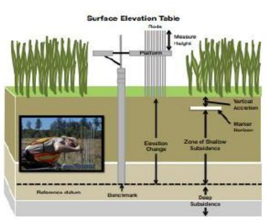


Figure 5.2 Effect of accretion and erosion on soil samples. A reference datum is usually given the designation "0," and future measurements should refer to it. For example, soil accretion of 3 cm at T2 would be reported as "+3 cm relative to the datum" where the initial datum would also be reported. Note that the "0" reference datum in this example is established by measuring the distance to a second, primary reference datum below the soil surface. The primary reference may be bedrock or a distinct soil layer such as clay (**Fig. 5.1**), or the bottom of an SET benchmark (**Fig. 5.3**).



EXAMPLE

- Rod height at T1 = 100.46 cm
- Rod height at T2 = 100.98 cm
  - Elevation change = 100.98 cm – 100.46 cm = 0.52 cm = 5.2 mm (common unit used for describing elevation changes in soil and sea level)
- Depth of the marker horizon at T1 = 0
  - The marker horizon is established during the first assessment
- Depth of the marker horizon at T2 = 8.6 mm
  - Vertical accretion = 8.6 mm – 0 mm = 8.6 mm
- Shallow subsidence = Vertical accretion – elevation change
  - 8.6 mm – 5.2 mm = 3.4 mm

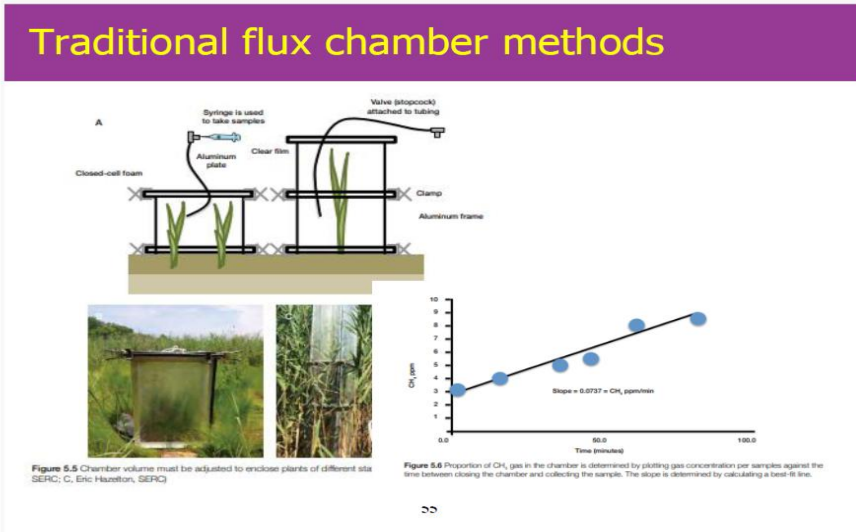
In the case of soil accretion, the top sub-sample is used to determine the change in the soil carbon due to change in the soil volume (Lovelock *et al.* 2014).

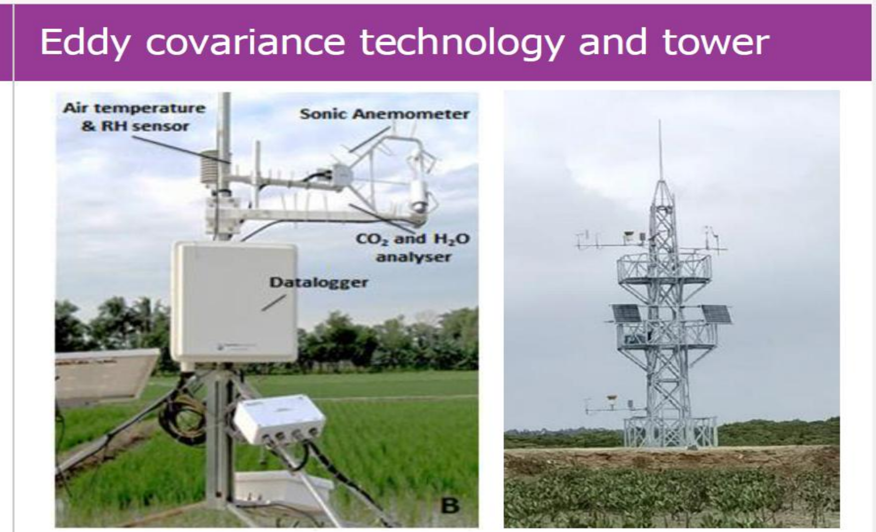
53

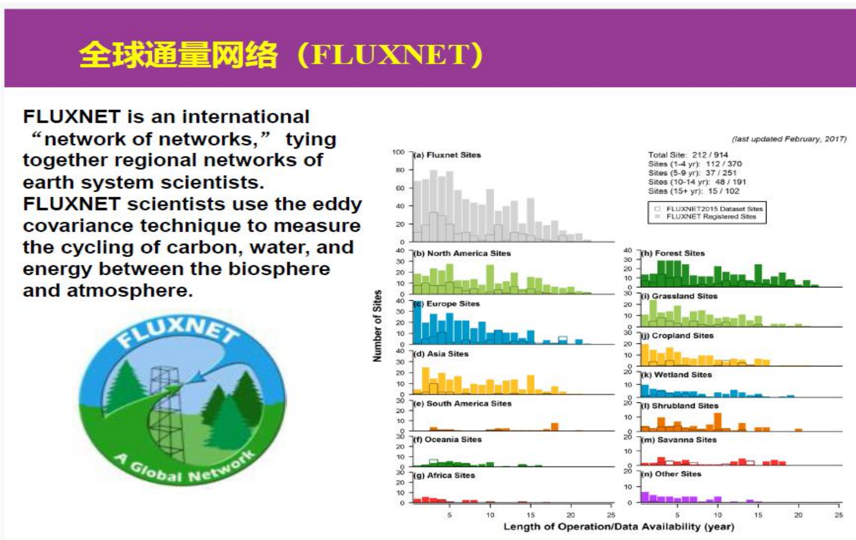
Key techniques for measuring blue carbon

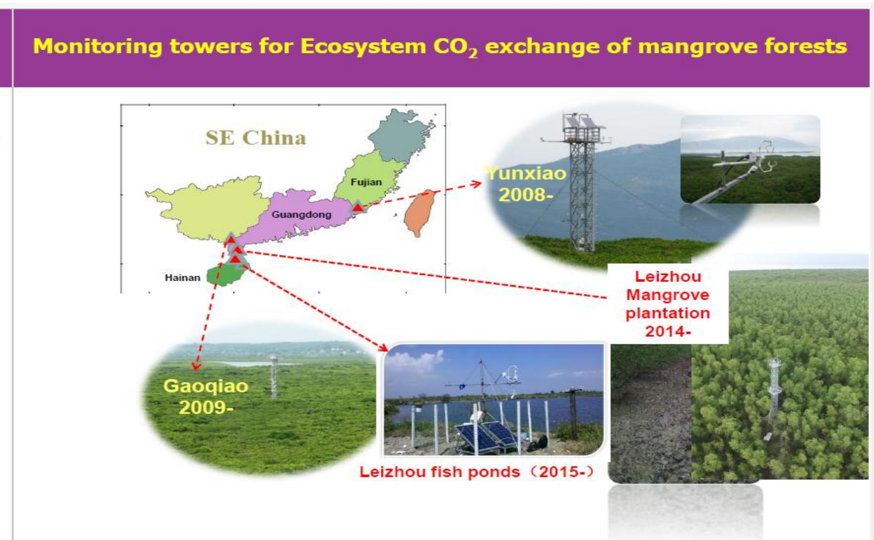
- **Stock Difference Method – this method estimates the difference in carbon stocks measured at two points in time and results in tier 3 estimates.**
- **Gain-loss Method – this method estimates the difference in carbon stocks based on emissions factors for speciffc activities (e.g., plantings, drainage, rewetting, deforestation) derived from the scientiffc literature and country activity data and results in tier 1 and 2 estimates.**
- **Flux Method – this method estimates the effux between the soil and vegetation and the atmosphere/water column through direct measurements or by modeling and results in tier 2 and 3 estimates.**

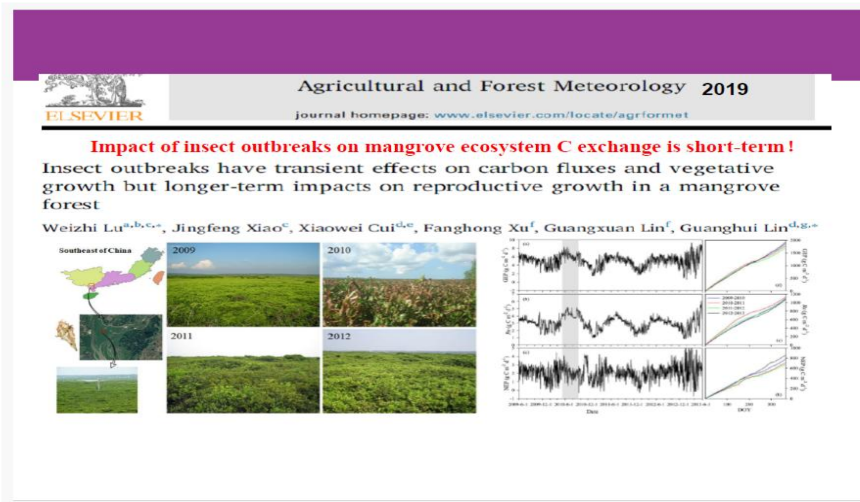
54

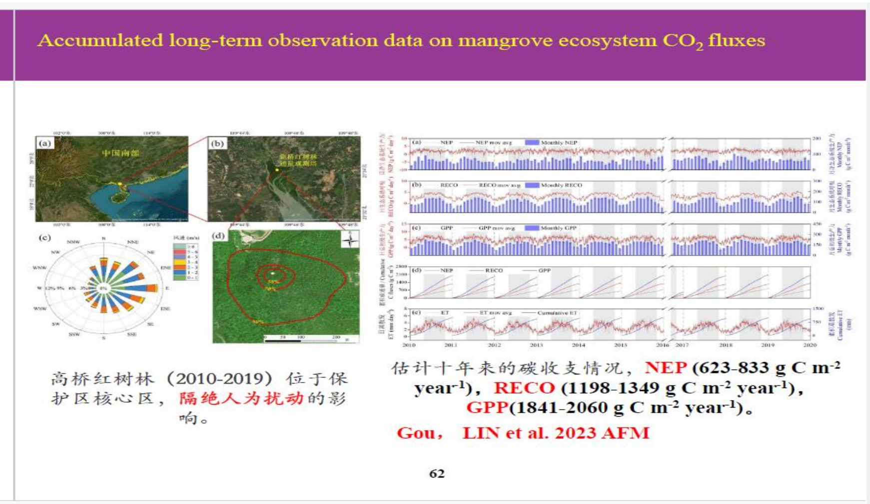

Traditional flux chamber methods
Syringe is used to take samples
Valve (stopcock) attached to tubing
Aluminum plate
Clear film
Closed-cell foam
Clamp
Aluminum frame
Slope = 0.0737 = CH4 ppm/min
Time (minutes)

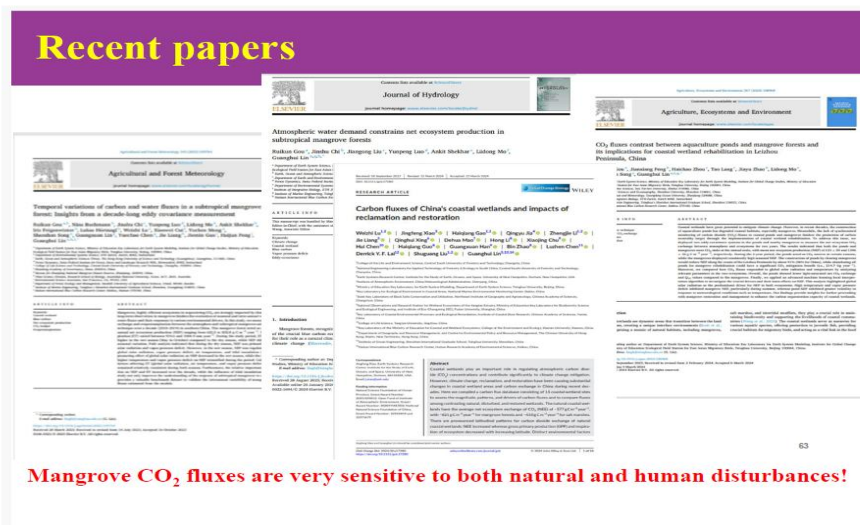

Eddy covariance technology and tower
Air temperature & RH sensor
Sonic Anemometer
CO2 and H2O analyser
Datalogger
B

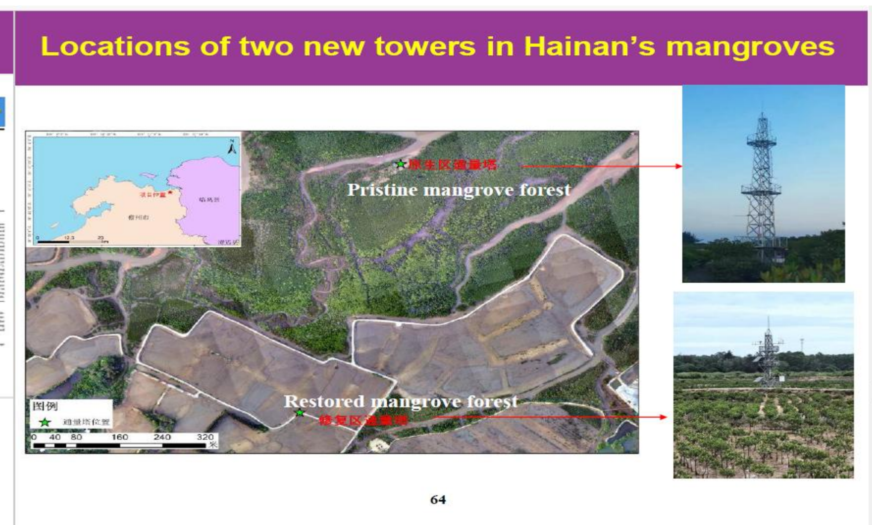

全球通量网络（FLUXNET）
FLUXNET is an international "network of networks," tying together regional networks of earth system scientists.
FLUXNET scientists use the eddy covariance technique to measure the cycling of carbon, water, and energy between the biosphere and atmosphere.
FLUXNET
A Global Network
(last updated February, 2017)
Number of Sites
Length of Operation/Data Availability (year)


Monitoring towers for Ecosystem CO2 exchange of mangrove forests
SE China
Fujian
Guangdong
Hainan
Yunxiao 2008-
Leizhou Mangrove plantation 2014-
Gaoqiao 2009-
Leizhou fish ponds（2015-）


Agricultural and Forest Meteorology 2019
journal homepage: www.elsevier.com/locate/agrformet
ELSEVIER
Impact of insect outbreaks on mangrove ecosystem C exchange is short-term!
Insect outbreaks have transient effects on carbon fluxes and vegetative growth but longer-term impacts on reproductive growth in a mangrove forest
Weizhi Lu, Jingfeng Xiao, Xiaowei Cui, Fanghong Xu, Guangxuan Lin, Guanghui Lin
Southeast of China
2009
2010
2011
2012


Accumulated long-term observation data on mangrove ecosystem CO_2 fluxes
高桥红树林（2010-2019）位于保护区核心区，隔绝人为扰动的影响。
估计十年来的碳收支情况，NEP (623-833 g C m-2 year-1)，RECO (1198-1349 g C m-2 year-1)，GPP(1841-2060 g C m-2 year-1)。
Gou， LIN et al. 2023 AFM
62


Recent papers
Journal of Hydrology
Atmospheric water demand constrains net ecosystem production in subtropical mangrove forests
Agricultural and Forest Meteorology
Temporal variations of carbon and water fluxes in a subtropical mangrove forest: Insights from a decade-long eddy covariance measurement
Carbon fluxes of China's coastal wetlands and impacts of reclamation and restoration
Agriculture, Ecosystems and Environment
CO_2 fluxes contrast between aquaculture ponds and mangrove forests and its implications for coastal wetland rehabilitation in Leizhou Peninsula, China
63
Mangrove CO_2 fluxes are very sensitive to both natural and human disturbances!


Locations of two new towers in Hainan's mangroves
Pristine mangrove forest
Restored mangrove forest
图例
0 40 80 160 240 320
64

Launch of a new consortium: CBCC

Mission of CBCC:

- ✓ Work together for BC
- ✓ Standardize the methods
- ✓ Share the data
- ✓ Publish influential papers
- ✓ Train new scientists
- ✓ Serve the needs of whole country and local communities

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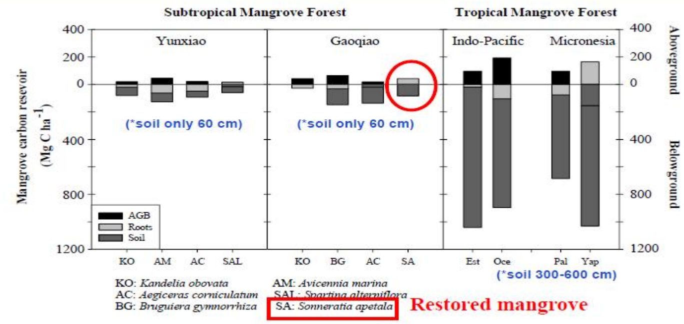
Comparison of mangrove carbon density between China and Indonesia



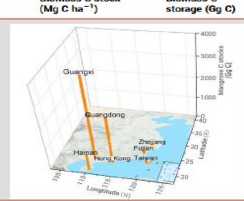
Mangrove forests in subtropical region have much less C reservoir than those in tropics. The C pool size is comparable with tropical upland ecosystems!

Donato et al. 2011 Nature Geoscience; Gao et al. 2019 Global Ecology and Conservation; Meng et al. 2022 Global Ecology and Biogeography

Estimation of blue C stocks and burial rates mangroves of China

Table 1. The distribution, average C stock, C storage, and C burial of mangroves in China

Province	Area (ha)	Soil C stock (Mg C ha^{-1})	Soil C storage (Gg C)	Biomass C stock (Mg C ha^{-1})	Biomass C storage (Gg C)	Total C storage (Gg C)	C burial (Gg C a^{-1})
Zhejiang	106	103.86	11			19	0.21
Fujian	827	103.86	86			149	1.6
Guangdong	9,205	142.13	1,308			1,920	17.86
Guangxi	11,251	255.59	2,876			3,940	21.83
Hainan	3,630	159.10	578			733	7.04
Hong Kong	104	142.13	15			22	0.2
Macao	13	142.13	2			3	0
Taiwan	736	103.86	76			132	1.43
Total	25,872		4,951			6,918	50.17



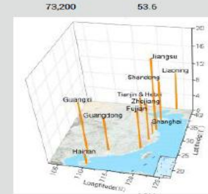
The area data sourced from Mao et al.,[27] the biomass and soil C stock sourced from Fu et al.,[38] C burial data sourced from Wang et al.[65] 1 Tg = 10^3 Gg = 10^6 Mg = 10^9 kg = 10^{12} g.

69

Carbon stocks and burial rate of tidal flats in China

Table 4. The distribution, average C stock, C storage, and C burial of tidal flats in China

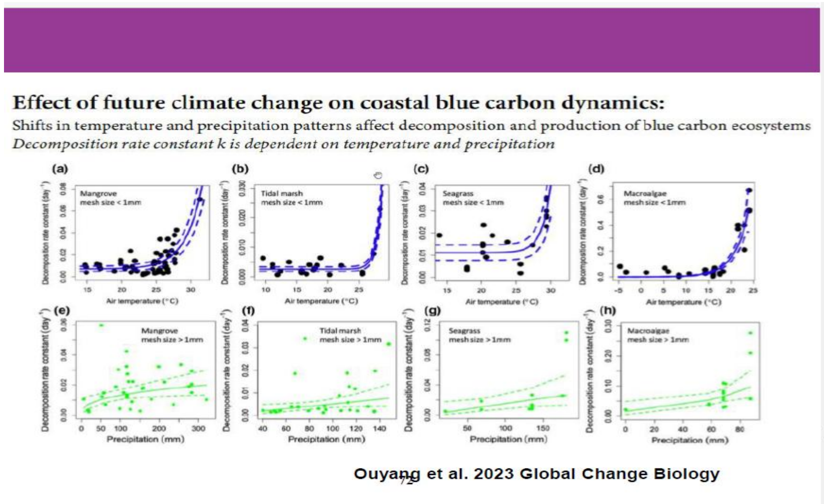
Provinces	Area (ha) Low	Area (ha) High	C stock (Mg C ha^{-1})	Total SOC storage (Tg C) Low	Total SOC storage (Tg C) High	C burial rate (g C m^{-2} year^{-1})	Soil C burial amount (Gg C year^{-1}) Low	Soil C burial amount (Gg C year^{-1}) High
Liaoning	0.54	133,100	69.9	0.00	9.30	107.45	0.00	143
Tianjin and Hebei	8,305	73,200	53.6	0.45	3.92	146.02	12	107
Shandong	34,208			2.81	10.15	192.95	66	239
Jiangsu	6,277			0.37	17.31	153.84	10	448
Shanghai	10,981			0.81	2.79	91.51	10	35
Zhejiang	21,740			1.48	9.02	153.84	33	204
Fujian	28,285			2.14	9.26	139.38	39	170
Guangdong	34,807			2.61	8.15	74.55	26	81
Guangxi	69,732			14.43	12.38	74.55	52	45
Hainan	5,031			0.63	2.48	136.63	7	27
Taiwan	18,075			1.37	–	139.38	25	–
Hongkong	2			0.00	–	74.55	0	–
Macao	7			0.00	–	74.55	0	–
Total	237,450	1,102,400		27.1	84.8		280	1,499

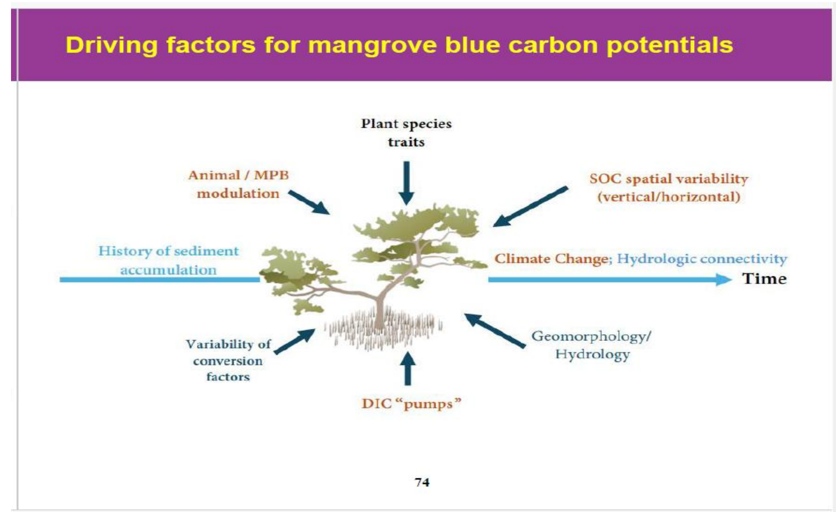


The area data sourced from Mao et al.[27] and the global tidal flat map,[57,59] the soil C stock sourced from Chen et al.,[59] C burial data sourced from Chen et al.[59] 1 Tg = 10^3 Gg = 10^6 Mg = 10^9 kg = 10^{12} g.

各地无植被滩涂（潮滩、光滩）具有高得多的碳库和碳埋速率！

70



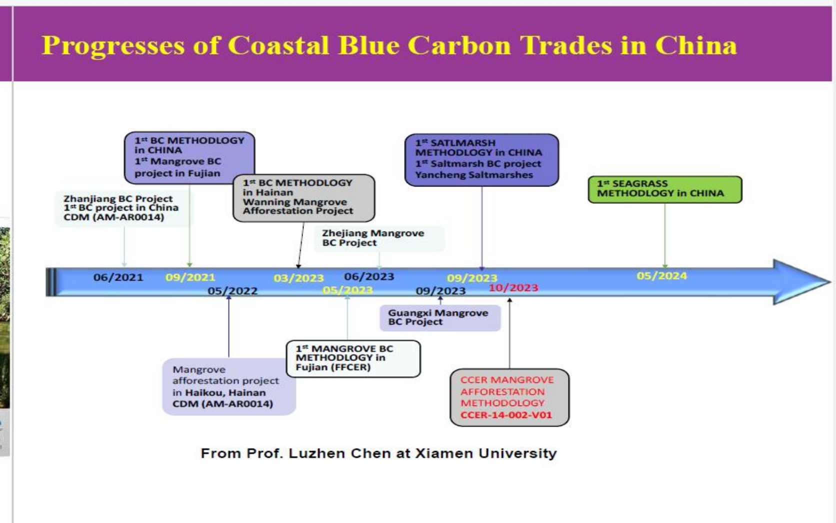


Outline

- Climate change as one of biggest threats to humankinds
- Blue carbon as key ecosystem service of mangrove wetlands
- Case studies of mangrove blue carbon
- Blue carbon trading and methodologies

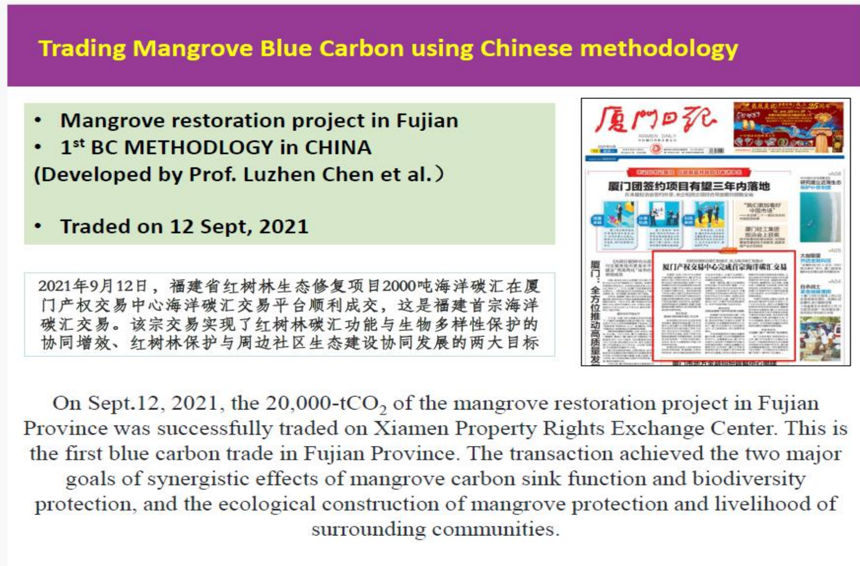
75

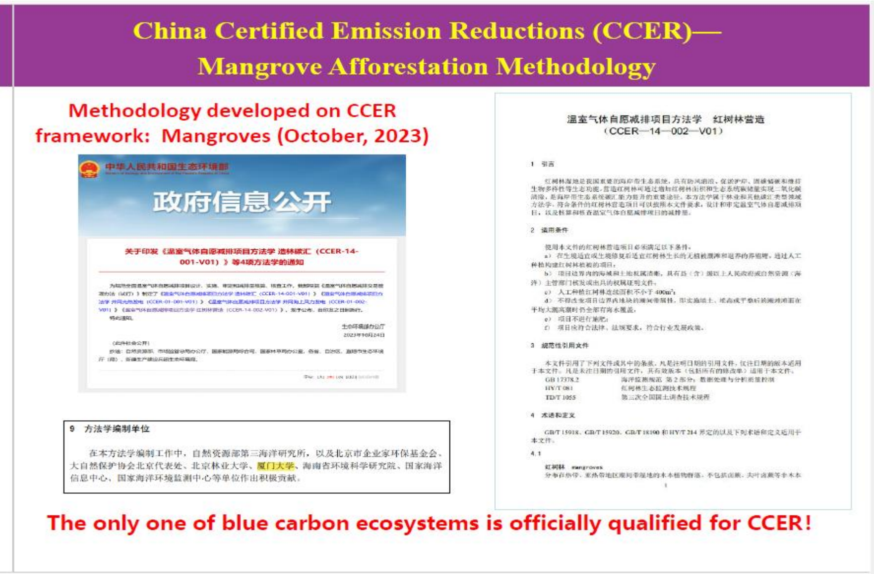

Methodology development for coastal blue carbon
陈鹭真、卢伟志、林光辉（主译, 2019)
ipcc
2013 Supplement
to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands
Chapter 4
Coastal Wetlands
Daniel M. Alongi (Australia)
Guangcheng Chen (China)
Gail L. Chmura (Canada)
Stephen Crooks (USA)
Ansarul Karim (Bangladesh)
Hillary A. Kennedy (UK)
Baowen Liao (China)
Guanghua Lin (China)
Tiffany Troxler (USA)
COASTAL BLUE CARBON
滨海蓝碳
Translated by Lin's group

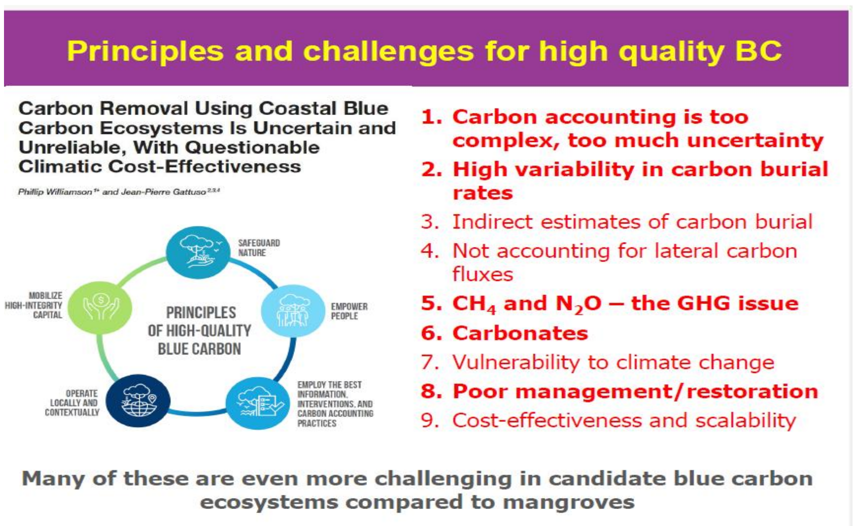

Progresses of Coastal Blue Carbon Trades in China
1st BC METHODLOGY in CHINA
1st Mangrove BC project in Fujian
Zhanjiang BC Project
1st BC project in China
CDM (AM-AR0014)
1st BC METHODLOGY in Hainan
Wanning Mangrove Afforestation Project
1st SATLMARSH METHODLOGY in CHINA
1st Saltmarsh BC project
Yancheng Saltmarshes
1st SEAGRASS METHODLOGY in CHINA
Zhejiang Mangrove BC Project
06/2021
09/2021
05/2022
03/2023
05/2023
06/2023
09/2023
09/2023
10/2023
05/2024
Guangxi Mangrove BC Project
1st MANGROVE BC METHODLOGY in Fujian (FFCER)
Mangrove afforestation project in Haikou, Hainan
CDM (AM-AR0014)
CCER MANGROVE AFFORESTATION METHODOLOGY
CCER-14-002-V01
From Prof. Luzhen Chen at Xiamen University


Trading Blue Carbon using CDM and CCB mechanisms
1st BC project in China
Mangrove afforestation project in Zhanjiang, Guangdong
CDM (AM-AR0014)
June 2021, Verra
2021
中国首个"蓝碳"交易项目签约仪式
世界海洋日暨全国
"广东湛江红树林造林项目"是中国首个符合核证碳标准(VCS)和气候社区生物多样性标准(CCB)的红树林碳汇项目。该项目由自然资源部第三海洋研究所组织并与广东湛江红树林国家级自然保护区管理局合作开发完成。
"Guangdong Zhanjiang Mangrove Afforestation Project" is the first mangrove blue carbon project in China that meets the Verified Carbon Standard (VCS) and the Climate Community Biodiversity Standard (CCB). This project was organized and completed in collaboration with the Guangdong Zhanjiang Mangrove National Nature Reserve Administration by the Third Institute of Oceanography, Ministry of

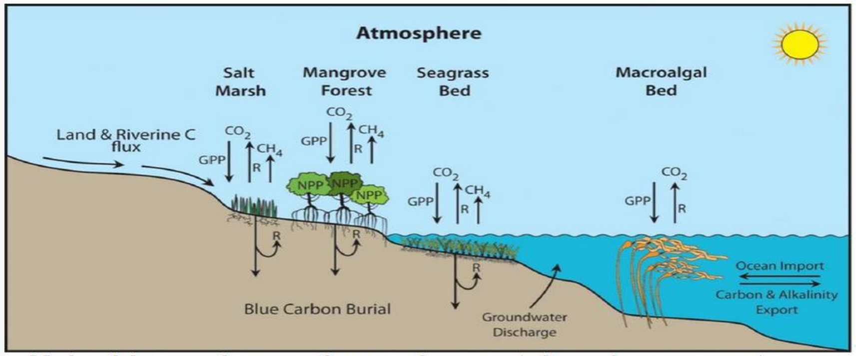

Trading of Mangrove Blue Carbon in China
Restored mangrove forests in Sanjiang, Haikou becomes 1st Blue C trade Project in Hainan Pr
海南首个"蓝碳"项目顺利通过第三方审定核查
海口市三江农场红树林碳汇项目报告
More and more trades on mangrove Blue C!
热烈庆祝
蓝碳生态产品价值实
80


Trading Mangrove Blue Carbon using Chinese methodology
• Mangrove restoration project in Fujian
• 1st BC METHODLOGY in CHINA
(Developed by Prof. Luzhen Chen et al.)
• Traded on 12 Sept, 2021
2021年9月12日，福建省红树林生态修复项目2000吨海洋碳汇在厦门产权交易中心海洋碳汇交易平台顺利成交，这是福建首宗海洋碳汇交易。该宗交易实现了红树林碳汇功能与生物多样性保护的协同增效、红树林保护与周边社区生态建设协同发展的两大目标
厦门日报
厦门团签约项目有望三年内落地
厦门产权交易中心完成首宗海洋碳汇交易
On Sept.12, 2021, the 20,000-tCO2 of the mangrove restoration project in Fujian Province was successfully traded on Xiamen Property Rights Exchange Center. This is the first blue carbon trade in Fujian Province. The transaction achieved the two major goals of synergistic effects of mangrove carbon sink function and biodiversity protection, and the ecological construction of mangrove protection and livelihood of surrounding communities.


China Certified Emission Reductions (CCER)—
Mangrove Afforestation Methodology
Methodology developed on CCER framework: Mangroves (October, 2023)
中华人民共和国生态环境部
政府信息公开
温室气体自愿减排项目方法学 红树林营造
(CCER—14—002—V01)
9 方法学编制单位
在本方法学编制工作中，自然资源部第三海洋研究所，以及北京市企业家环保基金会、大自然保护协会北京代表处、北京林业大学、厦门大学、海南省环境科学研究院、国家海洋信息中心、国家海洋环境监测中心等单位作出积极贡献。
The only one of blue carbon ecosystems is officially qualified for CCER!

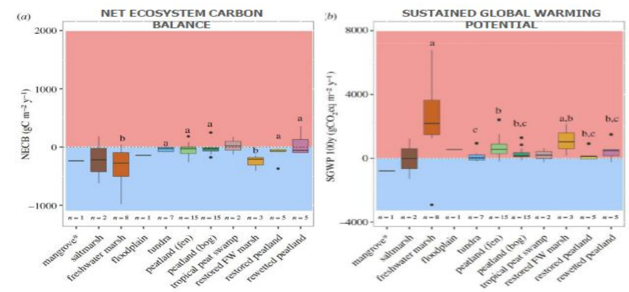

Principles and challenges for high quality BC
Carbon Removal Using Coastal Blue Carbon Ecosystems Is Uncertain and Unreliable, With Questionable Climatic Cost-Effectiveness
Phillip Williamson and Jean-Pierre Gattuso
SAFEGUARD NATURE
EMPOWER PEOPLE
EMPLOY THE BEST INFORMATION, INTERVENTIONS, AND CARBON ACCOUNTING PRACTICES
OPERATE LOCALLY AND CONTEXTUALLY
MOBILIZE HIGH-INTEGRITY CAPITAL
PRINCIPLES OF HIGH-QUALITY BLUE CARBON
1. Carbon accounting is too complex, too much uncertainty
2. High variability in carbon burial rates
3. Indirect estimates of carbon burial
4. Not accounting for lateral carbon fluxes
5. CH4 and N2O – the GHG issue
6. Carbonates
7. Vulnerability to climate change
8. Poor management/restoration
9. Cost-effectiveness and scalability
Many of these are even more challenging in candidate blue carbon ecosystems compared to mangroves

Green house gas issues:



Major blue carbon pathways in coastal marine ecosystems: capture and release CO_2, release CH_4 (greenhouse gases)

Green house gas issues:



For many ecosystems, their NECB is negative

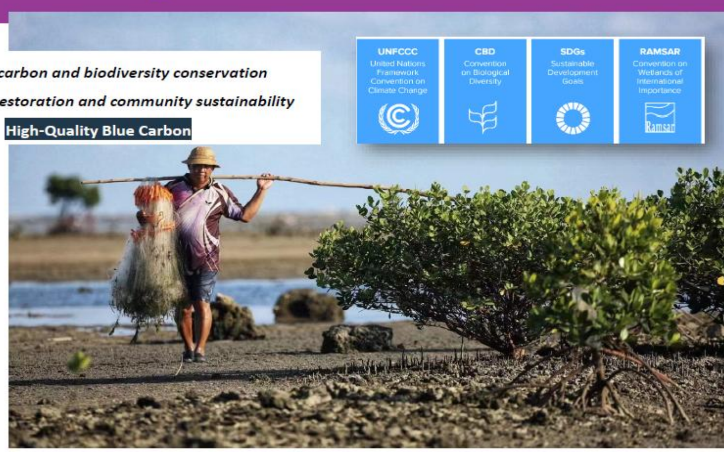
- But their Sustained Global Warming Potential (radiative effect of an ecosystem) is positive
- For mangroves, both NECB and SGWP are negative
- Are candidate blue carbon ecosystems positive or negative?

Taillardat et al. 2020. Journal of the Royal Society Interface Focus

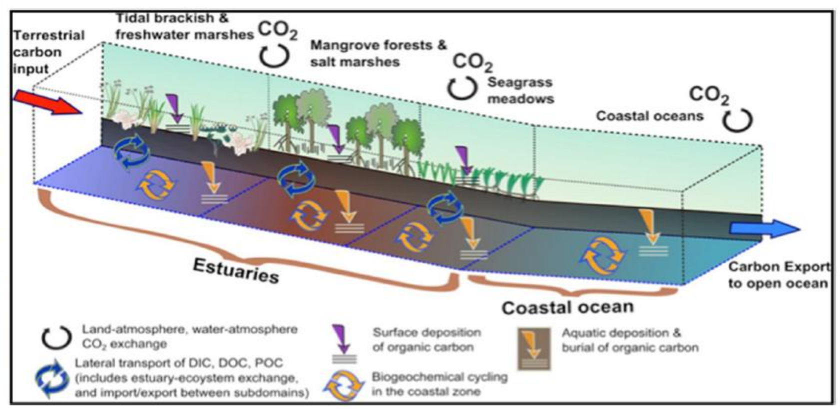
Co-benefits of mangrove conservation and restoration as NbS

- *Blue carbon and biodiversity conservation*
- *Coastal restoration and community sustainability*

High-Quality Blue Carbon



More research and cooperation urgently needed



Barr, Lin et al. 2014

Take home messages

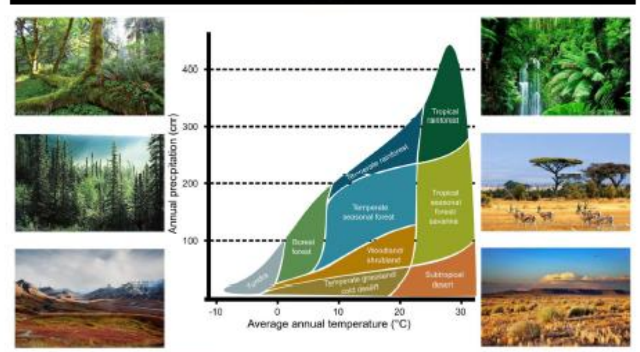
◆Blue carbon in mangrove and other coastal wetlands have significant potentials for mitigate change as NbS approach;

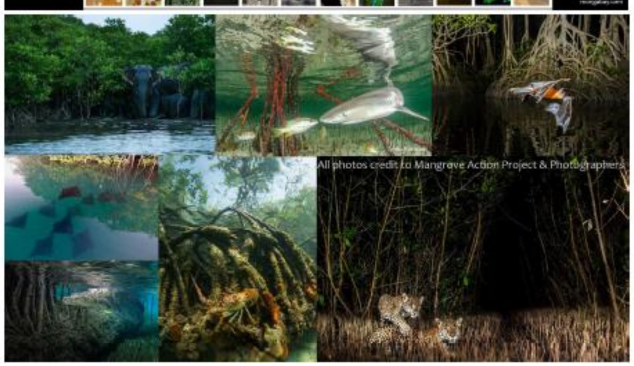
◆Mangrove wetlands of China are strong carbon sinks for atmospheric CO_2, which can be used as NbS for CC mitigation in addition to other ecosystem services;

◆Reforestation on abandoned fish ponds or degraded habitats of mangroves provide greater blue carbon benefits than afforestation on tidal mud flat, so it is better NOT converting mud flat into blue carbon ecosystems;

◆More studies and international collaboration are urgently needed to monitoring carbon flows between mangroves and other coastal ecosystems.

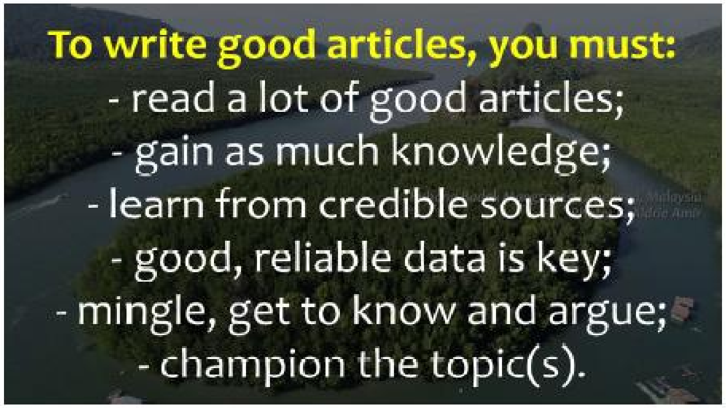
- **Lecture 10: Be the Voice of Mangroves, Write, share, communicate, CEPA for Mangrove**



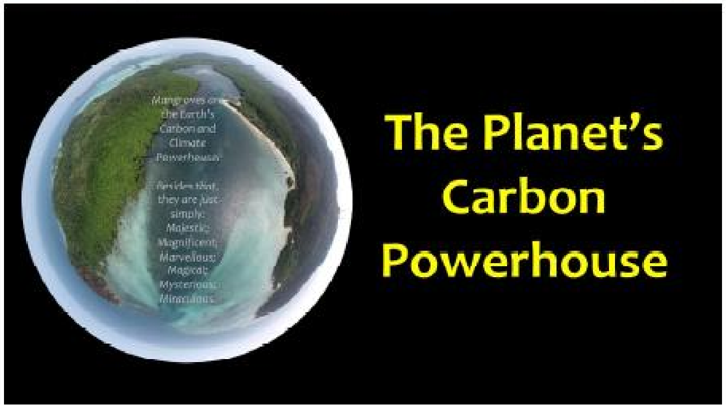



Substantial and solid voice
Substance, facts and figures
Not lousy noise or influence
Write 'about' versus write 'for' mangroves
Knowledge, ethics and integrity
Quality, brain and wisdom
Style, honour, respect and pride


Tell(show) the world
by communicating your stories,
your views, your ideas...
... your way!


To write good articles, you must:
- read a lot of good articles;
- gain as much knowledge;
- learn from credible sources;
- good, reliable data is key;
- mingle, get to know and argue;
- champion the topic(s).


Good Content
&
Good Technique


The Planet's Carbon Powerhouse

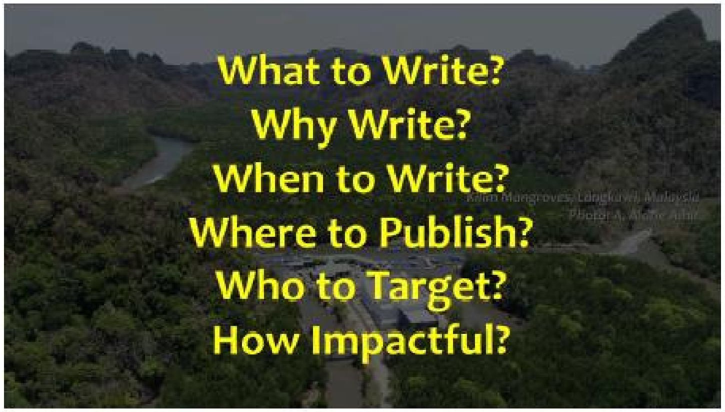

Dayang Bunting Mangroves, Langkawi, Malaysia
Photo: A. Aldrie Amir

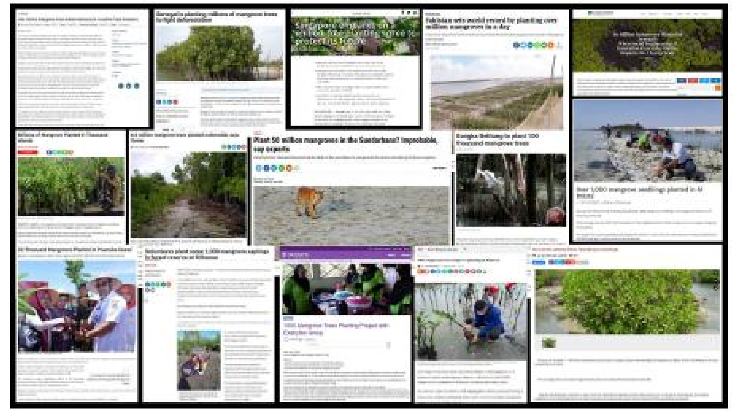

Sungai Pulai Mangroves, Johor, Malaysia
Photo: A. Aldrie Amir

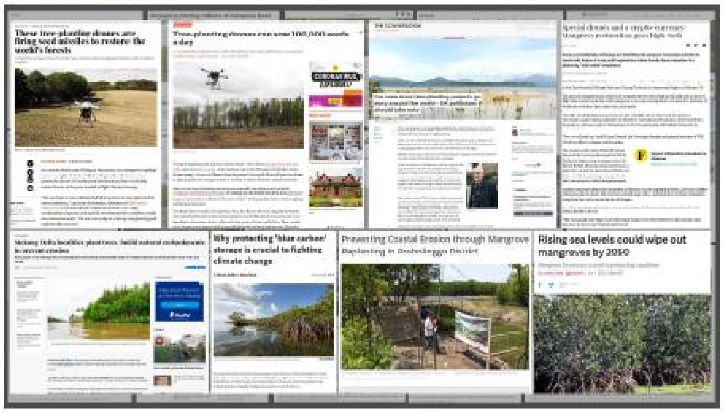

Photo: A. Aldrie Amir

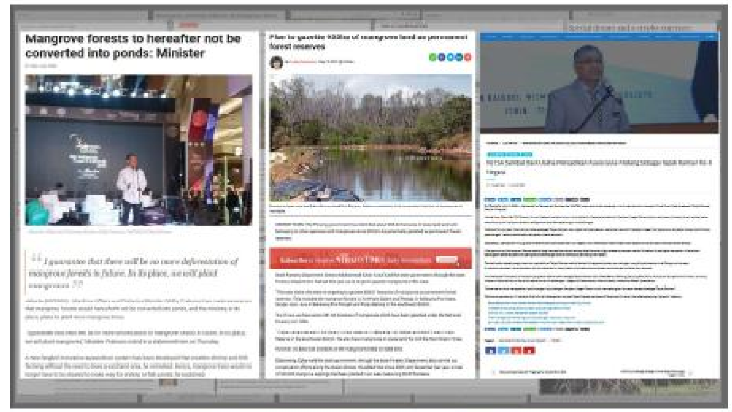

LETTERS
India's Ph.D. scholar outreach requirement
NEWS / Opinion
Why it's crucial to protect environmentally sensitive areas
LETTERS
MASS TOURISM HURTS MANGROVES
WORLD
PROTECT, PRESERVE ALL WETLANDS


LETTERS
The value of small mangrove patches
LETTERS
MASS TOURISM HURTS MANGROVES
NEWS / Opinion
New Straits Times | 26 July 2024 | Page 15
Exemplary governance vital in mangrove conservation
NEWS / Nation
BAN CONVERSION OF MANGROVES

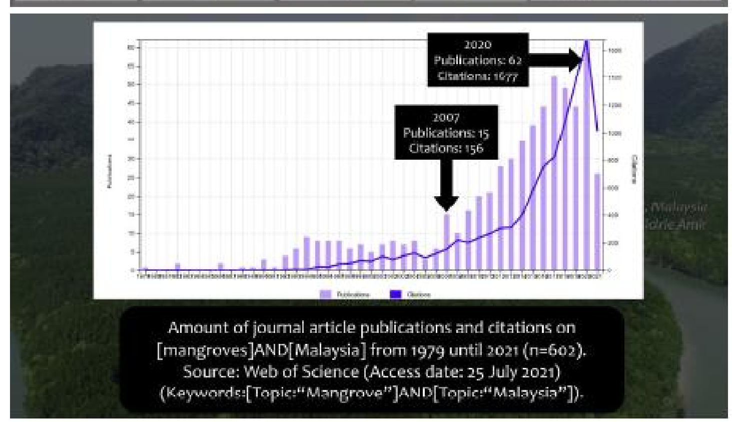

What to Write?
Why Write?
When to Write?
Where to Publish?
Who to Target?
How Impactful?



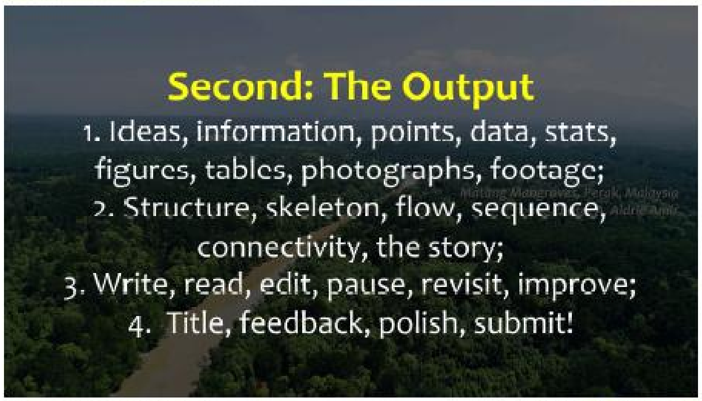

These tree-planting drones are firing seed missiles to restore the world's forests
Why protecting 'blue carbon' storage is crucial to fighting climate change
Preventing Coastal Erosion through Mangrove Replanting in Probolinggo District
Rising sea levels could wipe out mangroves by 2050


Mangrove forests to hereafter not be converted into ponds: Minister

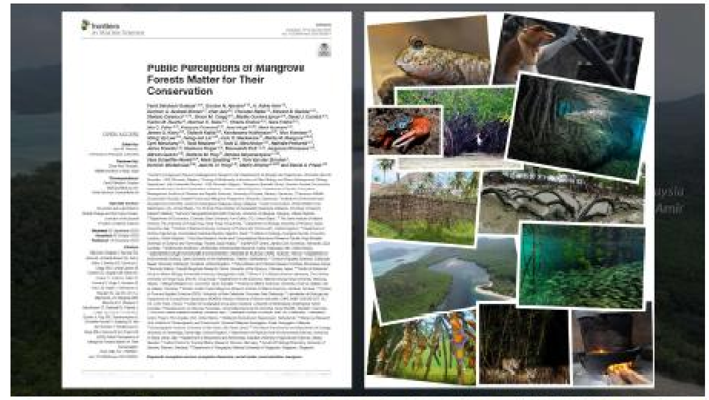

First: The Foundation
1. The topic, the subject, the angle;
2. The audience, the reader, the target group;
3. The platform, the medium, the publisher;
4. Research, read, observe, interview, ask, discuss, argue, brainstorm.


2020
Publications: 62
Citations: 1677
2007
Publications: 15
Citations: 156
Amount of journal article publications and citations on [mangroves]AND[Malaysia] from 1979 until 2021 (n=602).
Source: Web of Science (Access date: 25 July 2021)
(Keywords:[Topic:"Mangrove"]AND[Topic:"Malaysia"]).


Seri Buat Mangroves, Pahang, Malaysia
Photo: A. Aldrie Amir

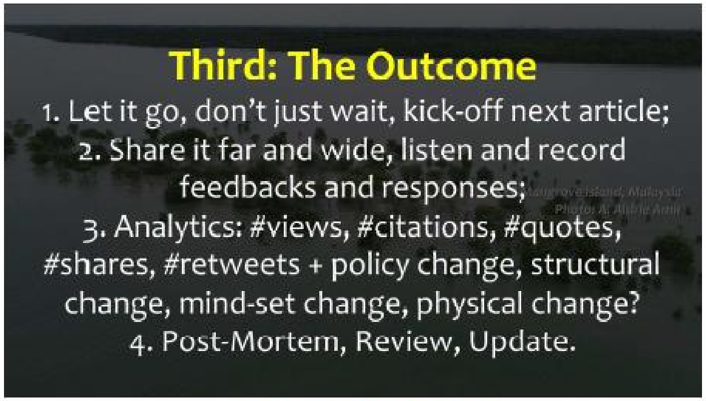

Second: The Output
1. Ideas, information, points, data, stats, figures, tables, photographs, footage;
2. Structure, skeleton, flow, sequence, connectivity, the story;
3. Write, read, edit, pause, revisit, improve;
4. Title, feedback, polish, submit!


14 OPINION
PROTECTING OUR MANGROVES AND COASTAL WETLANDS


Public Perceptions of Mangrove Forests Matter for Their Conservation


Sungai Kelang Mangroves, Selangor, Malaysia
Photo: A. Aldrie Amir


Impactful
Factual
Relevant
Honest
Respect
Informative
Interesting
Data-driven
Quality
Influential
Facilitative
Integrity
Ethical
Solutions


Third: The Outcome
1. Let it go, don't just wait, kick-off next article;
2. Share it far and wide, listen and record feedbacks and responses;
3. Analytics: #views, #citations, #quotes, #shares, #retweets + policy change, structural change, mind-set change, physical change?
4. Post-Mortem, Review, Update.


SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS


Mangrove:
A Nature's Love Story
27 Mei 2021
10.00 am -11.30 am
zoom
Meeting ID : 987 8924 0372
Passcode : 171425
LIVE
www.facebook.com/
Dr. Ahmad Aldrie Amir
EKOMAR

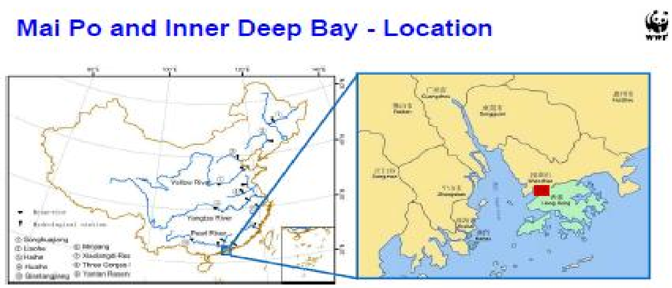

Geographers
Oceanographers
Policy Researchers
Lawyers
Modelers
Marine Scientists
Tourism Experts
Engineers
RS & GIS Experts
Climate Scientists
Geneticists
Pharmacists
Business Experts
Chemists
Town & Country Planners
Geologists
Tour Operators
Physicists
Ecologists
Zoologists
Bankers & Investors
Taxonomists
Historians
Anthropologists
Hydrologists
Social Scientists
Architects & Designers
Resource Managers
Foresters
IT Experts
Teachers
Microbiologists
Economists
Archaeologists
Botanists
Wireless & Sensor Technologists
Soil Scientists
Artists
www.facebook.com/group/mymangrove
The Malaysian Mangrove Research Alliance & Network (MyMangrove)
MyMangrove

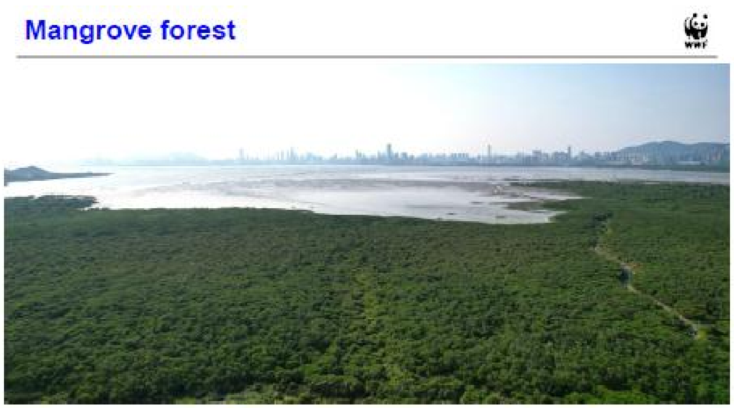

Start communicating!
1. List down your ideas;
2. Do not hesitate;
3. Do not procrastinate;
4. Self-discipline;
5. Start writing / publishing / producing now, otherwise your ideas will get nowhere!

- **Lecture 11: Wetland Conservation in Mai Po Nature Reserve**

Conservation of Mangrove in Hong Kong

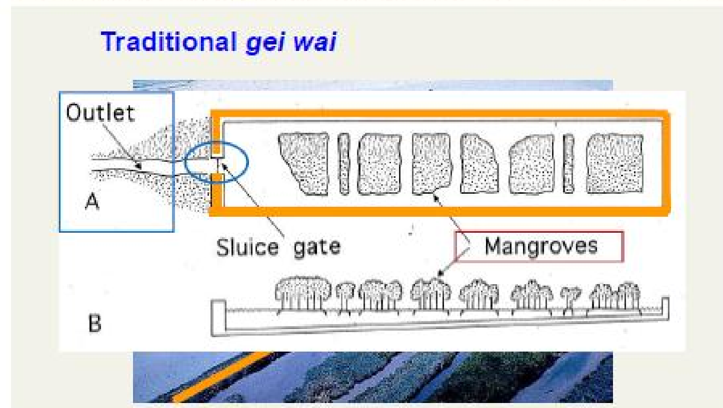
- Protect mangrove stands in Restricted Area, Marine Park or Marine Reserve - e.g. Mangroves in Hoi Ha Wan Marine Park.
- Designation of important mangrove stands as Sites of Special Scientific Interest - e.g. Ting Kok mangroves.
- Minimize the impact of urbanization through landuse planning and environmental assessment process.
  - An ecological assessment will be needed if a proposed development will affect established mangrove stands of any size
- Promote public awareness on the conservation of mangroves.
- Mangrove planting.



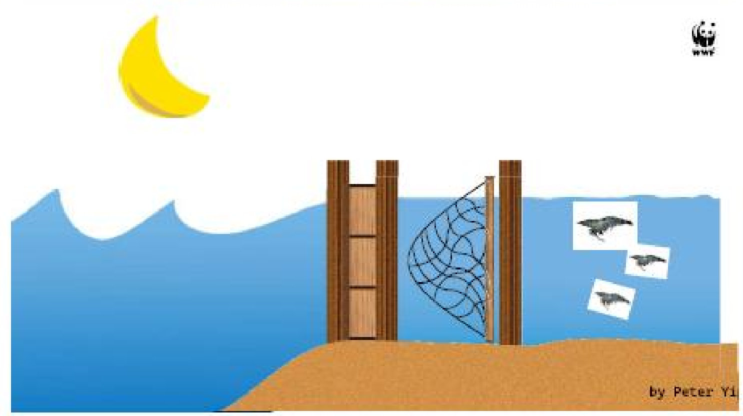

Mangrove forest


Mudflats


Gei wai (intertidal Shrimp Ponds)
Photo: © Anthony Sun

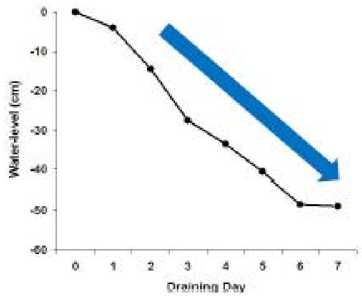

Traditional *gei wai*
Outlet
A
Sluice gate
Mangroves
B

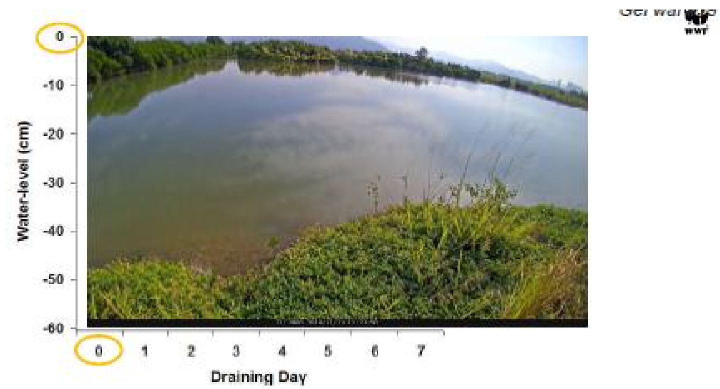

Stocking of shrimp larvae
Growing
Autumn
Winter
Summer
Spring
Harvesting

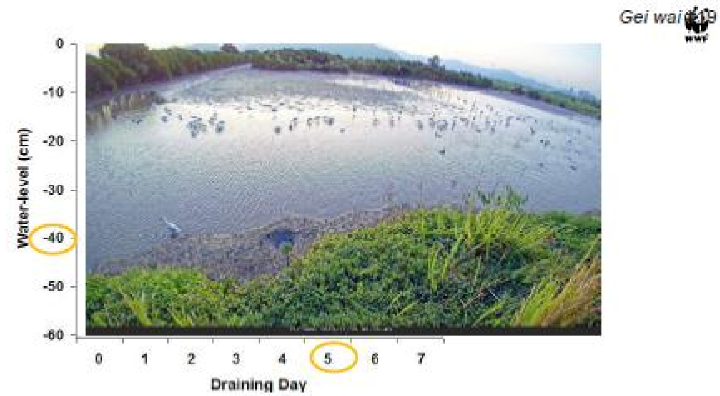

by Peter Yi

Management of water level in *gei wai*

Every winter, draining *gei wai* one by one to provide food for waterbirds





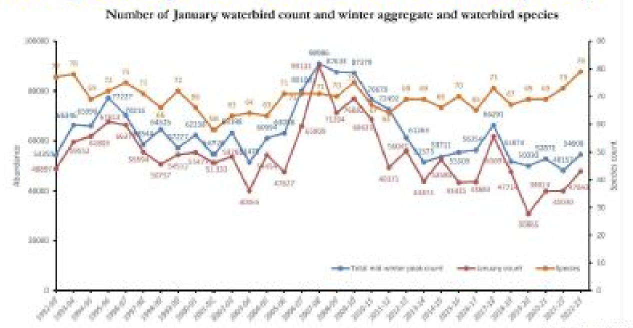


Fishponds

Ecological Importance of Mai Po and Deep Bay

Taxa	Number of species
plant	322
Birds	466
mammals	25
reptiles	22
amphibians	8
fishes	70
odonates	53
butterflies	107
moths	316
ants	over 15
bees and wasps	155
spiders	over 100
shrimps	12
crabs	40

Ecological Importance of Mai Po and Deep Bay



Mai Po conservation in 1980's

1981

- WWF-Hong Kong was founded and decided to undertake a project at Mai Po

1982

- WWF-Hong Kong submitted a proposal to the then Hong Kong Government (Hong Kong SAR now) to take over management of Mai Po at no cost

1982/83

- The then HK Govt. approved in principle, the establishment of the Mai Po Marshes Nature Reserve
- Acquisition and management of the first *gei wai* with funds from the Royal HK Jockey Club
- New land licenses (for conservation and education) were given to WWF-Hong Kong

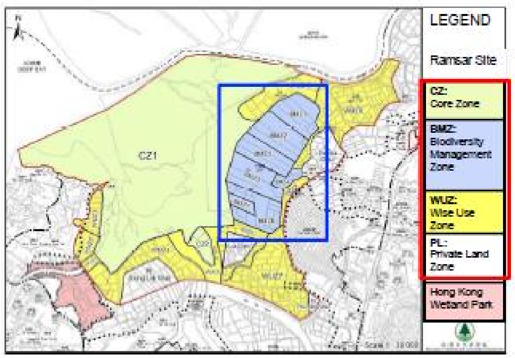
1983

- Proposal for setting up of a Mai Po Nature Reserve and Education Centre
- Constructed a Visitor Information Centre and a 1.2 km concrete footpath

What's happening in Mai Po Nature Reserve?

Mai Po Inner Deep Bay Ramsar Site (since 1995)

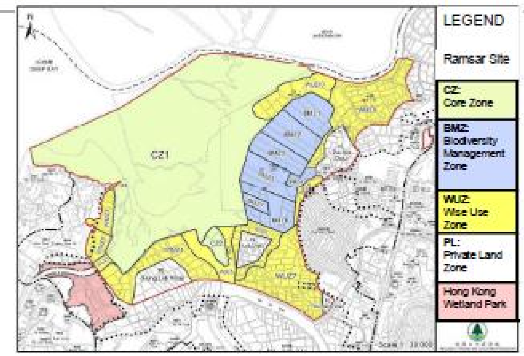
Mai Po and Inner Deep Bay Ramsar Site



Objectives

1. To **maintain or increase populations of priority species** by managing the required habitat diversity in a manner that integrates climate-adaptation strategies.
2. To **raise public awareness and educate citizens** about the importance of wetlands and their conservation, including the provision of universal access to MPNR by visitors.
3. To **share experience and knowledge** with other wetlands along the EAAF to enhance the conservation of migratory waterbirds.
4. To develop MPNR as a regional centre of excellence for **wetland research and monitoring**.

Mai Po and Inner Deep Bay Ramsar Site



Vision and Goals

Vision: The Mai Po Nature Reserve is an important staging area and wintering ground for migratory waterbirds in the EAAF. A core area sustains threatened wetland flora and fauna and, with support from all stakeholders, the reserve functions as a regional hub for environmental education and wetland management training.

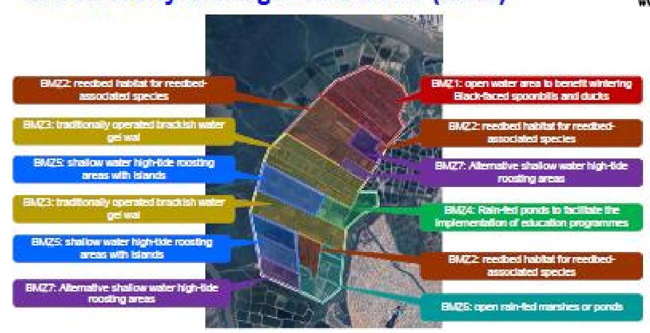
Goals:

a) To manage the Mai Po Nature Reserve as a climate-resilient and adaptive **staging and wintering ground for migratory wetland-dependent birds** along the EAAF as well as a habitat for threatened indigenous biodiversity;

b) To sustain **the traditional practice of *gei wai* operation** as an example of wise use of wetlands;

c) To serve as a **regional centre for knowledge, awareness and training** on wetland conservation.

Biodiversity Management Zone (BMZ)

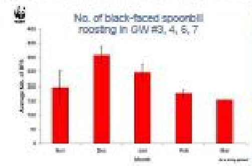


Biodiversity Management Zones (BMZ) in 2020

Objective 1. To maintain or increase populations of priority species by managing the required habitat diversity in a manner that integrates climate-adaptation strategies.

1.1 To provide suitable roosting and feeding habitats for wintering **Black-faced spoonbill**;
1.2 To provide high tide roosting sites for **shorebird assemblage**.
1.3 To provide suitable roosting and feeding habitats for the **duck assemblage**.
1.4 To provide suitable roosting and feeding habitats for **ardeids**.
1.5 To manage the reedbed habitat for **reedbed-associated bird assemblage**.
1.6 To provide a pre-roosting tree habitat for **Collared crow**.
1.7 To provide a perching tree habitat for **Eastern Imperial Eagle** and **Greater Spotted Eagle**
1.8 To identify and manage habitats for **Eurasian otters**.
1.9 To identify and maintain habitats for other focal key species and species groups, such as **Mai Po box jellyfish**.
1.10 To develop and manage diverse **freshwater habitats**.
1.11 To maintain **the traditional operation and landscape of the *gei wai*** habitats.
1.12 To manage the **intertidal mudflat**.
1.13 To conduct **additional management** to support achieving the above objectives.
1.14 To **minimise threats** towards conservation targets and associated habitats.

Habitats for black-faced spoonbill



Habitats for black-faced spoonbill

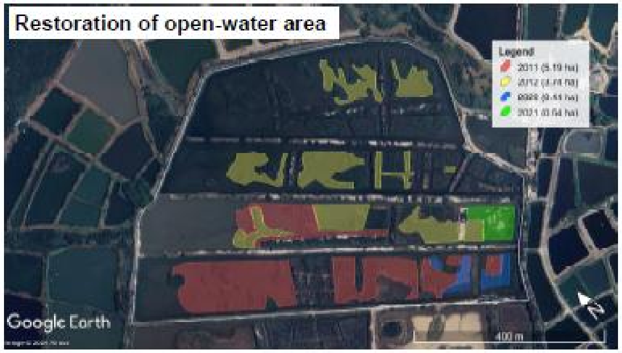
Habitats for black-faced spoonbill

Weeks before the arrival of black-faced spoonbill:
Grass-cutting on the bund

Habitats for black-faced spoonbill

Habitats for black-faced spoonbill

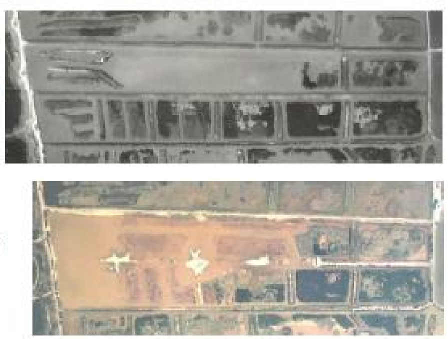
Habitats for black-faced spoonbill



High-tide roost: creation

1980

1987



Habitats for black-faced spoonbill

Provide suitable habitats by controlling the water level

Gei wai no.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
#3/#4/#6/#7												
					2	2	2	2	2			
				3						3		
	1	1	1								1	1

Key:

1 – Keep a low water level to provide shallow water for spoonbills to roost.

2 – Raise the water level to control the spread of grasses into the open-water areas of the *gei wai*.

3 – Lower or raise the water level to coincide with arrival/departure of spoonbills.

High-tide roosts for shorebirds

High-tide roost: creation

Shorebird assemblage

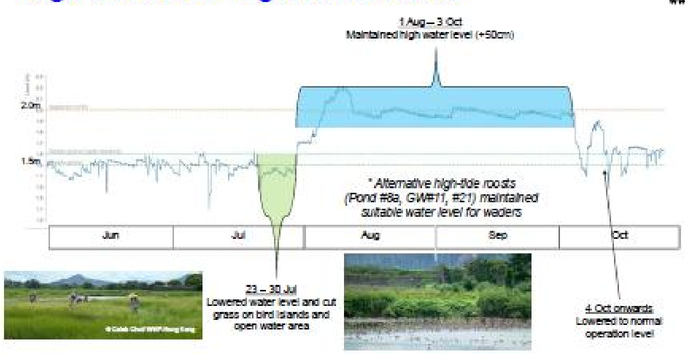
1. Shallow water
2. Large open water area
3. Creation of bird islands in different size and shape

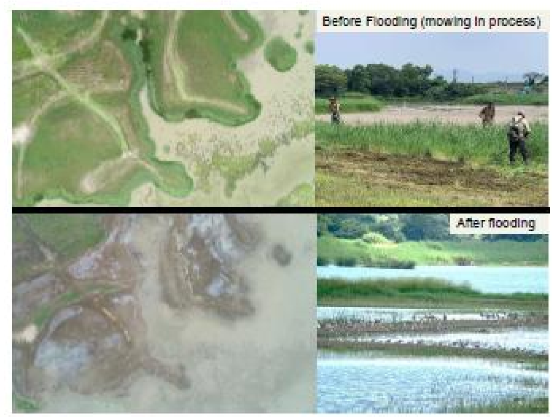
Shorebird assemblage

High tide roost

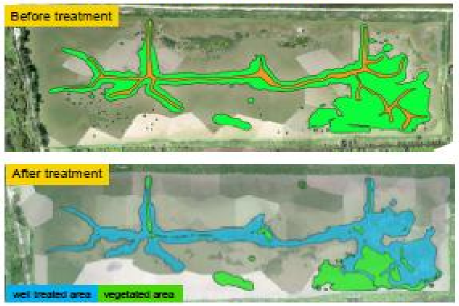
High tide roost: vegetation control

High tide roost: vegetation control





High tide roost: vegetation control



High tide roost: vegetation control

Gei wai Maintenance - Dredging

- Silt is flushed into the *gei wai* during water exchange which is carried out twice a month
- *Gei wai* channels have to be dredged every 10-15 years to maintain the deeper water areas for shrimp and fish
- The dredged mud is placed on the *gei wai* bunds

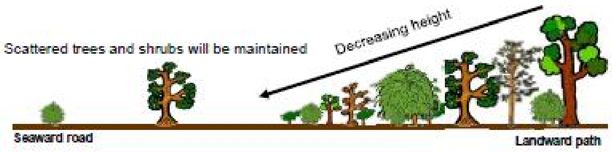
Gei wai Maintenance - Dredging

Tree Management

Avian predators

Tree Management

Along the *gei wai* bunds, maintain a balance between;
- open areas with few trees to retain traditional landscape and flight paths for waterbirds, with
- more vegetated areas that provide shade for visitors and habitats for forest birds.



Tree Management

Tree Management

Vegetation on mudflat: Mangroves

Clearance of mangrove seedlings on 45ha mudflat

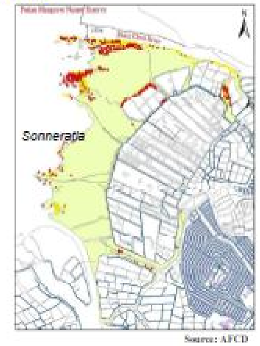
- To maintain the area of open mudflat suitable for waterbirds;
- To ensure an unobstructed view from the floating bird hides.

Clearance of mangrove seedlings on 45ha mudflat

Exotic Mangrove Management

- Early 1990s, exotic mangrove species were introduced to the northern coast of Deep Bay/Shenzhen Bay on a trial basis.
- The aim was to use these to 'green' the coastline as they can grow up to 1 m per year.
- Unfortunately, these *Sonneratia* spp. have now successfully established and are out-competing the local mangrove species.

Exotic Mangrove Management



Restoration of abandoned community ponds

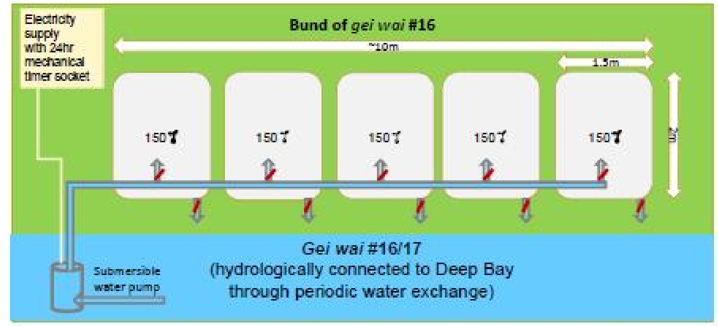
Restoration of abandoned community ponds

Traditional sluice gate repaired

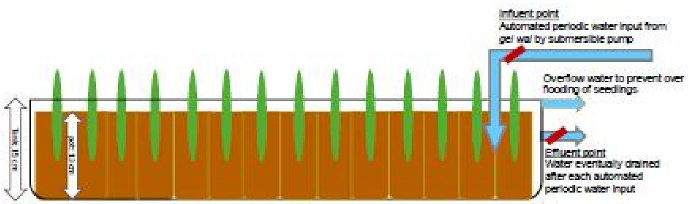
Overgrown vegetation cleared and pond floor re-profiled

Mangrove nursery establishment

Mangrove Nursery - Mimicking Tidal Flow

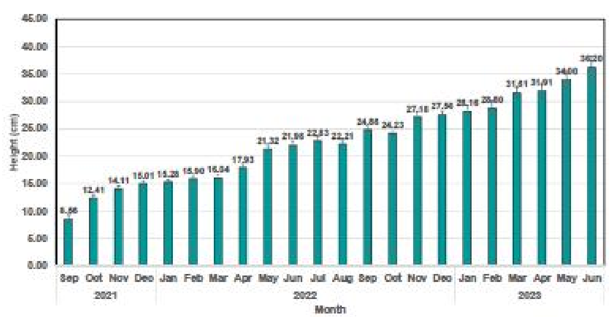


Mangrove Nursery - Mimicking Tidal Flow

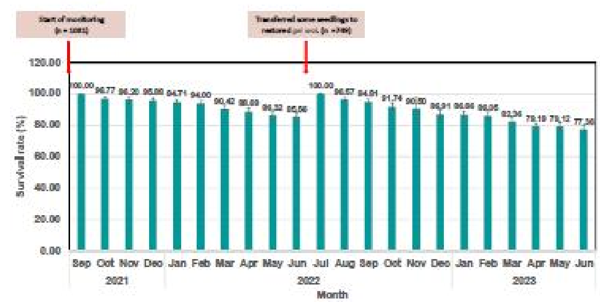


Mangrove Nursery - Mimicking Tidal Flow

Growth of *Aegiceras corniculatum* seedlings



Survival rate of *Aegiceras corniculatum* seedlings



Pest found in the nursery of *Aegiceras corniculatum*

Leaf miner   Lasiocampidae sp.   *Orgyia postica*

Septic tanks built to improve the water quality

Traditional sluice gate repaired

Pond floor re-profiled and mangrove planted

Aegiceras corniculatum (seedlings from nursery)

Kandelia obovate (droppers)

Bruguiera gymnorrhiza (droppers)

Mangrove planting by volunteers

Aegiceras corniculatum (seedlings from nursery)

Assess wave attenuation ability of mangrove in GBA

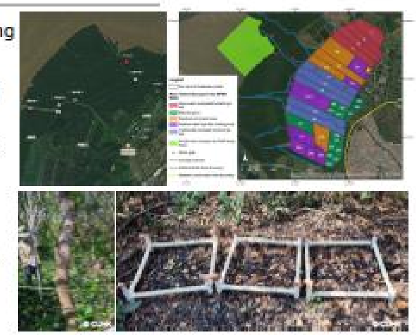
Partner: Hong Kong Polytechnic University & RED Construction Engineering Limited

- **Deploy wave sensors to collect water level data of mangroves in Mai Po Nature Reserve**
  - 9 wave sensors deployed
- **Data analysis and numerical simulation**
- **Estimate wave attenuation capacity of mangroves in Inner Deep Bay**

Assess carbon sequestration potential in Greater Bay Area (GBA)

Partner: The Chinese University of Hong Kong

- **Determine carbon sequestration potential of the restored *gei wai* (Powering our Wetland project)**
  - Ongoing data collection on biomass measurement, soil sampling, and greenhouse gas exchange
- **Determine carbon sequestration potential of mangroves in Mai Po Nature Reserve (MPNR) and other mangrove forest in GBA**
  - 14 sampling plots were developed
  - Ongoing data collection on biomass measurement, soil sampling, and greenhouse gas exchange
- **Develop a carbon sequestration monitoring protocol for the wetlands in GBA**



Annual water level management regime for high-tide roosting sites

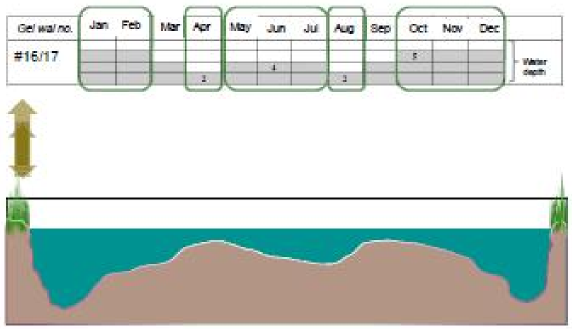
Gei wai pond	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
GW #8a	L	L	L	L	L	L	L	L	DD	F	F	F	F	F	F	F	F	L	L	L	L	L	L	L
GW #11	L	L	L	L	L	L	DD	F	F	F	F	F	F	L	L	L	L	L	L	L	L	L	L	L
GW #16/17	L	L	L	L	L	L	L	L	M	M	M	M	DD	F	F	F	F	F	F	L	L	L	L	L
GW #20	F	L	L	L	L	L	L	L	M	M	M	M	M	L	L	L	L	L	DD	F	F	F	F	F
GW #21	F	L	L	L	L	L	L	L	M	M	M	M	M	L	L	L	L	L	DD	F	F	F	F	F
GW #22	T	T	T	T	T	T	T	H	H	H	H	H	H	H	H	H	H	H	H	T	T	T	T	T

GW #8a, GW #11, GW #16/17, GW #20, GW #21:
- Drain down for cutting and immediate flooding will be applied as vegetation control measure, rotational flooding is scheduled across roosting sites.
- Immediate adaptive management such as adjustment of water levels should be conducted if shorebird number falls low in spring and autumn.
- Maintain medium water level if Black-winged stilt (or other waterbirds) are nesting and until hatching, lower water level before and after heavy rain.

GW #22:
- Allow free water exchange/intertidal operation from Nov and end of Mar.
- Maintain high water level to control the spread of vegetation from Apr to end of Oct.

L/M/H: Low/ medium/ high water levels, with periodic water exchange depending on Deep Bay tidal cycles, on average twice a month.
F: Flooding with highest water level capacity of specific gei wai.
DD: Drain down to facilitate island and open water area vegetation cutting.
T: Allow free water exchange with delayed intertidal cycle.

Management of water level



Research and Monitoring

Objective 4. To develop MPNR as a regional centre of excellence for wetland research and monitoring.

Key Activities:

1. Maintain the long-term monitoring programme for conservation targets, threats, and selected indicators of ecosystem change in MPNR and Deep Bay.
2. Conduct research that will help to improve habitat management and species conservation and recovery in MPNR and Deep Bay.
3. Produce research and monitoring reports and peer-reviewed publications.
4. Provide advisory and on-site support to external researchers.

Why do we conduct monitoring?

For habitat management

- evaluate effectiveness
- suggest improvement

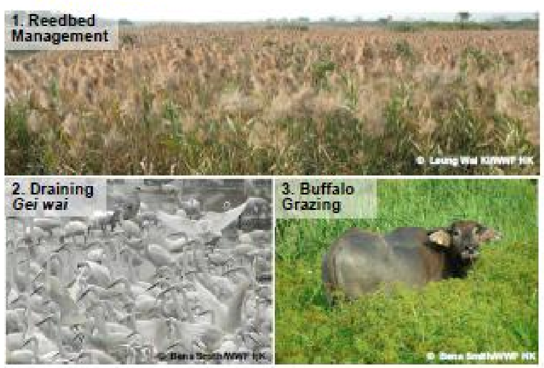
Timely data as indicator and alert

- avoid serious impact

Monitoring

Mai Po Conservation Targets

Research



Education and Awarness

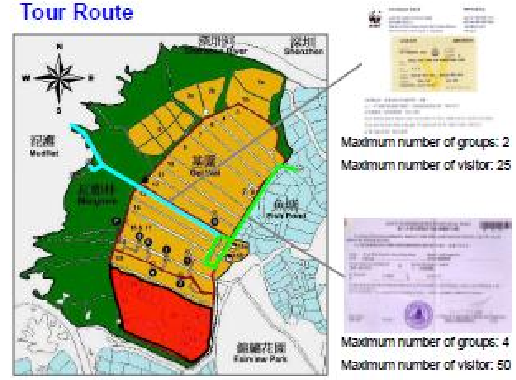
Objective 2. To raise public awareness and educate citizens about the importance of wetlands and their conservation, including the provision of universal access to MPNR by visitors.

Key Activities:

1. Regular review of approach and content of activities to complement recent developments in the sector
2. Provide students with quality learning experiences supported by teachers and motivate students to take corresponding conservation action.
3. Optimally utilize the new educational facilities under the MPNR Infrastructure upgrade project to support the continuous development of student education activities.
4. Increase the number of centre-based education activities from 400 in 2023-24 to 450 by 2028-29.
5. Use MPNR as one of the training hubs for teacher professional development programmes
6. Organize regular and season-specific Nature Schools.
7. develop fun-filled education activities in different formats to engage the public and specific segments of the community.

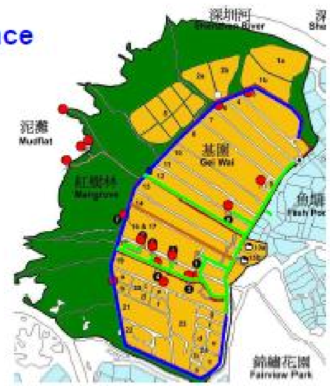
Major infrastructure

Tour Route



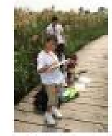
Reducing disturbance

- 17 Birdwatching Hides
- Barriers/Screens
  - Tall grass
  - Shrub barrier
  - Earth barrier
  - Approach to hides
- All tours are lead by trained guides (~25 pax / tour)



Education IN the Environment

Principles:


Fun


Engagement

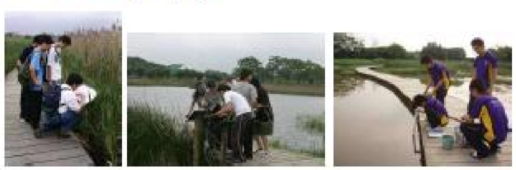

Complementing curriculum


Real-life experience


Promoting active and sustained learning

Student visit programme – secondary

1. Who wants to be a Wetland Reserve Officer?
2. Wetland Encounter
3. Wetland Ecologist
4. Sustainable Development @ Deep Bay
5. **Mangrove Ecology @ Deep Bay**
6. Urban Planner @ Deep Bay



Student visit programme – secondary

Mangrove Ecology

4-hour activity, including study the features and ecology of mangrove species and the threats they face

RUNDOWN

Welcome and programme introduction • Introduction of Mai Po Inner Deep Bay Ramsar Site • Introduction on mangrove and common wildlife in Mai Po	30 mins
Field Observation • Discover the species and habitat diversity of Mai Po • Understand the value of mangrove and other wetland habitats to wildlife and human	60 mins
Mangrove observation along the Floating Boardwalk • Explore the features and ecology of mangroves	75 mins
Indoor activity • Learn about the threats mangroves are facing and their importance	45 mins
Conclusion: Reflection and Q&A	15 mins
Total walking distance: 5km	

Student visit programme – secondary

Mangrove Ecology



Student visit programme – primary

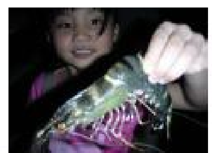
Senior form students (9 to 12 years old)

1. Story of Birds
2. Mai Po Insect Watch
3. Mai Po Detective



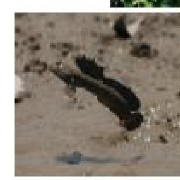

Public guided tours

- Exploring Mai Po
- **Mangrove Boardwalk**
- The Magic of Migration
- *Gei wai* Harvesting
- ....



'Mangrove Boardwalk Adventure' tour

- All year round
- Standard route + Floating Boardwalk
- Get to know about the importance of mangrove forest and its role in global climate change challenge
- Duration: 4 hours
- Distance: Around 6 km
- Age: 8 or above

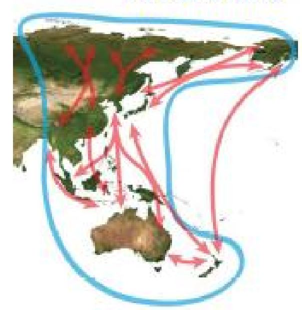

Regional Training and Outreach

Objective 3. To share experience and knowledge with other wetlands along the EAAF to enhance the conservation of migratory waterbirds.

Key Activities:

1. Conduct 13 training courses and study tours for wetland managers and officials annually, for around 200 participants in total.
2. On-site wetland training and advisory work at four to six important wetland sites along the EAAF for continued engagement, outreach, networking, and regional capacity building.
3. Develop an online network of wetland managers for communication.
4. Work with the Education Team to integrate Education on Sustainable Development in the wetland management training courses.

Wetland Management Training Programme



- Started in 1990
- Offering 10 Training Courses (8-day)
- Offering 5 study tours (1-5 days)
- About 150 participants each year

Participants

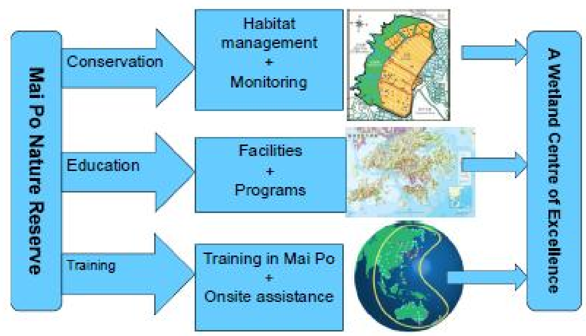
- Nature Reserve/ Wetland Park Staff
- Gov't Officials and/or Decision Makers
- Educators
- Research Institutes

Application after training

Survey on Application of Wetland Management Training Course (2012-2015)

China Wetlands Project

1. To protect biodiversity through capacity building, management planning and habitat restoration
2. To use wetlands wisely through the development and introduction of best practices
3. To raise the conservation awareness through education for sustainable development (ESD)



Thank you

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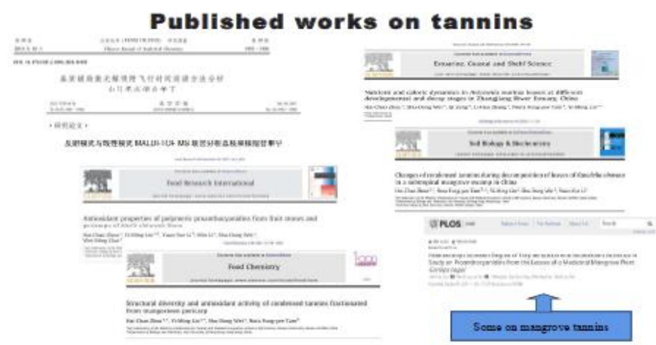
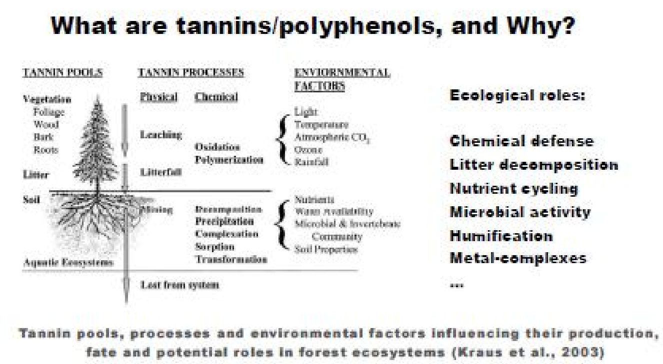
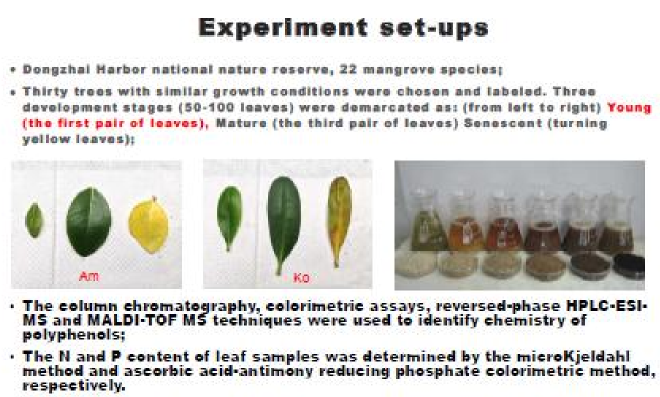
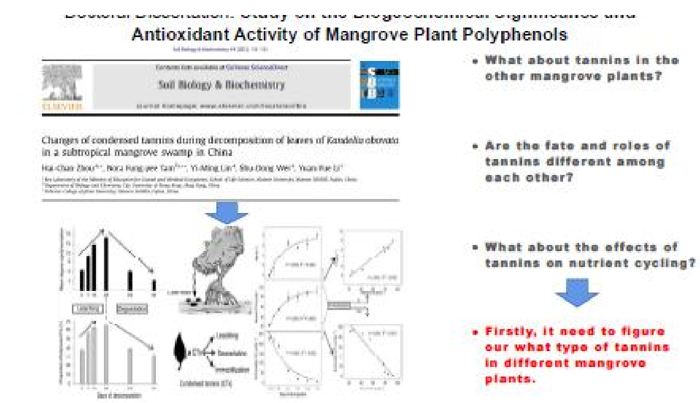
Xianji Wen (xjwen@wwf.org.hk)

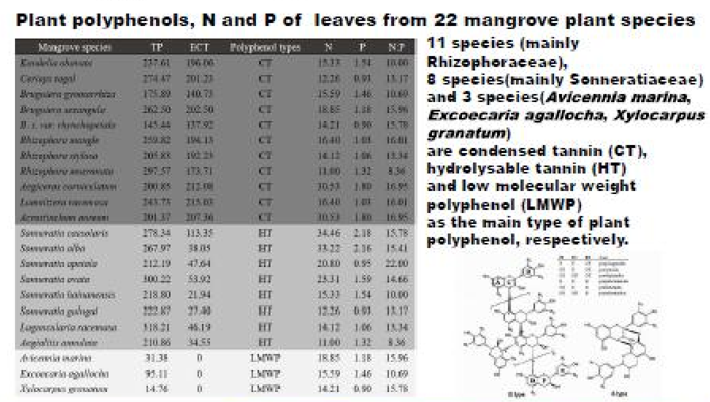
- **Lecture 12: Monitoring and Protection of Migratory Birds in Mangrove Wetlands**





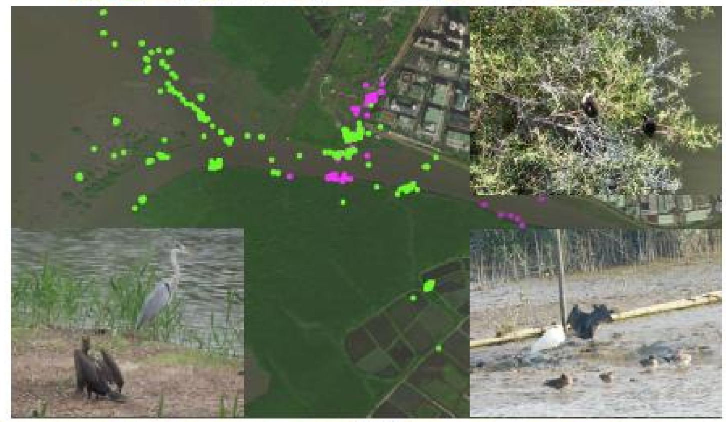






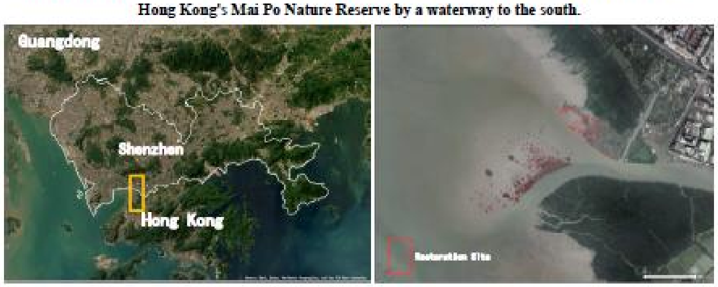
Mangrove species	TP	ECT	Polyphenol types	N	P	N:P
Kandelia obovata	227.61	196.06	CT	15.33	1.54	10.00
Ceriops tagal	274.47	201.23	CT	12.26	0.93	13.17
Bruguiera gymnorrhiza	175.89	140.73	CT	15.59	1.46	10.69
Bruguiera sexangula	262.50	202.50	CT	18.85	1.18	15.96
B. s. var. rhynchopetala	145.44	137.92	CT	14.21	0.90	15.78
Rhizophora mangle	259.82	194.13	CT	16.40	1.03	16.01
Rhizophora stylosa	205.88	192.23	CT	14.12	1.06	13.34
Rhizophora mucronata	297.57	173.71	CT	11.00	1.32	8.36
Aegiceras corniculatum	200.85	212.98	CT	30.53	1.80	16.95
Lumnitzera racemosa	243.75	215.03	CT	16.40	1.03	16.01
Acrostichum aureum	201.37	207.36	CT	30.53	1.80	16.95
Sonneratia caseolaris	278.34	113.35	HT	34.46	2.18	15.78
Sonneratia alba	267.97	38.05	HT	33.22	2.16	15.41
Sonneratia apetala	212.19	47.64	HT	20.80	0.95	22.00
Sonneratia ovata	300.22	53.92	HT	23.31	1.59	14.66
Sonneratia hainanensis	218.80	21.94	HT	15.33	1.54	10.00
Sonneratia gulngai	222.87	27.40	HT	12.26	0.93	13.17
Laguncularia racemosa	318.21	46.19	HT	14.12	1.06	13.34
Aegialitis annulata	210.86	34.55	HT	11.00	1.32	8.36
Avicennia marina	31.38	0	LMWP	18.85	1.18	15.96
Excoecaria agallocha	95.11	0	LMWP	15.59	1.46	10.69
Xylocarpus granatum	14.76	0	LMWP	14.21	0.90	15.78

Rescue a Group of Great Cormorants Trapped by High Buildings



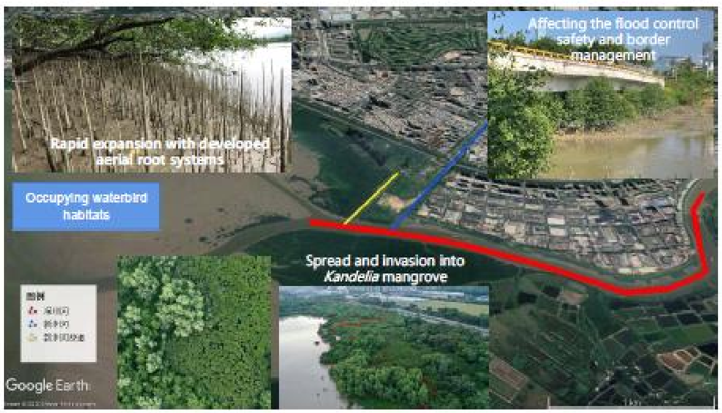
Background: Restoration for Birds

Shenzhen River estuary restoration area: bordered to the north by the Guangdong Neilingding Futian National Nature Reserve, to the east by the Futian Mangrove Ecological Park, and separated from Hong Kong's Mai Po Nature Reserve by a waterway to the south.

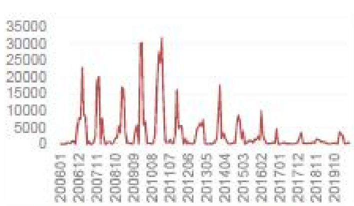


Dominant species: *Sonneratia* mangrove plants

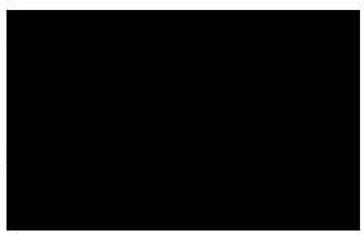
- Since 1990s, *Sonneratia* species were introduced to Shenzhen Bay for rapid afforestation. By 2017, these plants had spread to nearly 20 ha in the Shenzhen River estuary.
- The extensive spread of the non-native *Sonneratia* species has promoted siltation and land formation, reducing the river's water flow capacity and potentially affecting the city's flood control and drainage.

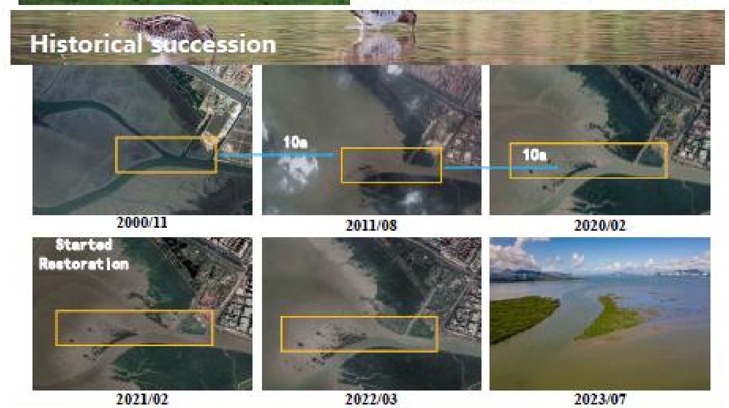


Spread of *Sonneratia* in the Shenzhen Estuary Invading Migratory Bird Habitats (MCF)

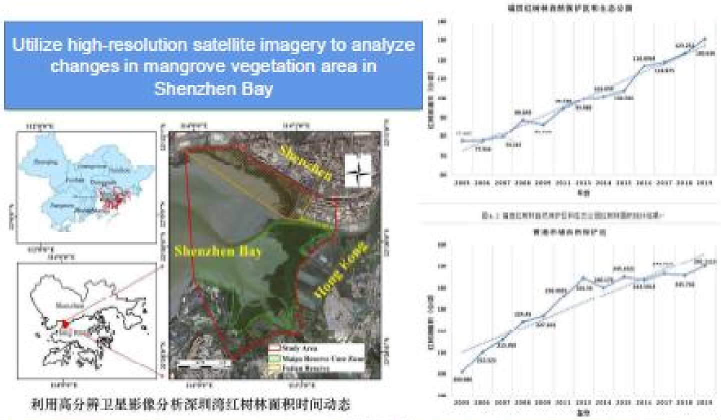


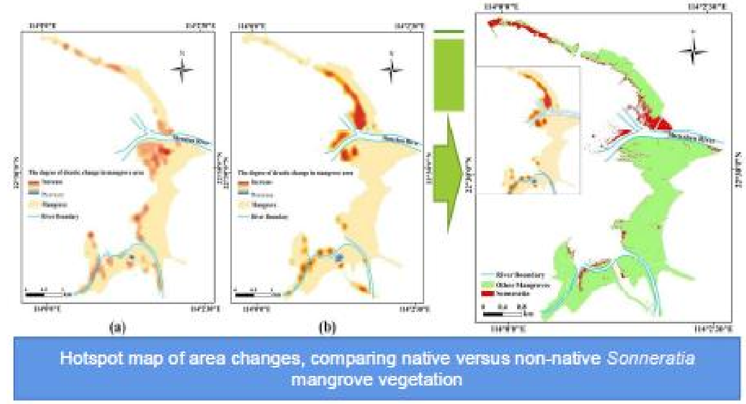
The Maximum Number of Birds Recorded in Single Monthly Surveys in the Shenzhen Estuary Wetland from 2006 to 2020 (Data Source: Shenzhen Bird Watching Society)

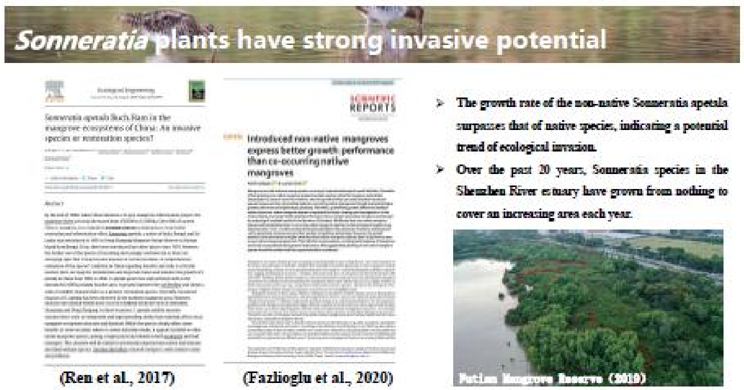


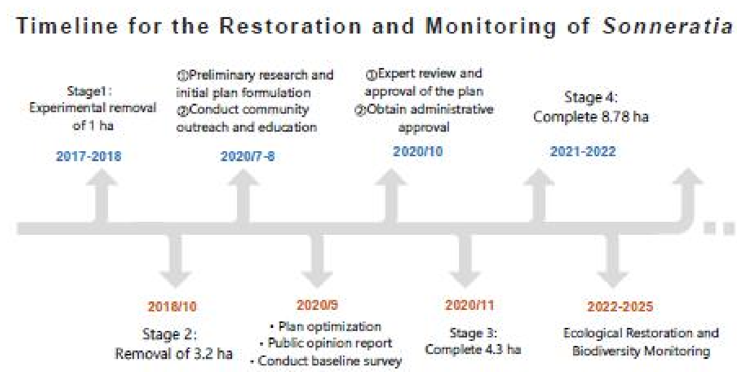


Distribution map of *Sonneratia apetala* in Shenzhen Bay
(Source: Professor Tam Fung Yee, City University of Hong Kong, Deep Bay Wetland Conservation Seminar, 2017)


Utilize high-resolution satellite imagery to analyze changes in mangrove vegetation area in Shenzhen Bay
Shenzhen
Shenzhen Bay
Hong Kong
利用高分辨卫星影像分析深圳湾红树林面积时间动态


Hotspot map of area changes, comparing native versus non-native *Sonneratia* mangrove vegetation
(a)
(b)


Sonneratia plants have strong invasive potential
Introduced non-native mangroves express better growth performance than co-occurring native mangroves
(Ren et al., 2017)
(Fazlioglu et al., 2020)
➢ The growth rate of the non-native Sonneratia apetala surpasses that of native species, indicating a potential trend of ecological invasion.
➢ Over the past 20 years, Sonneratia species in the Shenzhen River estuary have grown from nothing to cover an increasing area each year.
Futian Mangrove Reserve (2019)


Timeline for the Restoration and Monitoring of *Sonneratia*
Stage1: Experimental removal of 1 ha
2017-2018
①Preliminary research and initial plan formulation
②Conduct community outreach and education
2020/7-8
①Expert review and approval of the plan
②Obtain administrative approval
2020/10
Stage 4: Complete 8.78 ha
2021-2022
2018/10
Stage 2: Removal of 3.2 ha
2020/9
• Plan optimization
• Public opinion report
• Conduct baseline survey
2020/11
Stage 3: Complete 4.3 ha
2022-2025
Ecological Restoration and Biodiversity Monitoring


深圳市林业局
深圳市林业局
In October 2020, the Wildlife Protection Department organized an expert review meeting, and the "Plan" was approved. The project was approved in the same month.

Sonneratia still quickly regrows

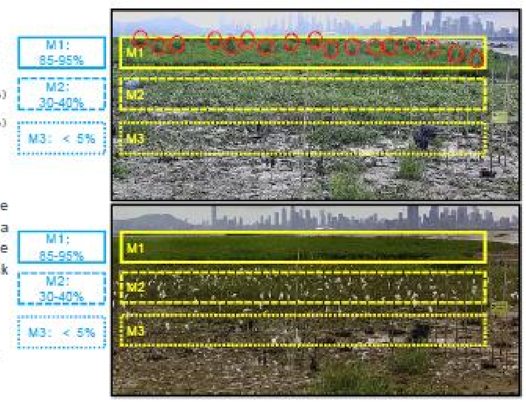
2019/10 2020/10

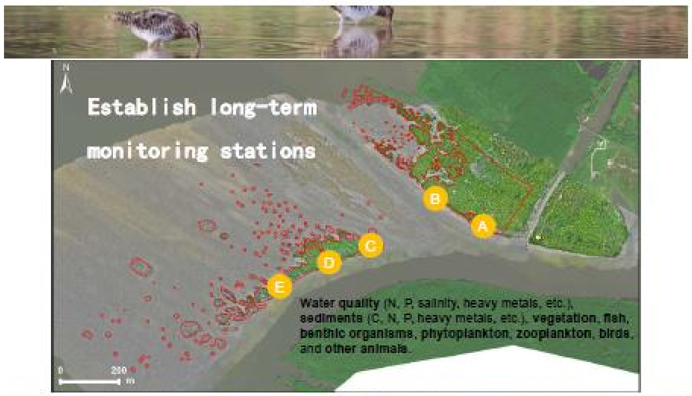
Remove fast-growing *Sonneratia* seedlings

Adaptive vegetation restoration methods

- **M1** Canopy closure (85-95%)
- **M2** Canopy closure (30-40%)
- **M3** Remove almost <5%

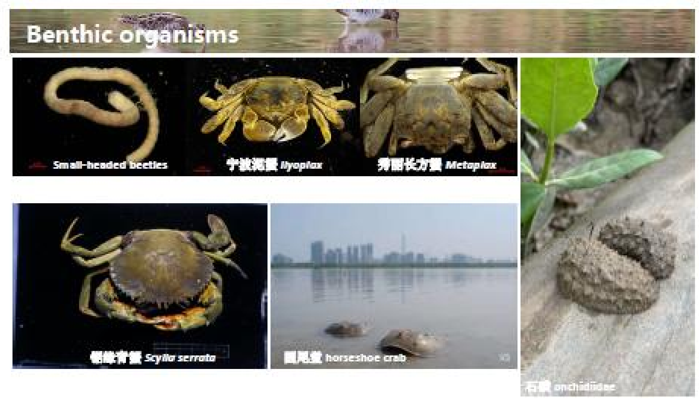
- Finished on 4/7, use on-site camera monitoring and drone surveillance to track bird distribution.
- Monitoring on 18/7、20/7 and 21/7



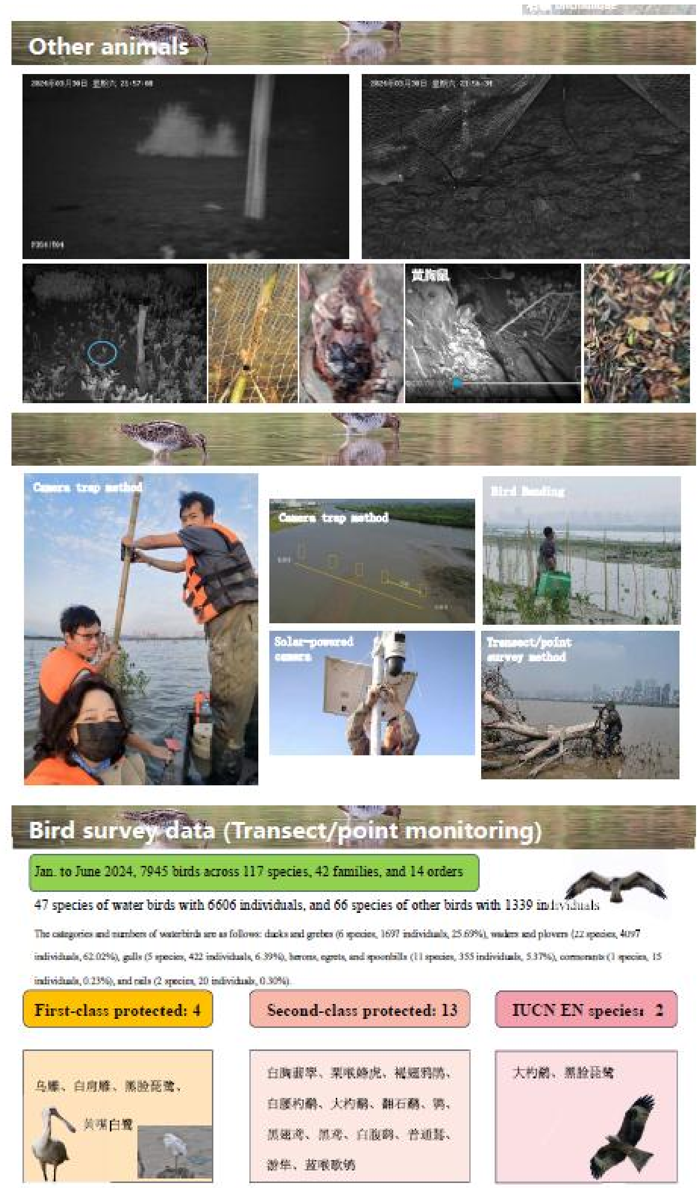

Establish long-term
monitoring stations
A
B
C
D
E
Water quality (N, P, salinity, heavy metals, etc.), sediments (C, N, P, heavy metals, etc.), vegetation, fish, benthic organisms, phytoplankton, zooplankton, birds, and other animals.


Phytoplankton (under a microscope)
Benthic larvae
Fleas and nematodes etc.


Zooplankton (under a microscope)
Diatoms
Green algae


Benthic organisms
Small-headed beetles
Ilyoplax
Metaplax
Scylla serrata
horseshoe crab
onchidiidae


Fish
A total of 31 fish species from 19 families and 8 orders were collected, including 20 economically important species. Among them, catfish and Nile tilapia are non-native invasive species
Bird monitoring
132 species, 42 families, and 15 orders

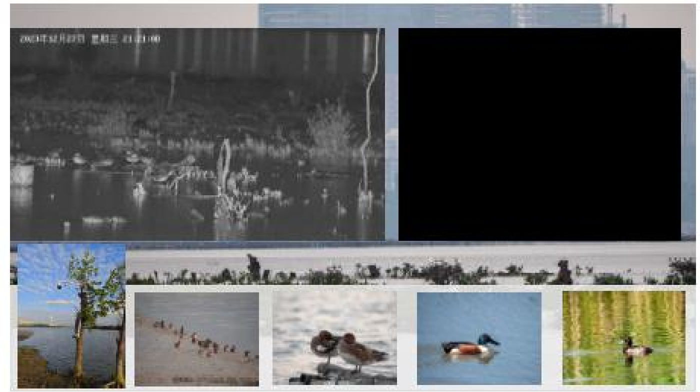

Other animals
Camera trap method
Camera trap method
Bird Banding
Solar-powered camera
Transect/point survey method
Bird survey data (Transect/point monitoring)
Jan. to June 2024, 7945 birds across 117 species, 42 families, and 14 orders
47 species of water birds with 6606 individuals, and 66 species of other birds with 1339 individuals
The categories and numbers of waterbirds are as follows: ducks and grebes (6 species, 1697 individuals, 25.69%), waders and plovers (22 species, 4097 individuals, 62.02%), gulls (5 species, 422 individuals, 6.39%), herons, egrets, and spoonbills (11 species, 355 individuals, 5.37%), cormorants (1 species, 15 individuals, 0.23%), and rails (2 species, 20 individuals, 0.30%).
First-class protected: 4
Second-class protected: 13
IUCN EN species: 2
乌雕、白肩雕、黑脸琵鹭、
黄嘴白鹭
白胸翡翠、栗喉蜂虎、褐翅鸦鹃、
白腰杓鹬、大杓鹬、翻石鹬、鹗、
黑翅鸢、黑鸢、白腹鹞、普通鵟、
游隼、蓝喉歌鸲
大杓鹬、黑脸琵鹭

2012/12/14 HK firstly banding

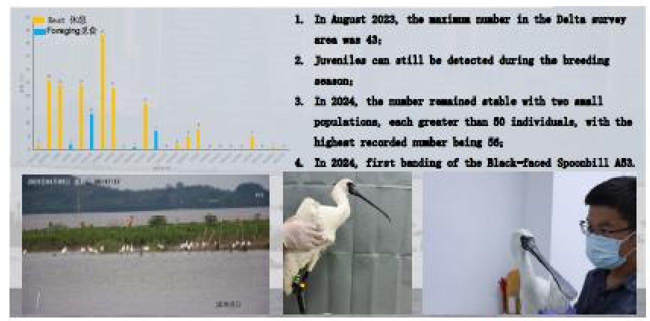
2014/10/25 HK firstly banding

Some take home messages;

- Mangrove restoration requires not only expanding the area but also focusing on biodiversity;
- Afforestation is mangrove restoration! BUT deforestation is also mangrove restoration;
- Strengthen cross-regional and cross-departmental cooperation and innovation in mechanisms.

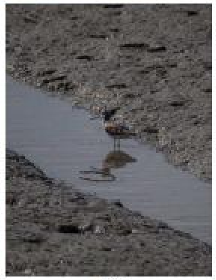


Black-faced Spoonbill



WY37

WY63



WY07

What is Bird Banding and its role?

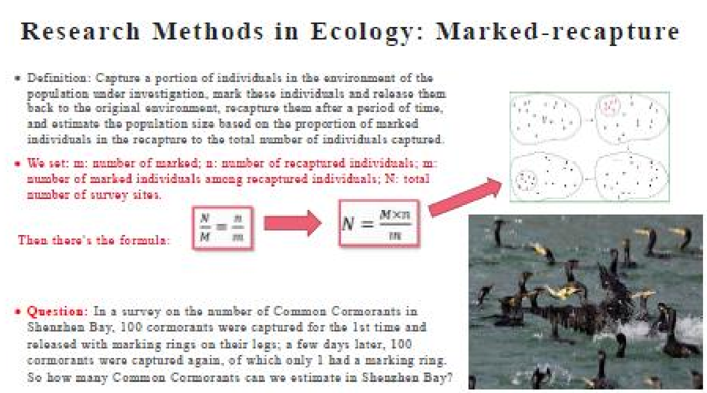
Bird Banding is the process of attaching a small, uniquely numbered ring to the leg of a bird to track its movements, behavior, and lifespan. （**ID card!**）
This method provides essential data for studying bird migration patterns, population dynamics, and ecological requirements, aiding in conservation and management efforts.

Metal anklets　Flag　Neck ring　Wing mark　Nose ring　Satellite tracker

保护候鸟 开展环志

A brief history of the development of bird banding

- **Early Beginnings** (Late 19th Century): Bird banding started in the late 1800s with Hans Christian Cornelius Mortensen, a Danish schoolteacher, who began attaching aluminum rings to birds to study their movements.
- **Expansion and Standardization** (Early 20th Century): The practice spread to North America and Europe, with organizations like the American Bird Banding Association (1909) and the British Trust for Ornithology (1933) establishing standardized methods and large-scale banding programs.
- **Modern Techniques and Technology** (Late 20th Century to Present): Advances in technology, such as GPS and radio telemetry, have enhanced the precision and scope of bird banding, allowing for more detailed tracking and data collection on bird migration and behavior.
- **The National Bird Banding Center of China (in 1982)** was established by the former Ministry of Forestry at the Chinese Academy of Forestry. It is a national-level R & D and management center, mainly responsible for the national bird banding technical management, information collection and compliance with the International Migratory Bird Protection Agreement.


Research Methods in Ecology: Marked-recapture
Definition: Capture a portion of individuals in the environment of the population under investigation, mark these individuals and release them back to the original environment, recapture them after a period of time, and estimate the population size based on the proportion of marked individuals in the recapture to the total number of individuals captured.
We set: m: number of marked; n: number of recaptured individuals; m: number of marked individuals among recaptured individuals; N: total number of survey sites.
Then there's the formula:
$\frac{N}{M} = \frac{n}{m}$
$N = \frac{M \times n}{m}$
Question: In a survey on the number of Common Cormorants in Shenzhen Bay, 100 cormorants were captured for the 1st time and released with marking rings on their legs; a few days later, 100 cormorants were captured again, of which only 1 had a marking ring. So how many Common Cormorants can we estimate in Shenzhen Bay?


Why bird banding?
Classification and identification
Molt
Measure
fatness
Sampling


"Mist netting method"
Field selection and catching time


Open a net
Selection of mist net
Open net method

Patrol the net

- Frequency: once every 30 minutes
- Adjust according to climatic factors: cold and hot summer, windy and rainy.

Close the net

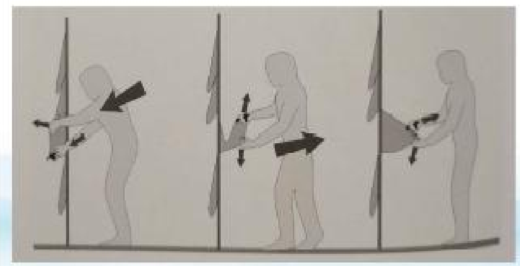
Untie the bird and temporary preservation of birds

Tool to hold the birds: bird bag

The principle of keeping bird bags: ensure the safety and health of birds.

- Dry, clean, dark and ventilated;
- A bag of individuals of the same species or at least the same species;
- Preservation: tie a slipknot and put it in a safe place to avoid natural enemies;
- Release as soon as possible;
- Check the bird bag after the end of bird banding;
- Clean the holding tools regularly.

General procedures for untie the bird: trunk, head, wings and toes.



Bird rings and Data Collection

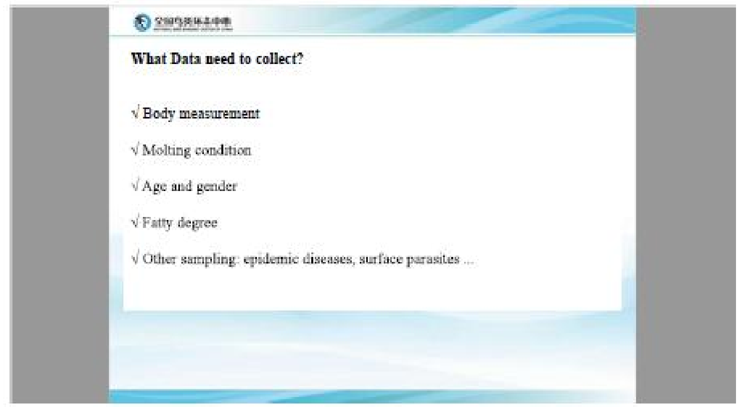
- Check the bird's leg to determine whether there is a ring.
- Species identification
- Choose and wear the appropriate ring.
- Measurement and photography

At the same time, someone must record it at the same time; Pay special attention to accurately record the ring number.

Table and tools for bird banding


Holding method:

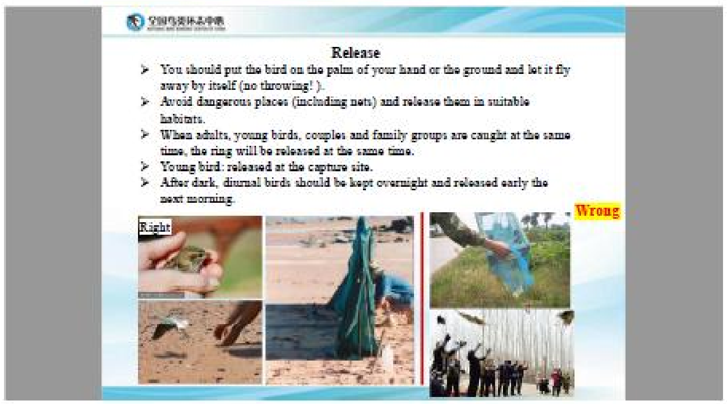

Absolutely forbidden:
Grasping flying feathers and tail feathers
Hold very tightly

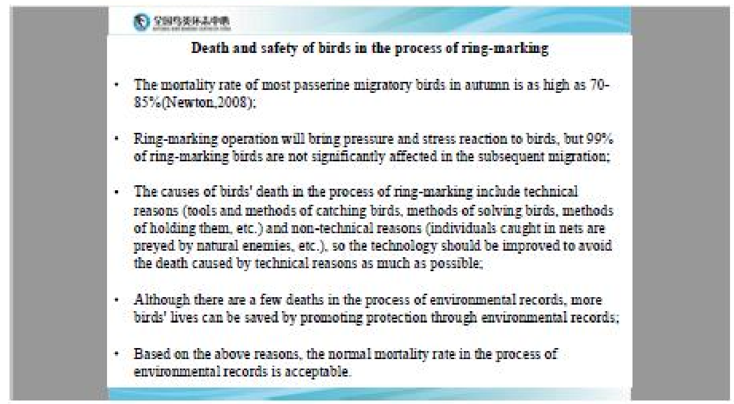

What Data need to collect?
√ Body measurement
√ Molting condition
√ Age and gender
√ Fatty degree
√ Other sampling: epidemic diseases, surface parasites ...


Fatty degree judgment
布斯（Busse）脂肪等级


Photograph


Ring number


Release
You should put the bird on the palm of your hand or the ground and let it fly away by itself (no throwing!).
Avoid dangerous places (including nets) and release them in suitable habitats.
When adults, young birds, couples and family groups are caught at the same time, the ring will be released at the same time.
Young bird: released at the capture site.
After dark, diurnal birds should be kept overnight and released early the next morning.
Right
Wrong


Death and safety of birds in the process of ring-marking
The mortality rate of most passerine migratory birds in autumn is as high as 70-85%(Newton,2008);
Ring-marking operation will bring pressure and stress reaction to birds, but 99% of ring-marking birds are not significantly affected in the subsequent migration;
The causes of birds' death in the process of ring-marking include technical reasons (tools and methods of catching birds, methods of solving birds, methods of holding them, etc.) and non-technical reasons (individuals caught in nets are preyed by natural enemies, etc.), so the technology should be improved to avoid the death caused by technical reasons as much as possible;
Although there are a few deaths in the process of environmental records, more birds' lives can be saved by promoting protection through environmental records;
Based on the above reasons, the normal mortality rate in the process of environmental records is acceptable.


Personal protection
Risks in bird catching: terrain, environment, tools and time.
Physical damage of birds to environmental volunteers: raptors, fish eaters and grain eaters.
Birds carry a variety of viruses and bacteria.


Publicity of bird rings


Management of bird banding in China
The forestry administrative authority is responsible for nationwide bird banding management;
The forestry administrative authority at or above the county level are responsible for the management of bird ringing within their jurisdiction;
In 1981, in order to implement the Agreement on the Protection of Migratory Birds and their Habitats signed between China and Japan, the National Bird Ringing Office was established in the former Ministry of Forestry;
In 1982, the National Bird Ringing Centre was established in the Chinese Academy of Forestry.
Satellite positioning tracker


Responsibilities of the National Bird Banding Center
Located at No. 1 Dongxiaofu, Haidian District, Beijing
• Prepare sign banding plans and technical procedures, organize the implementation, guide and coordinate sign banding activities;
• Supervise and distribute banding tools and markers, and coordinate the color marking of birds across the country;
• Collect and manage ring information;
• Carry out image ring training;
• Carry out international cooperation and information exchange


The way to carry out the work:
● Bird banding activities should be conducted at designated bird banding stations or institutions confirmed by the local bird banding station or forestry administrative authority. Other organizations and individuals are not allowed to conduct bird banding activities independently.
● Forestry administrative authorities should submit a list of bird banding stations or institutions conducting bird banding activities within their jurisdiction to the State Council's forestry administrative authority annually. This list will be compiled and published by the National Bird Banding Center.
Heilongjiang Xinglong Qingfeng bird protection ring station


National Bird Banding Management Regulations
● The establishment of a bird banding station requires the supporting organization to submit an application to the local forestry administrative authority. It must be confirmed by the banding center that the station has at least two qualified banding personnel, a fixed location for banding activities, and a source of funding;
● Before conducting banding activities, it is necessary to obtain administrative permission from the local or national forestry authority and to have the appropriate banding qualifications;
● Obtain bird banding tools and bands from the banding center or use tools and bands recognized by the banding center;
● Comply with relevant laws, regulations, and technical standards.
国家林业局关于印发《鸟类环志管理办法（试行）》和《鸟类环志技术规程（试行）》的通知
The National Forestry Administration issued the "Bird Banding Management Regulations (Trial Implementation)" and "Bird Banding Technical Guidelines (Trial Implementation)"


Bird Banding Station duties
● Formulate rules and regulations on bird ringing to ensure that it is operated in strict accordance with the technical regulations and to prevent the loss of bird resources due to bird ringing.
● Submit annual plans for bird ringing in the location on time, and apply for administrative licences in a timely manner in accordance with the law if it involves statutory administrative licences.
● Set up stable locations for bird ringing.
● After the completion of the ringing activities, report the ringing situation and recovery information to the National Bird Ringing Centre in a timely manner.
● Carry out publicity, education and technical training on bird protection, stop illegal ringing or indiscriminate hunting and other behaviours that damage bird resources and habitats, and report them to the competent wildlife authorities in a timely manner.


Requirements for bird banding personnel
● Staff and volunteers participating in bird banding activities should receive technical training from the China Bird Banding Center, Bird Banding Station or corresponding institutions, and can participate in organized banding activities only after passing the test.
● Foreign personnel to carry out bird banding work in China need to have effective bird banding qualifications and comply with relevant laws and regulations in China.

Access to administrative licenses in accordance with the law and regulation

The National Bird Ringing Centre, Bird Ringing Station or other institutions organizing bird ringing activities shall put forward a bird ringing plan on an annual basis, in which the birds that are planned to be captured:

1) If the wildlife is protected at the national level, it shall be reported to the forestry administrative department for approval in accordance with the law;

2) For wildlife under the second level of nation protection, it shall be reported to the provincial forestry administrative department for approval;

3) For non-National key protected wildlife, according to the relevant regulations of the location.

Those who implement the national bird ring plan approved by the National Forestry and Grassland Administration will no longer apply for a special hunting and catching license.

国家林业和草原局办公室文件

Wildlife Protection Law of the People's Republic of China

Some Important Things

Currently, bird ringing is managed as wildlife hunting.

The principle of 'whoever applies is responsible' is observed.

The ringing of birds in restricted areas and during restricted periods requires a license.

Anyone who captures birds for ringing without approval or in violation of the provisions of these Measures, or who keeps birds for other purposes, shall be dealt with by the competent administrative department of wildlife in accordance with illegal hunting and trapping of wildlife.

If the situation is serious and constitutes a crime, criminal responsibility shall be investigated according to law.

Establishment of Shenzhen University Bird Banding Monitoring Station 2023/6/15

Treatment of ringed birds

- If it is approved to catch birds to carry out ringing activities, the captured birds should be released on the spot after loading markers or signal transmitting devices in a timely manner, and should not be hidden or retained for other purposes.
- In the process of bird ringing, if unauthorised birds are captured by mistake, those suitable for ringing should be properly ringed, and those unsuitable for ringing should be released on the spot; and timely rescue measures should be taken for injured or sick individuals.
- In order to carry out the ringing activities, the birds released for artificial breeding, confiscation by law enforcement, sheltering and rescuing should be carried out in their natural distribution areas, and must be qualified for quarantine.

On June 15, 2023, the "National Bird Banding Center Shenzhen University Bird Banding Monitoring Station" was officially established at Shenzhen University


2023年秋季全国鸟类环志监测技术培训日程安排表

There are four main aspects of the bird banding:

① Tracking monitoring based on the support of wildlife rescue work of Shenzhen Nature Reserve Management Centre;

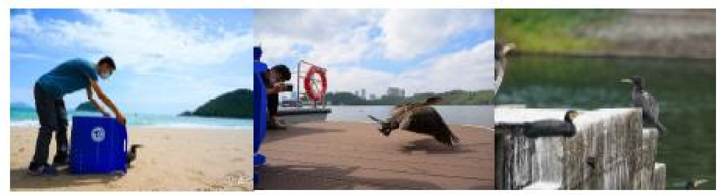
② Mangrove wetland combined with black-headed tern ringing monitoring and protection planning;

③ Bird-strike prevention and ringing protection at Shenzhen Bao'an International Airport;

④ Waterbird ringing monitoring in Futian Mangrove Reserve.

Tracking of released rescued birds

Based on the rescue work carried out by the Shenzhen Nature Reserve Management Centre, a total of 13 birds released were fitted with tracking devices, of which 7 out of 10 Common Cormorants migrated successfully to their breeding grounds, 4 kept their data back and migrated southwards to China, of which 2 returned to Guangdong, and 1 has already returned to its wintering site in Shenzhen Bay in 2022.



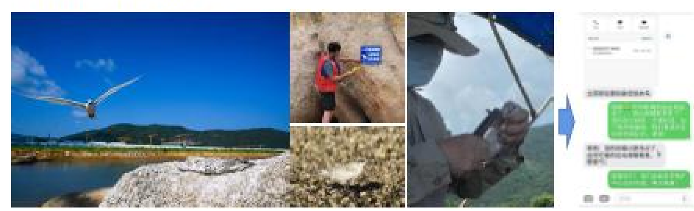
Mangrove wetland + Discovery of breeding grounds of black-pillow terns and monitoring by ring marks

Bright spot restoration project: restoration of rare and endangered mangrove plum community and breeding habitat of migratory birds tern

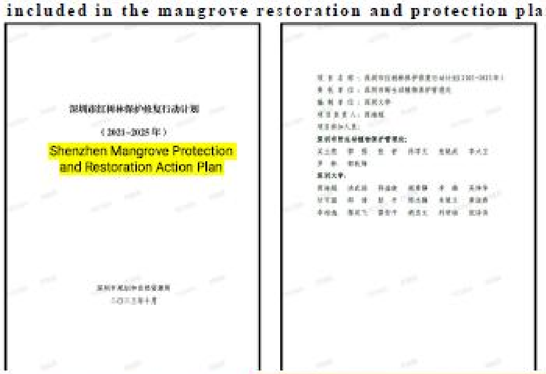
Restoration content: Rescue protection and restoration will enhance the small population of Prunus mume community and the breeding habitat of black-pillow tern recorded for the first time in Shenzhen, with an area of 1.30 hectares. The ongoing construction of Yinwan Road (Xianmoshi-Xinhai Avenue) has potential negative impacts;
Highlights of restoration: mangrove wetland restoration+migratory bird migration channel protection.

Ringing of juvenile black-headed terns on their breeding grounds

① When the team conducted a mangrove wetland survey in May 2023, it discovered a black-napped tern breeding ground in the surrounding coastal habitats;
② Problems faced: Due to the sea rush activities in the surrounding area, human activities are frequent, and there are artificial behaviors such as stealing and moving bird eggs;
③ Response methods: Carry out video surveillance on the breeding island, ring the young birds and accumulate incubation rate, young bird survival rate and other data, and plan to promote the breeding island protection plan.
④ There were a total of 27 rings this year, including 3 adult birds and 24 young birds. One young bird that died due to a typhoon was recovered.



The protection of black-napped tern breeding grounds has been included in the mangrove restoration and protection plan



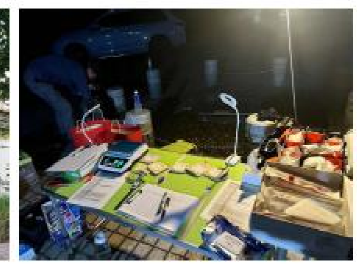
Public Awareness Education on Bird Banding

Bird banding monitoring for bird strike prevention at Shenzhen International Airport

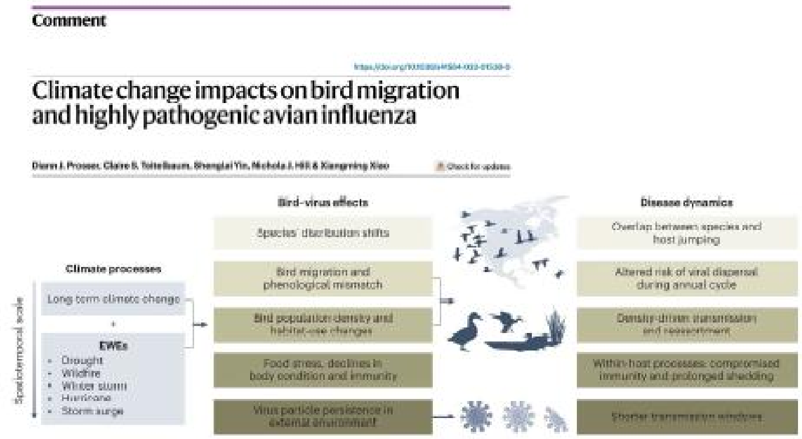
The team cooperated with Shenzhen Bao 'an Airport to rescue the birds in the bird net in the airport and ring the birds before releasing them back.

Since September, 64 individuals have been ringed, and birds at risk of bird strike have been worn with trackers. Among them, 4 species of turtledoves have been worn with trackers.

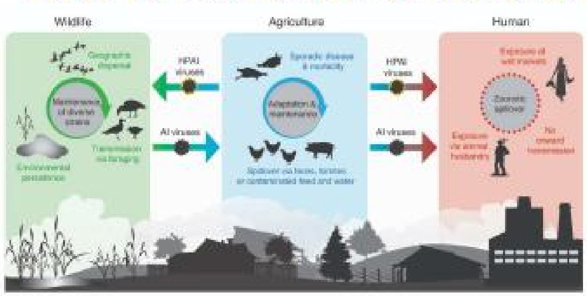
Bird banding monitoring in Futian Mangrove Reserve



Postcards and other small gifts for science popularization activities related to bird banding and monitoring

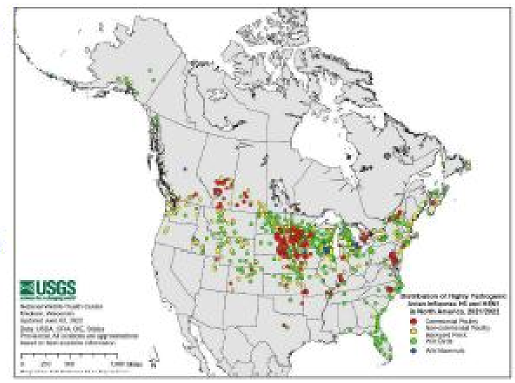


Generalized ecology of avian-origin influenza A viruses showing common directionality of cross-species transmission events



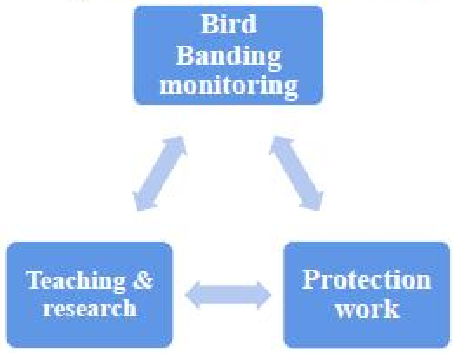
Source: https://americanornithology.org/highly-pathogenic-avian-influenza-hpai-an-emerging-disease-threat-in-north-america/

Distribution of Highly Pathogenic Avian Influenza H5 and H5N1 in North America



Source: https://americanornithology.org/highly-pathogenic-avian-influenza-hpai-an-emerging-disease-threat-in-north-america/

Plan for conducting bird banding monitoring in higher education institutions



What do we plan to do in the future?

① Based on the project to carry out mangrove wetland migratory bird ringing + zoonotic disease monitoring work;

② Strengthen the cooperation with Shenzhen Airport on bird banding and conservation + bird early warning, etc;

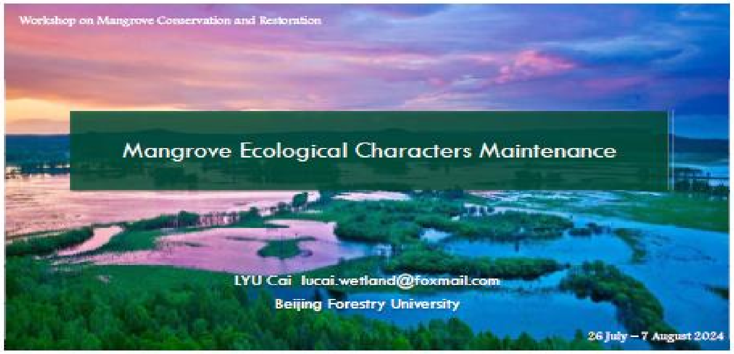
③ Carry out zoology internship for bird ringing and monitoring based on undergraduate teaching practice;

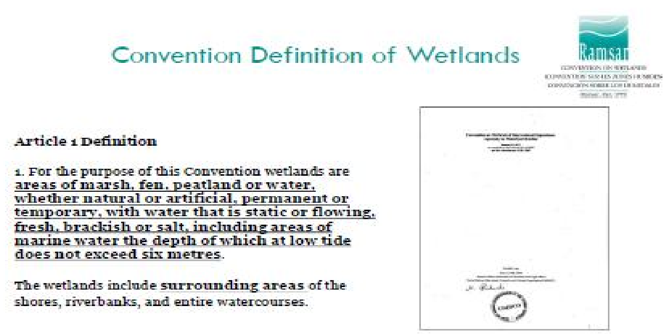
④ Bird ringing education (bird collision survey, etc.) based on undergraduates' competitions and public welfare projects;

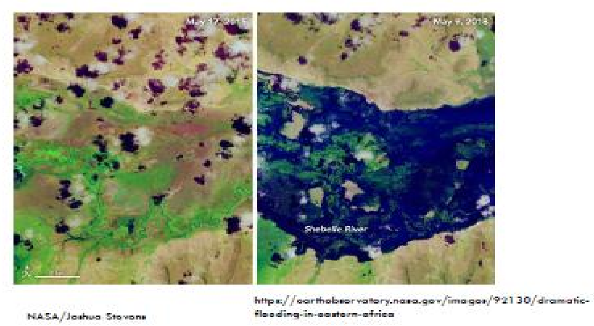
⑤ Hope to use IMC opportunity to establish an international network for bird banding and monitoring in mangroves and other wetland areas.

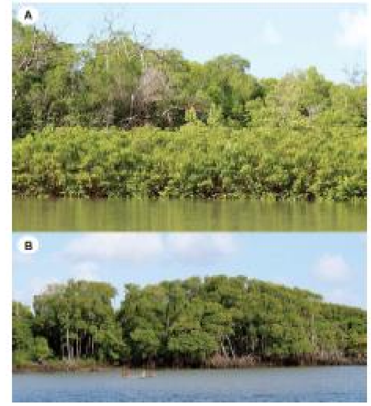
Map of Migratory Bird Flyways in China (National Action)
候鸟迁飞通道保护修复中国行动计划（2024-2030）

- **Lecture 13: mangrove Ecological Characters Maintenance**





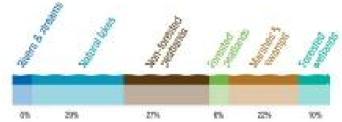




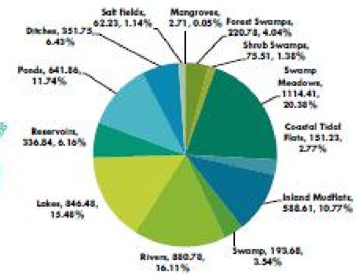
Ottoni et al. 2021
DOI: 10.1590/1676-0611-BN-2020-1172

Categories of Wetlands

Ramsar	China
3 classes 42 types • marine wetlands • artificial wetlands • inland wetlands. These groups can be classified further according to the type of water such as the fresh, alkaline, saline, and brackish water.	5 classes 42 types GB/T 24708-2009 • coastal wetlands • riverine wetlands • lake wetlands • marsh/swamp wetlands • artificial wetlands Statics by Ramsar Category is different by China's Category



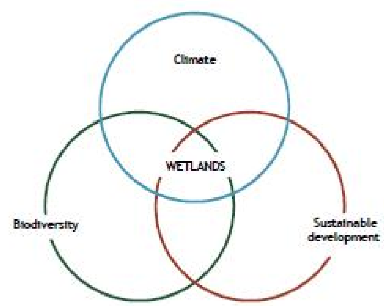
Areas (%) of world natural inland wetland classes



Areas (%) of wetland classes in China

2. Ecosystem Services

- Wetland ecosystem services **far exceed** those of terrestrial ecosystems
  - **critical food supplies** including rice and freshwater and coastal fish, **and fresh water, fibre and fuel.**
  - **regulating** services influence **climate and hydrological regimes**, and **reduce** both **pollution and disaster risk.**
  - natural features of wetlands often have **cultural and spiritual importance.**
- Wetlands offer **recreational possibilities and tourism benefits.**
- Storage and sequestration of **carbon** by wetlands play an important role in regulating the global climate.
  - **Peatlands and vegetated coastal wetlands** are large carbon sinks. Salt marshes sequester millions of tonnes of carbon annually.
  - Despite occupying only 3% of the land surface, peatlands store twice as much carbon as the world's forests
  - **Mangroves store 3-4 more times of Carbon than Rainforest**



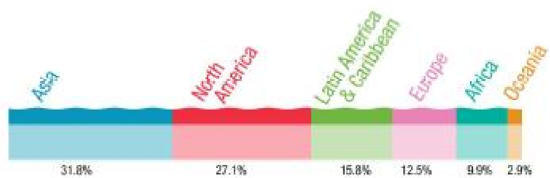
Water
Food
Water regulation
Climate regulation
Salinization of soils
Culture heritage
Recreation and tourism

Carbon cycle in/through Wetlands

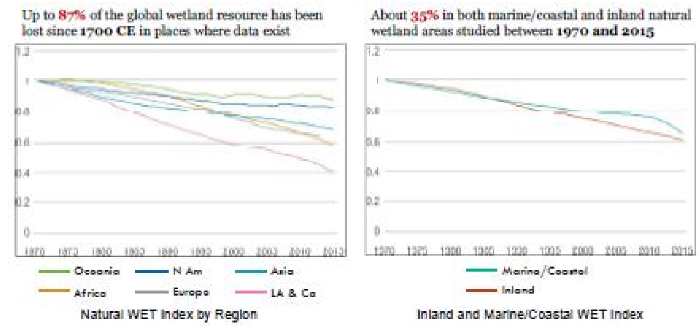
3. Status ,Trends & Drivers GWO 2018 & 2021

Area of global inland and coastal wetlands

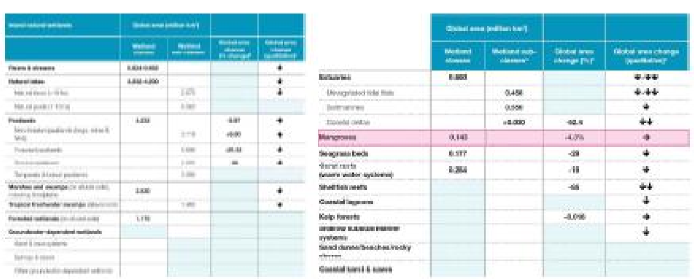
15-16 million km² GWO 2021
12.1 million km² GWO 2018



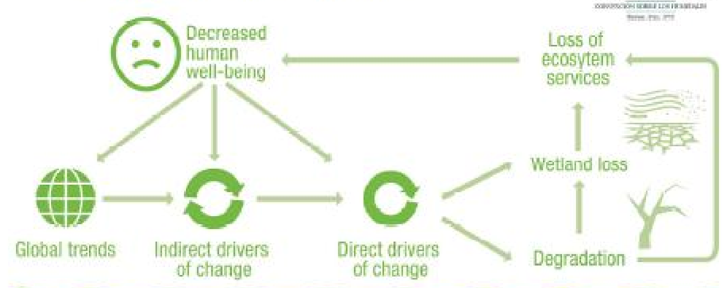
Loss of Wetlands GWO 2018



Trends of Wetlands GWO 2018



3. Status ,Trends & Drivers



Type of Drivers

GWO 2018

Direct drivers

Drainage and conversion, introduction of pollution and invasive species, extraction activities, and other actions affecting the water quantity and frequency of flooding and drying

Indirect drivers

Supply of energy, food, fibre, infrastructure, tourism and recreation

Direct and indirect drivers

Climate change: abnormal precipitation and evaporation, extreme weathers, phenology shift, warmer temperature

Global megatrends: demography, globalization, consumption and urbanization, with climate change creating uncertainty

Governance: awareness, inventory, monitoring, research, management

Alteration-Physical regime change

- Flow regime (quantity and frequency)
- Sediment
- Salinization
- Temperature

Extraction-Over use

- Water
- Fishing
- Wood harvesting
- Sand and gravel mining

Introduction-Over load

- Nutrients
- Chemicals
- Solid wastes
- Invasive Species

Conversion-Structure Change

- Drainage
- Reclamation/Construction/urbanization
- Activities/noise
- Buring/ploughing
- Community composition/horticulture

Hot Issues and Priorities of the Ramsar Convention

Themes

- **Climate & Carbon**-Impacts and responses, Blue Carbon, mitigation
- **Agriculture**-Maintaining and restoring the ecological character in agricultural wetlands
- **Biodiversity**-KM Global Biodiversity Framework, OECMs, Working coastal habitats
- **Sustainable Development**-SDGs

Tools

- **Application** of criteria for designating RS
- **Tools** for wetland assessment, mapping and monitoring: Carbon and Small Wetlands

Solutions

- **Financial** cost of wetland loss and degradation and investment required for restoration
- **Policy** and **legal** framework for conservation and wise use

4. Concept of Ecological Characters

Article 3.2 Ecological Character

Each Contracting Party shall arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the List **has changed, is changing or is likely to change** as the result of technological developments, pollution or other human interference. Information on such changes shall be passed without delay to the organization or government responsible for the continuing bureau duties specified in Article 8.

COP14 | 2022

"Wetlands Action for People and Nature"

Resolution XIV.13

The status of Sites in the List of Wetlands of International Importance

75% of the 2,439 Sites that had been designated by 30 June 2022, either the Ramsar Information Sheets (RISs) or adequate maps had not been submitted, or relevant RISs or maps had not been updated for over six years, so that recent information on the status of these Sites was not available

Convention on Wetlands (Ramsar, Iran, 1971)
5th Meeting of the Conference of the Contracting Parties
Kushiro, Japan
9-16 June 1993

Resolution 5.4: The Record of Ramsar sites where changes in ecological character have occurred, are occurring, or are likely to occur (Montreux Record)

DETERMINES that the purpose of the Montreux Record **is to identify priority sites for positive national and international conservation attention**, to guide implementation of the Monitoring Procedure, and to guide allocation of resources available under financial mechanisms;

CONVENTION ON WETLANDS (Ramsar, Iran, 1971)

Proceedings of the 6th Meeting of the Conference of the Contracting Parties (Brisbane, Australia, 19-27 March 1996)

RESOLUTION VI.1: WORKING DEFINITIONS OF ECOLOGICAL CHARACTER, GUIDELINES FOR DESCRIBING AND MAINTAINING THE ECOLOGICAL CHARACTER OF LISTED SITES, AND GUIDELINES FOR OPERATION OF THE MONTREUX RECORD

3.2 The Montreux Record is the principal tool of the Convention for highlighting those sites where **an adverse change in ecological character has occurred**, is occurring, or is likely to occur, and which are therefore in need of priority conservation attention. It shall be maintained as part of the Ramsar Database and shall be subject to continuous review.

When we look at people, there are... then we describe...

When we look at wetlands, there are... then we describe...


typical


unique

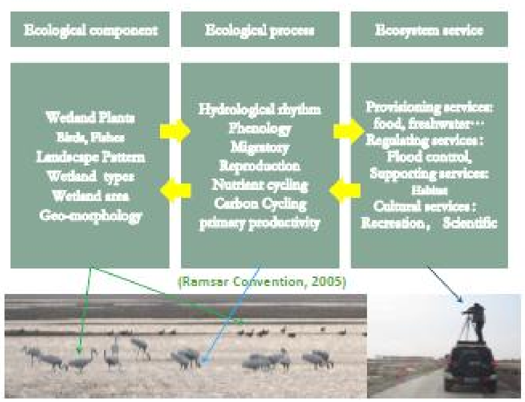

degraded

Wetlands also have characters: ecological characters

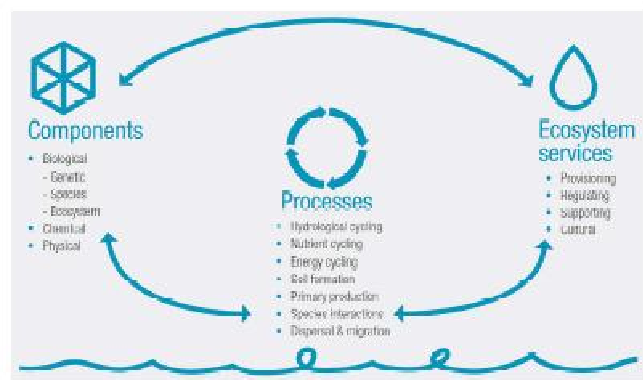
Ecological Characters:
Why a Wetland is THE WETLAND

The Concept of Ecological Character

=Ecological component
+Ecological process
+Ecosystem service

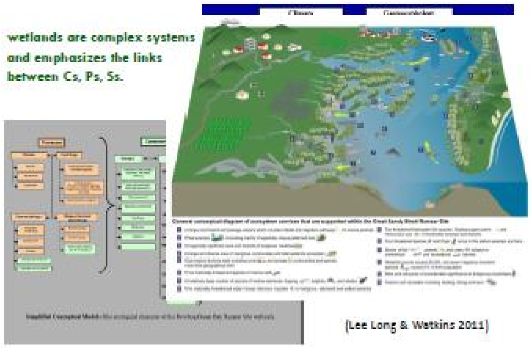


Momoge: World largest stopover site for Siberian Cranes



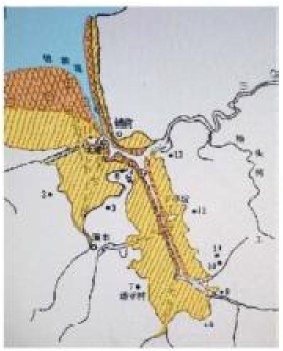
Conceptual Model for EC

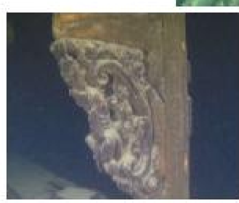
wetlands are complex systems and emphasizes the links between Cs, Ps, Ss.



(Lee Long & Watkins 2011)

1605 Earth Quake at Dongzhaigang, Hainan





Identifying Critical Characters

Principle of identifying critical character

—are key determinants of a sites' character and/or degree of importance and/or unique status;

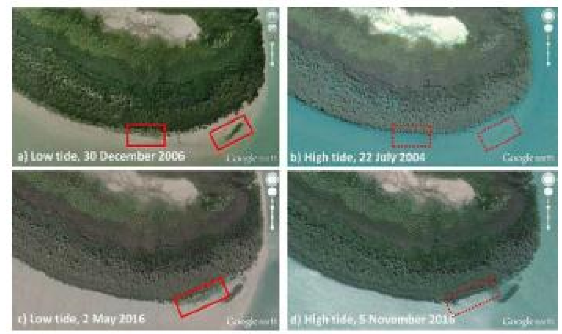
—if they change beyond their natural range, are likely to cause significant negative consequences to the ecosystem(s) of this site;

—have important ecological links in space or time to other ecosystems or populations

Thus, a critical C,P must meet 1, as well as 2 and/or 3

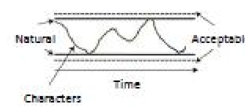
5. Ecological Character Description

- Describes the ecosystem services of a wetland, and the critical ecological components and ecological processes that underpin those services - at a given point in time
- Via ECD
  - ➢ provides a benchmark description at the time of listing, natural variability and limits of acceptable change (LAC) of the ecosystem
  - ➢ better dynamic monitoring on biodiversity
  - ➢ provides support for management plans, decisions and actions

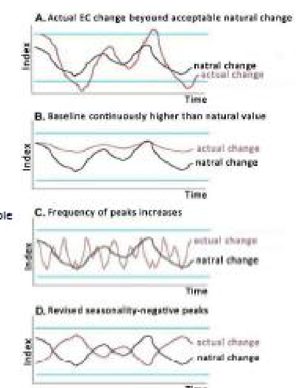


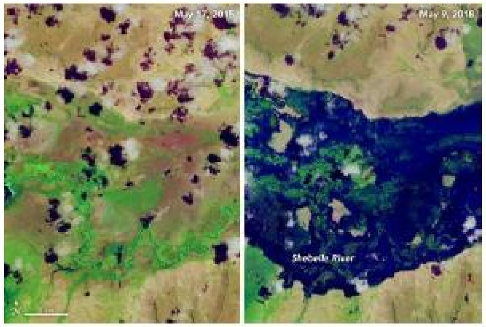
Rogers K et al 2017
DOI:10.1007/s10750-017-3257-5.

Setting LAC

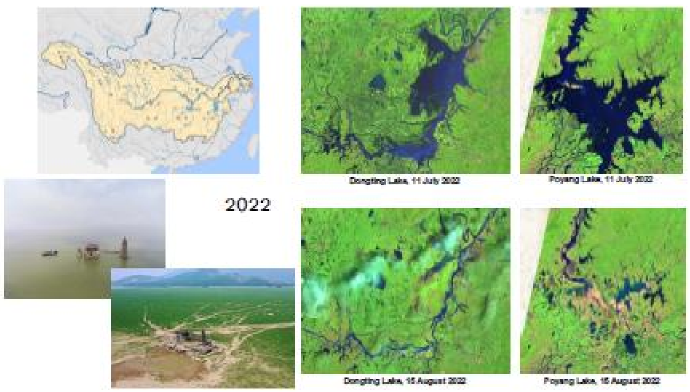


(after Phillips 2006).

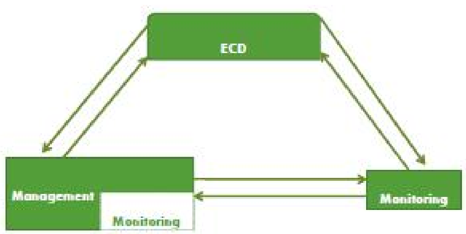




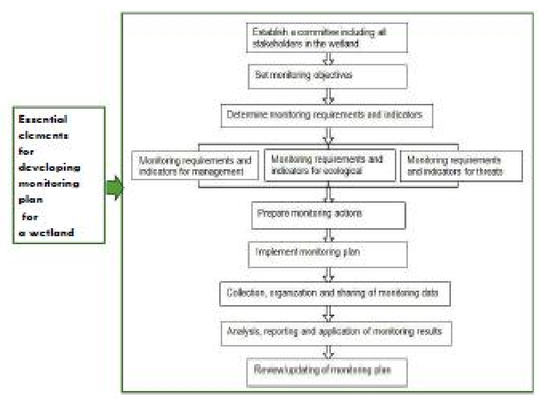
NASA/Joshua Stevens https://earthobservatory.nasa.gov/images/92130/dramatic-flooding-in-eastern-africa



Understanding the relationship between the ECD, Management and Monitoring

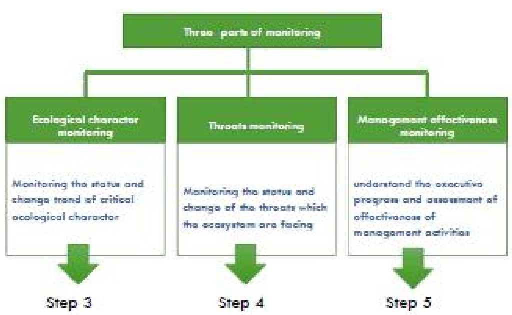


6. Ecological character monitoring and maintenance

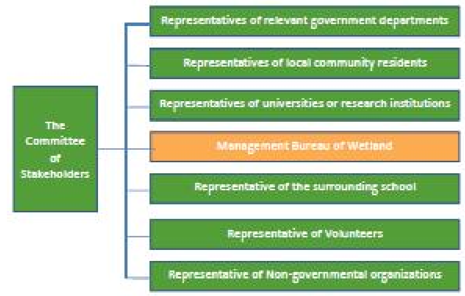


Step 1 Establishing Monitoring Committee of Stakeholders

Step 2 Identifying Monitoring Objectives



Step 1 Establishing Monitoring Committee of Stakeholders



Step 1 Establishing Monitoring Committee of Stakeholders

In order to ensure that

- integrates well with the development plans of all stakeholders,
- secures more supporting resources,
- facilitates implementation,

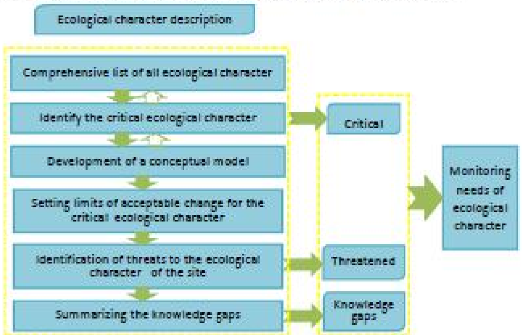
a committee of stakeholders in monitoring should be established at the outset.

Step 2 Identifying Monitoring Objectives

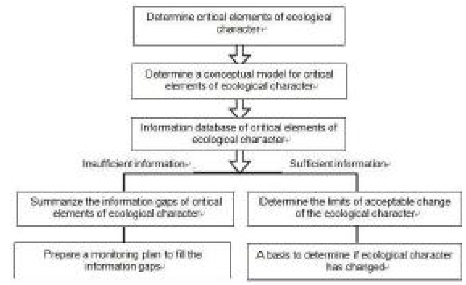
General "Guiding Principles"

- Answer the questions raised in the management process
- Iinvestigate the status and trends of change of ecological character;
- Investigate the threats that may influence ecological character;
- Monitor implementation progress and the effectiveness of management activities;
- Promote public participation and balance the interests of all parties.

Step 3 Identify Monitoring Needs and Indicators for Ecological Character



Step 3 Identify Wetland Monitoring Needs and Indicators for Ecological Character



Step 4 Identify Monitoring Needs and Indicators for Threats

Eexisting or potential threats to the ecological character of PAs

Actual or likely threat or threatening activities	Impacted ecological character	Potential impact(s) to ecosystem components, processes and/or services	Likelihood	Timing of threat

e.g., threats: Introduction and/or poor control of invasive species

A list of threats developed by the **International Union for the Conservation of Nature (IUCN)** and the **Conservation Measures Partnership (CMP)**

http://www.iucn.org/about/work/programmes/species/red_list/resources/technical_documents/new_classification_schemes/

These categories may be a useful starting point for identifying threats to ecological character of a Protected Area.

Step 5 Identify Monitoring Needs and Indicators for Management Effectiveness

Through monitoring of executive progress and effectiveness of wetland management activities, managers can assess the impacts of management actions on wetland ecosystem, review and update management plan.

Management activities	Excepted objectives	Implementation	Whether objectives has been achieved	Reason

Wetland restoration

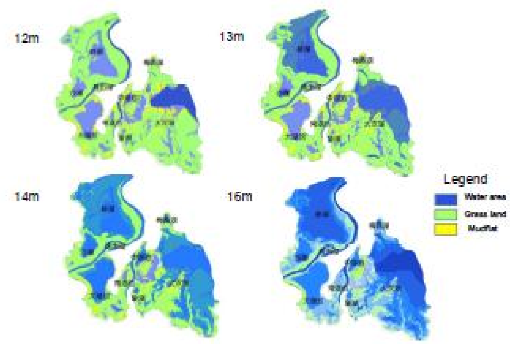
review of the extent of expected scenarios realized............

Step 6 Develop Action Plan for Monitoring Indicators

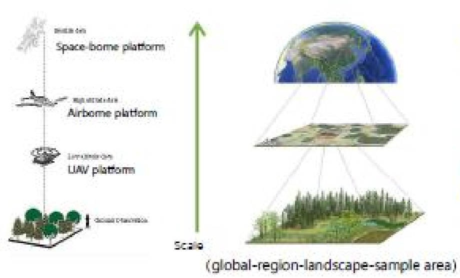
In this section, we should select monitoring methods, indentify monitoring frequency, and priority of monitoring activities as showing in the following table:

Indicators	Methods	Monitoring frequency	Source of funding	Priority

Monitor Change of wetland landscape by remote sensing technology



RS can provide biodiversity information of multiple spatial scale and time scale



Acoustic recorder

Step 7 Implementation of Monitoring Action Plan

Monitoring action plan should be implemented with contracting parties; the task arrangement should be recorded by management bureau.

Monitoring activities	Executor	Reporting frequency	Contact

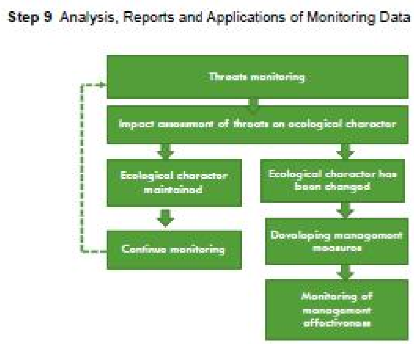
Step 8 Collection and Submission of Monitoring Data

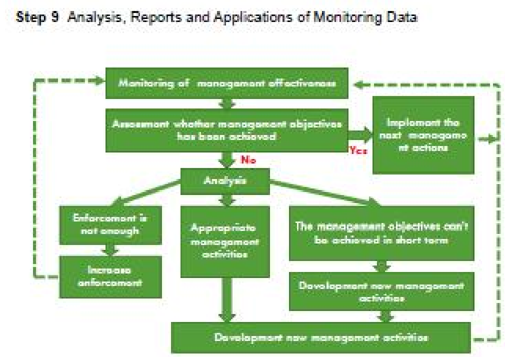
The executors of monitoring activities should submission data to the Bureau.

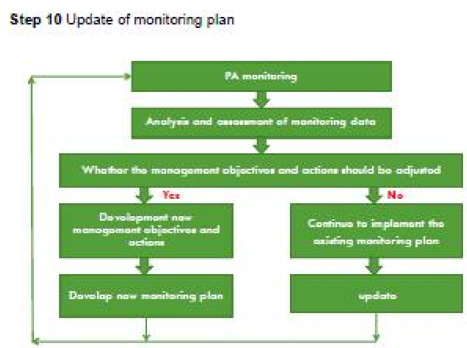
Plant survey

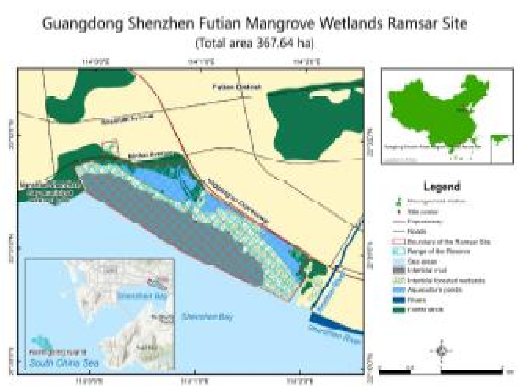
Sampling of benthos

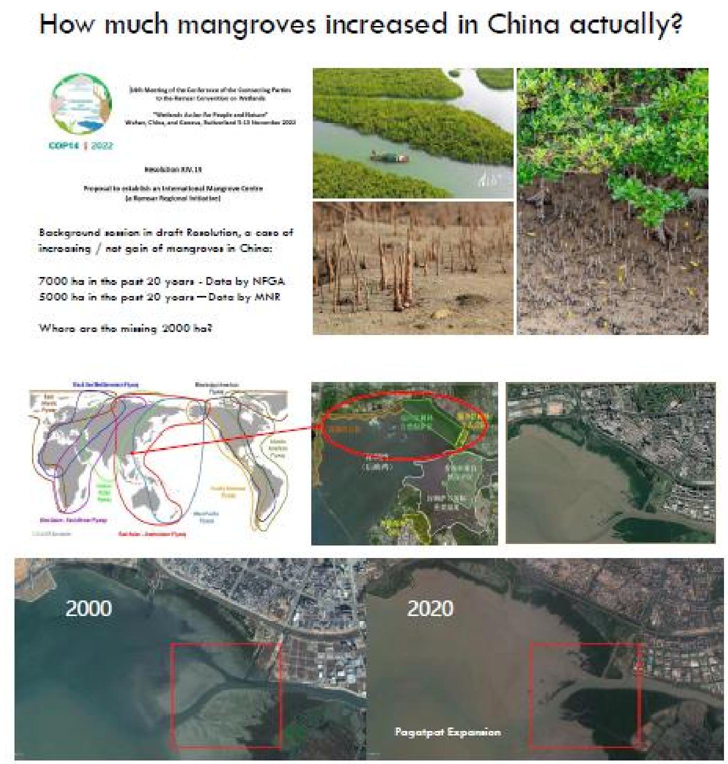
Step 9 Analysis, Reports and Applications of Monitoring Data

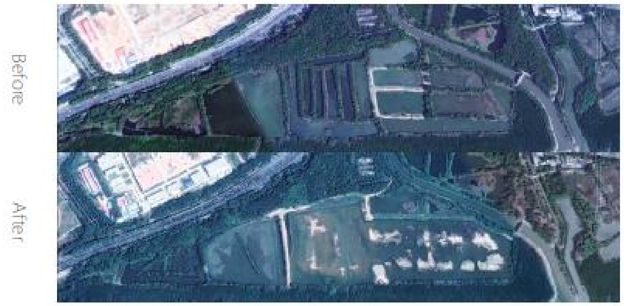

Step 9 Analysis, Reports and Applications of Monitoring Data
Threats monitoring
Impact assessment of threats on ecological character
Ecological character maintained
Ecological character has been changed
Continue monitoring
Developing management measures
Monitoring of management effectiveness


Step 9 Analysis, Reports and Applications of Monitoring Data
Monitoring of management effectiveness
Assessment whether management objectives has been achieved
Yes
Implement the next management actions
No
Analysis
Enforcement is not enough
Appropriate management activities
The management objectives can't be achieved in short term
Increase enforcement
Development new management activities
Development new management activities


Step 10 Update of monitoring plan
PA monitoring
Analysis and assessment of monitoring data
Whether the management objectives and actions should be adjusted
Yes
No
Development new management objectives and actions
Continue to implement the existing monitoring plan
Develop new monitoring plan
update


Guangdong Shenzhen Futian Mangrove Wetlands Ramsar Site
(Total area 367.64 ha)
Futian District
Shenzhen Bay
South China Sea
Legend


How much mangroves increased in China actually?
COP14 | 2022
Background session in draft Resolution, a case of increasing / net gain of mangroves in China:
7000 ha in the past 20 years - Data by NFGA
5000 ha in the past 20 years — Data by MNR
Where are the missing 2000 ha?
2000
2020
Pagatpat Expansion

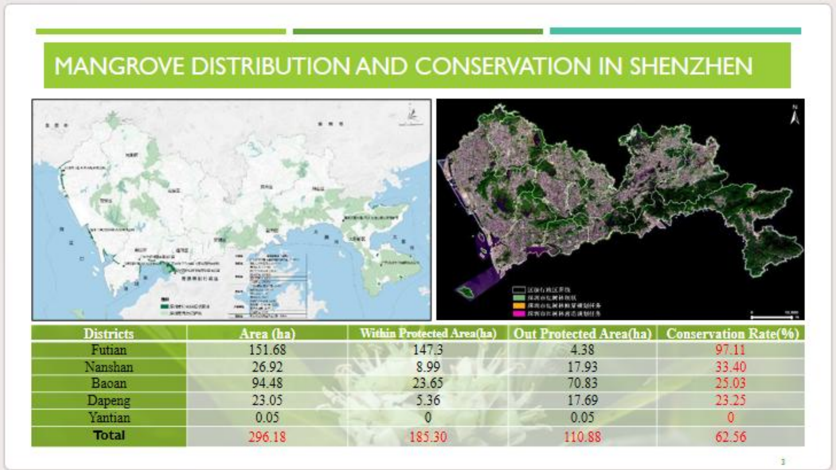


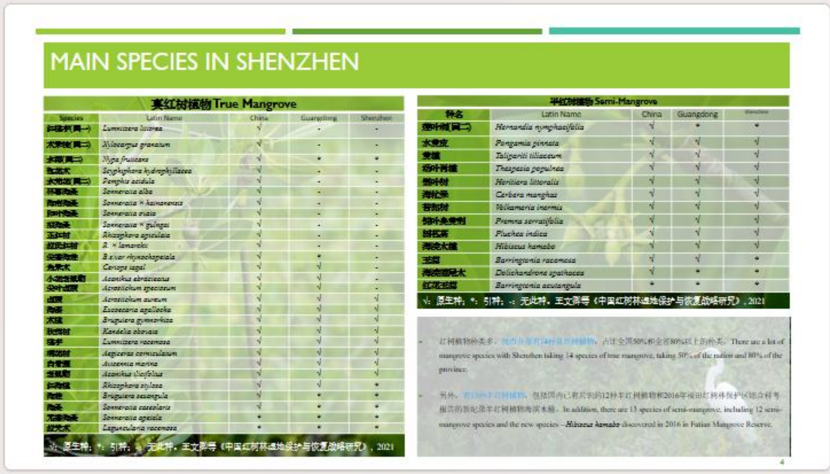
7. Group practice on EC based priorities

1. Select a shared region/site you are relatively familiar and have adequate data 5min
2. Background studies + list all major Components, Processes and ESs 20min
3. Draw a map of conceptual model + optional box conceptual model 20min
4. Identify 1-3 Critical ECs 20min
5. Describe regular changes and Limits of Acceptable Changes or GAP of 1 EC 10min
6. Practice on possible Drivers/Threats analysis, set Priorities 20min
7. Develop a draft manage plan/solution to maintain Critical ECs 10min
8. 3-4 Group reports 5 min each.

Annex 5 : Participant presentation slides

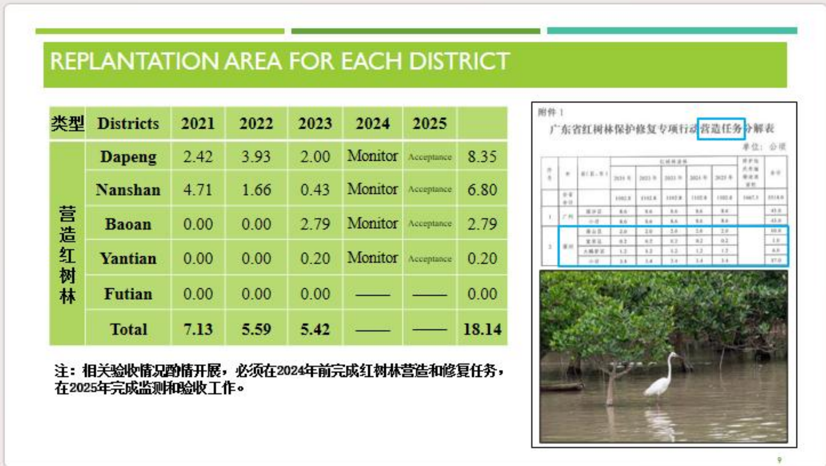
1- China





Type	Districts	Area(ha)	Type	Districts	Area(ha)
适宜营造	Futian	0.00	适宜修复	Futian	16.22
	Nanshan	6.80		Nanshan	12.16
	Baoan	2.79		Baoan	22.98
	Dapeng	8.35		Dapeng	6.99
	Yantian	0.20		Yantian	0
	Sub-Total	18.14		Sub-Total	58.35

Type	2021	2022	2023	2024	2025	Total
Replantation	7.13	5.59	5.42	Monitoring	Acceptance	18.14ha
Restoration	11.00	2.08	45.27	Monitoring	Acceptance	58.35ha


REPLANTATION AREA FOR EACH DISTRICT

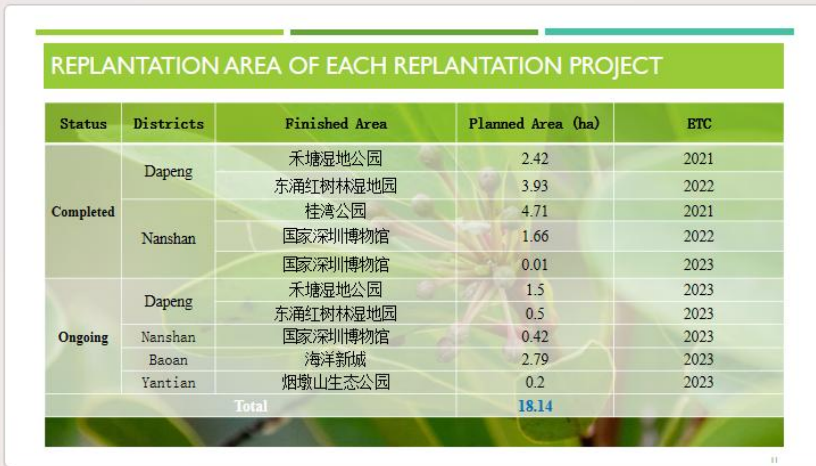
类型	Districts	2021	2022	2023	2024	2025	
营造红树林	Dapeng	2.42	3.93	2.00	Monitor	Acceptance	8.35
	Nanshan	4.71	1.66	0.43	Monitor	Acceptance	6.80
	Baoan	0.00	0.00	2.79	Monitor	Acceptance	2.79
	Yantian	0.00	0.00	0.20	Monitor	Acceptance	0.20
	Futian	0.00	0.00	0.00	——	——	0.00
	Total	7.13	5.59	5.42	——	——	18.14

注：相关验收情况酌情开展，必须在2024年前完成红树林营造和修复任务，在2025年完成监测和验收工作。
附件1
广东省红树林保护修复专项行动营造任务分解表
单位：公顷
9


REPLANTATION PROJECT

Districts	1Completed	Areas Completed	Practices and Species	2Plan	Planned Area	Practices and Species
Futian	0.00	-	-	-	-	-
Nanshan	4.71	1.Guiwan Park（4.71）	利用构建盖林地和潮沟等并种植乡土红树植物秋茄、木榄、桐花树、白骨壤、红海榄、卤蕨、银叶树和海漆等	2.09	1. 国家深圳博物馆（2.09）	参考桂湾公园，利用盖林地和潮沟构建并种植乡土红树植物秋茄、桐花树、白骨壤、红海榄和榄李等
Baoan	0.00	-	-	2.79	1. 海洋新城（2.79）	参考深圳河河口，结合构建潮沟和利用乡土植物控制外来种，营造乡土红树植物群落
Dapeng	2.42	1.禾塘湿地公园（2.42）	退塘还湿构建盖林地，种植乡土红树植物秋茄、红海榄、海漆、木榄、白骨壤、银叶树和桐花树等	5.93	1. 禾塘湿地公园（1.50） 2. 东涌红树林湿地园（4.43）	营造濒危珍稀红树植物榄李-红海榄群落，基于榄李等红树林分布区域，营造以榄李-红海榄为主；退塘还湿构建盖林地结合海草床耦合生态系统的修复方式
Yantian	0.00	-	-	0.20	1. 烟墩山生态公园（0.20）	利用乡土植物重建真红树-半红树植物群落：秋茄、桐花树、红海榄、白骨壤、海杧果、海漆和银叶树等
Total	7.13	-	-	11.01	（共计18.14公顷，对应完成省下达17公顷任务。）	

1已完成指2020-2021年期间完成的营造红树林面积；
2计划营造指2022-2025年计划营造的各个区的红树林面积，具体营造计划应该遵从预留不少于1年时间用于营造效果监测和评估验收，故2024年06月应完成营造种植工作，并及时开展相应的管护和营造成效监测与评估。
10


REPLANTATION AREA OF EACH REPLANTATION PROJECT

Status	Districts	Finished Area	Planned Area (ha)	ETC
Completed	Dapeng	禾塘湿地公园	2.42	2021
		东涌红树林湿地园	3.93	2022
	Nanshan	桂湾公园	4.71	2021
		国家深圳博物馆	1.66	2022
		国家深圳博物馆	0.01	2023
Ongoing	Dapeng	禾塘湿地公园	1.5	2023
		东涌红树林湿地园	0.5	2023
	Nanshan	国家深圳博物馆	0.42	2023
	Baoan	海洋新城	2.79	2023
	Yantian	烟墩山生态公园	0.2	2023
Total			18.14	

11

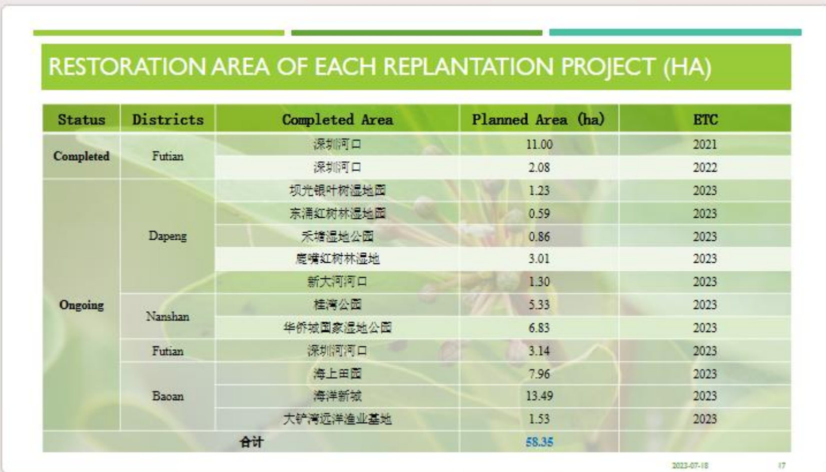

REPLANTATION PROJECT ACCOMPLISHED: DAPENG
禾塘湿地公园（2.42公顷）
禾塘湿地园
东涌红树林湿地园（3.93公顷）
东涌红树林湿地园
12

Districts	2021年	2022年	2023年	2024年	2025年	
Dapeng	0.00	0.00	22.98	Monitor	Acceptance	22.98
Nanshan	11.00	2.08	3.14	Monitor	Acceptance	16.22
Baoan	0.00	0.00	12.16	Monitor	Acceptance	12.16
Yantian	0.00	0.00	6.99	Monitor	Acceptance	6.99
Futian	0	0	0	——	——	0
Total	11.00	2.08	45.27	——	——	58.35

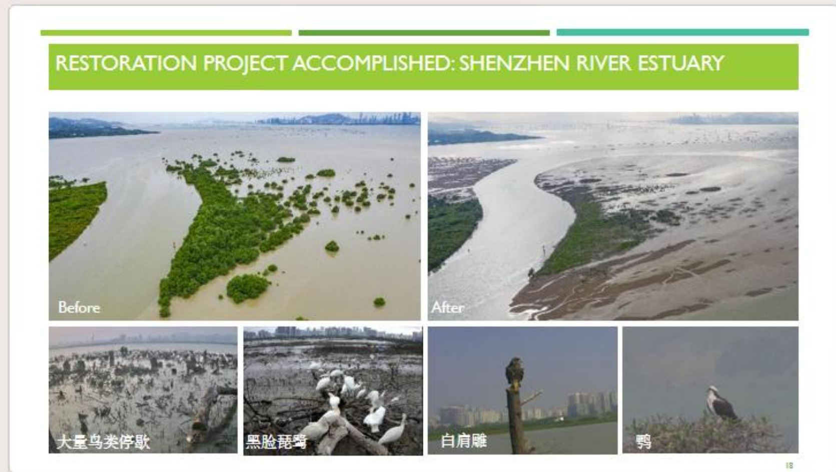
注：相关验收情况酌情开展，必须在2024年前完成红树林营造和修复任务，在2025年完成监测和验收工作。

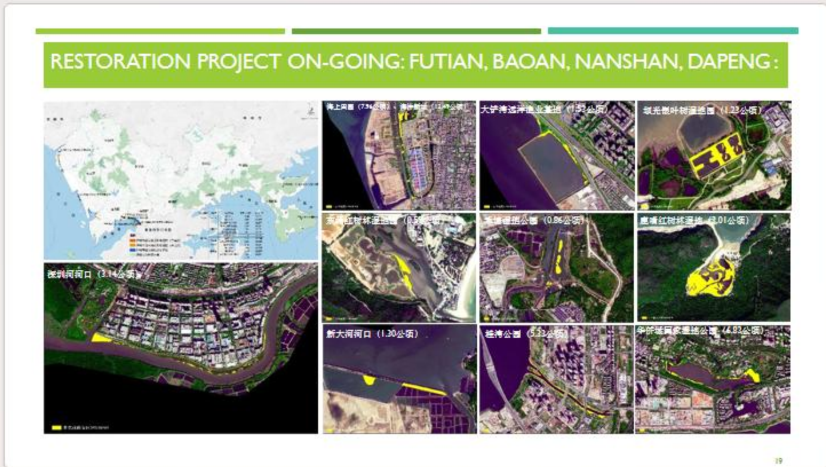
Districts	1Completed	Completed Area	2 Plan	Planned Area	Major Practice
Futian	13.08	深圳河河口 (13.08)	3.14	1. 深圳河河道（3.14）	修复更替外来红树植物，恢复典型乡土红树植物群落；基于水文连通，构建人工潮沟，提高与维持鸟类等湿地生物多样性
Nanshan	0	-	12.16	1. 华侨城国家湿地公园（6.83） 2. 桂湾公园（5.33）	修复更替外来红树植物，修复提升衰退秋茄林，恢复典型乡土红树林群落；基于水文连通，提高与维持鸟类等湿地生物多样性
Baoan	0	-	22.98	1. 大铲湾远洋渔业基地（1.53） 2. 西湾红树林公园（13.49） 3. 海上田园（7.96）	修复更替外来红树植物，恢复典型乡土红树植物群落；构建牡蛎礁-红树林的防风浪冲刷系统；基于水文生态，修复提升海上田园鱼塘红树林
Dapeng	0	-	6.99	1. 坝光银叶树湿地园（1.23） 2. 鹿嘴红树林湿地（3.01） 3. 禾塘湿地公园（0.86） 4. 东涌红树林湿地园（0.59） 5. 新大河河口（1.30）	修复更替外来红树植物，恢复典型乡土真红树植物-半红树植物群落
Yantian	0	-	-	-	-
Total	13.08	-	45.27	（共计58.35公顷，对应完成省下达34公顷修复任务。）	

[1]已完成指2020-2022年期间完成的修复红树林面积；
[2]计划营造指2022-2025年计划修复的红树林面积，其修复计划安排：除华侨城国家湿地公园和深圳湾公园涉及外来种修复清除面积较大，可于2022至2024年06月完成修复提升，其余区域确保2023年06月完成修复工作，以保证2025年完成修复效果评估与验收工作；



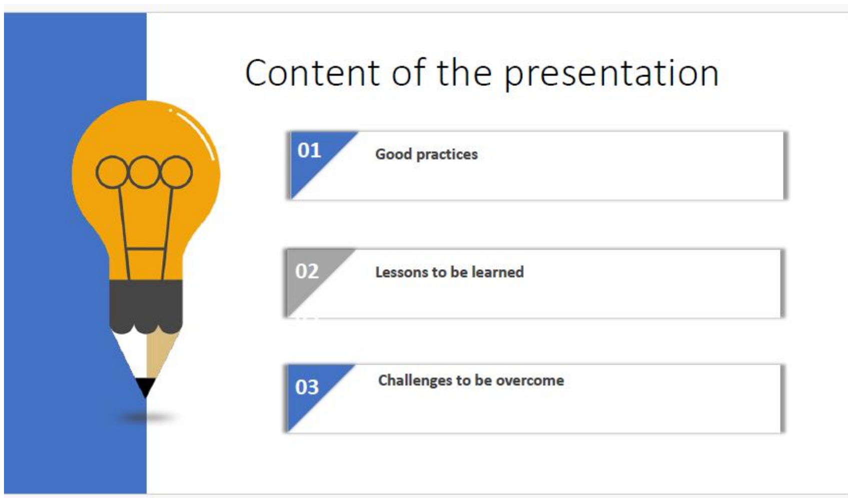
Status	Districts	Completed Area	Planned Area (ha)	ETC
Completed	Futian	深圳河口	11.00	2021
		深圳河口	2.08	2022
Ongoing	Dapeng	坝光银叶树湿地园	1.23	2023
		东涌红树林湿地园	0.59	2023
		禾塘湿地公园	0.86	2023
		鹿嘴红树林湿地	3.01	2023
		新大河河口	1.30	2023
	Nanshan	桂湾公园	5.33	2023
		华侨城国家湿地公园	6.83	2023
	Futian	深圳河河口	3.14	2023
	Baoan	海上田园	7.96	2023
		海洋新城	13.49	2023
		大铲湾远洋渔业基地	1.53	2023
合计			58.35	

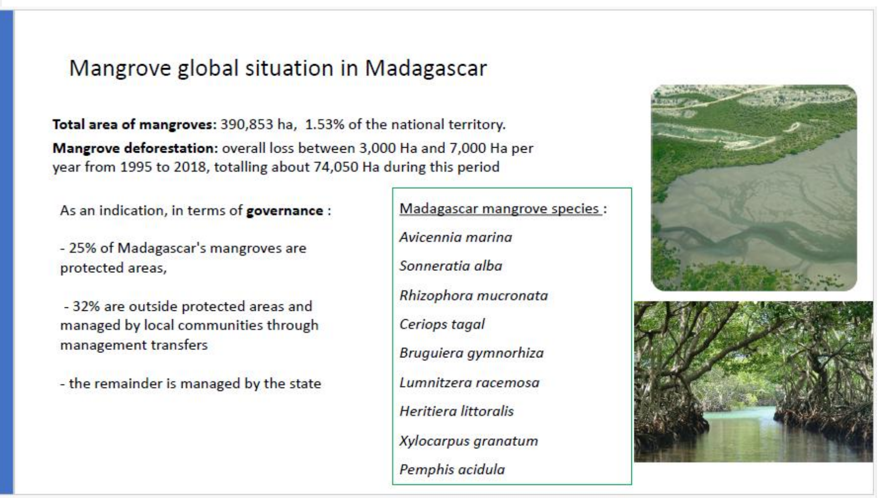


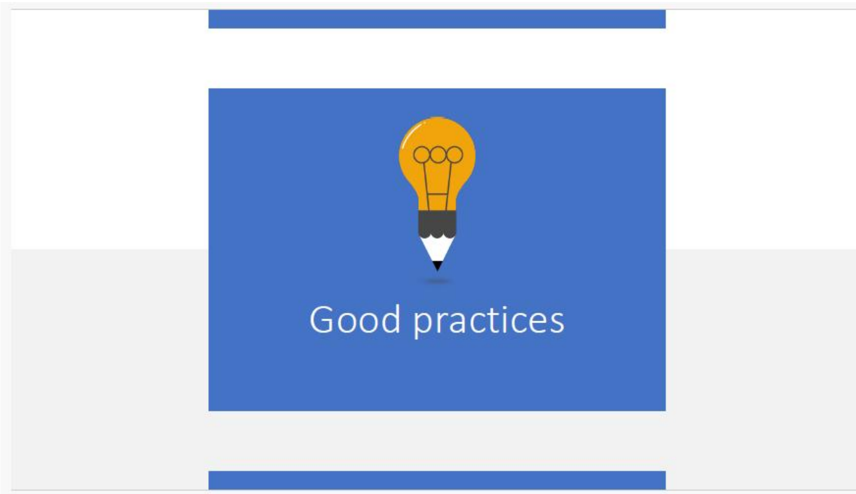


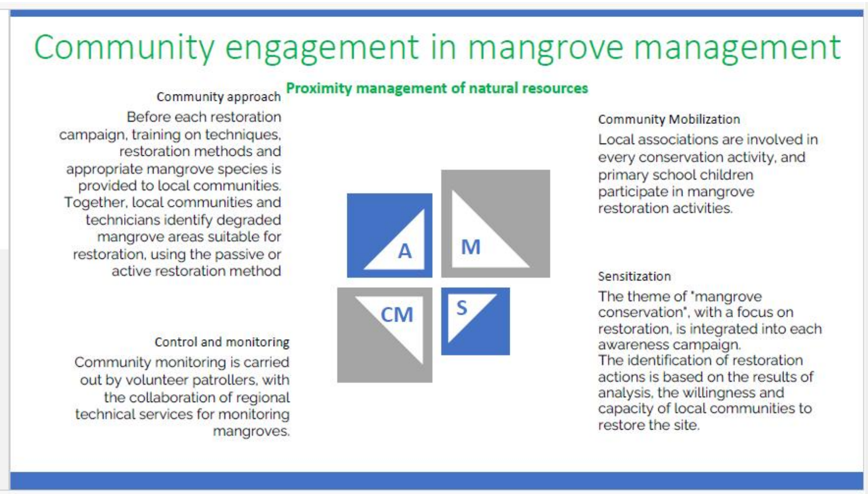
Districts	2030 Plan for Mangrove Replantation Distribution and Area	2035Plan for Mangrove Replantation Distribution and Area	2030 Plan for Mangrove Restoration Distribution and Area	2035Plan for Mangrove Restoration Distribution and Area
Futian	无相关内容	无相关内容	1.福田红树林保护区生境修复与外来红树植物更替修复（2.93）	1.福田红树林保护区生境修复与植物群落优化修复（6.00）
Nanshan	1.前海湾连通渠河道红树林营造（3.96）	无相关内容	1.前海湾双界河外来种清除更替修复（2.75）	1.深圳湾公园生境修复与植物群落优化（6.48）
Baoan	1.西乡河河口宜林地营造与乡土红树植物种植（9.50）；2.海洋新城宜林地营造与乡土红树林营造（20.00）	1.西湾红树林公园红树林-牡蛎礁复合生态系统营造（3.00）	1.西湾红树林公园生境修复与群落提升修复（20.85）；2.茅洲河流域外来种清除更替修复（7.48）；3.机场南排洪渠外来种清除修复（2.87）	1. 海洋新城片区生境修复与外来红树植物更替修复（29.31）；2. 西乡河河口红树林群落优化与外来种修复更替（13.25）
Dapeng	1.坝光片区白沙湾砂质海岸红树林公众参与营造（2.29）	无相关内容	1.鹿嘴河湖红树林生态系统优化与修复提升（8.00）	1.东涌红树林湿地园典型乡土海漆林修复提升（4.43）
Yantian	1.梧桐山生态公园红树林生境与乡土红树植物种植（0.20）；2.中英街滨海栈道红树林营造（0.10）	无相关内容	1.梧桐山生态公园红树林修复（0.40）；2.中英街滨海栈道红树林生境提升修复（0.10）	无相关内容
Total	16.05	23.00	45.38	86.85

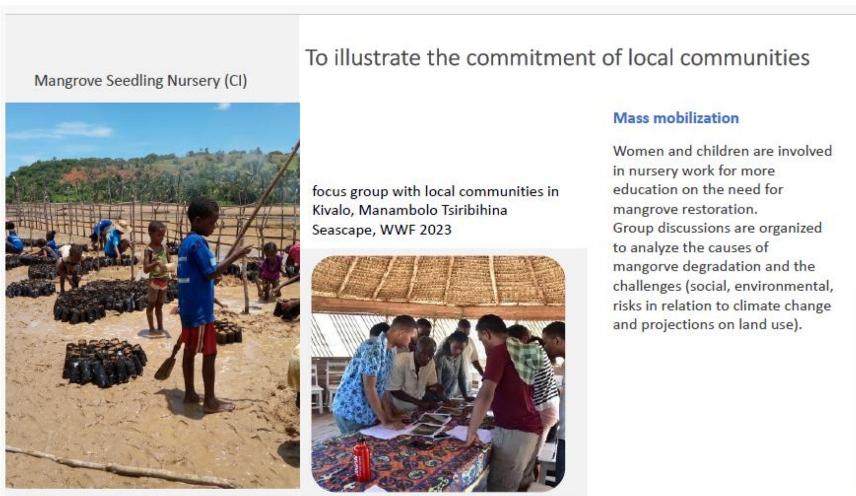
2- Madagascar

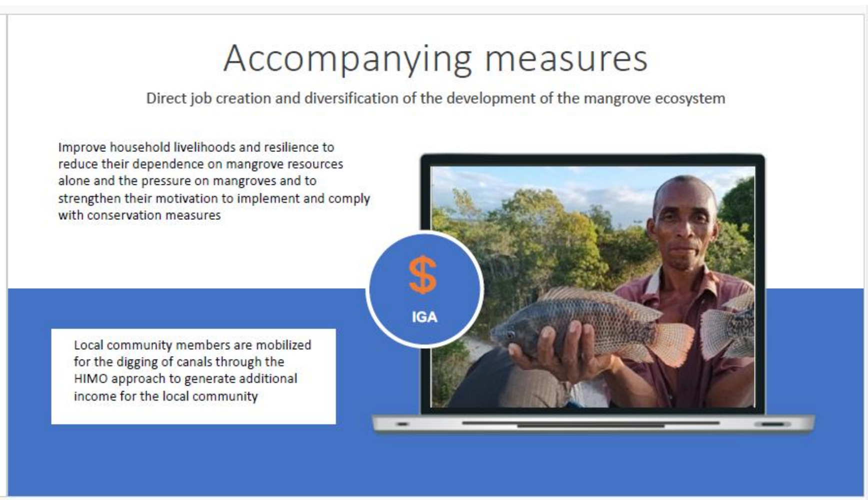





Good practices


Community engagement in mangrove management
Proximity management of natural resources
Community approach
Before each restoration campaign, training on techniques, restoration methods and appropriate mangrove species is provided to local communities. Together, local communities and technicians identify degraded mangrove areas suitable for restoration, using the passive or active restoration method
Community Mobilization
Local associations are involved in every conservation activity, and primary school children participate in mangrove restoration activities.
A
M
CM
S
Control and monitoring
Community monitoring is carried out by volunteer patrollers, with the collaboration of regional technical services for monitoring mangroves.
Sensitization
The theme of "mangrove conservation", with a focus on restoration, is integrated into each awareness campaign.
The identification of restoration actions is based on the results of analysis, the willingness and capacity of local communities to restore the site.


Mangrove Seedling Nursery (CI)
To illustrate the commitment of local communities
focus group with local communities in Kivalo, Manambolo Tsiribihina Seascape, WWF 2023
Mass mobilization
Women and children are involved in nursery work for more education on the need for mangrove restoration.
Group discussions are organized to analyze the causes of mangorve degradation and the challenges (social, environmental, risks in relation to climate change and projections on land use).


Accompanying measures
Direct job creation and diversification of the development of the mangrove ecosystem
Improve household livelihoods and resilience to reduce their dependence on mangrove resources alone and the pressure on mangroves and to strengthen their motivation to implement and comply with conservation measures
$
IGA
Local community members are mobilized for the digging of canals through the HIMO approach to generate additional income for the local community

Improving mangrove restoration techniques

Ecological restoration

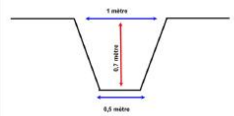
For more effective and successful restoration activities, the Community Based on Environmental Mangrove Restoration (CBEMR) approach is very often used.

Ecological restoration by improving the hydrological conditions of the site (creation or digging of canals) to be restored to promote the rapid growth of the planted propagules and will also facilitate the specific natural recolonization/regeneration of mangrove forests is practiced.

Every year, to ensure the proper functioning of the canals, interviews are carried out with members of the local community (Removal of sand slides in the canals during tidal swings)

Ecological restoration of the mangrove ecosystem

Setting up a drainage system



Reconstitution of mangrove-good soil

Improving mangrove restoration techniques

Use of new technologies

Benefits on reforestation by using drone :

- Large-scale intervention
- Access to difficult areas
- Moderate cost (restriction of agents to be mobilized)

Using drones to:

- Area mapping: for mangrove restoration
- Dropping mangrove seeds by drone
- Reforestation monitoring: planting area, success rate

Use of a seeding drone for mangrove restoration:

Drone Seed Dropping for Mangrove Planting

Species: *Avicennia marina*

Seed dropping: 1 ha in 10 minutes

Load capacity : 15 to 20 kg seeds/vol

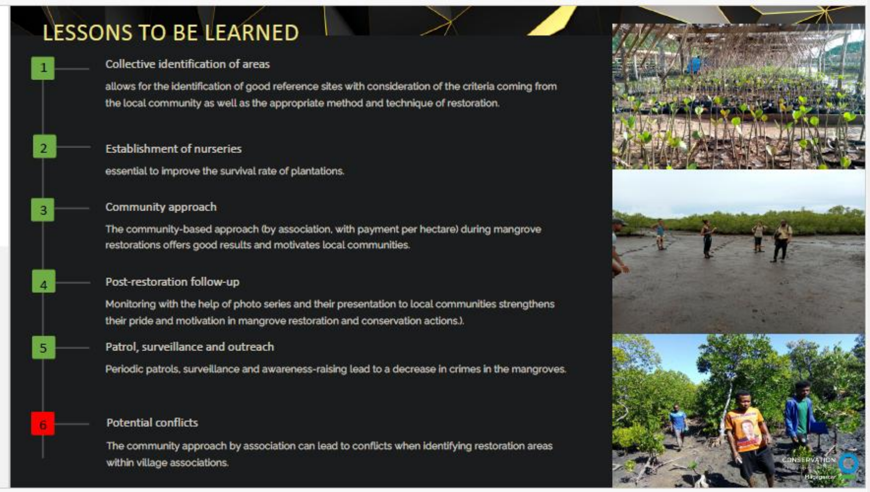
Type of seeding drone: GAIA 90, hexacopter

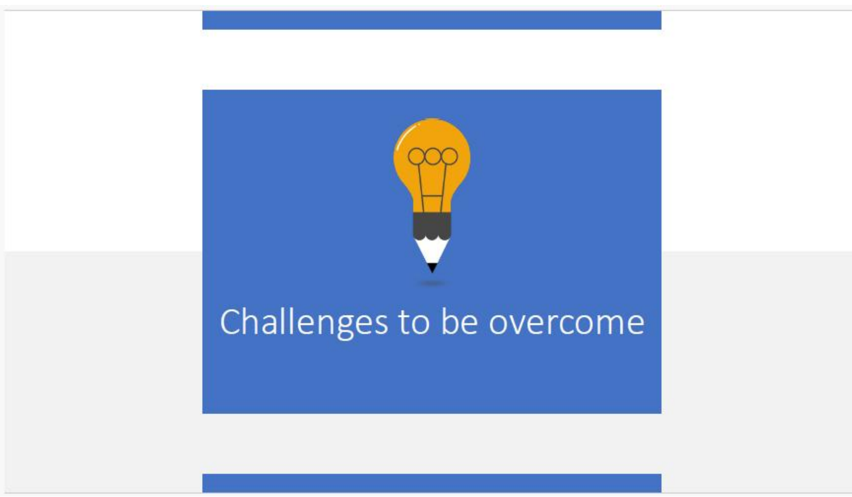
Success rate: 60 to 70%

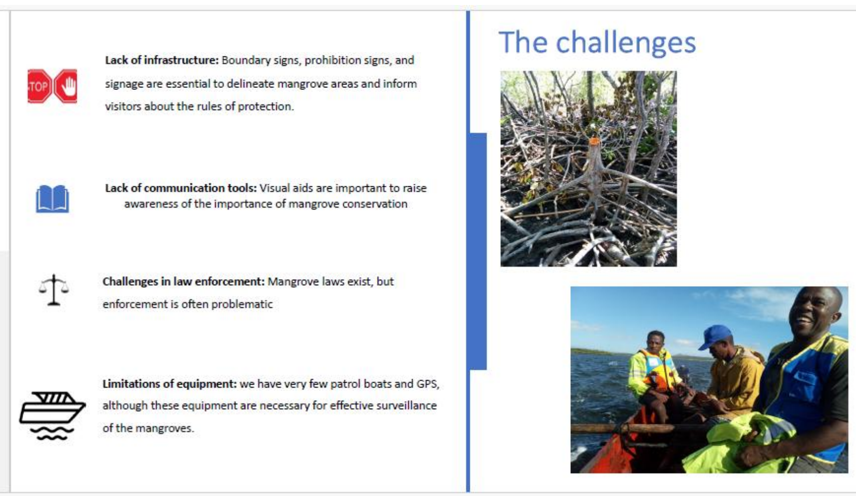
Accompanying measure:

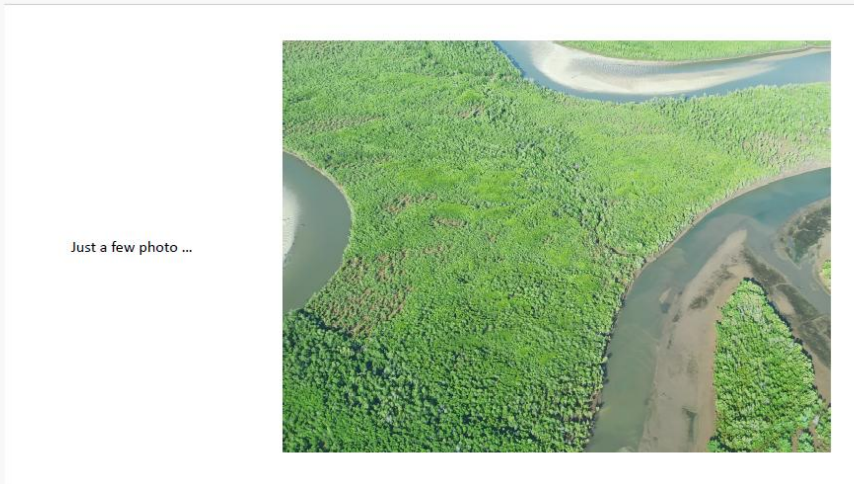
Sensitization of the local community for the protection of the restored area from cattle


Lesson to be learned


LESSONS TO BE LEARNED
1
Collective identification of areas
allows for the identification of good reference sites with consideration of the criteria coming from the local community as well as the appropriate method and technique of restoration.
2
Establishment of nurseries
essential to improve the survival rate of plantations.
3
Community approach
The community-based approach (by association, with payment per hectare) during mangrove restorations offers good results and motivates local communities.
4
Post-restoration follow-up
Monitoring with the help of photo series and their presentation to local communities strengthens their pride and motivation in mangrove restoration and conservation actions.)
5
Patrol, surveillance and outreach
Periodic patrols, surveillance and awareness-raising lead to a decrease in crimes in the mangroves.
6
Potential conflicts
The community approach by association can lead to conflicts when identifying restoration areas within village associations.


Challenges to be overcome

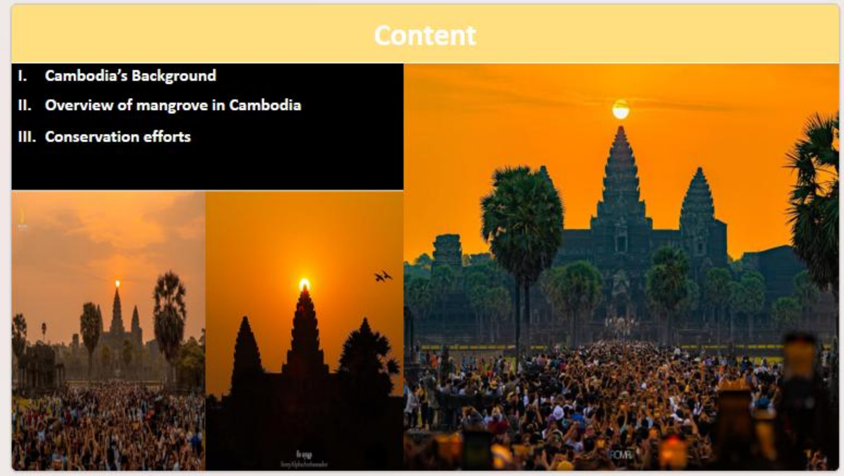

The challenges
Lack of infrastructure: Boundary signs, prohibition signs, and signage are essential to delineate mangrove areas and inform visitors about the rules of protection.
Lack of communication tools: Visual aids are important to raise awareness of the importance of mangrove conservation
Challenges in law enforcement: Mangrove laws exist, but enforcement is often problematic
Limitations of equipment: we have very few patrol boats and GPS, although these equipment are necessary for effective surveillance of the mangroves.

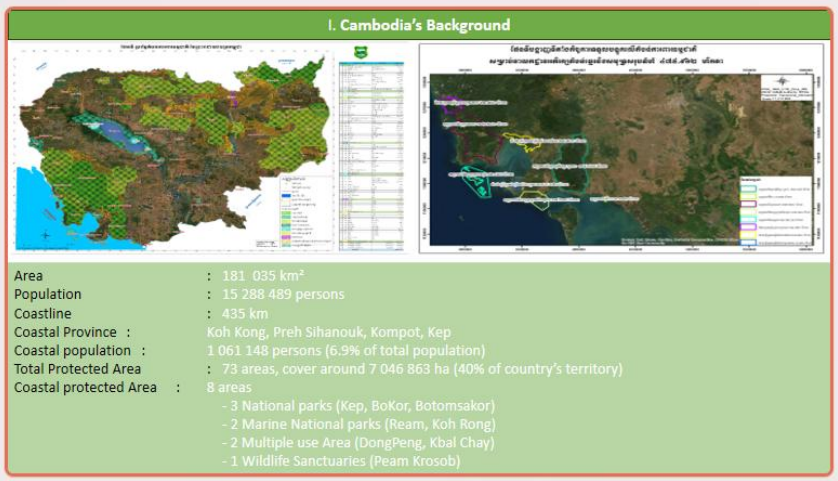

Just a few photo ...

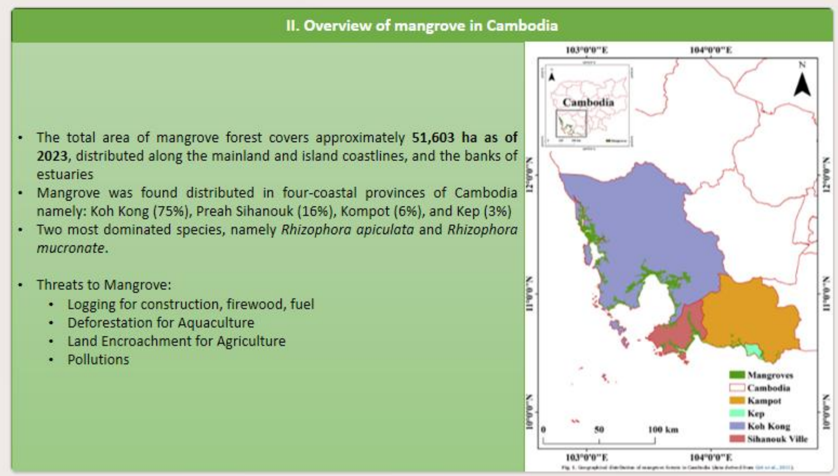

WWF MDG
Thank you
CONSERVATION INTERNATIONAL
Madagascar
FORESTS 4 FUTURE
WWF
IMC 展示中心
IMC Exhibition Center
julien.soa@yahoo.com

3- Cambodia

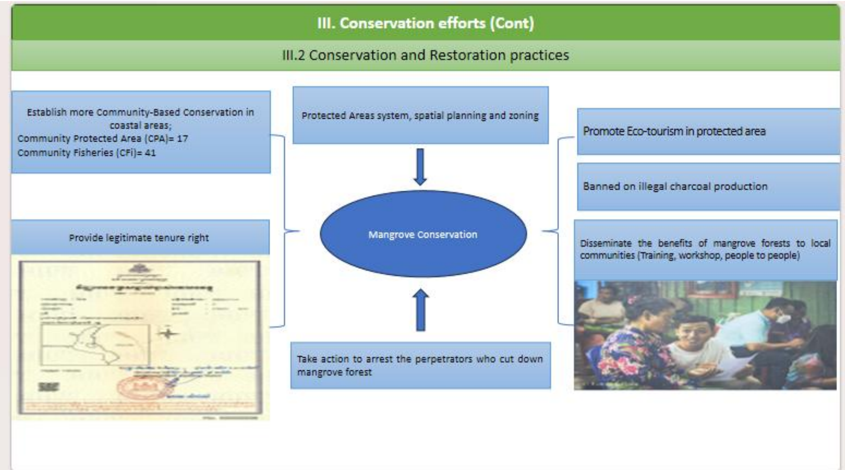

Cambodia's Experience In Mangrove Conservation and Restoration
Workshop
On
Mangrove Conservation and Restoration
China, 25th July to 8th August 2024
PANHAROTH KIM


Content
I. Cambodia's Background
II. Overview of mangrove in Cambodia
III. Conservation efforts

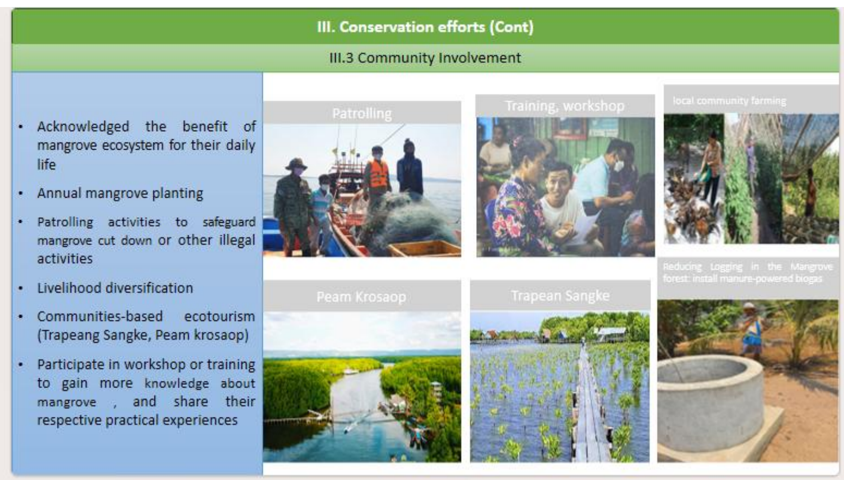

I. Cambodia's Background
Area : 181 035 km²
Population : 15 288 489 persons
Coastline : 435 km
Coastal Province : Koh Kong, Preh Sihanouk, Kompot, Kep
Coastal population : 1 061 148 persons (6.9% of total population)
Total Protected Area : 73 areas, cover around 7 046 863 ha (40% of country's territory)
Coastal protected Area : 8 areas
- 3 National parks (Kep, BoKor, Botomsakor)
- 2 Marine National parks (Ream, Koh Rong)
- 2 Multiple use Area (DongPeng, Kbal Chay)
- 1 Wildlife Sanctuaries (Peam Krosob)


II. Overview of mangrove in Cambodia
• The total area of mangrove forest covers approximately 51,603 ha as of 2023, distributed along the mainland and island coastlines, and the banks of estuaries
• Mangrove was found distributed in four-coastal provinces of Cambodia namely: Koh Kong (75%), Preah Sihanouk (16%), Kompot (6%), and Kep (3%)
• Two most dominated species, namely Rhizophora apiculata and Rhizophora mucronate.
• Threats to Mangrove:
• Logging for construction, firewood, fuel
• Deforestation for Aquaculture
• Land Encroachment for Agriculture
• Pollutions
103°0'0"E
104°0'0"E
Cambodia
12°0'0"N
11°0'0"N
10°0'0"N
0
50
100 km
Mangroves
Cambodia
Kampot
Kep
Koh Kong
Sihanouk Ville


III. Conservation efforts
III.1 Policy and Legislation Framework
Objectives:
1. Maintain the forest cover of at least 60% of land area and to promote the preservation of ecosystem, the protection of biodiversity and the conservation of natural protected areas.
2. To intensify tree planting movement
3. Improving protected area management
4. Enhancing local communities' livelihood
5. To protect, conserve and manage both ecological and socio-economic system to ensure the long-term sustainability of coastal ecosystems of mangroves as a flagship species and other coastal resources and benefits of the coastal resources-dependent dwellers in Cambodia.
Long-Term Strategy for Carbon Neutrality


III. Conservation efforts (Cont)
III.2 Conservation and Restoration practices
Establish more Community-Based Conservation in coastal areas;
Community Protected Area (CPA)= 17
Community Fisheries (CFi)= 41
Provide legitimate tenure right
Protected Areas system, spatial planning and zoning
Mangrove Conservation
Take action to arrest the perpetrators who cut down mangrove forest
Promote Eco-tourism in protected area
Banned on illegal charcoal production
Disseminate the benefits of mangrove forests to local communities (Training, workshop, people to people)


III. Conservation efforts (Cont)
III. Conservation and Restoration practice (Cont)
Best Practice Guidelines for Mangrove Restoration
1. Restoration Approach:
• Follow Guidelines for Mangrove Restoration
• Re-plantation of multi-species of mangrove
• Improve and expand mangrove nursery in coastal area
• Lunched "Green Sprout" Campaign to call for public involvement and awareness raising
2. Several NGOs, Agencies, and communities have been involved in mangrove restoration such as;
• Culture and Environment Preservation Association (CEPA), Wetlands International ,The Participatory Management of Mangrove Resource (PMMR), IUCN, Mangrove for the Future (MFF), ActionAid, Coastal Zone Management project of DANIDA
3. Private Sectors involvement:
• British Chevening Alumni Association of Cambodia, Vital Company, Panasonic company, Heineken Cambodia, ATALIAN Cambodia

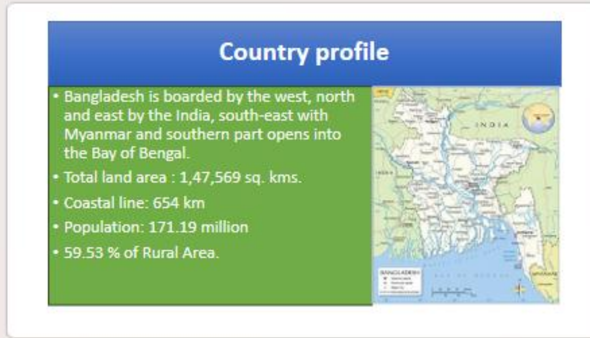

III. Conservation efforts (Cont)
III.3 Community Involvement
• Acknowledged the benefit of mangrove ecosystem for their daily life
• Annual mangrove planting
• Patrolling activities to safeguard mangrove cut down or other illegal activities
• Livelihood diversification
• Communities-based ecotourism (Trapeang Sangke, Peam krosaop)
• Participate in workshop or training to gain more knowledge about mangrove , and share their respective practical experiences
Patrolling
Training, workshop
local community farming
Peam Krosaop
Trapean Sangke
Reducing Logging in the Mangrove forest: install manure-powered biogas


III. Conservation efforts (Cont)
III.3 Monitoring and Assessment
There are some reports on Cambodia's environmental status, such as:
• 4th Environmental status report
• Biodiversity, Climate Change Vulnerability and Adaptation Needs Assessment of Kep Province
• Mangrove Biodiversity Survey Report (Peam Krasop wildlife sanctuary and Koh Kapik Ramsar site)
• Cambodia Forest Cover 2018
• 6th National Report to Convention on Biological Diversity
• National State of Ocean and Coasts 2018: Blue Economy Growth, Cambodia
• Report of Shoreline Assessment
CAMBODIA
CAMBODIA FOREST COVER
DECEMBER 2020
Report of Shoreline Assessment


Thank you for your attention!!!!

4- Bangladesh

1



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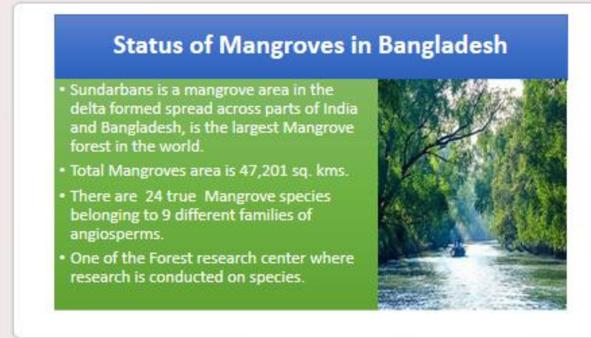

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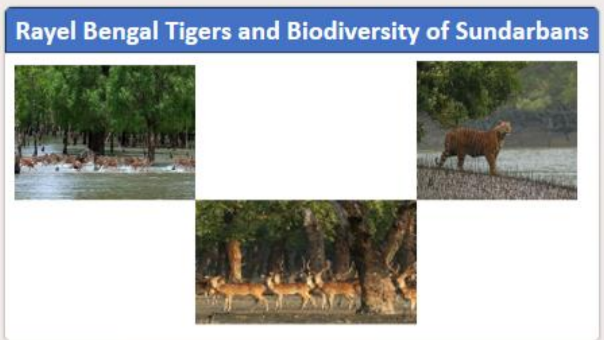

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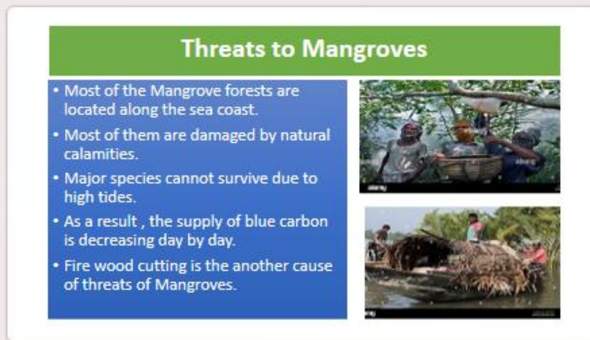


5

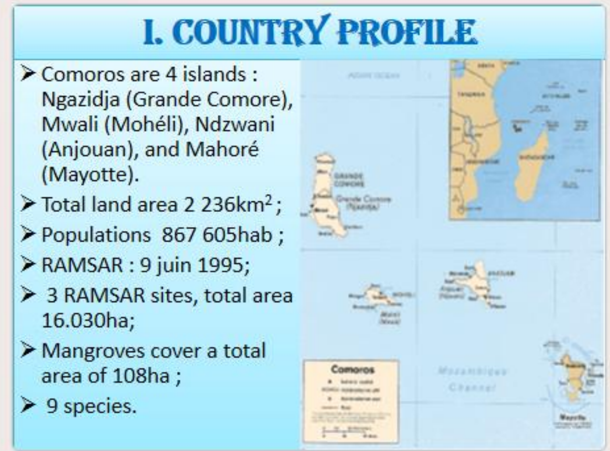
6


Conservation efforts by Establishing Judicial court
• Separate Forest Courts have been established to Forest criminals.
• Saw mills license regulations are place to prevent illegal cutting of large trees.
• Enforcement law has been applied for illegal forest activities.
7
Mangrove forest Management in Bangladesh
• Acknowledge the benefit of mangrove ecosystem for their daily life of the local peoples.
• Encouraging mass planting of tree saplings through Social forestry programs.
• Planting of trees along river banks to prevent river erosion.
8
Progress of Mangrove Restoration
• Mangrove forest harbor unique biodiversity, prevent soil erosion, provide for livelihoods and carbon capture .
• Sundarbans hold significant biodiversity in terms of fauna, 250 species of fish, 300 species of birds and Dolphin.
• Afforestation with Roosting, foraging and breeding of the mammals.
9
Mangroves Benefits for Bangladesh
• Ecosystem functions : biodiversity, blue carbon, disaster prevention and mitigation, stability.
• Sundarbans protect fauna from cyclones despite cautionary signal warning 10.
• Mangrove forest Sundarbans protect higher the water salinity and ensure the pure drinking water.
10
Thank You!
11

5- Comoros

1 00:07

2 00:01



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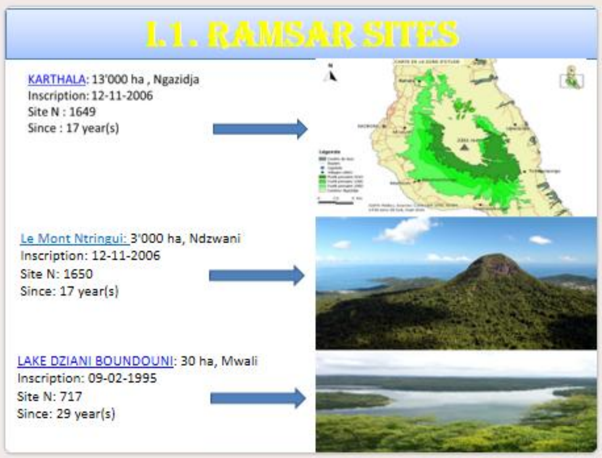

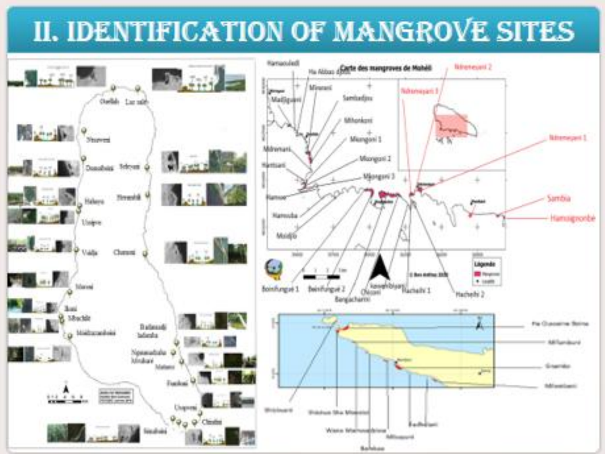

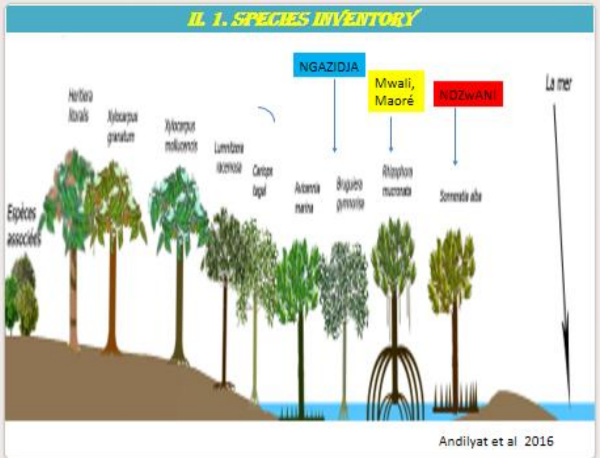

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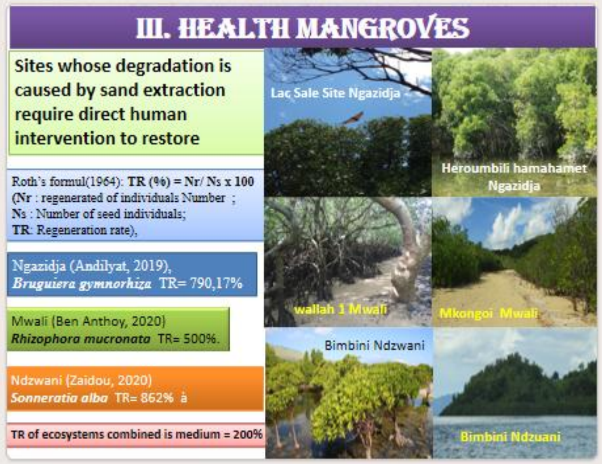
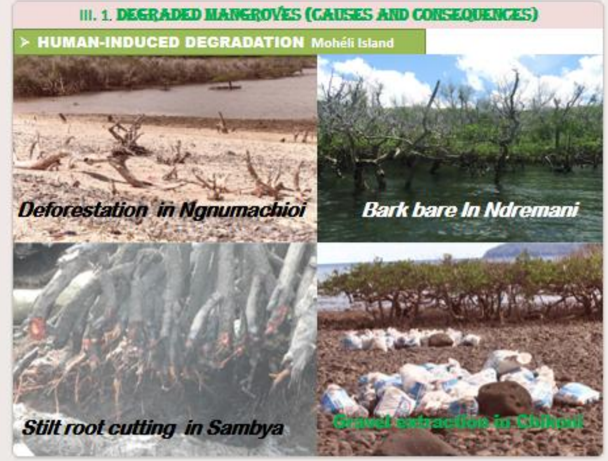
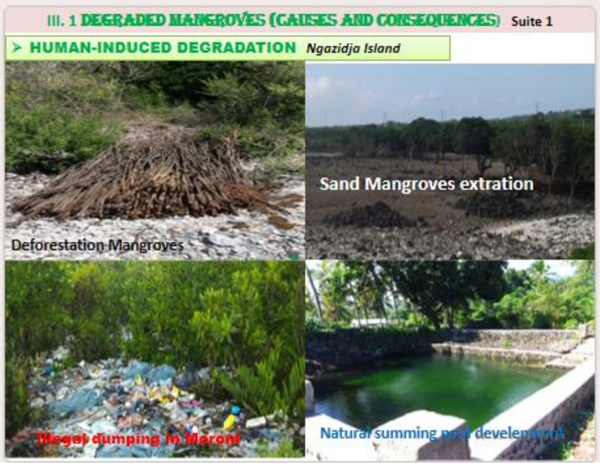
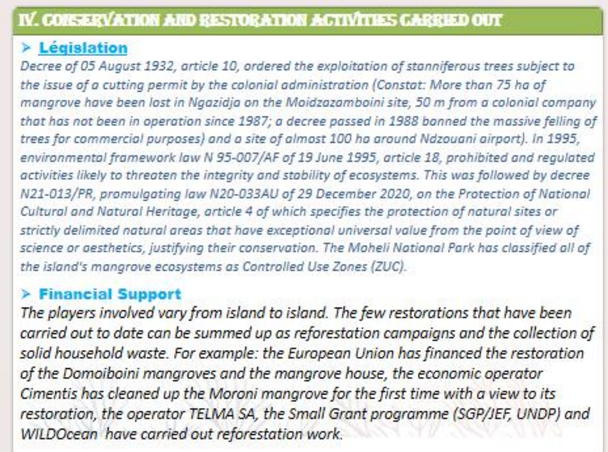


8 00:08



9 00:03






IV. 1. MONITORING AND ASSESSMENT OF MANGROVES
Monitoring group in Park
50-100 m of Transect
Parameter releved
13
00:09
IV. 2. MANGOVE RESTORATION INITIATIVES
Restoration Actions Ndzwani island in Oini
Palétuvier de 12 m de hauteur à Oini
Ancien pépinière de 2012
Plantation de 2018
14
00:05
IV. 2. MANGOVE RESTORATION INITIATIVES (suite 1)
Ngazidja Island Nursery
Rhizophora mucronata (5 cm/ month)
Marcottage aérien de Lumnitzera racemosa
Auxin Intake to Large Specimens by Abderemane Ymadoudine
Avicenia marina germinating in Mwali and transplanting in Ngazidja by Oumou
Multiplication of specimens (Ngazidja Island)
15
00:05
IV. 2. MANGOVE RESTORATION INITIATIVES (suite)
Reforestation campaign in Ngazidja island
Marine Biology Students (UDC)
Environmental Science Students (UDC)
Reforestation by Autority
Cleaning Moroni's Mangrove
Successful planting


RESTAURANT


➤ ICONI'S Mangrove development plan


THANK YOU VERY MUCH
MERCI BEAUCOUP
MARAHABA MENDJI

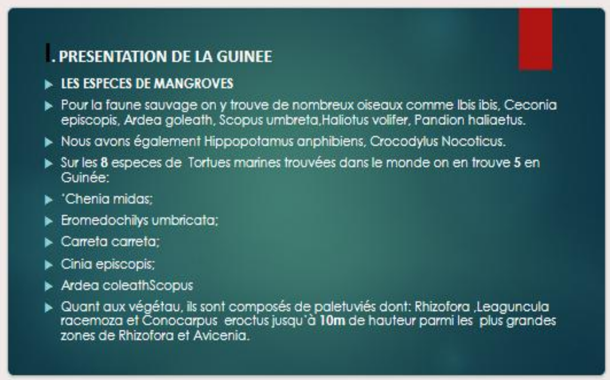
6- Guinea

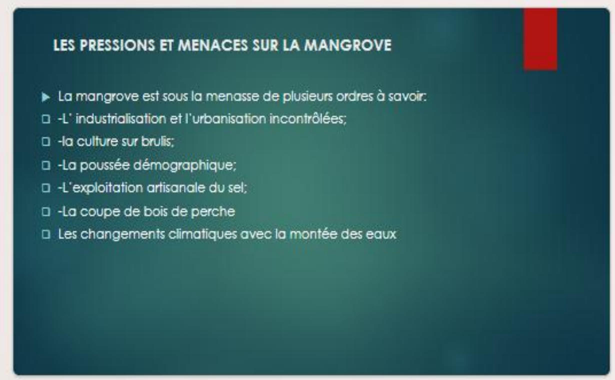

WORSHOP ON MANROVES CONSERVATION AND RESTAURATION
EXPERIENCE DE LA GUINEE
PLAN
I.PRESENTATION DE LA GUINEE
II.LES PRESSIONS ET MENACES SUR LA MANGROVE
III.LES ACTIONS MENEES
IV. CONCLUSIONS ET RECOMMANDATIONS
Faya Nestor KONDIANO
REPUBLIQUE DE GUINEE


I. PRESENTATION DE LA GUINEE
La République de Guinée, située en Afrique de l'Ouest est limitée à l'Ouest par l'Océan Atlantique, et partage ses frontières avec six (6) pays : la Guinée Bissaou au Nord –Ouest, le Sénégal au Nord, le Mali au Nord-Est, la Cote du Voire à l' Est, le Libéria et la Sierra-léone au Sud et couvre une superficie de 245 857km2 avec une population. de 13,86 Millions d'Habitants.
C'est un pays de Zones Humides avec plus de 300 km de façades Maritime et 16 sites Ramsar d'une superficie de 90 654,46ha
Elle a ratifier la convention de Ramsar le18 Dembre 1992
A l'adhésion, la guinée a inscrit 05 sites Ramsar dont 04 sont marins


PRESENTATION DE LA GUINEE
GUINEA-BISSAU
SENEGAL
MALI
GUINEA
CONAKRY
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
NORTH ATLANTIC OCEAN


I. PRESENTATION DE LA GUINEE


I. PRESENTATION DE LA GUINEE
LES ESPECES DE MANGROVES
Pour la faune sauvage on y trouve de nombreux oiseaux comme Ibis ibis, Ceconia episcopis, Ardea goleath, Scopus umbreta,Haliotus volifer, Pandion haliaetus.
Nous avons également Hippopotamus anphibiens, Crocodylus Nocoticus.
Sur les 8 especes de Tortues marines trouvées dans le monde on en trouve 5 en Guinée:
'Chenia midas;
Eromedochilys umbricata;
Carreta carreta;
Cinia episcopis;
Ardea coleathScopus
Quant aux végétau, ils sont composés de paletuviés dont: Rhizofora ,Leaguncula racemoza et Conocarpus eroctus jusqu'à 10m de hauteur parmi les plus grandes zones de Rhizofora et Avicenia.

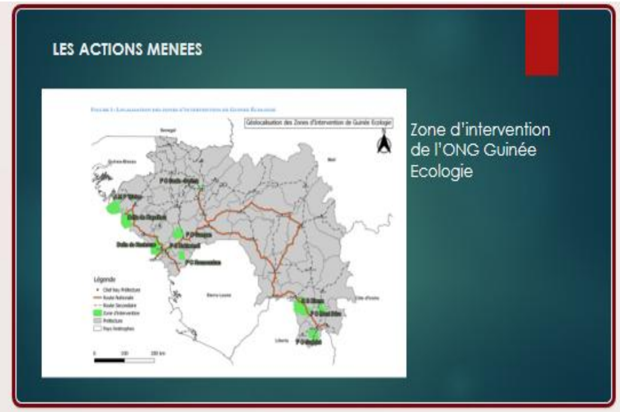

LES PRESSIONS ET MENACES SUR LA MANGROVE
La mangrove est sous la menasse de plusieurs ordres à savoir:
-L' industrialisation et l'urbanisation incontrôlées;
-la culture sur brulis;
-La poussée démographique;
-L'exploitation artisanale du sel;
-La coupe de bois de perche
Les changements climatiques avec la montée des eaux


LES PRESSIONS ET MENACES SUR LA MANGROVE
La déforestation des mangroves guinéennes est imputée à la production de sel. Les données d'analyse des connaissances et des modes d'exploitation des producteurs susu combinées à celles des sciences biotechniques permettent de remettre en question les idées reçues et de proposer des actions en accord avec les demandes des populations locales.

7


LES ACTIONS MENEES
Pour la pérennisation des mangroves, une équipe de conservateurs est déployée sur le terrain pour la sécurisation, la surveillance, l'éduction environnementale des communautés et des élèves au travers les Directions techniques qui relèvent du Ministère de l'Environnement et du Développement Durable.
La revision du Code de la Faune sauvage et Règlementation de la Chasse
La multiplication des projets modernes pour l'extraction du sel
et le respect stricte de la règlementation environnementales et forestières sont de riguere.
A cela s'ajoute son partenariat avec des ONG de la place , comme Guinée-Ecologie, Biotope-Guinée, Ouest Africa Blue qui sont entrain de réaliser les actions de reboisement, de la sensibilisation des communautés et la création du marché de crédit carbone.

8


LES ACTIONS MENEES
Zone d'intervention de l'ONG Guinée Ecologie

9


LES ACTIONS MENEES
En 2023, deux principaux sites, reconnus comme des sites importants pour la conservation de la biodiversité ont été identifiés pour servir de zone d'action. Il s'agit du Delta de Kapatchez et du Delta de Konkouré. Plusieurs sous activités ont été réalisé dans ce cadre avec l'appui financier de la Fondation Dob Ecologie, de la Fondation Audemars-Watkins et du PRCM.

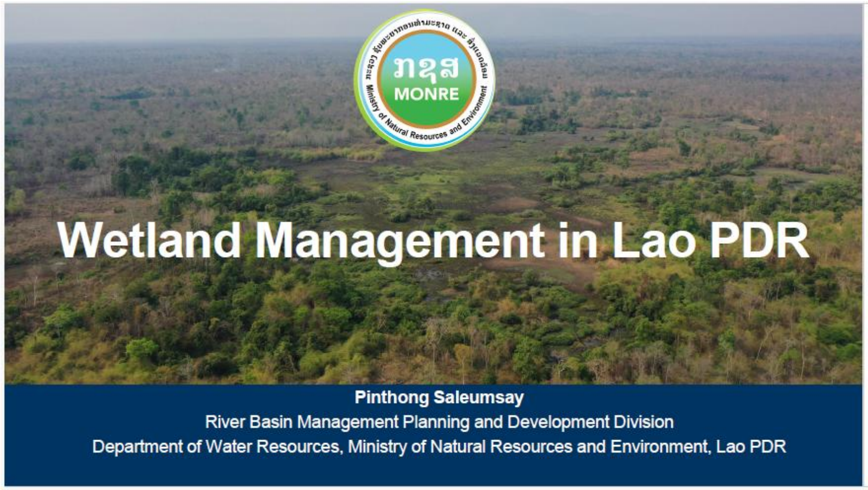

.LES ACTIONS MENEES

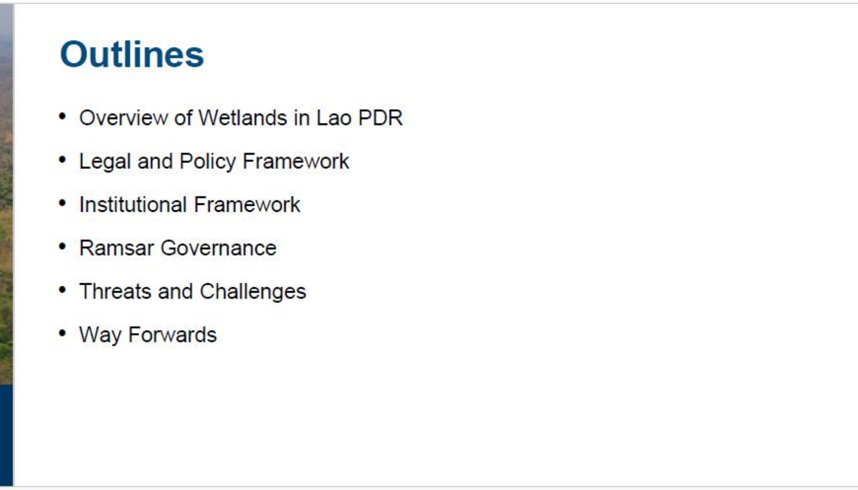

Conclusion et recommandations
La conservation et la restauration des mangrove dans le monde interpelle tous les pays à une prise de conscience car c'est le seul moyen pour parvenir à la maintenance de l'équilibre écologique de celles-ci.
Ainsi nous recommandons à L'IMC ce qui suit:
-L' assistance technique aux pays membres ;
-La poursuite du renforcement des capacités;
-les appuis financiers
-L'assistance technique pour l'élaboration des projets.

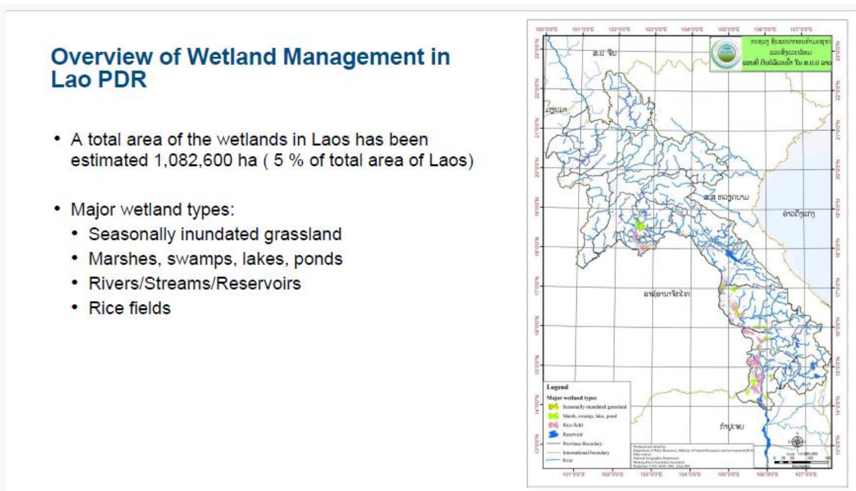

MERCI POUR VOTRE AIMABLE ATTENTION

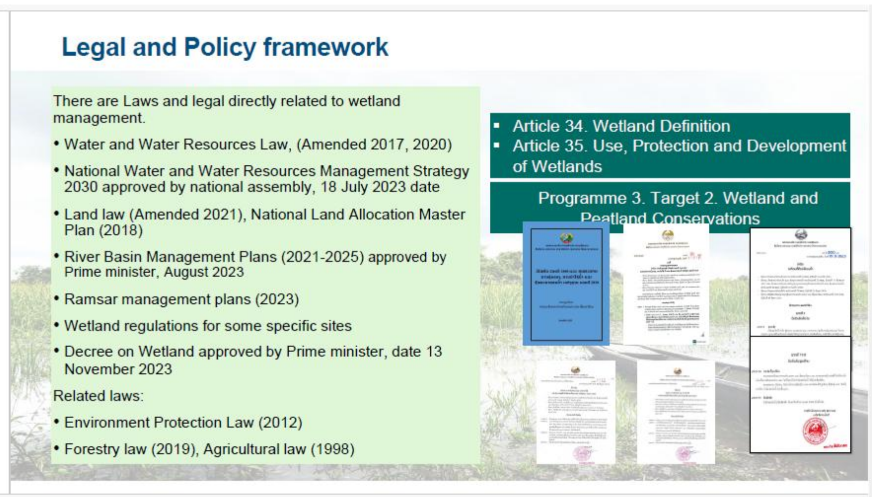

Minnistere de l'Environnement
et du Développement Durable
Direction Nationale des Forets
et de la Faune
Division Faune et Protection
de la Nature
Republique de Guinée

7- Lao


MONRE
Ministry of Natural Resources and Environment
Wetland Management in Lao PDR
Pinthong Saleumsay
River Basin Management Planning and Development Division
Department of Water Resources, Ministry of Natural Resources and Environment, Lao PDR


Outlines
• Overview of Wetlands in Lao PDR
• Legal and Policy Framework
• Institutional Framework
• Ramsar Governance
• Threats and Challenges
• Way Forwards


Overview of Wetland Management in Lao PDR
• A total area of the wetlands in Laos has been estimated 1,082,600 ha (5 % of total area of Laos)
• Major wetland types:
• Seasonally inundated grassland
• Marshes, swamps, lakes, ponds
• Rivers/Streams/Reservoirs
• Rice fields
Legend
Major wetland types


Legal and Policy framework
There are Laws and legal directly related to wetland management.
• Water and Water Resources Law, (Amended 2017, 2020)
• National Water and Water Resources Management Strategy 2030 approved by national assembly, 18 July 2023 date
• Land law (Amended 2021), National Land Allocation Master Plan (2018)
• River Basin Management Plans (2021-2025) approved by Prime minister, August 2023
• Ramsar management plans (2023)
• Wetland regulations for some specific sites
• Decree on Wetland approved by Prime minister, date 13 November 2023
Related laws:
• Environment Protection Law (2012)
• Forestry law (2019), Agricultural law (1998)
▪ Article 34. Wetland Definition
▪ Article 35. Use, Protection and Development of Wetlands
Programme 3. Target 2. Wetland and Peatland Conservations

Institutional Framework

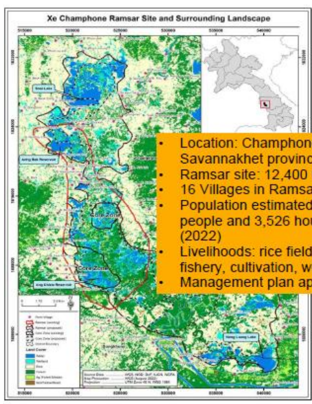
- **Department of Water Resources, MoNRE** has the overall responsibility for management of the wetlands in the country including peatland and Ramsar sites;
- If a wetland is in any type of land, that sector will be the key responsible agency, but need to coordinate with MONRE.

Eg. Wetland in forest land, the forest sector will be the responsible agency.

Ramsar Governance

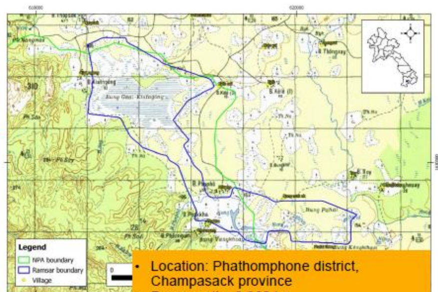
- The convention entered into force in Lao PDR on September 2010 (2 sites)
- National Ramsar Committee (2011)
  - Chaired by the Vice Prime Minister
  - Involvement of Minister of MoNRE and MAF and 5 other ministries.
  - Secretariat under DWR, MONRE
  - Two provincial committees SVK+CPS provinces, (coordination by PoNRE)
  - Ramsar implementation teams at provincial & district levels

Xe Champhone Ramsar site



- Location: Champhone district, Savannakhet province
- Ramsar site: 12,400 ha
- 16 Villages in Ramsar area
- Population estimated: 21,579 people and 3,526 household (2022)
- Livelihoods: rice field, farming, fishery, cultivation, weave silk etc.,
- Management plan approved 2023

Buang Kiat Ngong Ramsar site



- Location: Phathomphone district, Champasack province
- Ramsar site: 2,360 ha
- 8 Villages in Ramsar area
- Population estimated: 9,397 people and 2,185 household (2022)
- Livelihoods: rice field, farming, fishery, cultivation etc.,
- Management plan approved 2023

Threats and Management issue

- Encroachment
- Hunting and over harvesting
- Invasive species
- Habitat degradation
- Hydrological modification
- Climate change
- Pollution


Some activities:

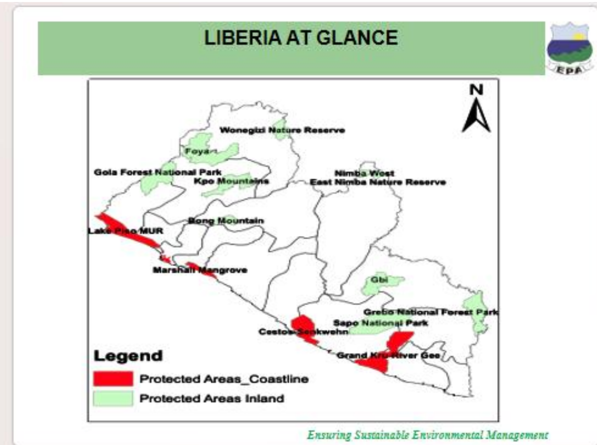

Way forwards
• Published/Imprement the Decree on Wetland
• Awareness raising and capacity building;
• Continue wetland inventory and demarcation;
• Regulation formulation and enforcement;
• Livelihood improvement;
• Integrated management of Ramsar sites and other wetlands;
• Propose additional Ramsar sites: Nongkhamsen, Beungsanan…
• National cooperation


THANK YOU

8- Liberia


EPA
LIBERIA
Environmental Protection Agency
Ensuring environmental protection & conserving biodiversity
The status of wetlands conservation and restoration in Liberia
Levi Z. Piah
National Focal Point, Ramsar Convention, Liberia Blue Ocean Programme
26th July – 8th August, 2024. Shenzhen, China


OUTLINE
❖ Liberia at glance
❖ Legislation
❖ Drivers of mangrove degradation in Liberia
❖ Marshall Wetlands Mangrove Pictorials
❖ Opportunities
❖ Challenges
❖ Recommendation
Ensuring Sustainable Environmental Management


LIBERIA AT GLANCE
N
Wonegizi Nature Reserve
Foya
Gola Forest National Park
Kpo Mountains
Nimba West
East Nimba Nature Reserve
Bong Mountain
Marshall Mangrove
Gbi
Sapo National Park
Legend
Protected Areas_Coastline
Protected Areas Inland
Ensuring Sustainable Environmental Management


Mangrove Species in Liberia
➢ Mangrove forests in Liberia covers about 37,142 ha of the total land surface
➢ Liberia"s mangroves have six species:
➢ Avicennia germinans, Rhizophora racemosa (Most common)
➢ Rhizophora harrisonii, Rhizophora mangle Conocarpus erectus
➢ and Laguncularia racemose


Liberia status on carbon sink
➢ Liberia is regarded as the third LUNGS of the world according to report from the 2022 COP in Cairo, Egypt
➢ Liberia has 43% of the Upper Guinea Forest according to the tropical forest inventory conducted by the Forestry Development Authority in 2020
➢ The Amazon Rain Forest in Brazil, the first Lung
➢ The Congo Basin in Central and Southern Africa is the Second Lungs
➢ Liberia still possess primary mangrove forest void of human induced activities
➢ The country has a potential of creating more Ramsar Sites but seriously challenge with capacity issue
➢ The current Ramsar Sites have not been updated since 2012

Legislation: Environmental Protection & Management Law (2003) and Wetland Policy 2014

- **Section 74 - Management of Rivers, Lakes and Wetlands (EPML)**

❖ The Agency may by published notice prescribe general or specific guidelines or standards for the management of rivers, lakes, and wetlands which shall include but not limited to the following:

❖ Measures for prevention or control of soil erosion

❖ The conservation of any vegetation growing in and around a river, lake or wetlands

❖ The contingency plan for the prevention and control of any deliberate or accidental discharge which is likely to pollute the river, wetland or lake

Ensuring Sustainable Environmental Management

7

Legislation Cont'd

❖ The control measures to be taken in harvesting aquatic and non-living resources to ensure optimum sustainable yields; and

❖ Promotion of environmental friendly tourism

❖ Halt and reverse current mangrove degradation in Liberia such that the wetland ecosystems of the country are managed for the maintenance of wetland biological diversity.

❖ Raise public awareness and promote understanding of the essential linkages between socio-economic development and mangrove conservation/protection and to ensure that wetland knowledge becomes an integral part of the educational system of Liberia.

Ensuring Sustainable Environmental Management

8

Mangrove Ecosystems

Ensuring Sustainable Environmental Management

9

Ramsar Sites

❑ There are several mangrove forests in Liberia along the coastline (some are largely untouched)

❑ 3 of 5 Ramsar Sites comprise primarily of mangrove forest

❑ These are

- Mesurado Wetlands
- Marshall Wetlands
- Lake Piso Wetlands

Drivers of Mangrove Degradation in Liberia

❑ Mangrove harvesting for fuel wood

❑ Unsustainable/unregulated/wasteful fishing

❑ Hunting of birds and other wildlife species ;(e.g. Sea turtles, monkeys, use of chemicals and explosives, etc.)

❑ Reclaiming of wetlands for construction purpose,

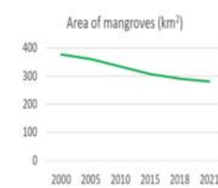
❑ Dumping of wastes (plastics, garbage, & other solid wastes)

❑ Intense charcoal burning and fuel wood collection

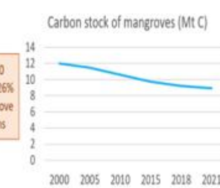
❑ Effluent discharge from industries into the wetlands (oil refinery and paint factories, cement factories, etc.)

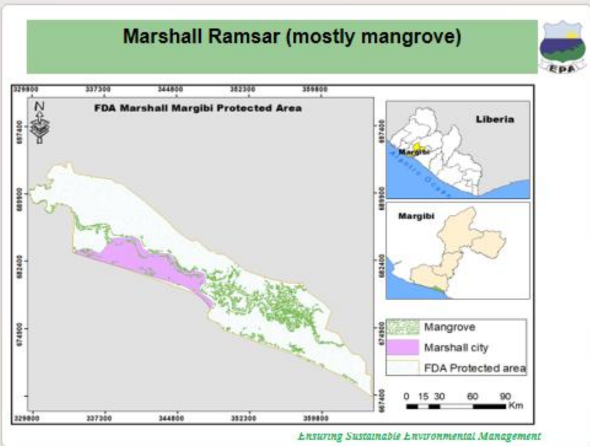
Mangrove trend, Liberia

Source		2000	2005	2010	2015	2018	2021
Ecosystem Extent Accounts	Area (km^2)	377.9	361.3	334.1	306.9	291.1	280.8
Ecosystem Service Accounts	Total carbon (Mt)	12.0	11.5	10.6	9.7	9.2	8.9



Since 2000 Liberia lost 26% of its mangrove ecosystems




Marshall Ramsar (mostly mangrove)
FDA Marshall Margibi Protected Area
Liberia
Margibi
Mangrove
Marshall city
FDA Protected area
0 15 30 60 90
Km
Ensuring Sustainable Environmental Management

13


Mangrove ecosystems near the city
Ensuring Sustainable Environmental Management

14

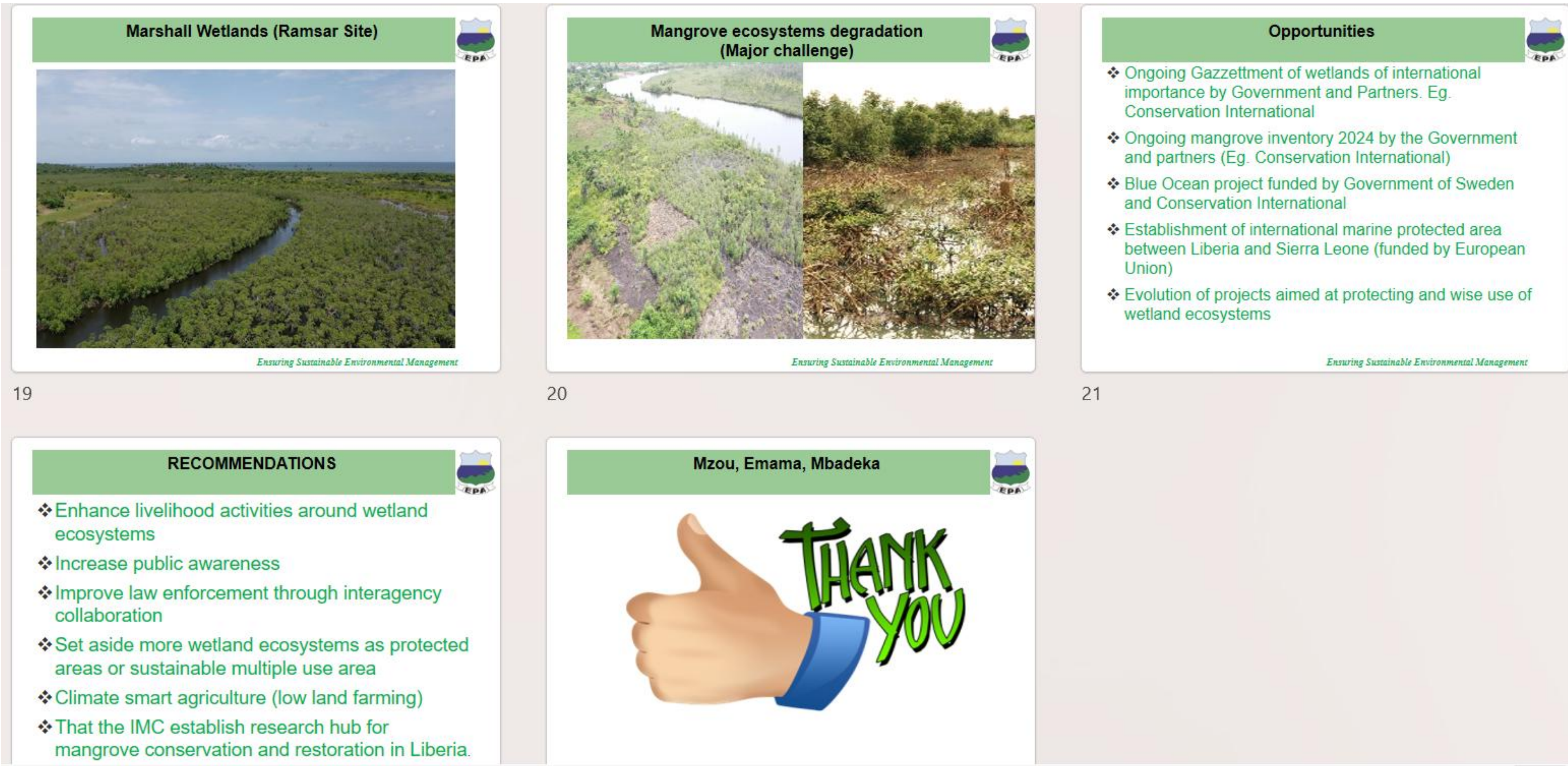

Mangrove area communities
Ensuring Sustainable Environmental Management

15


Primary/Natural Wetland (Marshall)

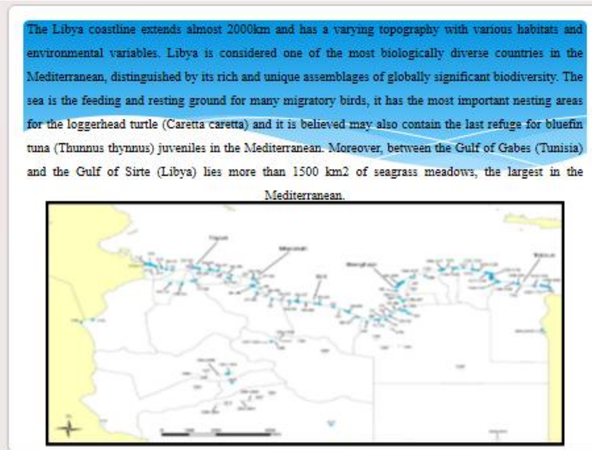

Primary/Natural Mangrove Forest (Marshall)


Marshall Wetland (Ramsar Site)


Marshall Wetlands (Ramsar Site)
EPA
Ensuring Sustainable Environmental Management
19
Mangrove ecosystems degradation
(Major challenge)
EPA
Ensuring Sustainable Environmental Management
20
Opportunities
EPA
❖ Ongoing Gazzettment of wetlands of international importance by Government and Partners. Eg. Conservation International
❖ Ongoing mangrove inventory 2024 by the Government and partners (Eg. Conservation International)
❖ Blue Ocean project funded by Government of Sweden and Conservation International
❖ Establishment of international marine protected area between Liberia and Sierra Leone (funded by European Union)
❖ Evolution of projects aimed at protecting and wise use of wetland ecosystems
Ensuring Sustainable Environmental Management
21
RECOMMENDATIONS
EPA
❖ Enhance livelihood activities around wetland ecosystems
❖ Increase public awareness
❖ Improve law enforcement through interagency collaboration
❖ Set aside more wetland ecosystems as protected areas or sustainable multiple use area
❖ Climate smart agriculture (low land farming)
❖ That the IMC establish research hub for mangrove conservation and restoration in Liberia.
Mzou, Emama, Mbadeka
EPA
THANK YOU

9- Libyan


Libyan Wetland
IMC Workshop, 2024/7/30
A.Berbash


The Libya coastline extends almost 2000km and has a varying topography with various habitats and environmental variables. Libya is considered one of the most biologically diverse countries in the Mediterranean, distinguished by its rich and unique assemblages of globally significant biodiversity. The sea is the feeding and resting ground for many migratory birds, it has the most important nesting areas for the loggerhead turtle (Caretta caretta) and it is believed may also contain the last refuge for bluefin tuna (Thunnus thynnus) juveniles in the Mediterranean. Moreover, between the Gulf of Gabes (Tunisia) and the Gulf of Sirte (Libya) lies more than 1500 km2 of seagrass meadows, the largest in the Mediterranean.


more than 250 wetland
Natural wetland
Coastal lagoons, golfs, sabkhas, Salinas, wadi, springs, oases, islands, tidal areas.
Artificial (man-made) wetland
Dams, water reservoir, sewage farm, aquaculture.
2 Ramsar site
Ain Elshakika is made of hyper-saline coastal Sebekha with limestone rock formations from the south, dunes, and mud flats with extensive shrubs from the west to the east, 33 ha (Ramsar Site)
Ain Elzarga with a hypersaline coastal lagoon with mudflats and saltmarshes, 50ha (Ramsar Site


7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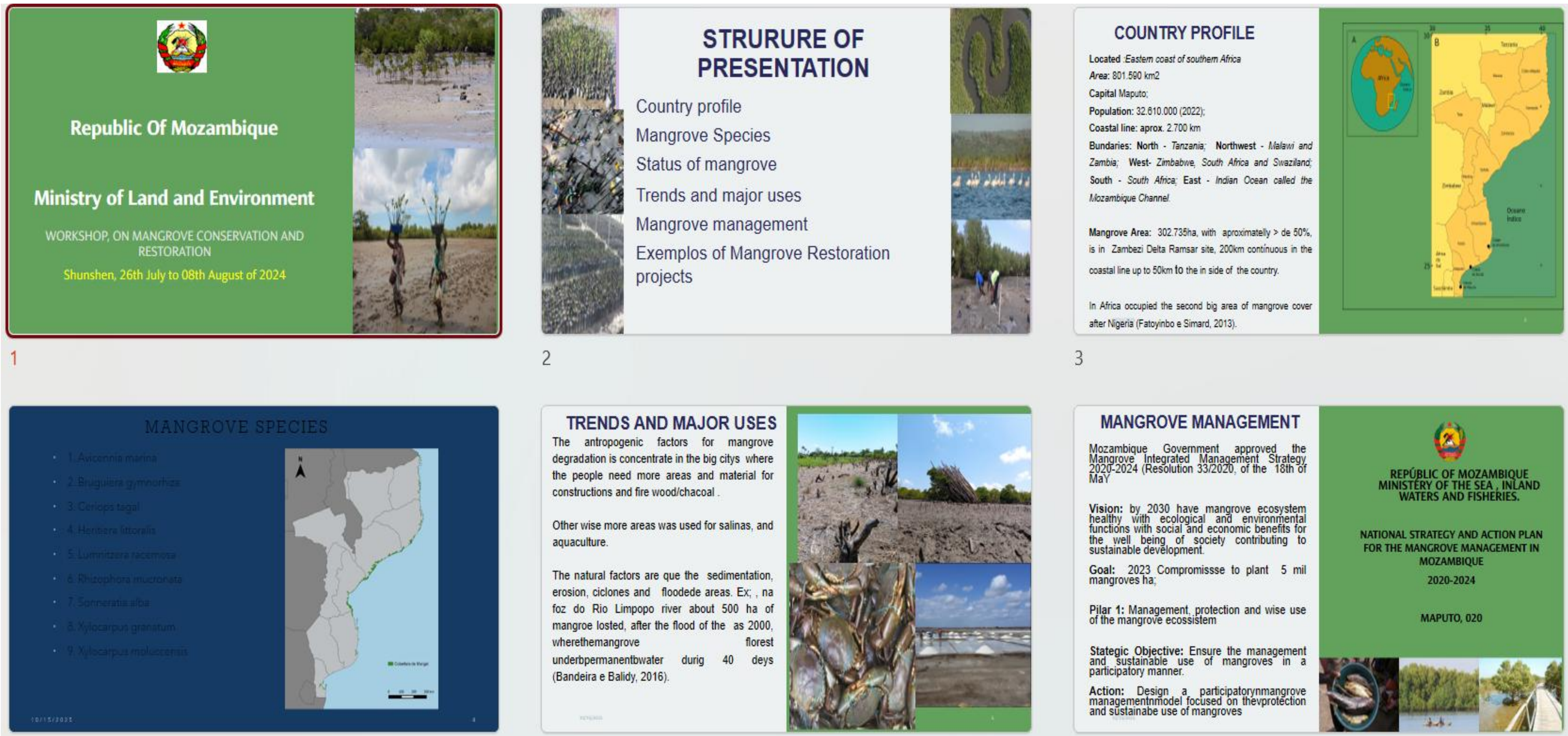
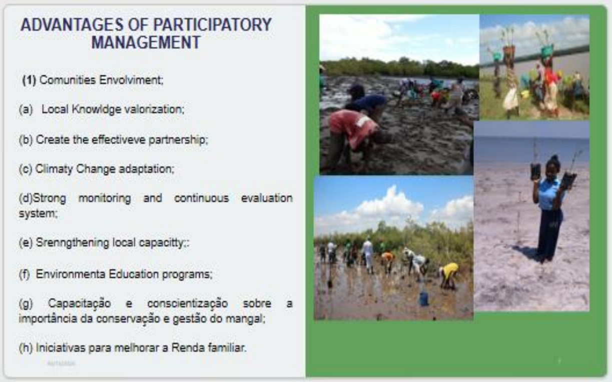
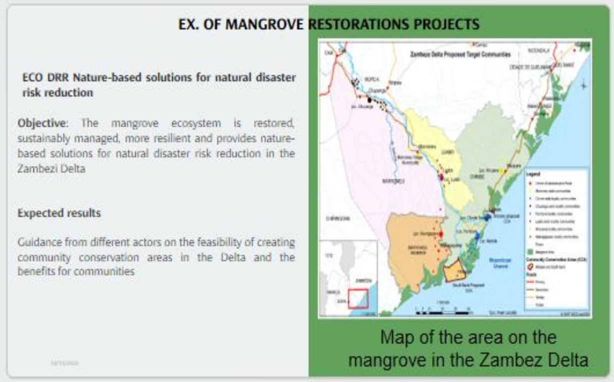
10- Mozambique

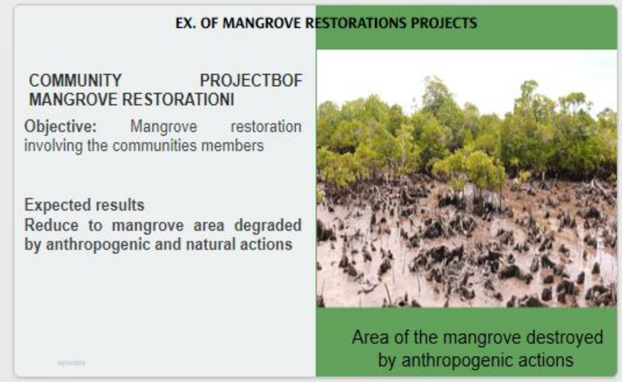



ADVANTAGES OF PARTICIPATORY MANAGEMENT
(1) Comunities Envolviment;
(a) Local Knowldge valorization;
(b) Create the effectiveve partnership;
(c) Climaty Change adaptation;
(d)Strong monitoring and continuous evaluation system;
(e) Srenngthening local capacity;;
(f) Environmenta Education programs;
(g) Capacitação e conscientização sobre a importância da conservação e gestão do mangal;
(h) Iniciativas para melhorar a Renda familiar.

7


EX. OF MANGROVE RESTORATIONS PROJECTS
ECO DRR Nature-based solutions for natural disaster risk reduction
Objective: The mangrove ecosystem is restored, sustainably managed, more resilient and provides nature-based solutions for natural disaster risk reduction in the Zambezi Delta
Expected results
Guidance from different actors on the feasibility of creating community conservation areas in the Delta and the benefits for communities
Map of the area on the mangrove in the Zambez Delta

8


EX. OF MANGROVE RESTORATIONS PROJECTS
COMMUNITY PROJECTBOF MANGROVE RESTORATIONI
Objective: Mangrove restoration involving the communities members
Expected results
Reduce to mangrove area degraded by anthropogenic and natural actions
Area of the mangrove destroyed by anthropogenic actions

9

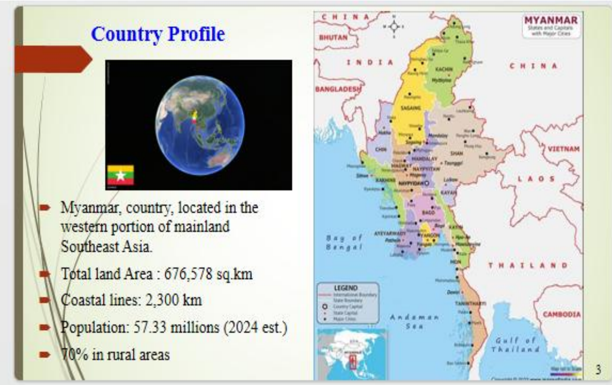

EX. OF MANGROVE RESTORATIONS PROJECTS
MANGROVE RESTORATION AND LIVELIHOOD SUPPORT THROUGH COMMUNITY PARTICIPATION IN MOZAMBIQUE
Objective: To improve mangrove management in Mozambique through restoration, community empowerment and generating baseline information to support decision making.
Expected results
1. Mangrove mapping and change detection between 2003 and 2018/9 (update of last mapping). Healthy, degraded and restored areas will be identified
2. Mangrove structural assessment in healthy, degraded and restored areas
3. Mangrove fauna assessment in healthy, degraded and restored areas


THANK YOU

11- Myanmar

1

2



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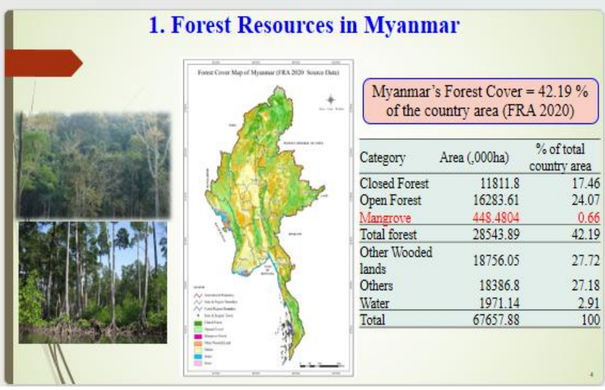
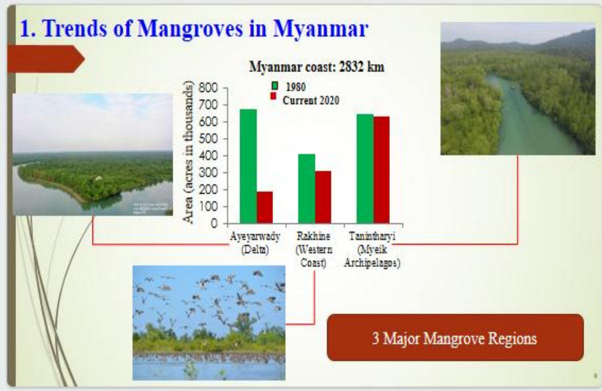



1. Status of Mangroves in Myanmar
Socioeconomic of Over 5.8 Millions of Coastal Inhabitants and National Development
Regulatory Services
Cultural Services
2008 (Before Nargis Cyclone)
2013 (After Nargis Cyclone)
MiPya Village, Kyauk Tan Township, Yangon
2018 (After Nargis Cyclone)
Moken (Sea gypsy)

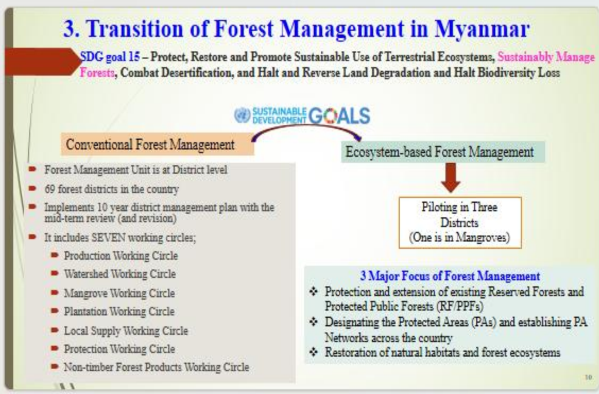
7


1. Trends of Mangroves in Myanmar
Myanmar coast: 2832 km
1980
Current 2020
Area (acres in thousands)
800
700
600
500
400
300
200
100
0
Ayeyarwady (Delta)
Rakhine (Western Coast)
Taninthayi (Myeik Archipelagos)
3 Major Mangrove Regions

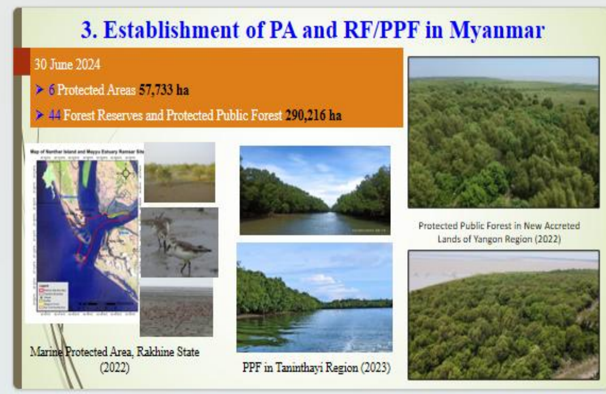
8

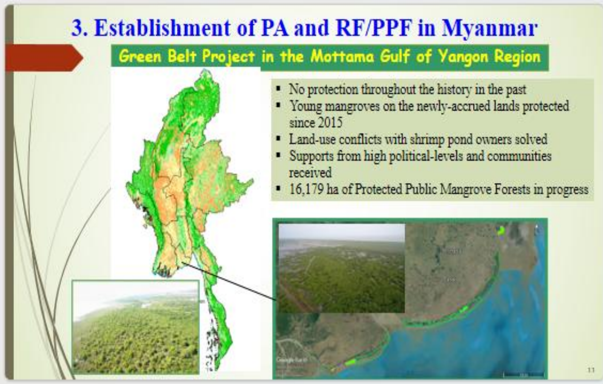

2. Major Issues and Threats to Mangroves
Land use changes due to Human Settlement, Rice Field Encroachment, and Shrimp Farming
Charcoal Production
Fuel wood cutting
Human Settlement
Rice Field
Shrimp farming
Charcoal and fuel wood

9

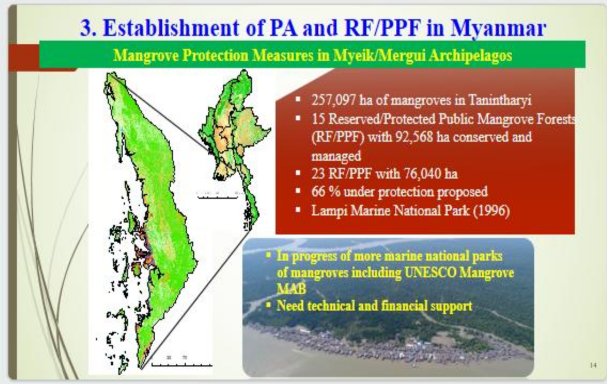

3. Transition of Forest Management in Myanmar
SDG goal 15 – Protect, Restore and Promote Sustainable Use of Terrestrial Ecosystems, Sustainably Manage Forests, Combat Desertification, and Halt and Reverse Land Degradation and Halt Biodiversity Loss
SUSTAINABLE DEVELOPMENT GOALS
Conventional Forest Management
Ecosystem-based Forest Management
Forest Management Unit is at District level
69 forest districts in the country
Implements 10 year district management plan with the mid-term review (and revision)
It includes SEVEN working circles;
Production Working Circle
Watershed Working Circle
Mangrove Working Circle
Plantation Working Circle
Local Supply Working Circle
Protection Working Circle
Non-timber Forest Products Working Circle
Piloting in Three Districts (One is in Mangroves)
3 Major Focus of Forest Management
Protection and extension of existing Reserved Forests and Protected Public Forests (RF/PPFs)
Designating the Protected Areas (PAs) and establishing PA Networks across the country
Restoration of natural habitats and forest ecosystems


3. Mangrove Management Strategies in Myanmar
1. Marine Protected Area development
2. Constitution of Permanent Forest Estates (Reserves and Protected Public Forests)
3. Restoring the mangrove ecosystems (Plantations, Community Forestry, Private Forestry, etc.)


3. Establishment of PA and RF/PPF in Myanmar
30 June 2024
6 Protected Areas 57,733 ha
44 Forest Reserves and Protected Public Forest 290,216 ha
Marine Protected Area, Rakhine State (2022)
PPF in Tanintharyi Region (2023)
Protected Public Forest in New Accreted Lands of Yangon Region (2022)


3. Establishment of PA and RF/PPF in Myanmar
Green Belt Project in the Mottama Gulf of Yangon Region
▪ No protection throughout the history in the past
▪ Young mangroves on the newly-accrued lands protected since 2015
▪ Land-use conflicts with shrimp pond owners solved
▪ Supports from high political-levels and communities received
▪ 16,179 ha of Protected Public Mangrove Forests in progress

13


3. Establishment of PA and RF/PPF in Myanmar
Mangrove Protection Measures in Myeik/Mergui Archipelagos
▪ 257,097 ha of mangroves in Tanintharyi
▪ 15 Reserved/Protected Public Mangrove Forests (RF/PPF) with 92,568 ha conserved and managed
▪ 23 RF/PPF with 76,040 ha
▪ 66 % under protection proposed
▪ Lampi Marine National Park (1996)
▪ In progress of more marine national parks of mangroves including UNESCO Mangrove MAB
▪ Need technical and financial support

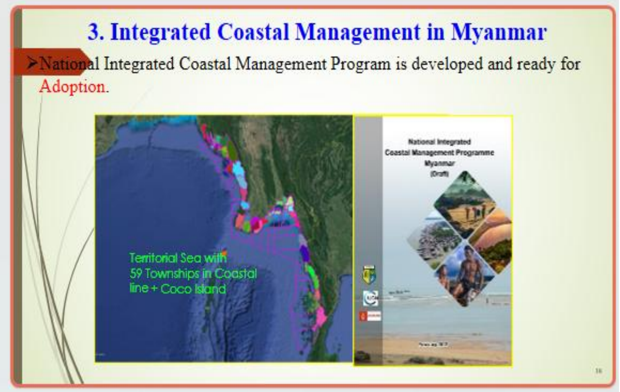
14


3. Progress of Mangrove restoration in Myanmar
Myanmar Reforestation and Rehabilitation Programme (2017-2027)
➢ 12,000 hectares of Mangrove Plantations has been established by planting 36.3 millions of Mangrove Seedlings from 2017 to 2023.

15


3. Progress of Mangrove restoration in Myanmar
Community Participation Strengthened
Community Forestry in Mangroves
▪ FD grants CF for 30 years
▪ Total Mangrove CF (6,247) ha over the Myanmar Coasts
▪ Total Mangrove CF in Tanintharyi Coast (3,886) ha
▪ Reserved/Protected Public Mangrove Forests are granted to CF
Kanyin Chaung CF in Tanintharyi Region
▪ Karen Ethnic Communities
▪ Locally conserved since 1952
▪ Transition to CF since 2001
▪ Officially granted certification in 2019 for their own management

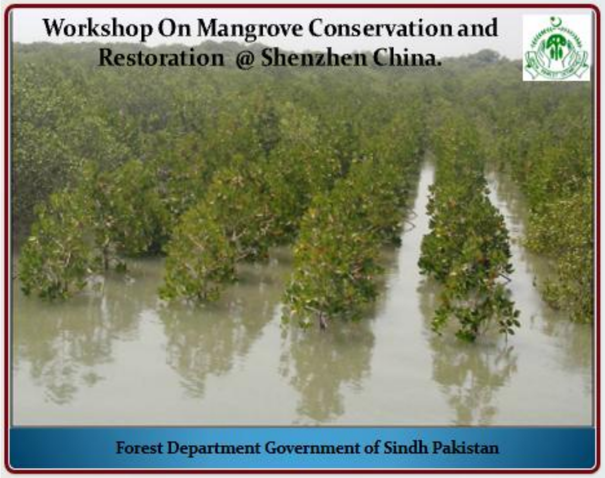

3. Progress of Mangrove restoration in Myanmar
• Community Participated Mangrove Planting in 60 Townships of Coastal Area
• Public Awareness Raising (Mangrove Planting Campaign in International Mangrove Day)


3. Integrated Coastal Management in Myanmar
➢National Integrated Coastal Management Program is developed and ready for Adoption.
Territorial Sea with 59 Townships in Coastal line + Coco Island
National Integrated Coastal Management Programme Myanmar (Draft)


4. Collaborative Opportunities for Mangrove Management
Protected Area Management (Primary Mangroves + Biodiversity Conservation)
Mangrove Restoration (Degraded Mangrove Areas and Newly accreted lands)
Research Collaboration
Capacity Building
Community Forestry and Rural Development
Public Awareness and Community Extension


Thank you for Your Kind Attention
Local people's Livelihood in harmony with Natural Mangroves

12- Pakistan



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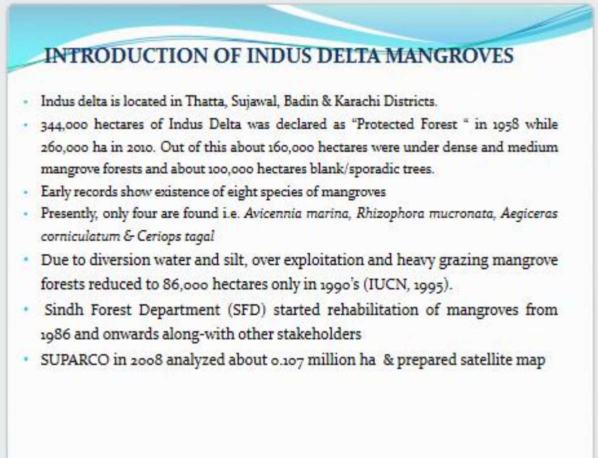

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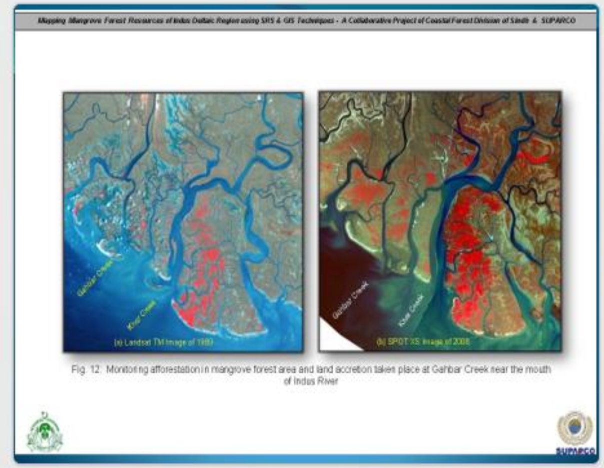

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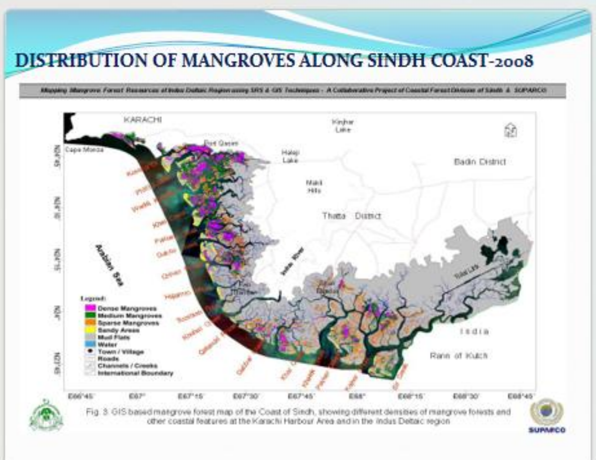
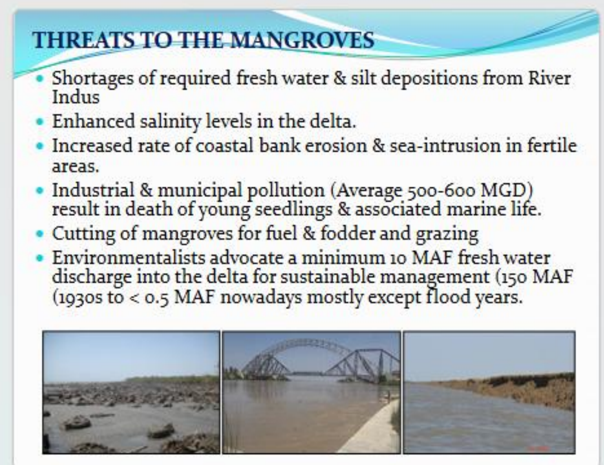




Role of mangroves in addressing the effects of Climate change

- Mangroves provide a variety of ecosystem services to adjacent coastal populations, such as the provision of food and coastal defense services by reducing risk from coastal hazards.
- Mangroves reduce waves damage: mangroves significantly attenuate waves. Studies suggest wave height can be reduced by 13 to 66 percent over a 100-meter-wide mangrove belt, while wave height can be reduced by 50 to 100 percent over a 500-meter-wide mangrove belt.
- Reduce Storm surges : Where mangroves are extensive they are able to reduce storm surge water depths as the surge flows inland. While storm surge depths may only be reduced by 5-50 cm per kilometer width of mangroves, nevertheless a small reduction in water level can already greatly reduce the extent of flooding in low lying areas behind the mangroves. Debris movement can also be reduced by mangroves: the complex network of roots and branches can serve to trap even large moving objects.

7

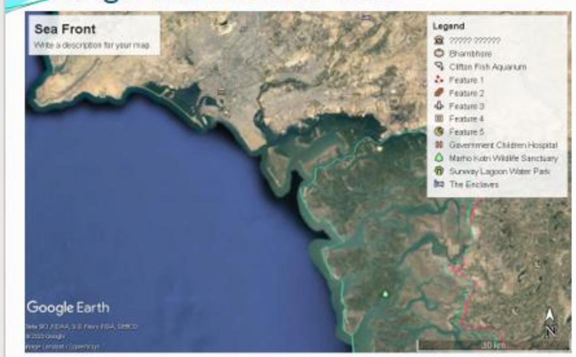
- Prevents High wind speeds : The dense mangrove forest canopies also reduce wind speeds locally. This prevents further development of wind and swell waves in and immediately behind the mangroves, potentially reducing damage to nearby infrastructure.
- Reduce Tsunami damage: Mangroves reduced tsunami impacts by reducing the destructive energy of water flowing inland. Mangrove belts several hundred meters wide have been shown to reduce tsunami height by between 5 and 30%. Wider mangrove forests are more effective at reducing tsunami height, as well as speed of the water and the area flooded by the tsunami. Dense forest vegetation also helps to reduce tsunami depth and area of flooding.

8

- Reduce erosion :
- Mangroves generally reduce erosion and enhance sedimentation.
- The mangrove vegetation reduces wave energy and slows the flow of water over the soil surface, reducing the water's capacity to dislodge sediments and carry them out of the mangrove area.
- At the same time the slower water flows can allow already suspended sediments to settle out from the water, resulting in increased deposition of sediment.
- Competing Sea Level Rise :
- Mangroves contribute to an increase in soil volume by capturing riverine or coastal sediments that pass through, as well as adding their own organic matter in the form of roots, leaves and woody material.
- The fine mangrove roots also help to trap and bind the particles. Due to a lack of oxygen in the waterlogged soil, organic matter is not broken down by soil organisms.
- This allows the organic matter to build up over time, producing the deep peaty soils that underlie mangroves in some areas. Mangrove root growth also pushes the soil upward, resulting in a higher soil level.

9

Mangroves on Sea Front



REHABILITATION OF INDUS DELTA BY SFD AND STAKEHOLDERS

- *Rhizophora mucronata* was re-introduced in the Indus Delta in 1986

REHABILITATION OF INDUS DELTA BY SFD AND STAKEHOLDERS

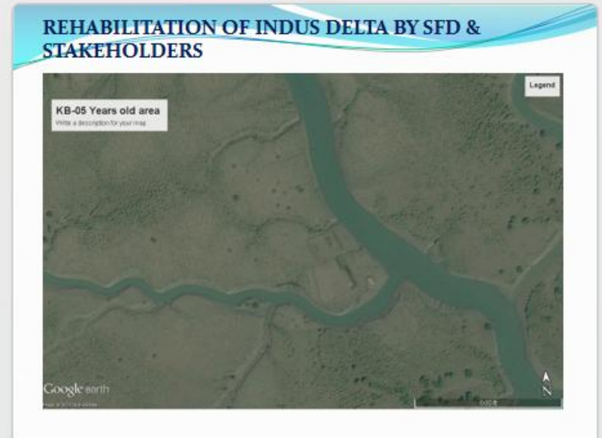
- A Joint (SFD & IUCN) Rehabilitation Project in Phitti Creek system in 1993-1994 over 350 hectares


NATURAL REGENERATION IN RE-INTRODUCED AREA

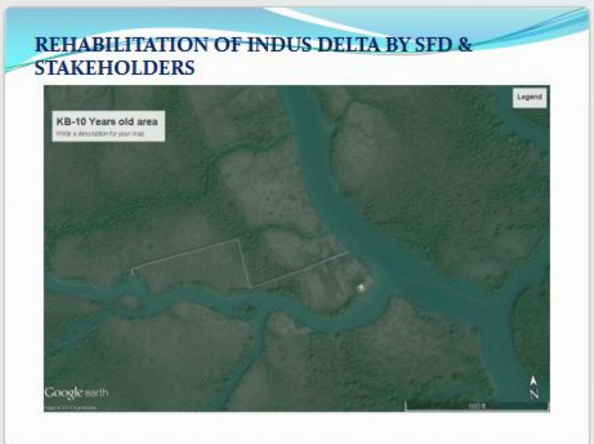
13

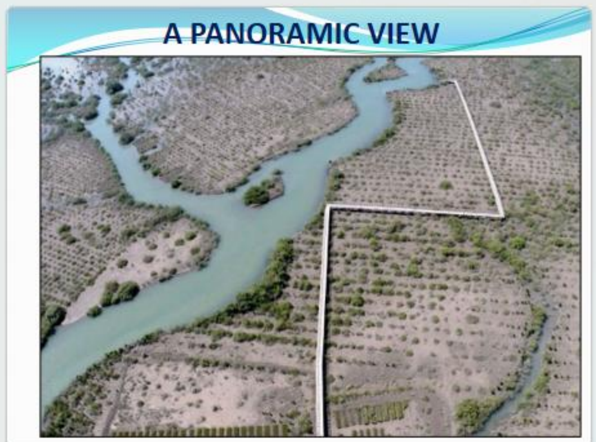

Rehabilitation of Indus Delta by SFD in Keti Bundar
KB-Newly planted area
Legend
Google earth

14


REHABILITATION OF INDUS DELTA BY SFD & STAKEHOLDERS
KB-05 Years old area
Legend
Google earth

15


REHABILITATION OF INDUS DELTA BY SFD & STAKEHOLDERS
KB-10 Years old area
Legend
Google earth


A PANORAMIC VIEW


RESTORED MANGROVE ECOSYSTEM

PROCESS OF REHABILITATION

- Recruitment & Training of local labour force
- Propagule/Seed Collection from Delta & Its Storage
- Transportation of Propagules to the nursery & Planting sites
- Nursery raising near planting sites
- Field Planting in various soil types
- Watch & Ward – restocking & protection of planting sites from grazing & browsing
- Community engagement & incentivization
- Outcome of planting efforts

19

20

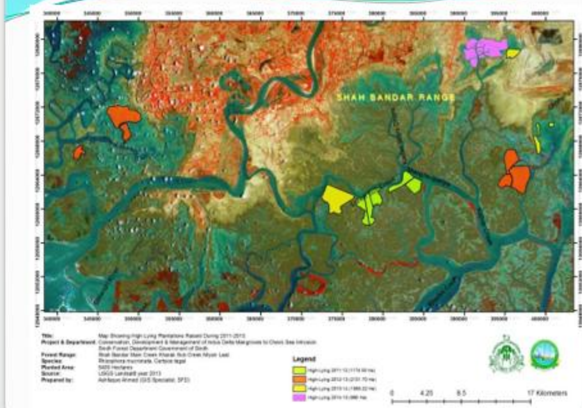
21

OUTCOME OF PLANTING & PROTECTION ACTIVITIES

25

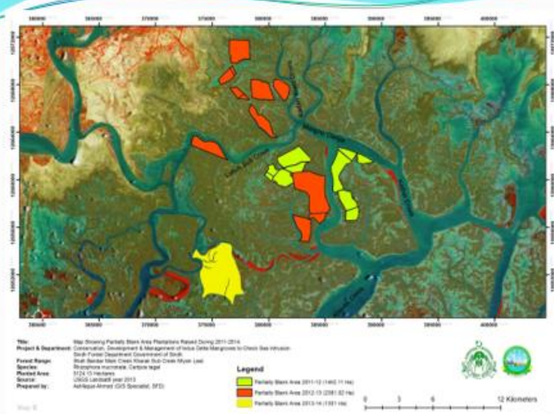
26

HL PLANTATIONS RAISED DURING 2011-15



27

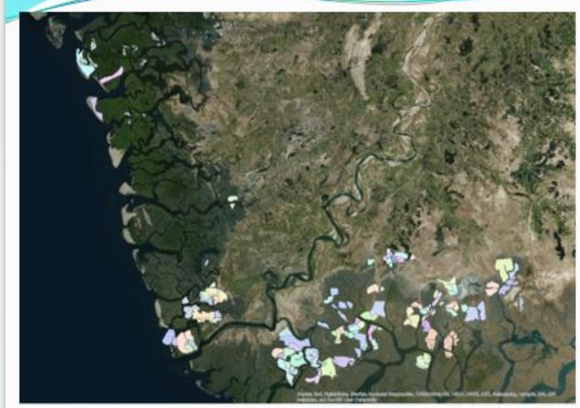
PB PLANTATIONS RAISED DURING 2011-14

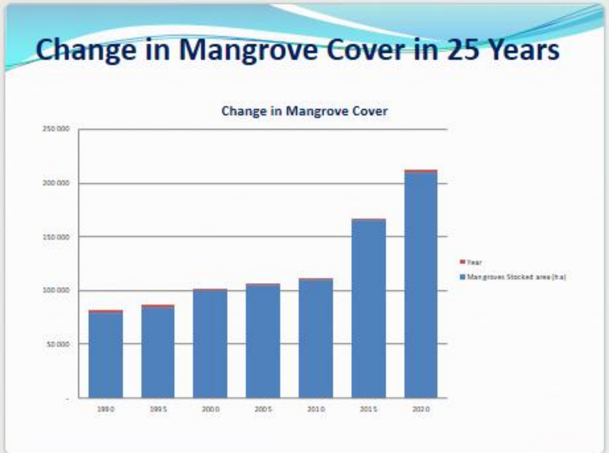


LATEST ESTIMATION OF INDUS DELTA MANGROVES

- Due to continuous rehabilitation efforts since 2008 in the Restoration process of Indus Delta Mangroves following Achievements have been made:
  - Guinness World Records were set in 2009, 2013 and 2018 and
  - Pakistan is currently GWR holder in planting maximum number of saplings in one day through 300 volunteers.
- **Current estimates of mangroves ranges around**
  - **240,000 ha an increase of about 133,000 ha in 13 years**
  - **Plantation and Protection of about 2.43 billion plants**
- With this increase & achievements, Pakistan is currently occupying 10th position globally & 5th in Asia.
- **The key finding is that over the past 25 years, the area of mangroves in Pakistan has increased from 92,110 ha in 1993 to 211,790 ha in 2018, a rise of 230% (WB, 2022).**

CONSOLIDATED SHAPE FILES OF PLANTED AREAS IN DELTA

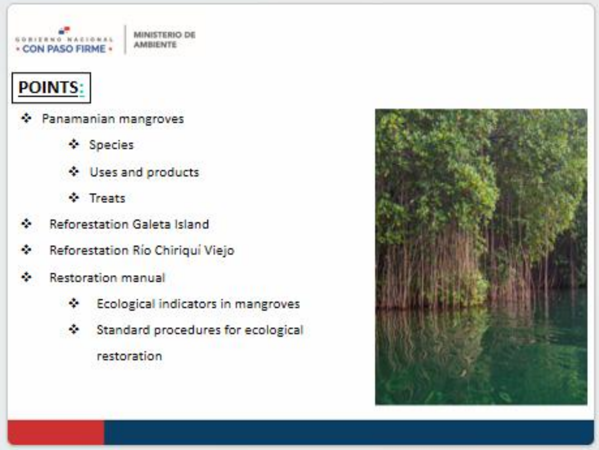



Change in Mangrove Cover in 25 Years
Change in Mangrove Cover
250 000
200 000
150 000
100 000
50 000
-
1990
1995
2000
2005
2010
2015
2020
Year
Mangroves Stocked area (ha)


GUINNESS WORLD RECORDS – 2009, 2013 & 2018
GUINNESS WORLD RECORDS
CERTIFICATE

13- Panama

1



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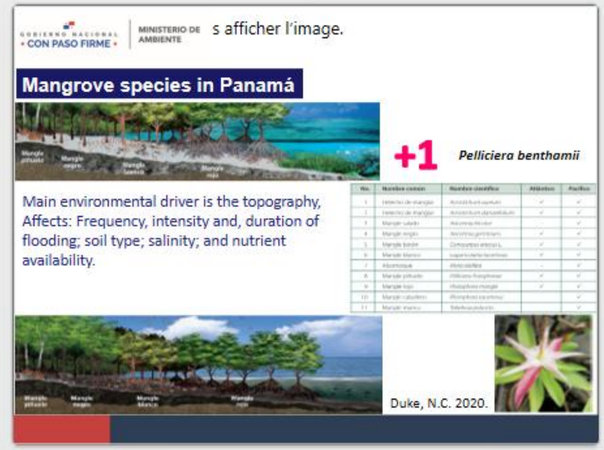

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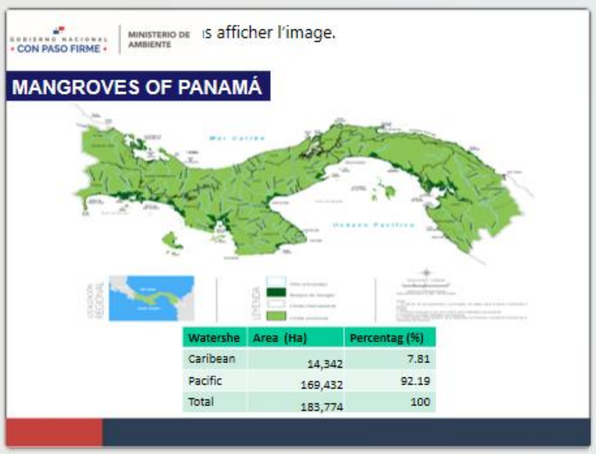

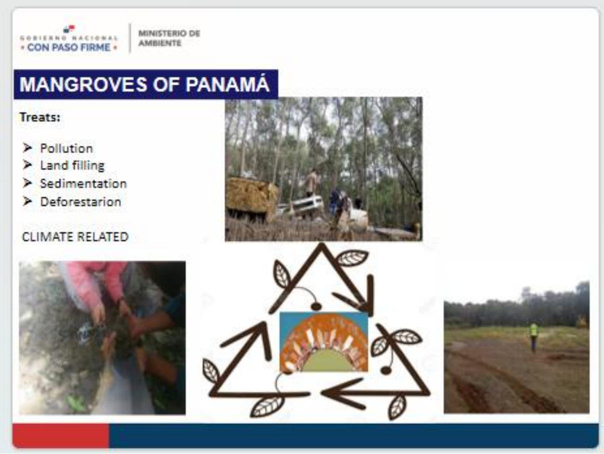

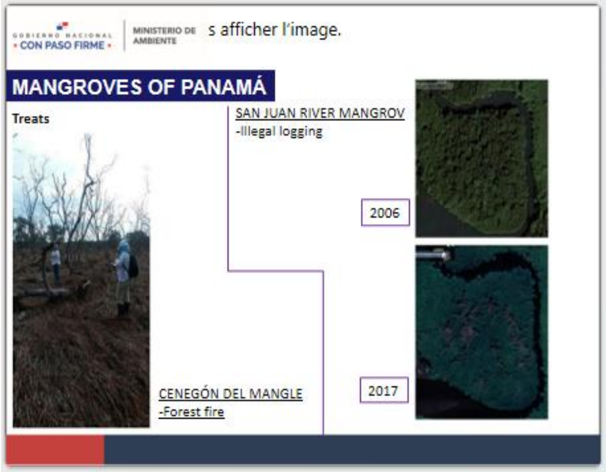
CON PASO FIRME
MINISTERIO DE AMBIENTE
s afficher l'image.
MANGROVES OF PANAMÁ
Treats
SAN JUAN RIVER MANGROV
-Illegal logging
2006
CENEGÓN DEL MANGLE
-Forest fire
2017

7


CON PASO FIRME
MINISTERIO DE AMBIENTE
afficher l'image.
Reforestation Project Galeta Island
Land filled for old military base

8


CON PASO FIRME
MINISTERIO DE AMBIENTE
s afficher l'image.
Reforestation Project Galeta Island
AES 5.4 ha reforested.
Methodology: First hidrological restoration then reforestation (coral fillings)
Species:
Rhizophora mangle (red mangrove),
Laguncularia racemosa (white mangrove)
Conocarpus erectus (Little button Mangrove)

9


CON PASO FIRME
MINISTERIO DE AMBIENTE
s afficher l'image.
River Chiriquí Viejo reforestation:
50 Ha


CON PASO FIRME
MINISTERIO DE AMBIENTE
s afficher l'image.
River Chiriquí Viejo reforestation
First report of Riley technique (bambu stakes)
5 years


CON PASO FIRME
MINISTERIO DE AMBIENTE
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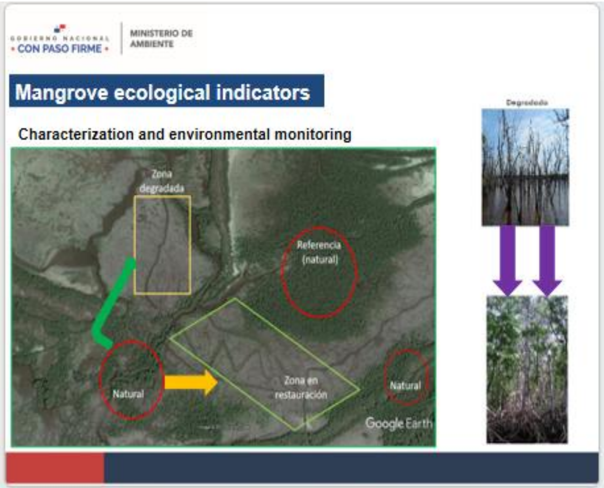
MANUAL DE TÉCNICAS DE RESTAURACIÓN PARA ÁREAS DEGRADADAS DE MANGLAR EN PANAMÁ



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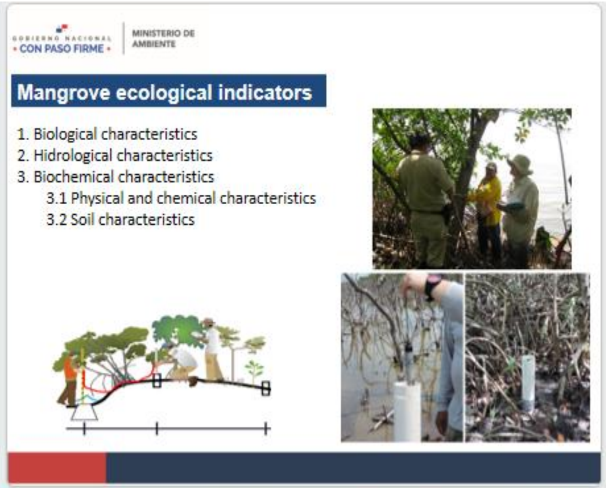


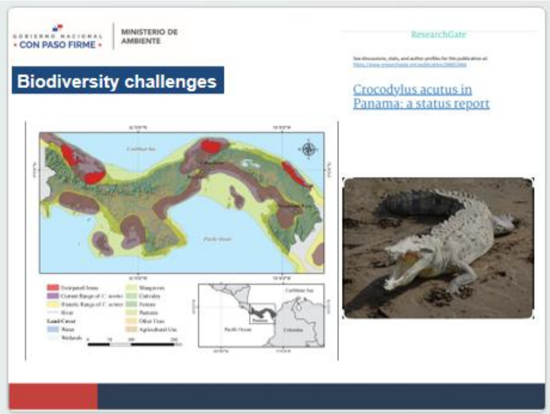
14

15

Advantages	Disadvantages
Fast growing due to competition	Heavy to transport
Suitable for low nutrient soils	Requires more soil
Many plants and species	Hard to install
Facilitates establishment of other pioneer species	

Advantages	Disadvantages
Low cost	Used for black, white and Little button mangrove species
Many seeds per Ha	Only used in harvest season for seeds of black, White and Little button mangrove species
Effectivity increases with good timing of harvest of seeds and tidal waves	


GOBIERNO NACIONAL • CON PASO FIRME •
MINISTERIO DE AMBIENTE
Standard procedures for ecological restoration
➤ Mangrove reforestation techniques applied in Panamá.
Plantation of seedlings in bambu stakes
Advantages
Disadvantages
Environmentally friendly
Easy to install
Bambu stakes increase costs
Protects seedlings from predators
Transportation
Maintain humidity in the dry season


GOBIERNO NACIONAL • CON PASO FIRME •
MINISTERIO DE AMBIENTE
Biodiversity challenges
ResearchGate
Crocodylus acutus in Panama: a status report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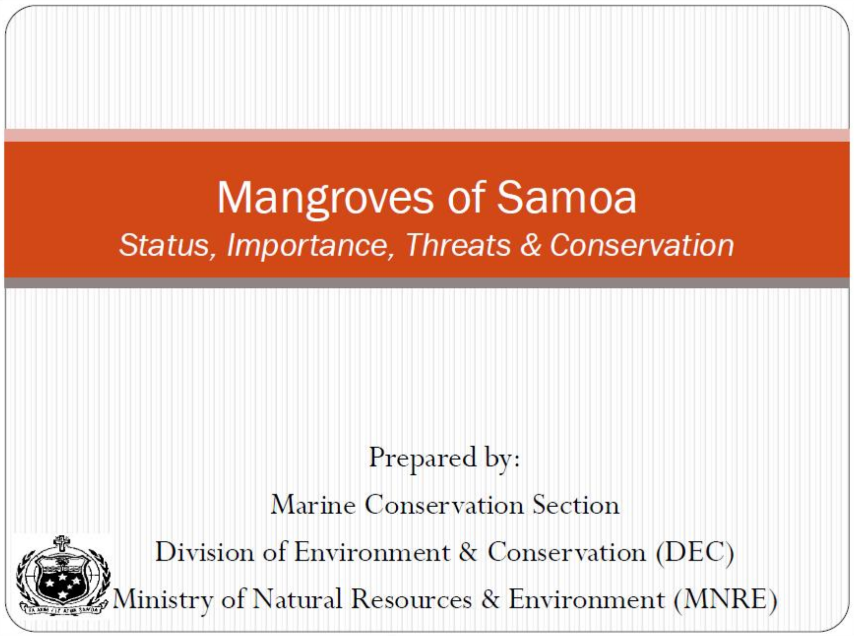
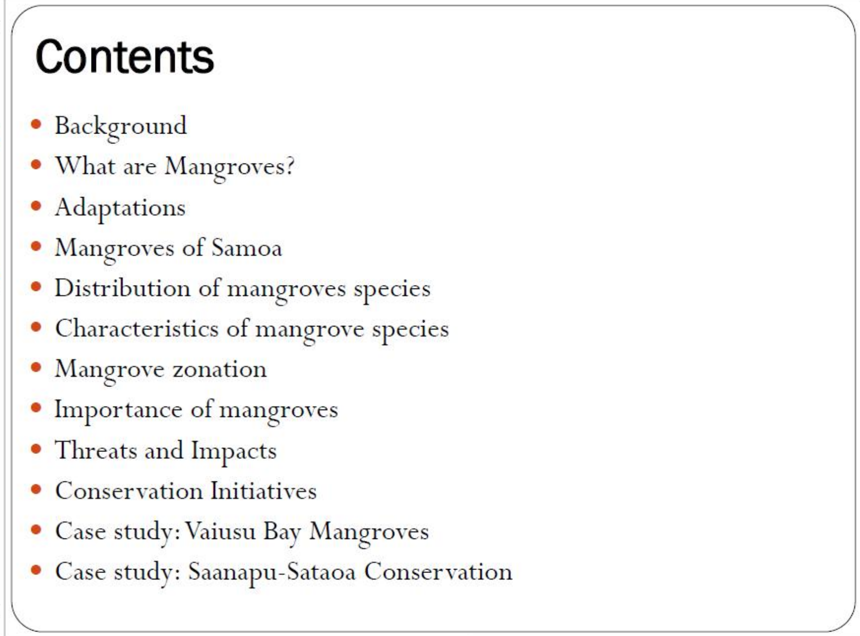
THANK YOU!
vgonzalez@miambiente.gob.pa

14- Samoa


Mangroves of Samoa
Status, Importance, Threats & Conservation
Prepared by:
Marine Conservation Section
Division of Environment & Conservation (DEC)
Ministry of Natural Resources & Environment (MNRE)


Contents
Background
What are Mangroves?
Adaptations
Mangroves of Samoa
Distribution of mangroves species
Characteristics of mangrove species
Mangrove zonation
Importance of mangroves
Threats and Impacts
Conservation Initiatives
Case study: Vaiusu Bay Mangroves
Case study: Saanapu-Sataoa Conservation

Background:

- MNRE is primarily responsible for the sustainable development and management of Samoa's natural resources and environment. The work is mandated under various legislations, regulations, policies and multilateral environmental agreements.
- The overall objective of the Marine Conservation Section (MCS) is *Sustainable development and management of marine biological resources and the environment.*
- 5 Main Components of the MCS:
  - Ecosystem conservation & management eg. mangroves & coral reefs
  - Species conservation & management eg. turtles, whales, sharks, dolphins
  - Establishment of Marine protected areas/sanctuary eg. Palolo deep
  - Implementation of Conventions eg. CBD, CITES, RAMSAR
  - Awareness and Information Programs

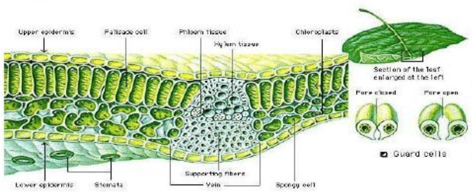
What are Mangroves?

- Mangroves are trees or shrubs, growing more than 0.5meters in height that live between the land and sea.
- Mangrove ecosystems are commonly found along the sheltered coastlines where sediments are deposited, such as estuaries.
- They have the ability to adapt to the environmental conditions such as high salinity, low oxygen, poor nutrient availability and substrate mobility.

Adaptations:

Mangroves are able to adapt to the different environmental stresses through:

- **Preventing water loss:** leaves have a thick-walled epidermis covered by a waxy cuticle which acts like a waterproof skin. Leaves have a fleshy structure containing layers of water storing cells called **spongy cells**.

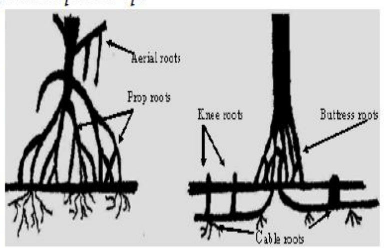


Adaptations:

- **Ability to excrete and exclude salt:**
  1. **Exclusion:** roots take up only water but exclude the bulk of the salt.
  2. **Extrusion:** excess salt is excreted through special glands on their leaves which gets washed away when it rains.
  3. **Accumulation:** excess salt is accumulated in older leaves and bark which fall off getting rid of the salt.
- Different species remove salt using the above mechanisms.

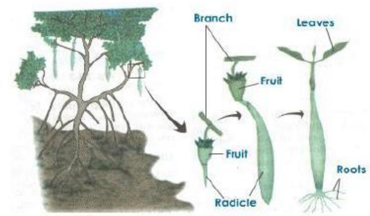
Adaptations:

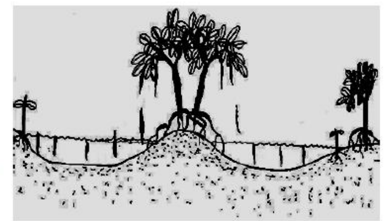
- **Specialized root structures:** lack of oxygen and the constant changing of tide means that mangroves to have to adapt to these situation.
  - Breathing roots called "pneumatophores" which help with the air exchange when roots are exposed above the water and mud.
  - Intertwining masses of the roots help anchor the tree from being eroded by the changing tides and waves eg. *Rhizophora sp.*



Adaptations:

- **Specialized reproduction:** embryo germinates while still attached to the parent tree into a seedling, afterwards the seedling either drops and takes root or floats until it takes root in a favorable muddy shore. This reproduction method is called **viviparity**.





Mangroves of Samoa

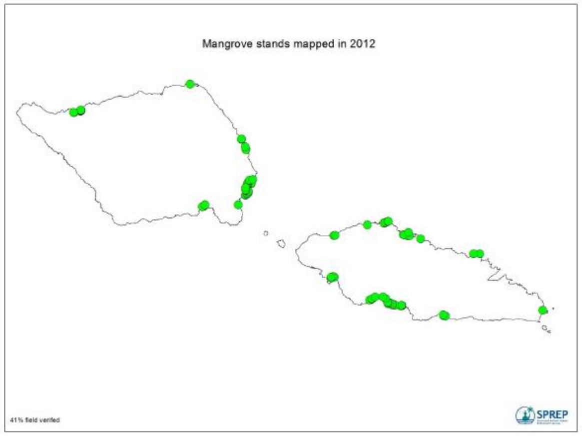
- Over 80 mangrove species are found worldwide, only 3 are found in Samoa. However, recent surveys conducted by DEC under the Mangrove Ecosystems for Climate Change Adaptation and Livelihood (MESCAL) confirmed 2 additional Species. Total mangroves species found in Samoa is now 5.
- The largest mangrove area in Samoa is the Vaiusu Bay mangrove area, extending from the Mulinu'u Peninsula to Fugalei, Vaitoloa, Vaiusu and part of Vaitele .

Species Name	Common Name	Status
Rhizophora samoensis	Red/Female mangrove	Common
Bruguiera gymnorhiza	Oriental/Male mangrove	Common
Xylocarpus granatum	White mangrove/Puzzle-nut	Rare
Acrostichum speciosum (new)	Swamp fern	Common
Pemphis acidula (new)	Reef mangrove	Rare

Map of Vaiusu Mangrove Bay

Distribution of Mangroves:

- Total area of mangroves = 217.85 hectares & found on Upolu & Savaii. However, there are more mangrove sites that are yet to be included.



Characteristics of mangrove species of Samoa

1. *Rhizophora samoensis* (Red mangrove)

- Stilt roots which allows the mangroves to survive from the changing tides.
- Flowers are whitish yellow in colour
- Tips of leaves are blunt
- Seedlings are usually longer & thinner

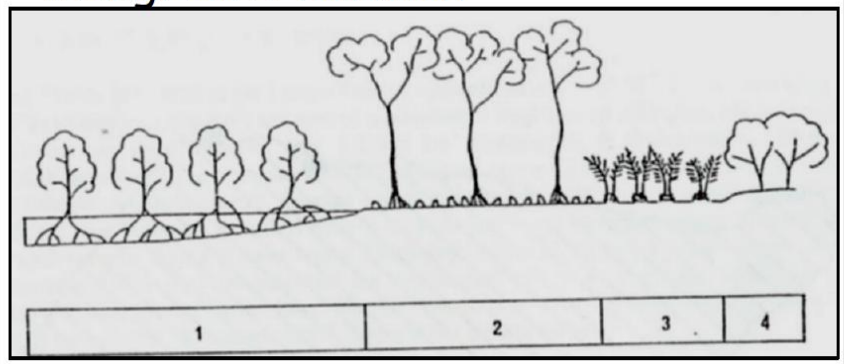
2. *Bruguiera gymnnorrhiza* (Oriental/Male mangrove)

- Thick vertical buttress roots growing around the trunk and knee-like roots that grow up above the mud surface.
- Flowers are reddish, pale yellow, white or green in colour
- Tips of the leaves are pointed
- Seedlings are shorter and fatter

3. *Xylocapus spp* (White mangrove)

- Rare mangrove with biggest stand found in Salailua, Savaii
- Leaves are oval shaped
- Flowers are creamy white in colour
- Seeds are round

Mangrove Zonation

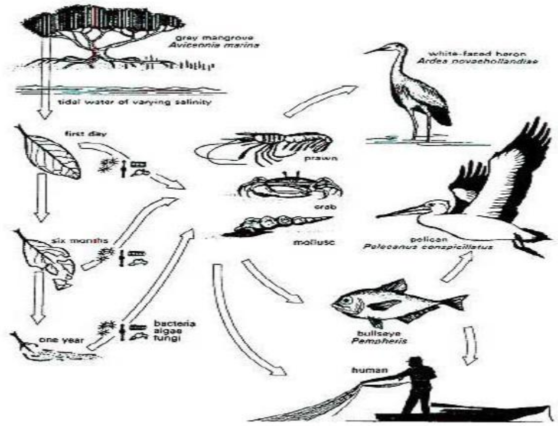


1. *Rhizophora Zone*
2. *Bruguiera Zone*
3. *Fern Zone*
4. *Beach Hibiscus & Coastal Forest Zone*

Importance of Mangroves:

Ecological Values:

- Mangroves are one of the starting points of the food chain of marine & seashore life.



Importance of Mangroves:

Ecological Values:

- Provides shelter & nursery grounds for a vast range of marine & terrestrial wildlife.

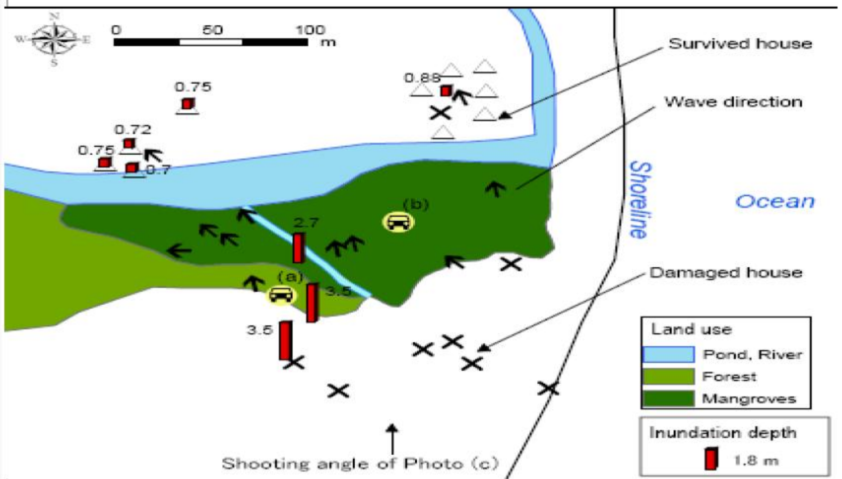
Importance of Mangroves:

Ecological Values:

- Shoreline & lagoon protection – filter water & trap debris (sediments/nutrients/rubbish) before reaching the coral reef and seagrass beds.
- Stabilizes coastal areas from erosion especially during storms, hurricanes and tsunami.

Example of shoreline protection: Malaela Mangroves Before & After Tsunami in 2009

Post tsunami assessment of Malaela



Importance of Mangroves:

Community Values:

- Provide food source for surrounding communities.
- Oysters, prawns, mud crabs and various species of fish are caught or collected for everyday subsistence.

Importance of Mangroves:

Community Values:

- Marine resources associated with mangroves also have commercial value.
- Crabs, prawns, clams and fish are caught/collected and sold at the local fish market or along the side of the roads.
- In developed countries, commercial fishing industries place a high value on mangrove resources such as prawns.

Importance of Mangroves:

Community Values:

- Support eco-tourism providing income for local communities
- Firewood as fuel for cooking
- Timber for building houses and canoes
- Medicines for various illnesses eg. sores
- Colouring dyes


Threats & Impacts:
Human Activities:
Rubbish disposal in and around mangrove areas especially by industries and companies
Pollution of area leads to poisoned ecosystems and the spread of diseases


Threats & Impacts:
Human Activities:
Large areas of mangrove swamps and forests have been reclaimed to create more land for the increasing population and developments.

Threats & Impacts:

Human Activities:

- Excessive clearing and cutting of mangroves for various uses eg. Firewood and construction materials.


Threats & Impacts:

Natural Phenomenon:

- Cyclones and strong storms can generate strong winds and wave action that can topple and uproot mangrove trees.
- Heavy rainfall can lead to high discharge of rivers and streams leading to flooding.
- Tsunami can also uproot and destroy large areas of mangroves.


Threats & Impacts:

Natural Phenomenon:

- Pigs can also cause damage to mangrove areas especially when they dig up the seedlings that are starting to establish into mangrove plants.

Conservation Initiatives:

- Mangrove Ecosystems for Climate Change Adaptation and Livelihoods (MESCAL)
- 4 years project which also involves Fiji, Tonga, Solomon Island and Vanuatu
- **Aim:** increase the resilience to climate change for the people of the Pacific Island Countries.

Mangrove Ecosystems for Climate Change Adaptation and Livelihoods

MESCAL

SAMOA

- Research
- Mapping of mangroves
- Development of a specific law for the protection and sustainable management of mangroves in Samoa.

Conservation Initiatives:

Establish mangrove reserves or protected areas:

- As reserves or protected areas mangroves would be fully protected by law
- Allows for easy governance and management of mangrove resources

Conservation Initiatives:

Re-habilitation Programs:

- Promote the re-planting of mangrove seedlings or juvenilles in areas that have been degraded.

Conservation Initiatives (cont)

Stop habitat destruction:

- Stop the disposal of rubbish into mangrove areas
- Stop the reclamation of mangrove areas
- Stop the excessive cutting and clearing of mangroves

Establish legislations:

- Develop specific laws regarding the use and management of mangrove resources
- Enforce legislations for the effective management of mangroves

Conservation Initiatives:

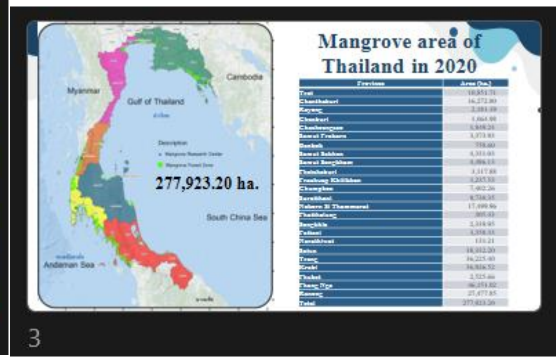
Public Awareness:

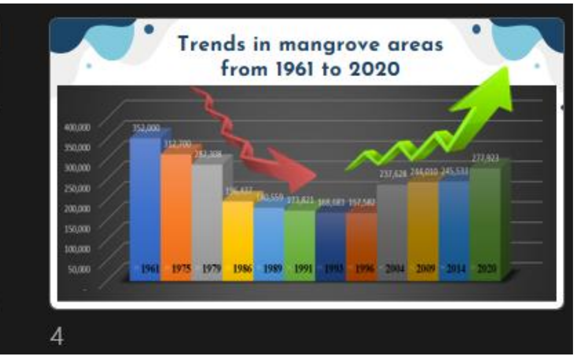
- It is important to inform and educate the public on the important values of mangroves and the harmful impacts of our actions.


THANK YOU
Any Questions?

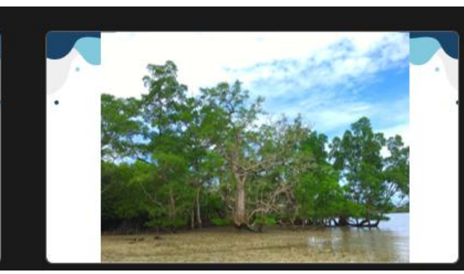
15- Thailand

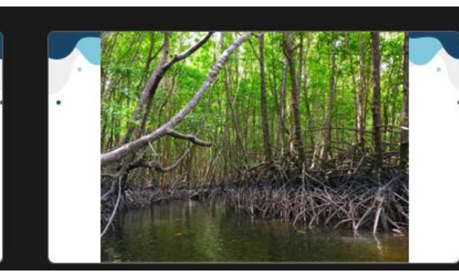

Case and Experience Sharing
on Mangrove Conservation
in Thailand
Suchart Yamprasai
Mangrove Resources Research and Development Institute,
Department of Marine and Coastal Resources,
Ministry of Natural Resources and Environment, Thailand

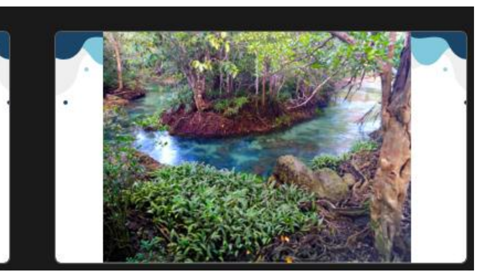

Mangrove area of
Thailand in 2020
277,923.20 ha.
Myanmar
Gulf of Thailand
Cambodia
South China Sea
Andaman Sea
3


Trends in mangrove areas
from 1961 to 2020
1961
1975
1979
1986
1989
1991
1993
1996
2004
2009
2014
2020
4


Mangrove species
in Thailand
In Thailand, there are 102 species of mangroves (trees and shrubs).
41 species of true mangroves.
61 species of mangrove associated.





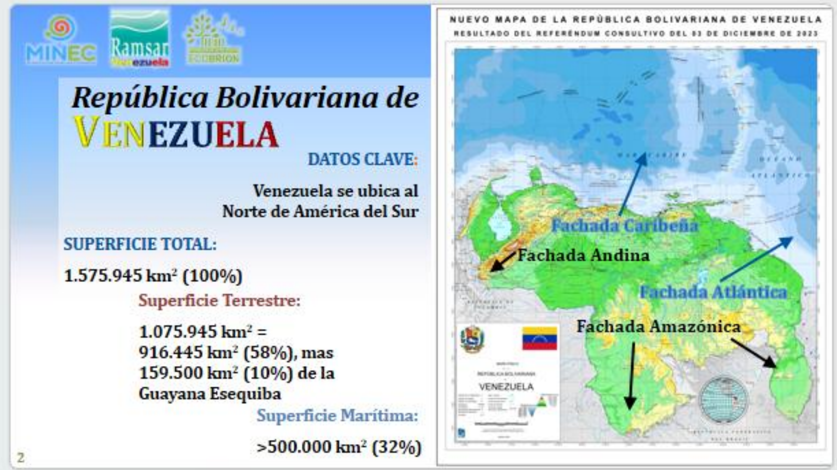



9
Wildlife in Mangrove
Category
Species (Update 2023)
Amphibians 4
Reptiles 22
Mammals 16
birds 226
Total 268
10
Handbook Mangrove Planting
Handbook for Mangrove Nursery and Planting.
Handbook for mangrove planting for carbon credits.
People's participation
Collaborated with 696 local communities to conserve and restore mangrove.


Conservation and Protection Laws in Thailand
6 Act.
- Forestry Act B.E. 1941
- National Parks Act B.E. 1961 and update 2019
- National Reserved Forests Act B.E. 1964
- Wildlife Conservation and Protection Act B.E. 1992 and update 2019
- Marine and Coastal Resources Management Promotion Act B.E. 2015
- Community Forest Act 2019
11
Report intrusion point
at any time on the website.
12
People's participation
"The key of success in mangrove conservation"
Thank you
Phang nga Bay, Ramsar site

16- Venezuela

1



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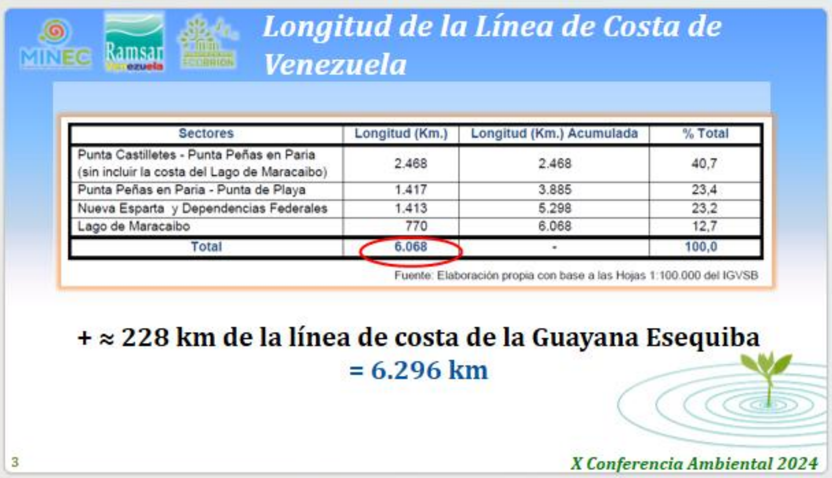
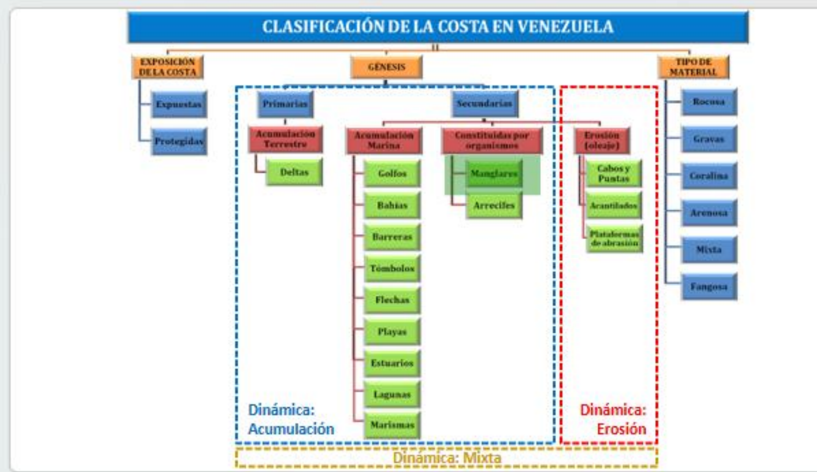


Sectores	Longitud (Km.)	Longitud (Km.) Acumulada	% Total
Punta Castilletes - Punta Peñas en Paria (sin incluir la costa del Lago de Maracaibo)	2.468	2.468	40,7
Punta Peñas en Paria - Punta de Playa	1.417	3.885	23,4
Nueva Esparta y Dependencias Federales	1.413	5.298	23,2
Lago de Maracaibo	770	6.068	12,7
Total	6.068	-	100,0

Fuente: Elaboración propia con base a las Hojas 1:100.000 del IGVSB




MINEC
Ramsar Venezuela
Los Humedales
Los humedales son zonas donde el agua es el principal factor controlador del medio y la vida vegetal y animal asociada a él. Los humedales se dan donde la capa freática se halla en la superficie terrestre o cerca de ella o donde la tierra está cubierta por aguas poco profundas
Según RAMSAR los humedales son "extensiones de marismas, pantanos, turberas o aguas de régimen natural o artificial, permanentes o temporales, estancadas o corrientes, dulces, salobres o saladas las extensiones de agua marina cuya profundidad en marea baja no exceda los seis (6) metros"
Grupo de Humedales de Venezuela (2011):
Ecosistemas que se encuentran entre los sistemas acuáticos y terrestres, naturales o construidos, que soportan una biota adaptada a condiciones de suelos saturados o inundados por aguas superficiales o subsuperficiales de forma permanente o estacional, y que son estratégicos por los beneficios sociales que se derivan de su conservación.
Son sistemas que de manera permanente o temporal están cubiertos de agua, de allí que los suelos se saturan y en consecuencia presentan déficits de oxígeno, lo que les da características únicas, distintos a un ambiente terrestre o acuático.
5
X Conferencia Ambiental 2024

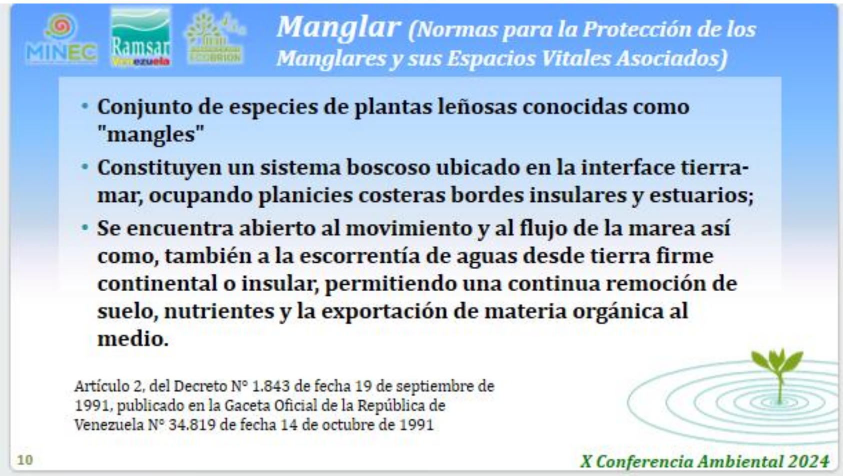
5

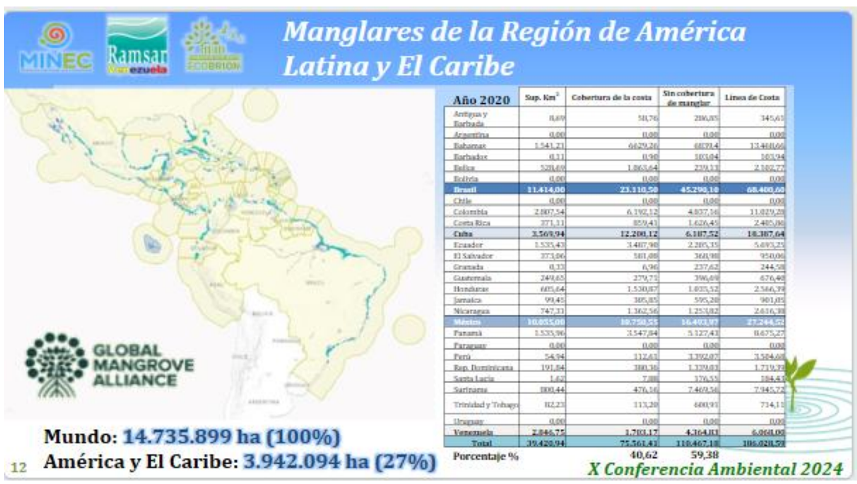

MINEC
Ramsar Venezuela
Tipos de Humedales empleados en Venezuela
En general, se reconocen cinco tipos de humedales principales:
1. Marinos (humedales costeros, inclusive lagunas costeras, costas rocosas y arrecifes de coral)
2. Estuarinos (incluidos deltas, marismas de marea y manglares)
3. Lacustres (humedales asociados con lagos)
4. Ribereños (humedales adyacentes a ríos y arroyos)
5. Palustres (es decir, "pantanosos" - marismas, pantanos y ciénagas)
6. + Artificiales (como estanques de cría de peces y camarones, embalses, canales de riego, entre otros
6
X Conferencia Ambiental 2024

6


MINEC
Ramsar Venezuela
157 Humedales de Venezuela Inventariados
Marinos o Costeros
N° 85 (54%)
Superficie:
21.198,49
(52%)
Humedales de Venezuela
Artificial (20)
Estuarino (10)
Estuarino, Ribereño (1)
Lacustre (5)
Lacustre, Artificial (1)
Lacustre, Palustre (3)
Marino (44)
Marino, Estuarino (19)
Marino, Estuarino, Palustre (11)
Palustre (29)
Palustre, Artificial (1)
Ribereño (2)
Ribereño, Palustre (11)
5 Sitios Ramsar
Fuente: Rodríguez, R. (1999). Conservación de Humedales en Venezuela: Inventario, diagnóstico ambiental y estrategia. Comité Venezolano de la Unión Mundial para la Naturaleza. Caracas, Venezuela
MAR CARIBE
COLOMBIA
BRASIL
7
X Conferencia Ambiental 2024


MINEC
Ramsar Venezuela
5 Sitios Ramsar: Humedales de Importancia Internacional
RFS y Reserva de Pesca Ciénega Los Olivitos, Zulia
RFS Cuare, Falcón
PN Laguna de La Restinga, Nueva Esparta
PN Laguna de Tacarigua, Miranda
PN Archipiélago Los Roques, Dependencias Federales
5 Sitios Ramsar
2 Reservas de Fauna Silvestre (RFS)
3 Parques Nacionales (PN)
Superficie Total 313.139 hectáreas
5 Planes de Ordenamiento y Reglamento de Uso (PORU) Vigentes que incluyen lineamientos para atención de los manglares y sus espacios vitales asociados
8
X Conferencia Ambiental 2024





Año 2020	Sup. Km²	Cobertura de la costa	Sin cobertura de manglar	Linea de Costa
Antigua y Barbuda	8,69	58,76	286,85	345,61
Argentina	0,00	0,00	0,00	0,00
Bahamas	1.541,21	6629,26	6839,4	13.468,66
Barbados	0,11	0,90	103,04	103,94
Belice	528,69	1.863,64	239,13	2.102,77
Bolivia	0,00	0,00	0,00	0,00
Brasil	**11.414,00**	**23.110,50**	**45.290,10**	**68.400,60**
Chile	0,00	0,00	0,00	0,00
Colombia	2.807,54	6.192,12	4.837,16	11.029,28
Costa Rica	371,11	859,41	1.626,45	2.485,86
Cuba	**3.569,94**	**12.200,12**	**6.187,52**	**18.387,64**
Ecuador	1.535,43	3.487,90	2.205,35	5.693,25
El Salvador	373,06	581,08	368,98	950,06
Granada	0,33	6,96	237,62	244,58
Guatemala	249,65	279,71	396,69	676,40
Honduras	605,64	1.530,87	1.035,52	2.566,39
Jamaica	99,45	305,85	595,20	901,05
Nicaragua	747,31	1.362,56	1.253,82	2.616,38
México	**10.055,00**	**10.750,55**	**16.493,97**	**27.244,52**
Panamá	1.535,96	3.547,84	5.127,43	8.675,27
Paraguay	0,00	0,00	0,00	0,00
Perú	54,94	112,61	3.392,07	3.504,68
Rep. Dominicana	191,84	380,36	1.339,03	1.719,39
Santa Lucía	1,62	7,88	376,55	384,43
Surinama	800,44	476,16	7.469,56	7.945,72
Trinidad y Tobago	82,23	113,20	600,91	714,11
Uruguay	0,00	0,00	0,00	0,00
Venezuela	**2.846,75**	**1.703,17**	**4.364,83**	**6.068,00**
Total	**39.420,94**	**75.561,43**	**110.467,18**	**186.028,59**
Porcentaje %		40,62	59,38	

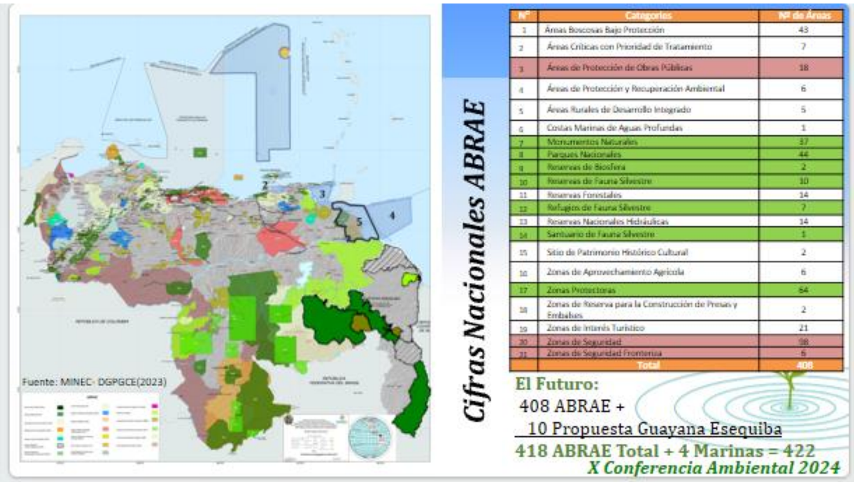

MINEC
Ramsar
Venezuela
Manglares en Venezuela
GLOBAL MANGROVE ALLIANCE
MAR CARIBE
TRINIDAD Y TOBAGO
OCÉANO ATLÁNTICO
Mundo: 14.735.899 ha (100%)
América y El Caribe: 3.942.094 ha (27%)
Venezuela: 284.675 ha (2% mundo y 7% AEC)
13
X Conferencia Ambiental 2024


MINEC
Ramsar
Venezuela
Manglares y Espacios
Protegidos en el Mundo
y en Venezuela
14
X Conferencia Ambiental 2024


Conservación de los Servicios Funcionales y Ecosistémicos y los Espacios Culturales
Parque nacional laguna de Tacarigua
Estado Miranda, Venezuela
Áreas Bajo Régimen de Administración Especial (ABRAE)
ABRAE: Áreas del territorio que se encuentran sometidas a un régimen especial de manejo conforme a leyes especiales (Artículo. 15 LOPOT, 1983)
Gondelles (1992) las define como: "...espacios geográficos, sitios y elementos del medio con características biofísicas singulares o con otras cualidades y potencialidades en lo socio - cultural, las cuales ameritan recibir del Estado una protección efectiva y permanente bajo un régimen de administración sui géneris que garantice la integridad física sin merma de sus valores, mediante una utilización acorde con esos objetivos y una protección y manejo adecuados a dichas características. Estas áreas se consideran singulares por el hecho de no ser comunes, y porque sus cualidades son de particular interés para la ciencia y para la sociedad en general".


MINEC
Ramsar Venezuela
ECOSIEN
Aspectos Relevantes de la Política de Ordenación del Territorio para las ABRAE y su Vinculación con los Humedales
▪ Conservación de los servicios funcionales y ecosistémicos
▪ Representatividad ecológica
▪ Uso del criterio de corredores biológicos
▪ Protección de cuencas hidrográficas
▪ Conservación de tierras agrícolas
▪ Conservación de bosques productores de maderas
▪ Conservación de fauna
▪ Resguardo de instalaciones estratégicas de la Nación
▪ Participación del Poder Popular
17
X Conferencia Ambiental 2024

17


Fuente: MINEC- DGPGCE(2023)
Cifras Nacionales ABRAE

Nº	Categorías	Nº de Áreas
1	Áreas Boscosas Bajo Protección	43
2	Áreas Críticas con Prioridad de Tratamiento	7
3	Áreas de Protección de Obras Públicas	18
4	Áreas de Protección y Recuperación Ambiental	6
5	Áreas Rurales de Desarrollo Integrado	5
6	Costas Marinas de Aguas Profundas	1
7	Monumentos Naturales	37
8	Parques Nacionales	44
9	Reservas de Biosfera	2
10	Reservas de Fauna Silvestre	10
11	Reservas Forestales	14
12	Refugios de Fauna Silvestre	7
13	Reservas Nacionales Hidráulicas	14
14	Santuario de Fauna Silvestre	1
15	Sitio de Patrimonio Histórico Cultural	2
16	Zonas de Aprovechamiento Agrícola	6
17	Zonas Protectoras	64
18	Zonas de Reserva para la Construcción de Presas y Embalses	2
19	Zonas de Interés Turístico	21
20	Zonas de Seguridad	98
21	Zonas de Seguridad Fronteriza	6
	Total	408

El Futuro:
408 ABRAE +
10 Propuesta Guayana Esequiba
418 ABRAE Total + 4 Marinas = 422
X Conferencia Ambiental 2024

18


Cifras Nacionales ABRAE

Nº	Categorías	Nº Total de Áreas
1	Áreas Boscosas Bajo Protección	43
2	Áreas Críticas con Prioridad de Tratamiento	7
3	Áreas de Protección de Obras Públicas	18
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16	Zonas de Aprovechamiento Agrícola	6
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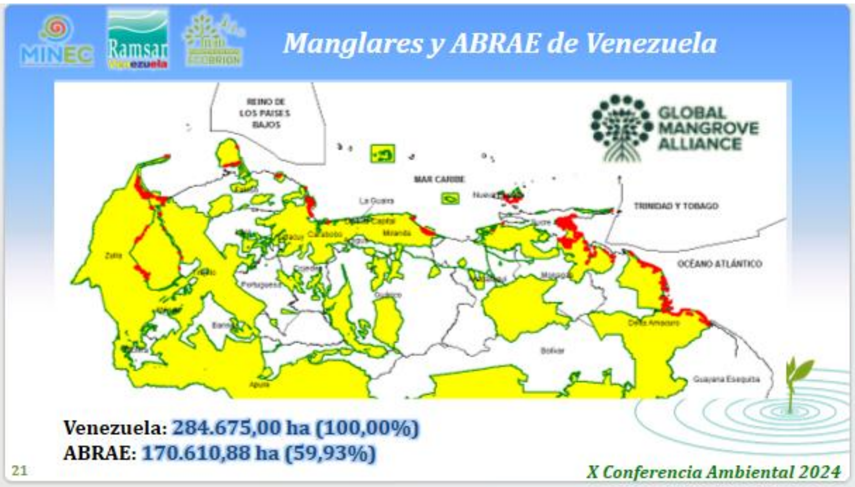
18	Zonas de Reserva para la Construcción de Presas y Embalses	2
19	Zonas de Interés Turístico	21
20	Zonas de Seguridad	98
21	Zonas de Seguridad Fronteriza	6
21	Total	408

El Futuro
408 ABRAE +
10 Propuesta
Guayana
Esequiba = 418
Fuente: MINEC- DGPGCE (2023)

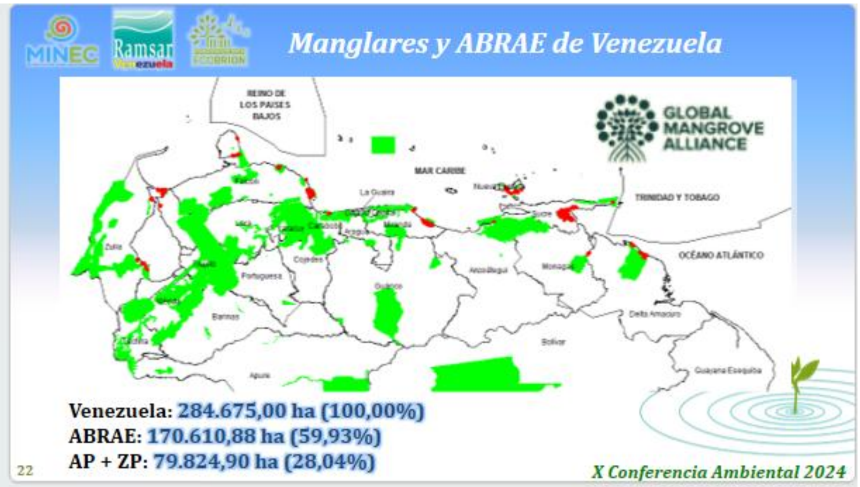
Ámbito	Superficie de Venezuela (ha)**	Superficie de Zona Costera (ha)	Nº ABRAE Total Venezuela	Superficie ABRAE Total (ha) Venezuela*	% Superficie de Venezuela
Espacio Terrestre	91.644.500,00	5.850.700,00	408	61.876.796,66	67,52
Espacio Acuático Marino	50.000.000,00	8.508.000,00		2.118.204,09	4,24
Total	141.644.500,00	14.358.700,00	408	63.995.000,75	71,76

X Conferencia Ambiental 2024

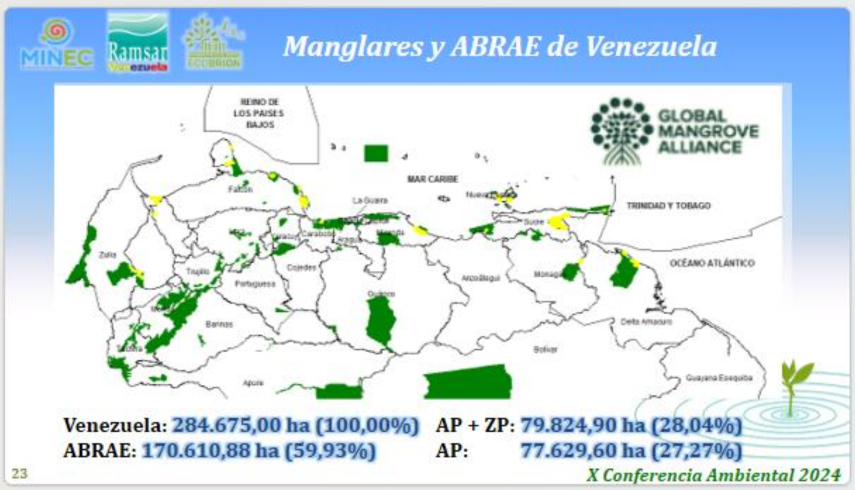

MINEC
Ramsar Venezuela
ECOSIEN
Inventario de ABRAE en las Zonas Costeras
MAR CARIBE
99 ABRAE
19 Categorías específicas
24% Total ABRAE Nacional
10,3 Sup. Total ABRAE
51 ABRAE con ecosistemas marino - costeros
12% Total ABRAE Nacional
4% Espacio Acuático
20
X Conferencia Ambiental 2024

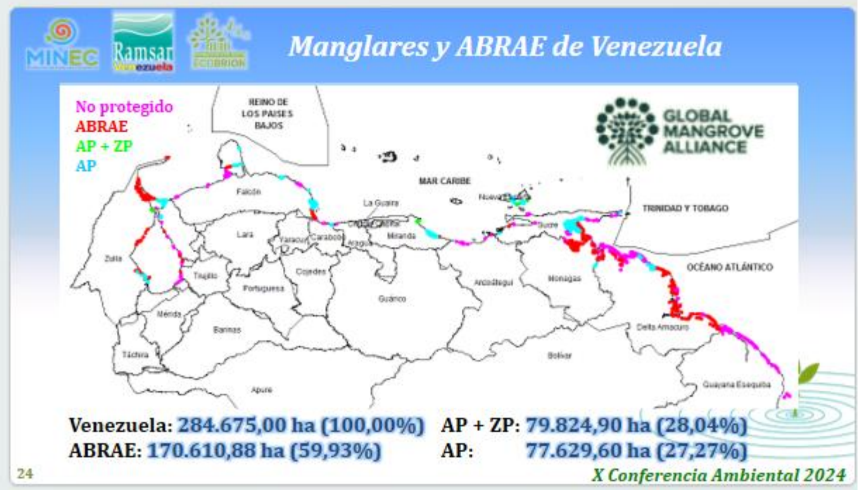

Manglares y ABRAE de Venezuela
GLOBAL MANGROVE ALLIANCE
Venezuela: 284.675,00 ha (100,00%)
ABRAE: 170.610,88 ha (59,93%)
21
X Conferencia Ambiental 2024

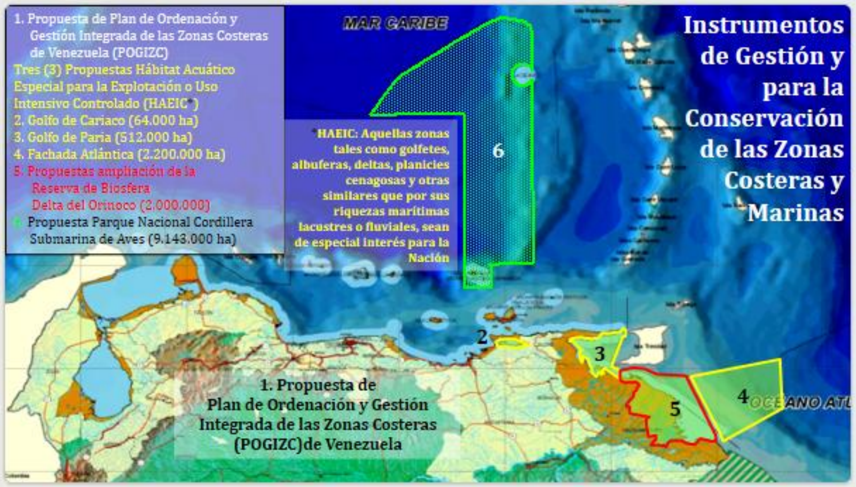
21


Manglares y ABRAE de Venezuela
GLOBAL MANGROVE ALLIANCE
Venezuela: 284.675,00 ha (100,00%)
ABRAE: 170.610,88 ha (59,93%)
AP + ZP: 79.824,90 ha (28,04%)
22
X Conferencia Ambiental 2024

22


Manglares y ABRAE de Venezuela
GLOBAL MANGROVE ALLIANCE
Venezuela: 284.675,00 ha (100,00%)
ABRAE: 170.610,88 ha (59,93%)
AP + ZP: 79.824,90 ha (28,04%)
AP: 77.629,60 ha (27,27%)
23
X Conferencia Ambiental 2024

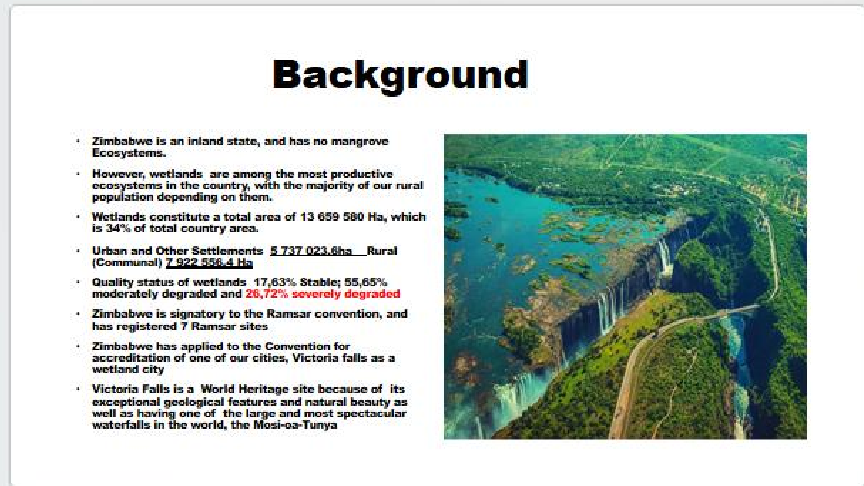

Manglares y ABRAE de Venezuela
No protegido
ABRAE
AP + ZP
AP
GLOBAL MANGROVE ALLIANCE
Venezuela: 284.675,00 ha (100,00%)
ABRAE: 170.610,88 ha (59,93%)
AP + ZP: 79.824,90 ha (28,04%)
AP: 77.629,60 ha (27,27%)
24
X Conferencia Ambiental 2024


1. Propuesta de Plan de Ordenación y Gestión Integrada de las Zonas Costeras de Venezuela (POGIZC)
Tres (3) Propuestas Hábitat Acuático Especial para la Explotación o Uso Intensivo Controlado (HAEIC*)
2. Golfo de Cariaco (64.000 ha)
3. Golfo de Paria (512.000 ha)
4. Fachada Atlántica (2.200.000 ha)
5. Propuestas ampliación de la Reserva de Biosfera Delta del Orinoco (2.000.000)
Propuesta Parque Nacional Cordillera Submarina de Aves (9.143.000 ha)
MAR CARIBE
*HAEIC: Aquellas zonas tales como golfetes, albuferas, deltas, planicies cenagosas y otras similares que por sus riquezas marítimas lacustres o fluviales, sean de especial interés para la Nación
6
Instrumentos de Gestión y para la Conservación de las Zonas Costeras y Marinas
2
3
4
5
OCEANO ATL
1. Propuesta de Plan de Ordenación y Gestión Integrada de las Zonas Costeras (POGIZC)de Venezuela


MINEC
Ramsar
X Conferencia Ambiental 2024
"Aprovechamiento sustentable de la diversidad biológica en el ecosistema manglar"
Manglares y Espacios Protegidos de Venezuela
Gracias...

17- Zimbabwe


Wetlands Management in Zimbabwe
Presentation at the Workshop on Mangrove Conservation and Restoration-Shenzhen China 2024
milton.muusha@ema.co.zw
1


Background
Zimbabwe is an inland state, and has no mangrove Ecosystems.
However, wetlands are among the most productive ecosystems in the country, with the majority of our rural population depending on them.
Wetlands constitute a total area of 13 659 580 Ha, which is 34% of total country area.
Urban and Other Settlements 5 737 023,6ha Rural (Communal) 7 922 556,4 Ha
Quality status of wetlands 17,63% Stable; 55,65% moderately degraded and 26,72% severely degraded
Zimbabwe is signatory to the Ramsar convention, and has registered 7 Ramsar sites
Zimbabwe has applied to the Convention for accreditation of one of our cities, Victoria falls as a wetland city
Victoria Falls is a World Heritage site because of its exceptional geological features and natural beauty as well as having one of the large and most spectacular waterfalls in the world, the Mosi-oa-Tunya
2


Zimbabwe Ramsar Sites (7)
Zimbabwe Ramsar Sites
Legend
Driefontein Grasslands


Migratory Birds
Driefontein Grasslands is home to about 85% of the total national population of the globally vulnerable wattled crane Bugeranus carunculatus and the endangered grey crowned crane Balearica regulorum.
Grey crowned cranes (Balearica regulorum) and wattled cranes (Bugeranus carunculatus) are both 'specially protected' species under Zimbabwe's Parks and Wildlife Act
The Driefontein Grasslands are among the key remaining habitats for the cranes.
Crane Birds

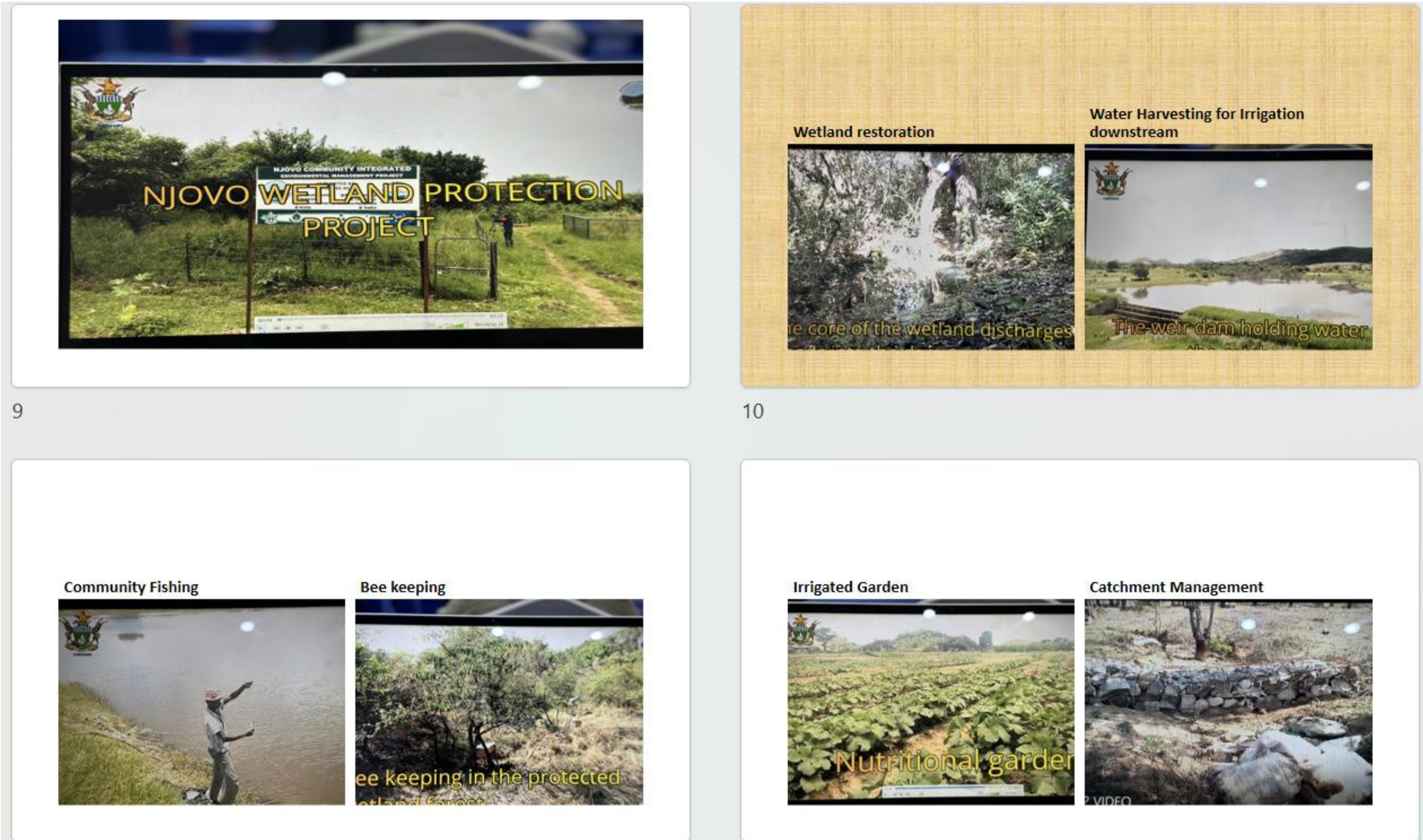

THREATS TO WETLANDS
• Settlement encroachment
• Agricultural encroachment (Cropping and Livestock grazing)
• Invasive alien species invasion
• Brick moulding
• deforestation

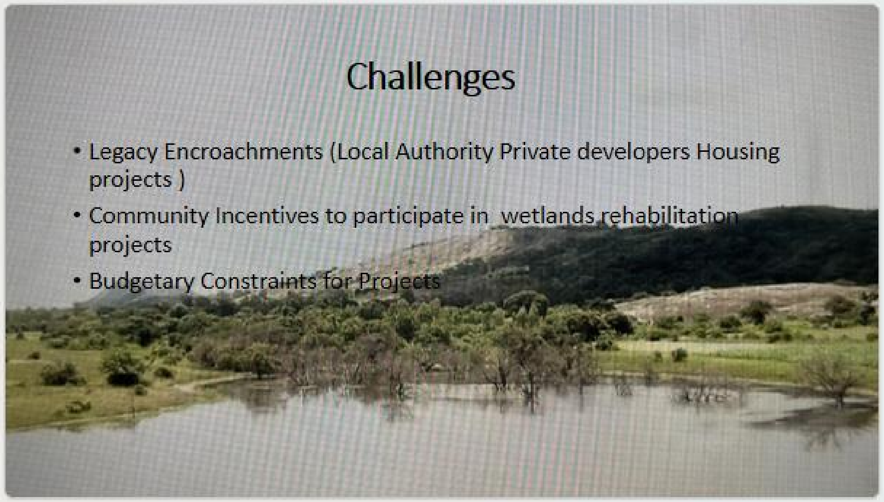
5

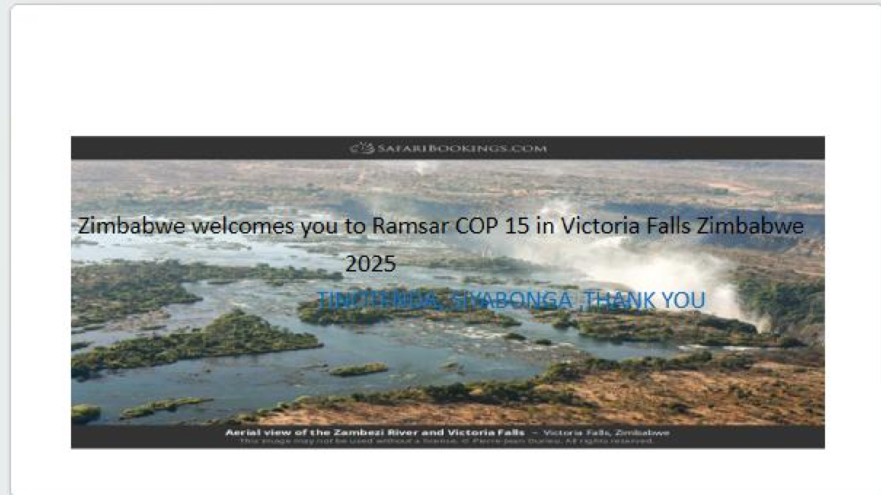
6


ZIMBABWE'S NATIONAL DEVELOPMENT STRATEGY 1(2021-2025)
REDUCE AREA OF DEGRADED WETLANDS BY 30%
TARGET 1 051 650HA
• Demarcate and map all wetland areas in the country(National Wetlands Masterplan) (2021)
• Gazette wetlands as reserved areas (All wetland areas in 11 Major towns by 2025)
• Develop National Wetland Management Guidelines and National Wetland Rehabilitation Guidelines for the country (2021)
• Development of Local authorities Masterplans(2024- To leave out all Ecologically sensitive areas) and Integrated Landuse Plans for all River Catchment areas


NDS 1 and Wetlands
• LAW ENFORCEMENT
-National Legislation
-Local Authority By-Laws
-Traditional Leaders By-Laws
• SUPPORT COMMUNITY SUSTAINABLE WETLAND MANAGEMENT PROJECTS(FISCUS and Development Partners)
• SUPPORT TRADITIONAL WETLANDS MANAGEMENT PRACTICES
• AWARENESS CAMPAIGNS


NJOVO COMMUNITY INTEGRATED
ENVIRONMENTAL MANAGEMENT PROJECT
NJOVO WETLAND PROTECTION PROJECT
9
Wetland restoration
e core of the wetland discharges
Water Harvesting for Irrigation downstream
The weir dam holding water
10
Community Fishing
Bee keeping
ee keeping in the protected
Irrigated Garden
Nutritional garde
Catchment Management


Challenges
• Legacy Encroachments (Local Authority Private developers Housing projects)
• Community Incentives to participate in wetlands rehabilitation projects
• Budgetary Constraints for Projects


SAFARIBOOKINGS.COM
Zimbabwe welcomes you to Ramsar COP 15 in Victoria Falls Zimbabwe 2025
SIYABONGA ,THANK YOU
Aerial view of the Zambezi River and Victoria Falls – Victoria Falls, Zimbabwe