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Universität Bremen

Vegetation diversity and soil carbon storage in a tropical mangrove forest, Sarawak, South China Sea

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Abstract:

Mangroves are defined as trees and shrubs those grow in the intertidal zones. Among different services, carbon sequestration in soil is one of the essential services provided by the mangroves. This study was conducted to assess the vegetation diversity and soil carbon storage in pure mangrove (3 plots) and mangrove associates area (3 plots) in a tropical mangrove forest, Sarawak, South China Sea. A total of 25 species of plants (16 associates and 9 true mangroves) were indentified from both the areas of this forest. Cation exchange capacity was found to be 0.83 and 0.78 Cmol/kg for mangrove associate and true mangrove area, respectively. Mangrove associates area stored more soil carbon (8,046-14,979 Mg C/ha) than true mangrove area (7,900-9,905 Mg C/ha) in this forest floor within <1 m depth. Soil carbon was not significantly different in different depths of the mangrove and mangrove associates area during the study period. The soil carbon was higher compared to the soil of other mangrove forest of the world suggesting the influences of the variation of plant density/species, location and postioning of the forest and other embient environmental factors of the forest ecosystem itself.

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Biogeochemical properties of tidal borne sediments in a tropical mangrove ecosystem of Malaysia

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Abstract:

Mangroves are frequently inundated by tidal action carrying enormous amount of suspended and dissolved particles. Sediments transported by tidal waters are being trapped by mangrove roots and playing productive roles in the coastal mangrove ecosystems but less studied in the tropical mangroves. This study examined the biogeochemical properties of tidal borne sediments of an undisturbed mangrove area of Sarawak, Malaysia. Sediments were found to be rich in cation exchange capacity (17.05 ± 1.28 cmol/kg sediments), organic matter (15.39 ± 1.68%), organic carbon (13.17 ± 2.98%), nutrients (carbon 14.52 ± 3.29%, nitrogen 11.61 ± 2.24 mg/g, sulphur 9.58 ± 0.79 mg/g, phosphorous 1.76 ± 0.35 mg/g, potassium 3.45 ± 0.19 mg/g, calcium 34.31 ± 3.47 mg/g, magnesium 18.48 ± 2.49 mg/g, sodium 16.21 ± 1.08 mg/g). Significant relationship ($p<0.05$) of sediment nutrients with nutrient concentrations of leaf, stipule, flower, propagule, stem, bark, root of Rhizophora apiculata and Xylocapus granatum trees and their saplings, seedlings are the clear indication of nutritive roles of sediments in growth, health, and productivity of this ecosystem. Results provide useful information on productive roles of this undisturbed mangrove forest. Long-term research including various influencing parameters would help develop a model of sedimentation process of this tropical region.

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Comparison of physico-chemical features of the Rupsha-Pashur river system of the Sundarbans habitat: a time bound case study

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Abstract:

The Sundarbans is the largest mangrove wetland in the world. It covers an area of about 1mha, of which 60% is located in Bangladesh and the remaining western portion, comprising 40%, lies in India. This study was conducted to compare some physico-chemical parameters (BOD, DO, TDS, EC, hardness, alkalinity, temperature, and content of Na+, Mg2+, K+, Ca2+, Cl-, SO42-, and HCO3-) of water and soil of the Rupsha-Pashur river in the Sundarbans, the world's largest mangrove forest with secondary data. The study was conducted over six sampling points: Mongla port, Karamjol point, and Karamjol canal, Joymony and Harbaria point, Harbaria canal of the Rupsha-Pashur river during July to December (2016) and January to February (2017). Result indicated that the concentration of water EC, HCO3-,Cl-, SO42- K+,Ca2+, and Mg2+ had increased since 2011, while PO43-,Na+, TDS and SiO2 had decreased. The highest concentration of HCO3-, Cl-, SO42-, K+, Ca2+, Mg2+ was observed during December to February; nonetheless, the lowest value was obtained in July to September month. Moreover, in July to October, almost all sampling points exhibit low soil value of EC, CEC, OC, Na+, K+, Cl- and high value of OM, HCO3-, Ca2+ and Mg2+. The alkalinity and hardness of river water was higher in winter and summer than during the rainy season. Sea water intrusion and industrial discharge may contribute the high concentration of Cl-, TDS, SO42-, HCO3-, Ca2+, Mg2+, Na+ and K+. Throughout the year, for all sampling locations, the measured average temperature, pH, EC, salinity of Pashur river water were well matched with studies performed in this area and other regions. The results suggest that the water quality and sediment quality of Rupsha-Pashur river system is influenced by the monthly variations, tidal forces and local environment. The results of this research could significantly improve the quality of holistic ecological research of this unique Sundarbans ecosystem.

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Natural gap creation and regeneration dynamics of tropical and subtropical mangroves

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Abstract:

Canopy gaps in mangrove forests vary in size but are distinctly characterised by their unique circular openings. In the Avicennia marina mangroves of Moreton Bay, Australia, gap size (n=52) ranged from 27.12m^2 to 473.85m^2 with an average (±SD) of 133.66±102.51m^2. While in Matang mangroves in Malaysia, covered predominantly by the Rhizophoras (n=14), gap size ranged from 390m^2 to 5112m^2, with the average (±SD) of 1783±1379m^2. Canopy openings created a means for natural regeneration whereby dormant seedlings growing underneath the canopies have had the opportunity to progress and ultimately replacing the dead trees. This was proven from the analyses on gap dynamics using a series of historical aerial photographs. The estimated canopy turnover for a hectare of mangrove forest in Moreton Bay was 316.9±115.67 years, while in Pulau Kecil in Matang, it was estimated at 25.5±6.9 years. In conclusion, the findings of this study on canopy turnover through the dynamics of gap creation and closure support the hypothesis that disturbance prevents mangrove forest from reaching more senescent stage. In other words, the creation of canopy gaps is determined to be an important form of disturbance that drives the natural rejuvenation in mangroves and maintain the 'forever young' condition of the forests.

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Searching for carbon neutrality for charcoal and pole production in Matang Mangrove Forest Reserve, Malaysia

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Abstract:

Well known as the most carbon-rich forests in the world, the socio-economic values of mangroves have been well documented. Local communities living within and adjacent to mangrove areas derive their livelihood from fisheries and the extraction of timber products among other mangrove ecosystem goods and services.

Located on the northwest coast of Peninsular Malaysia (04°45' N,100°35' E) the Matang Mangrove Forest Reserve (MMFR) covers approximately 40288 ha.

Under a silviculture management since 1902 the forest area is 85% covered by *Rhizophora apiculata* mangrove species, known for its use in commercial timber and fuelwood. Following rotation cycles, more than 30,000 ha are exploited for charcoal (30 years old) and pole production (20 years) and used in its national and international trade.

In order to estimate carbon sequestration, an extensive literature review from previous studies regarding mangrove biomass in MMFR was done, whereas carbon emissions were calculated from the known silvicultural activity chain.

With this project we aim at enhancing the understanding of the carbon sequestration potential of mangrove forest silviculture in the world's longest managed mangrove forest and at providing for the first time information about the carbon emissions coming from the exploitation activities in order to evaluate if MMFR is carbon neutral.

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Importance of rhizosphere conservation in mangroves of Indian Sundarbans

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Abstract:

Indian Sundarbans is the abode of diverse mangrove species. This magnificent mangrove habitat is highly threatened mainly due to anthropogenic activities and changed natural factors like salinity, pH, nutrient contents etc. The mangrove forest soil is rapidly undergoing degradation. Under this context the conservation of mangrove rhizospheric zone which is considered to harbor a number of plant growth promoting and nutrient cycling microbes is important as significantly as the above ground mangrove biomass. The plant growth promoting effect of the rhizospheric bacteria becomes more essential when the growth environment of the host plant is unfavorable like degraded microniche. The present research highlights detailed analysis of cultivable bacterial populations harboring the rhizosphere of different mangrove species under both degraded and pristine habitat from Indian Sundarbans and demonstrates the disappearnce of important plant growth promoting bacteria from the degraded niche. The study includes isolation of cellulose degraders, free living nitrogen fixers, phosphorus solubilizers, sulfur oxidizers, ammonifying and nitrifying bacteria, ammonia oxidizers, aerobic de-nitrifiers and sulphate reducers from the soil depth of 0-30 cm by serial dilution with subsequent culture in specific media based on the biochemical reactions involved and evaluation of plant growth promotion activity by these microbes on mangrove community.

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Assessment of carrying capacity for promoting ecotourism in the Sundarbans ecosystem, Bangladesh

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Abstract:

Tourism activities in the Sundarbans are growing rapidly, especially since the Sundarbans was certified as a UNESCO World Heritage Centre in 1997. Among the tourist areas of the Sundabans, Karamjal, Harberia, Kochikhali, Kotka, Dubla, Kolagachia and Nilkamal are the major sites that attract the largest numbers of visitors. Rapid but unplanned tourism activities have created various social and environmental concerns. If appropriate planning measures are not derived from the consideration of the carrying capacities of these sites, tourism centers will be overloaded, tourism quality will be degraded, and therefore the benefit obtained from tourism activities will be reduced. This research follows the methodology of Ceballos-Lascurain (1996) and Cifuentes (1999) in estimating the carrying capacity of 7 different sites in the Sundarbans. The carrying capacities of above mentioned 7 tourism sites are quantitatively evaluated as physical carrying capacity (PCC) real carrying capacity (RCC) and effective carrying capacity (ECC). Where PCC>RCC>ECC, maximum PCC was found in Karamjal (9450 visitors/day) and minimum was in Dubla (2400 visitors/day).In terms of RCC and ECC, Karamjal shows the highest (1908 visitors/day and 1146 visitors/day, respectively), and Nilkamal (Hironpoint KeoraShuti) shows the lowest (146 visitors/day and 86 visitors/day, respectively). The management option could be a sectoral integration of all relevant sectors for promotion of ecotourism. Regarding this, the result of this research could be used as a preliminary benchmark for planning and future ecological research in the Sundarbans ecosystem.

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Galls on *Rhizophora mangle*: relationship with environmental variables and effects on vegetation

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Abstract:

Estuaries of the gulf of Urabá at the Colombian Caribbean, are mainly cover by extensive mangrove forests and encloses about 4000 ha. However, most trees of the ecosystem show galls on stems and aerial roots of Rhizophora mangle. Although galls phenomenon has occurred in different zones of the world, the role of the environmental conditions on the incidence of the illness, the effect of galls in the vegetation structure and thus in the ecological equilibrium, are unknown. In order to clarify this lack of knowledge, in both forests with presence and lack of galls, structure and dynamic of the vegetation and environmental variables, were measured. Significant differences were found in the environmental conditions. Mangroves at the Atrato river delta, highly infected, were characterized by low salinity, high alluvial sedimentation rate, high soil organic matter percentages and concentrations of Cu, Mn and As concentration. Instead, mangroves at the Rionegro bay, that lack the infection, were characterized by higher concentrations of Ca and Mg, and higher pore-water salinity. Besides, variables as organic carbon, organic matter; Cu and Fe had quadratic correlation with the galls. Furthermore, growth and mortality of seedlings and trees do not increase with the presence of galls, we did not find significant differences between places with and without galls, what support the idea of high defense mechanism of R. mangle against pathogens.

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Users' perceptions on mangrove services and protected area in the Amazon

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Abstract:

To produce efficient engagement projects for mangrove conservation, it is crucial to understand how locals perceive and value mangroves and the services provided. Therefore, our study aims to assess local users' perceptions of mangrove ecosystem services in two community-based protected areas on the Amazonian coast. Local residents were interviewed about mangrove services and protected area management. A mix-methods approach was used, including a qualitative investigation and a discourse analysis. Regarding goods and services, crab, fish and other food sources were the most mentioned benefits. Most interviewees associated the protected area's function to the delivery of financial and material credits, which were donated to users in the first years of implementation. To assess spatial perception, interviewees were asked where the protected area is. Some of them do not know where it is, and most informants, especially randomly-selected ones, referred to a specific address: the headquarters of the mother association. These perceptions indicate a mental model of the protected area as a poverty alleviation program, where geographical borders are poorly known, and the conceptual connection of the protected area to nature conservation is only incipient. The ignored spatial aspects and poor link to conservation impair a participatory and adaptive spatial planning of the protected area.

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Spatial interconnectedness of ecosystem service supply and demand in adjacent mangrove sustainable-use protected areas

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Abstract:

The northern Brazilian coast hosts the largest continuous protected mangrove strip on the planet, which includes 3,220 km^2 distributed along a network of 17 protected areas under the 'extractive reserves' model. By exploring perceptions of local stakeholders in regards to supply and demand of ecosystem services in two of these areas, our study exemplifies how local knowledge may be systematically applied to integrated, ecosystem-based management, and zoning strategies at a local scale. The results show the perceived extend of spatial interconnectedness between two of these extractive reserves, in regards to fisheries-related ecosystem services. We conclude that for further sustainable use of these two protected areas their interconnectedness needs to be further assessed and considered for the design of conservation and management measures.

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Calculating costs and benefits of Mangrove Forest Landscape Restoration (MFLR) in Indonesia

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Abstract:

This paper presents the results of a cost-benefit analysis, which was prepared subsequent to the development of mangrove forest landscape restoration (MFLR) opportunity maps by multi-stakeholder groups in two critically degraded Indonesian landscapes; Demak Central Java and Tanjung Panang, Gorontalo. Costs were determined by considering the implementation and transaction costs of restoration, as well as opportunity costs to fish farmers and pond owners. Benefit was determined by calculating the ecosystem value of two reference landscapes including direct and indirect values.

There were striking differences in terms of opportunity costs to fish farmers in the two landscapes. Farmers in Tanjung Panjang, profit more per hectare, and manage much larger areas than their counterparts from Demak, resulting in high opportunity cost. The actual cost of mangrove restoration in Demak was significantly higher than Tanjung Panjang, due to the need for expensive measures to overcome erosion and subsidence in that landscape.

Although costs of restoration may be high, they are still outstripped by the benefits of mangroves in both landscapes over short (10 year) and medium term (20 year) horizons, however this does not consider the socioeconomic and cultural value placed on individual ownership of coastal resources versus the perceived value of a “commons” resource.

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Mangrove forest landscape restoration (MFLR) and restoration opportunity mapping in Indonesia

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Abstract:

Global performance of mangrove rehabilitation has been brought into question over past decades, due to numerous failed mono-generic planting attempts in unsuitable habitats; often selected due to poor understanding of the biophysical requirements of establishing mangroves coupled with a lack of stakeholder support to address change in land use and tenure in degraded and converted mangrove areas.

Significant examples of successful mangrove rehabilitation do exist across many regions and at various scales and can be categorized by four major technical approaches. In cases where mangrove forest landscape restoration was achieved, supporting social, economic and policy conditions were met.

Demand for research on successful mangrove restoration by the Government of Indonesia (GOI) has led to the application of the Restoration Opportunities Assessment Method (ROAM, developed by IUCN and the World Resources Institute) to evaluate Mangrove Forest Landscape Restoration (MFLR) opportunity in two critically degraded mangrove-aquaculture agroecosystems in Indonesia.

Opportunity mapping with multiple stakeholder groups in these two landscapes, informed by new social and ecological field research revealed minimum immediate restoration opportunity in Demak, Central Java, and moderate to large-scale restoration opportunities in Gorontalo, Sulawesi.

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Novel mangrove ecosystems and their services in Kane'ohe Bay, Hawai'i

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Abstract:

Rhizophora mangle was introduced to Hawai'i in 1907 and subsequently resulted in a novel ecosystem along some of Hawai'i's low energy coastlines. Hawai'i's mangrove forests are divided into two main classes, stream mouth mangrove forests (SMMF) and coastal mangrove forests (CMF). In 2014, we sampled three of Kāne'ohe Bay's eight SMMF. We used ArcGIS, satellite imagery and the Landscape Development Intensity index (LDI) to characterize *R. mangle* cover and watershed land use. Mangrove canopy cover ranged from 13% to 97%. Watershed LDIs ranged from 0.97 E15 sej ha^{-1} yr^{-1} in the least developed watershed to 20.8 E15 sej ha^{-1} yr^{-1} in the most developed watershed. *R. mangle* canopy cover was negatively correlated with LDI. SMMF were occupied by native marine and estuarine fish and benthic macroinvertebrate species, although non-native species were also present. SMMF had lower dissolved oxygen saturation, higher temperature, and greater sediment percent organic matter, with greater mangrove canopy cover. In June 2017, we will sample 3 paired SMMF and CMF within Kāne`ohe Bay to assess the influence of watershed land use, non-native *R. mangle canopy* cover and mangrove forest class on ecosystem services. We will present the preliminary results of the 2017 study.

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Mangrove vegetation dynamics of the Tanbi Wetland National Park, Gambia

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Abstract:

Changes in mangrove vegetation have been identified as important indicators of environmental deterioration. The mangroves of the Tanbi Wetland National Park (TWNP) connect the Atlantic coast with the estuary of the River Gambia and as such, play an invaluable role in the agriculture, tourism and fisheries sectors of The Gambia. Our research seeks to understand the long-term changes in the mangrove vegetation in order to strengthen the formulation of sustainable alternative livelihoods and adaptation strategies to climate change.

Mangrove vegetation dynamics was assessed by remote sensing, using decadal Landsat images covering 1973-2012. Physicochemical parameters were analyzed during the rainy and dry seasons for correlation with climate data. Our findings indicate that the long-term changes in salinity (24.5 and 35.8 ppt) and water temperature (27.6°C and 30.2°C) during the rainy and dry seasons respectively are retarding mangrove growth. Mangrove vegetation cover declined by 6%, while grassland increased by 56.4%. This research concludes that long-term hyper-salinity is the cause for the stunted vegetation and lack of mangrove rejuvenation in TWNP. We propose that specialized replanting systems such as the use of saplings be adopted instead of the conventional use of propagules. Alternative livelihoods also need to be diversified to support coastal communities.

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Mangroves as orientors of coastal integrity and sustainability

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Abstract:

Mangroves ecosystems are recognized for their geomorphic competence, primary production, and diverse delivery of ecosystem services. As a result, they are considered key components of Critical Transition Zones (CTZ's) - subtropical and tropical coasts. Proper management is essential because of their roles as zones of convergence of materials, energy and productivity as well as self-maintaining sources of ecological services. Mangrove conservation is important because in spite of their high resilience they are threatened by an unstoppable “ecological squeeze” both land- and seawards. We suggest that mangroves remain undervalued in their ecological role and that they are not only high performers, but actually orchestrators (orientors) of coastal landscapes. Based on the Orientor Theory, we suggest that they act as autocatalytic features generating basic ecological services as well as spawning others that create order and structures at higher levels of organization. Mangroves are drivers of coastal order and wealth because of their orientor features. Furthermore, based on these attributes and their role as implicit attractors for coastal dynamics, we suggest a regenerative approach to policy making based on that conceptual framework. Such policy is essential to protect coastal systems' integrity, health and vigor, all of which are aspects of sustainability.

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Conserved mangroves sustaining cultural diversity of traditional communities

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Abstract:

Mangroves are among the most productive ecosystems in the world, providing ecosystem goods and services to society and marine systems. Brazil is the 3rd country on mangrove area on tropical and subtropical zones. The fishery in Brazil is mainly artisanal, which depends on mangrove ecosystem services directly or indirectly. The Cananéia-Iguape Coastal System (CICS), located in Southeastern Brazil, consists on a unique complex of lagoon channels, with a mangrove extent of 15,193 ha. In this coastal area, mangroves have been monitored, using satellite images and permanent plots, which has provided subsidies for the management. Monitoring of estuarine fisheries has also been performed. The present study used the CICS as a study case to analyze the relationship between the estuarine fishery and the conservation status of mangroves, and consequently established a relationship between the conservation status of mangroves and the cultural diversity of traditional communities (fishing gear used). Data bases (2014) of mangrove forest structure vegetation, interstitial salinities and the landings of artisanal fisheries were used. The CICS was divided into two main sectors based on mangrove conservation status: conserved and altered. QGIS was used to map artisanal fisheries landings and mangrove sectors. The conserved mangrove sector was characterised by interstitial salinity between 24 to 30, and mangrove forests reaching less than 20% of dominance of basal area (BA) of dead trunks. At the altered mangrove forests sector the interstitial salinity varied between 0 and 4, and mangroves reached 60% of dominance of BA of dead trunks. In the conserved mangrove sector, the artisanal fishery landings were more diverse, with 17 species which use mangrove ecosystem during their life cycles, such as *Centropomus* spp., *Mugil curema*, *Crassostrea brasiliana*, *Ucides cordatus*, *Litopenaeus schmitti*, *Cathorops spixii*, *Mytella* spp., *Callinectes* spp. and *Caranx* spp. Traditional fishing gear such as extrativism for crabs, lift net, fish-weir, surface and bottom gillnets were used to catch these species by local communities. On the other hand, in the altered mangrove forests sector, seven species were caught by artisanal fishery. The conserved mangrove sector showed higher diversity in terms of diversity index (H=1.42) than the altered mangrove sector (H=0.84). The present study showed that conserved mangroves sustain cultural diversity of traditional communities, once a multiplicity of traditional fishing gear is used to catch different species of natural resources which use mangrove ecosystem in their life cycle.

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An evaluation of the artisanal shrimp fishery in the Berau estuary, East Kalimantan, Indonesia

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Abstract:

The Indonesian coastal population is growing and exerting an increasing pressure on natural resources among which shrimps are an important source of income and food. Catches of the artisanal fishery add up to a notable amount of the total shrimp catch but there is scarce information about it, it is difficult to manage and its sustainability has yet to be evaluated. This study examines the shrimp fishery in the mangrove-fringed Berau estuary in East Kalimantan in regard to fished species, different fishing gears and gear-specific catches.

Shrimp catches mainly consisted of ten species. The three different gears gondrong (trammel net), trawl and togok (lift net) showed distinct differences in their catches regarding their species composition as well as the size-frequency distribution of shrimps. Gondrong catches had the smallest diversity and mostly consisted of bigger species and of on average bigger individuals compared to individuals of the same species caught with the other gears. The more diverse catches achieved with togok showed a trend towards smaller species and individuals. Gondrong caught immature individuals with a much lower percentage, indicating a more sustainable fishing practice. Gear-specific catches need to be further investigated to, in case of overfished shrimp stocks, identify management options.

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An ecosystem model to assess optimal rehabilitation management of coastal ecosystems for blue carbon sequestration

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Abstract:

The high capacity of coastal ecosystems to sequester and store "blue carbon" is now affording them increasing attention in coastal conservation and climate change mitigation efforts. Deciding where and how to focus limited conservation budgets on rehabilitation for blue carbon is, however, no simple task. Blue carbon return on rehabilitation investment depends not just on spatial and logistical implementation decisions and costs, but critically on forecasted trajectories of blue carbon return and associated uncertainty. The future of blue carbon stock trajectories at given locations is a complex function of the impacts of hydro-ecological conditions, sediment availability, connectivity to source populations, and risk from climate change-associated deterministic (sea level rise) and stochastic (storm damage) threats on forest and sediment dynamics. This talk will outline conceptual mangrove ecosystem functioning model development, and peer-reviewed data population of a subsequent process-based model to generate spatially-explicit trajectories of blue carbon potential according to site conditions and ecosystem rehabilitation options through time. It will discuss future model implementation within decision-making tools to assess the cost: benefit potential of rehabilitation actions for enhancing blue carbon sequestration in south eastern Australia, as well as it's utility within coastal ecosystem risk assessment frameworks (e.g. IUCN Red List of Ecosystems).

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Coast Land Protection: The novel way of foresting Mangroves along the coastline

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Abstract:

Statement of the problem: Environmental issue of water and air pollution – "Necessity is the mother of invention." Likewise, when the team in the organization saw the hazards created by the factories of an industrial estate named SIPCOT in the Cuddalore district, Tamil Nadu state, India they decided to bring a permanent solution to the problem. Another greater issue that bothered was the fresh water bodies and the back waters near the industrial estate were very badly polluted by the residues and the discharge of the factories. Theory and Orientation: The villagers could not afford to protest to shut down the factories because these people who are basically agriculturists and fisherfolks and due to the recent droughts, they had to solely depend on the factories for their jobs and livelihood. But the threats due to the pollution increased day by day. Thus, emerged the Aalamaram-NGO to work for the welfare of the villagers in 2009. To everybody's great surprise, mangrove reforestation has been enthusiastically taken up by the rural based NGO, AALAMARAM. The NGO's volunteers from the surrounding villages of Thyagavalli, Nochikadu, Naduthittu, Thiruchopuram, Poondiyankuppam,rajapettai and Sothikuppam extended their sincere co-operation in planting the seedlings, carefully nursing them and vigilantly preserving them.The youngsters of the nearby villages voluntarily took part in this noble mission. Students and other working people of the village took turns in groups and got into the marshy lands to plant and nurse the plants in the night hours. Their selfless service from 2009 made their dreams come true. Nearly 5,000 mangrove saplings were planted along the bank of Uppanar River. The industrial area of Cuddalore, SIPCOT is located on the bank and wishing that the mangroves would purify the water and the air polluted by these industries, volunteers eagerly planted saplings of mangrove and avicennia along the river bank. Motivated by the interest showed by the villagers in protecting the saplings, we, the office bearers of the AALAMARAM NGO also planned to expand thisproject to the other nearby coastal villages too. The saplings grew almost to the heights of 5feet. Inspite of the flood that affected the mangrove plants in 2015 and the heavy downpours and storms that attacked the coast the volunteers still continue to carry out their mission.

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Mangrove restoration and service-provisioning: the macrobenthic perspective.

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Abstract:

In recent years, many programs aimed at restoring or rehabilitating mangrove forests have been developed worldwide. However, not all the proposed rehabilitation and restoration techniques have been successful in reestablishing most of the mangrove key ecological processes, which should always be the real goal of restoration attempts. It also became evident that stakeholders, conservation managers and NGOs engaged in mangrove rehabilitation need science-based, reliable tools to evaluate the ecological success of their efforts. The present contribution focusses on the need to include macrofaunal parameters in the development of such assessment tools. Indeed, it is becoming now evident that there are no healthy mangroves without viable invertebrate assemblages. Thus, structural, ecological and biological parameters of these assemblages should be considered.

We will focus on the use of data on the role of crabs and gastropods in the mangrove food web, their taxonomic diversity and abundance as well as their genetic structure and diversity as a set of reliable parameters to be included in mangrove management and restoration plans. The use of these tools in management and rehabilitation programs will be discussed both in the light of the literature and of the results obtained in ongoing projects of our groups.

IUCN SSC Species Survival Commission Mangrove Specialist Group

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Using ecosystem services for mangrove conservation: key priorities for the future

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Abstract:

In the last decade we have gained a much clearer idea of the ecosystem service value of mangroves, to the extent that mangroves are now firmly on the international climate change and conservation policy agendas. After this surge of research and interest in mangrove ecosystem services, it is time to take stock of the field, and think about the advances we hope to see over the next decade. This talk will focus on 3 key priorities to improve the conservation of mangrove ecosystem services. Firstly, we now have robust protocols to measure many ecosystem services, especially carbon, but cultural ecosystem services are not understood to the same extent. This constrains conservation, because in some settings cultural values can be a key reason to conserve an area. Secondly, we are good at producing static, site-scale assessments of mangrove ecosystem services, but for real policy impact we must do better at scaling these up to national/regional levels, and showing how ecosystem services are impacted by anthropogenic stressors through time. Finally, severe governance gaps remain, that are constraining the implementation of mechanisms that utilize mangrove ecosystem services, such as Payments for Ecosystem Services (PES) schemes. Tackling these research gaps will help decision makers better incorporate mangroves into management and conservation planning.

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Physiological and morphological response of *Brugueria sexangula* seedlings to increased temperature, organic matter and nutrients

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Abstract:

Mangrove forests provide important ecosystem services. Unfortunately, these forests are under threat from anthropogenic activities such as shrimp pond construction and operation. These activities increase the discharge of nutrients and organic material into mangrove areas and may affect the growth of mangrove seedlings. Nutrient additions could interact with increasing global temperatures and alter mangrove seedlings growth. We grew seeds of the mangrove Bruguiera sexangula in temperature-controlled chambers and investigated the single and combined effects of increased temperature (23 to 33 °C), sediment organic matter (fish feed pellets) and dissolved nutrients (ammonium) on the seedlings morphology and physiology. Seedling survival, growth and leaf number were highest in the control and ammonium enriched and lowest in the organic matter enriched. Opposite to control treatments, ammonium enrichment lead to a higher above-ground compared to below-ground biomass. Moreover, combined effects of temperature and ammonium addition caused differences in the root morphology with generally fewer but longer and thicker roots in the ammonium enriched with possible impact on the stability and growth success. Overall, seedlings appeared to grow best under 33 °C and under 23°C with ammonium enriched treatments highlighting the importance to consider both pressures in combination. Our results could be useful to support mangrove restoration adjacent to shrimp ponds.

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Future directions of mangrove modeling: IBMbedding

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Abstract:

The mangrove ecotone hinges on river discharge from the landward and tidal inundation from the seaward side. In many regions, the landward influence has changed by an altered chemical composition of riverine waters. Sea-level rise and increased frequency of storm surges are predictions of how humans will alter the oceanic influence on mangroves.

Traditionally, these influences have been simulated by process-based ecosystem models that operate on the landscape level and are comprised of broad components and bulk flows among them. Recently individual-based models (IBMs) have been used increasingly to model mangrove forest dynamics. IBMs are suitable to simulate the species composition of mangrove communities based on life processes of individual trees. They are powerful tools for the simulation of gap formation by disturbance and gap closure by forest regeneration. These are clear advantages, but IBMs have also important disadvantages: They work at small spatial scale. External driving forces, such as hydrodynamics, and ecosystem processes (nutrient cycling) are ignored in most mangrove IBMs. It seems that we have lost the big picture in mangrove modeling.

Here I will present a large-scale modeling approach in which mesoFON is embedded in the General Ecosystem Model and the advantages of both worlds are combined.

IUCN SSC Species Survival Commission Mangrove Specialist Group

ZMT LEIBNIZ CENTRE for Tropical Marine Research

Digging into Sediments and Microbes for Nature Conservation (DiSeMiNation): Application to Mangrove Ecosystems

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Abstract:

The establishment of protected areas to preserve ecosystem services, while allowing for sustainable use by local communities, requires a sound knowledge of abiotic and biotic drivers of spatial species assemblages and how these translate into ecosystem processes that underlie services. Numerous ecosystem services of tropical mangrove forests, both for local communities and globally, depend on sediment processes that are mainly driven by the sediment microbiota, too often overseen thus far. DiSeMiNation aims at unraveling how the floral and faunal communities, environmental conditions and human resource-use govern service-relevant microbial processes in mangrove ecosystems. Six regions have been targeted worldwide, to get a global overview of microbial community composition and their drivers in mangrove ecosystems. We will present the general framework of our "conservationomics" approach, an innovative combination of cutting-edge technologies and methods in biology, chemistry and socio-ecological sciences. This approach is expected to provide a sound basis for knowledge-driven spatial conservation planning not solely in mangroves, but also easily transferrable to other coastal ecosystems.

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Decadal changes in mangrove and pond aquaculture cover and related ecological and biogeochemical impacts on eastern Hainan, tropical China (1966-2009)

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Abstract:

Mangrove forests provide valuable ecosystem functions but have been under pressure from land-uses such as shrimp ponds. We analyzed decadal changes in mangrove cover and aquaculture pond cover for five estuaries on the east coast of Hainan, tropical China, using aerial photos and satellite images from 1964 to 2009. Moreover, we determine historical changes in the sedimentary biogeochemistry in four sediment cores from the largest remaining mangrove area in eastern Hainan (Wenchang/Wenjiao estuary, WWE). Overall mangrove loss was 73% (from 3798 ha in 1966 to 1041 ha in 2009), ranging from 63% in WWE to virtually 100% loss in Qingge. At the same time, land cover of aquaculture ponds increased from 550 ha in 1966 to 3944 ha in 2009. An increase in individual mangrove area patches, from 230 to 2134 indicates strong fragmentation of the remaining mangrove areas. This is characteristic for extensive conversion of mangrove area into pond aquaculture and has negative consequences for ecosystem functioning. An increase in sedimentary C_{org}, TN, $\delta 15N$ and $\delta 13C_{org}$ and a decrease in the C/N ratio towards the upper core layers indicate a change in the primary organic matter source from mangrove to aquaculture based suspended matter. Thus, the large scale conversion of mangrove areas to aquaculture ponds in eastern Hainan reveals drastic ecological and biogeochemical changes in a relatively short time scale. This is one of the longest time series documenting mangrove decline and mirrors what has happened in many tropical estuaries worldwide.

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Science and sustainable mangrove management – what are we missing?

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Abstract:

"Mangroves are declining worldwide", this is the mantra with which many mangrove texts are opening. Since the magnitude and the importance of ecosystem services delivered by mangroves have been well described and appear to be widely known, the fact that threats and impacts are continuing unabated is difficult to explain. While there is a great body of solid research in a global scientific community as to the ecology, dynamics, and conservation needs of mangrove ecosystems, it is surprising that this is often not translated into sustainable management (policies). In view of the theme of the meeting we wish to explore which knowledge may still be lacking. Key questions relate to which mangrove services are insufficiently recognized? What could explain the gap between needs expressed and -insufficient- action? What are the factors that shape mangrove management decisions? We will reflect on these questions from the perspective of the diverse geographical areas and the range of scientific approaches our team is familiar with. This will entail reflections informed by taxonomy, dispersal, range, forestry, as well as human-mangrove relations. The contribution is intended as a basis for discussion, both regarding the science-policy gap as well as research priorities.

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Mangroves of Batticaloa, Sri Lanka: climate change and sea level rise scenarios

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Abstract:

Sri Lanka is an island with a 2000 km shallow coast line and 10,000 ha of mangroves. Batticaloa in the east has around 2000 ha mangroves and 400 km coast. Batticaloa district with lagoons and water ways is ideal for mangroves. Around 30% of mangroves had been lost and fragmented over the past few decades to shrimp farms and paddy fields in particular. Climate change and sea level rise would cause increase in depth of connected waterways and move inland with increased salinity with frequent floods. Recognizing our experiences of mangrove patches in zero salinity areas, fragmented patches, preference of *Rhizophora* in deep waters, soil patterns in the coast, rivermouth and lagoons it is predictable that there would be a significant increase of mangroves following the sea level rise. They would preferably be restored in the areas of paddy fields and shrimp farms and expanded at rivermouths. Significant expansion will be by the fragmented patches. Losses may be seen in shallow mangroves. Changes of species composition would be prevalent.

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Nitrogen composition of mangrove leaf litter is a major control of leaf decomposition and food choice in crabs

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Abstract:

Mangrove conservation implies maintenance of their valuable ecosystem services like 'blue carbon' storage and food supply for organisms. Leaves form a large pool of carbon, nitrogen and energy that is a major driver of element cycles and detrital food web in mangrove forests and coastal waters. However, gaps in knowledge exist on transformation and fate of leaf nitrogen and on reasons for preferential consumption of leaves from specific trees by crabs.

We investigated (i) amount and composition (δ13C, δ15N, amino acids, hexosamines) of nitrogenous organic matter (NOM) in a leaf litter decomposition experiment (5 species) and (ii) diet, food preferences and consumption rates of 8 crab species in mangroves of Segara Anakan, Java, Indonesia, by stomach content analysis and feeding experiments.

The biochemical composition of leaves differed among species and over time. Leaves preferentially consumed by crabs had a high amount of NOM and biochemical compositions were significantly different from that of disliked leaves.

Our findings suggest an increasing proportion of labile NOM in decomposing leaves over time that is partly related to leaf-colonizing bacteria. We infer that NOM composition is a determinant of decomposition rate and bioavailability of mangrove leaves and hence partly explains leaf preferences in crabs.

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Mangrove restoration for carbon sequestration and climate change mitigation

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Abstract:

Mangroves are of great ecological and economic significance in terms of carbon sequestration. The carbon sequestration is about 10 times greater and carbon storage is 4 time higher in mangroves than tropical forests. Globally mangroves store up to 20 PgC, equivalent to 2.5 times annual global CO_2 emission. Conversion and degradation of mangroves generates 10% of emission from global deforestation. The carbon sequestration potential is influenced by soil salinity, tidal regimes, temperature and soil moisture, besides mangrove species composition. My study in southeast India reveals that Avicennia marina sequesters carbon 75% higher than *Rhizophora mucronata*, due to growth efficiency and high biomass production in 16 year old planted site. The carbon sequestration is positively correlated with age of planted site, tree diameter at breast height of 1.3 meters, net canopy photosynthesis, but negatively correlated with soil temperature. The planted site has 7 fold higher carbon in sediments of the planted site than the barren site. The mangroves in India absorb over 9 million tons of carbon dioxide daily valued at around USD 173 billion in the international market. Restoration of mangroves in degrading sites and appropriate management practices especially against sea level rise deserve top priority to mitigate climate change.

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Spatial variation of organic carbon stocks and sources in Indonesian mangrove ecosystems

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Abstract:

Mangroves are an important natural 'blue carbon' sink. They accumulate high amounts of organic carbon (C_{org}) in the sediment. However, degradation of mangrove ecosystems can strongly impair this ecosystem service. Carbon stocks and sources in mangrove ecosystems have been rarely studied in detail and previous studies mostly disregard the high spatial variability of environmental conditions, therefore, existing global mangrove carbon budgets still have large uncertainties. In order to better understand the 'blue carbon' storage of mangroves, we measured Corg stocks and identified Corg sources in three Indonesian mangrove ecosystems with different environmental conditions; (i) a degraded estuarine mangrove in Segara Anakan, Central Java, (ii) an almost unaltered estuarine mangrove in Berau, East Kalimantan, and (iii) a pristine marine mangrove in Kongsi Island, North Jakarta. Samples were analysed for Corg content, total nitrogen content, stable carbon and nitrogen isotopes ($\delta 13C_{org}$ and $\delta 15N$). Our results indicate that the undegraded mangrove ecosystems store higher amounts of Corg, and in contrast to other studies, the marine mangroves in Kongsi exhibited a lower Corg stock. Furthermore, the high C/N values and the low variability of $\delta 13C_{org}$ observed in undegraded estuarine mangroves indicate stable accumulation of predominantly autochthonous organic matter compared to degraded estuarine mangroves, which implies that degradation has an impact on Corg stocks and sources distribution.

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Comparative assessment of the structure of the mangrove community of Nagsaulay, San Juan, Batangas, Philippines in 2011 and 2017

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Abstract:

Mangroves, despite the numerous ecosystem services these provide, are continuously threatened by various human activities. Thus, regular monitoring is important to mitigate the impacts of their rapid decline. This study compared the community structure of the mangroves in Nagsaulay, San Juan, Batangas, Philippines in 2011 and 2017. Six mangrove species –*Rhizophora apiculata*, *Rhizophora mucronata*, *Rhizophora stylosa*, *Ceriops decandra*, *Avicennia marina* and *Sonneratia alba*– were identified in 2017, similar to those in 2011. However, highest importance value shifted from *R. apiculata* to *A. marina*. The change could be attributed to differences in freshwater inputs in 2011 and 2017 and *A. marina* being euryhaline. As *A. marina* dominated, the scatter plot diagram showed indistinct zonation patterns. Likewise, community diversity and productivity were lower in 2017.

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Not net loss? Implications of large-scale restoration projects for global mangrove ecosystem services

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Abstract:

For decades, "No net loss" has been the principal approach to protecting coastal wetlands including mangroves. While this approach may ensure no areal change in mangroves, no-net-loss of biodiversity and ecosystem services supported by mangroves is difficult to measure, monitor or achieve. The geomorphologic (e.g. tidal regime, hydrological period), ecological (e.g. aridity, nutrient availability, faunal diversity and abundance), socio-economic (e.g. demand for consumptive use, management practices) and biogeographic (IWP vs AEP) settings of mangroves are known to influence the productivity, biodiversity and system-level ecology of mangrove forests and therefore their capacity for services. Recent efforts in mangrove restoration may improve success of replanting, but evidence suggests the popular approach of planting monospecific seedlings to achieve "no net loss" in mangrove forest area may be a disservice to protecting mangrove ecosystem services. Research on the relationship between mangrove forest characteristics (e.g. area, minimal functional forest size, tree diversity, patch connectedness) and capacity for services is urgently required to ensure "no net loss" in mangrove ecosystem functionality and help guide future investments in mangrove restoration.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

Beginnings of a Benthic Index of Biological Integrity of mangroves forests in South Sulawesi, Indonesia

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Abstract:

More than 60% of the Indonesian mangrove forest estate has been degraded or converted to other uses in the past three decades. Beyond vegetative surveys of success/failure, biological monitoring can be used to better determine the utility of institutions rehabilitation efforts. The Benthic Index of Biological Integrity (B-IBI) has proven useful in monitoring the rehabilitation of riverine systems and has been adapted for mangroves. Previous selection of biological indicators however, was more appropriate for determining water quality than forest health. In order to develop a biological index to monitor mangrove forest health in Indonesia, it is necessary to determine appropriate indicator species and functional groups. This study stratified mangrove forests in South Sulawesi, Indonesia by hydro-morphological type (fringe, riverine or basin) and condition (natural or rehabilitated), before sampling benthic macroinvertebrate communities to begin to determine which organisms and functional groups might be used to develop a B-IBI. Analysis of diversity indices, Bray-Curtis distance and Correspondence Analysis showed variations, but no significant differences of populations between sites, perhaps due to lack of replicates. Species abundance was examined using the Kruskal-Wallis test, and showed significant differences between sites in terms of species composition which should inform the developing of a future B-IBI.

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The role of mangroves in safeguarding vulnerable fishing cat populations in Godavari Delta, India

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Abstract:

Godavari Estuary, which forms at the confluence of Godavari River with Bay of Bengal in the east coast of India, is a complex of different types of habitats such as mangrove forests, bay, mudflats, tidal flats, and riverine sand bars. These mangroves are very important as they help in protecting the coastal regions against coastal erosion and natural calamities such as cyclones and tsunamis. They also provide good refuge to one of the most threatened small cat species the Fishing cat Prionailurus viverrinus. Due to a complex root system coupled with porous clayey substratum, mangroves are comparatively less accessible to humans than inland wetlands, they provide potentially safer habitats for the fishing cat populations to persist. During our project period from 2015-2016, we recorded 35 species of mangroves belonging to 17 families, from which Avicenniaceae is the most abundant family followed by Euphorbiaceae. *Avicennia marina* (IVI = 42.152), *Excoecaria agallocha* (IVI = 20.731) and *Aegiceras corniculatum* (IVI = 10.363). *Ceriops decandra* is the only near threatened mangroves present. Camera trapping was done to ascertain the presence of fishing cat. This study thus highlighted the importance of healthy mangrove forests in conservation of the threatened cat since the likelihood of occurrence of fishing cat was higher in dense mangrove patches and lower in the human-modified habitats such as, agricultural farms, aquaculture ponds etc. At the same time being the top predator, fishing cats can act as flagship species for enhanced protection of the Godavari mangroves. So, this project which took place in Godavari mangroves of southern India helped in understanding the mutual relationship of mangroves and fishing cats in their conservation, and finally in protecting the local communities' dependent on this ecosystem.

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Designated mangrove research and training forest Rufiji Delta, Tanzania

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Abstract:

The multiple-use and extractable nature of mangrove resources encourage their overexploitation, conversion, degradation and loss. In Rufiji Delta, major threats are uncontrolled cutting for poles and timber and conversion to paddy farming, the implications of which are not sufficiently understood. This warrants long-term studies in order to provide a sound ecological basis for sustainable utilization, management and enforcement. Accordingly, an active research, education and technology transfer facility has been designated through institutional consultations, coordination and networking with three core objectives (i) to improve, share and apply scientific knowledge on assessment of carbon stocks, restoration and sustainable use to support the conservation of mangrove ecosystems; (ii) to strengthen and build capacity for integrated mangrove management institutions and strategies, and empower dependent communities to engage in decision-making and management that conserves, restores and sustainably uses mangrove ecosystems; (iii) to enhance mangrove forest governance by encouraging integrated management programs and conservation investments that are ecologically and socio-economically sound. Baseline studies are ongoing for ecological and socio-economic conditions engaging graduate students parallel to installation of monitoring facilities for physical environmental parameters. Here we share the experiences and lessons on the path to the designation, demonstrating the value of institutional coordination and partnerships.

IUCN SSC Species Survival Commission Mangrove Specialist Group

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Local stakeholder perceptions as key component to improve mangrove management in Matang, Malaysia

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Abstract:

Sustainable management of a socio-ecological system (SES) requires a good understanding of: (i) ecosystem functionality, (ii) decision-making system, and (iii) interactions between social and ecological units. Coastal ecosystems like mangroves are at the interface between terrestrial and marine ecosystems, making the management potentially more complex.

Matang Mangrove Forest Reserve represents the largest patch of mangroves in peninsular Malaysia, and it has been under silvicultural management for charcoal and timber production since 1902.

The aim of this study is to bring the current management regime in Matang closer towards sustainability. The focus lies on a key component of 'social' sustainability: the degree of popular support of three main management discourses: (i) Optimization- 'keep up the good work, but keep improving', (ii) Change for the better- 'ecotourism & participatory management for sustainability', and (iii) Continuity – 'business as usual is the way to go' identified from a previous study using Q methodology.

During the present investigation (questionnaire-based survey), we found that Discourse (ii) was most popular among the local stakeholders. Additionally, we identified some conflicts among different stakeholders; however, we did not observe significantly polarized perceptions. The present findings indicate the opportunities for further improvement and fine-tuning of the management regime in Matang.

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A retrospective of mangrove extent estimations in Colombian Pacific mangroves: implications for the conservation of a unique Neotropical tidal forest

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Abstract:

Nature conservation, management and environmental policy should rely on accurate scientific information and interpretation. Often inaccurate numbers related to the decline of a natural resource get the attention of the general public (an even the scientific community) and propagate generating confusion and misleading decisions, funding priorities and policies directed by environmental decision-makers. Here we analyse the previous and most recent estimations of mangrove coverage of a relatively pristine mangrove area of the Neotropics (the Colombian Pacific coast). Our comparison reveals highly differing numbers of mangrove coverage based on the methods used. As opposed to what is commonly claimed by some studies and the media, mangrove cover in this region has stayed relatively stable at least over the last 15 years. Very old estimates likely overestimated mangrove area due to the lack of the more precise methods (satellite images) available in recent times. Mangroves in the Pacific coast of Colombia, despite very localized losses, remain one of the most well preserved tidal forests of the Neotropics. Future well-documented estimations should need to be carefully performed in order to not mislead decision-makers working in the environmental sector.

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Biotic interactions and development of *Avicennia germinans* during autogenic regeneration: a case for facilitation in mangrove restoration

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Abstract:

Mangrove forest degradation is rapidly expanding, and the outcomes of many restoration efforts not satisfactory. Further than the conventional even-spaced planting, restoration strategies that incorporate facilitative interactions are appreciated for improved outcome. Yet facilitation is seldom considered in mangrove restoration. This study reports a case for facilitation, biotic feedback and mangrove regeneration. Using spatio-temporal patterns of plant distribution and morphological metrics in a regenerating mangrove forest, we analyzed the effect of neighborhood interactions and positive feedbacks of dwarf mangrove colonizers and herbaceous vegetation on the morphological development of *Avicennia germinans*. We found marked differences between interspersed individuals and counterparts in denser (clustered) patches. Both numbers and length of stem internodes were significantly higher in the denser neighborhood than recorded for sparsely distributed trees. Stem height and crown attributes of focal plants showed positive spatial autocorrelation to the height of the neighboring plants and legacies of herbaceous vegetation. These results demonstrate the potential of facilitative interactions among conspecific neighbors in accelerating growth and establishment of mangrove species in severely degraded mangrove forests. What's more, the study brings an opportunity to stimulate discussion on how the concept of facilitation can be integrated in the framework of mangrove restoration through clump planting.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

No mangrove, no prawns; is "outwelling" still a hypothesis?

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Abstract:

This is about the mangrove carbon budget study initiated in the mid-1970s, by our Universiti Sains Malaysia team. We considered the following:

i) The vertical (or atmospheric) component where carbon dioxide is absorbed through photosynthesis and the photosynthesised carbon returned to the atmosphere through respiration.

ii) The horizontal (or hydrological) component: where carbon is moved in and out of the mangrove by freshwater and tidal flows.

iii) Carbon sequestration in soil to, demonstrate the huge carbon footprint of pond aquaculture.

We traced the "outwelling" story through a series of landmark publications: from the seminal study of Golley et al. (1962) to the critical review of Nixon (1980). I will mainly discuss our attempts at measuring the horizontal fluxes.

We used the method of Kjerve et al. (1981). Despite measuring over a few continuous spring-neap tidal cycles, we were unable to obtain mass balance.

We use an alternative approach (Simpson et al., 1997) that included tide gauge data in conjunction with section flow data to determine the hypsometry of the system. A salt balance condition was then applied to permit determination of freshwater discharge. The main problem is the high tidal noise (some two orders of magnitude) to signal (freshwater discharge) ratio. This requires more accurate current measurements that perhaps an ADCP may provide?

IUCN SSC Species Survival Commission Mangrove Specialist Group

ZMT LEIBNIZ CENTRE for Tropical Marine Research

Ecosystem carbon stocks of mangrove forest in the Colombian Pacific

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Abstract:

Carbon (C) sequestration is one of the main ecosystem services provided by mangrove systems However, for many places the size and variation of mangroves C storage remains unknown. To address this knowledge gap, we quantified C stocks in two bays of the Colombian Pacific coast. We also examined differences in ecosystem C stocks due to the size and structure of mangrove forest vegetation. Mangrove ecosystem C stocks ranged from 23022.45 10^6 Mg C ha^{-1} and 13.59 X 10^6 Mg C ha^{-1} in both coastal bays. Belowground biomass represented the single largest pool of total C in these ecosystems. We found significant differences in ecosystem C stocks across locations (Malaga Bay and Buenaventura Bay) and mangrove types (riverine and basin). Coupled with their other ecosystem services, an understanding of the size of mangrove C stocks underscores their values in the formulation of conservation and climate change mitigation strategies in the pacific mangroves of South America.

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Meanings of Mangroves:

Past stories and contemporary images of mangroves of the Chocó Ecoregion

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Abstract:

Mangrove ecosystems have been made sense of by the North-West South American inhabitants since ancient times. The diverse, coexisting mangrove epistemologies nurture and are nurtured by a cumulus of images envisioning future mangrove systems and everyday practices fostering the conservation and use of the existing. While mangrove ecosystems have been widely investigated from a social-ecological perspective, their 'systems' have been discretely studied. Thus, we explore past and current discourses on mangroves' systems and the meaning-making practices encouraged by them in the Chocóan Ecoregion. By applying an interdisciplinary novel approach, in order to understanding the iterative relationship and interactive dynamics of mangroves, this presentation illustrates two multi-temporal scales in the construction of mangroves as meaningful knowledge. We draw on the mangroves located in the Ecuadorian-Colombian border region and illustrate the vastly understudied: a) mirroring and contradictory discourses of how humans make sense of these mangroves through stories told, scientific accounts and political statements; b) linkages and the mutual influences of mangrove ecosystems conservation practices; and c) insights on how to better achieve the desired sustainable development by looking at the socio-institutional structures that determine changeable 'values' that are ascribed to mangroves and their changing conditions.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

Leaf gas exchange characteristics of *Rhizophora mangle* in response to salinity and flooding gradients in the Pacific Coast of Colombia

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Abstract:

The littoral fringe of the Pacific coast of Colombia is inhabited by extensive mangrove Communities. Salinity and flooding exert effect on photosynthesis and distribution of mangrove species. We determined the relationship between leaf gas exchange characteristics, salinity and hydroperiod of the mangrove *Rhizophora mangle* L. Data of leaf gas exchange, light intensity (PPFD), and interstitial water salinity (PSU) were taken throughout the tidal cycle, using an IRGA (Model CI-340, Biosciences) and a Light-meter (Model Licor 1400) respectively. Diurnal salinity changes in the estuary have significant effect on the photosynthetic performance of the species. Hydroperiod alone had no detectable effect on leaf gas exchange. However, short-term tidal flooding caused a 20% reduction in maximum leaf-level carbon assimilation rate. There was little consistency of carbon assimilation responses between stations. We obtained little evidence that contrasting salinities affect leaf gas exchange characteristics of mangrove saplings over long time intervals. However, tidal changes of salinity may cause short-term depressions in leaf gas exchange. High tide reduced the amount of assimilated carbon when environmental conditions change rapidly due to hydroperiod. The adaptation of mangrove plants to salinity will likely reveal photosynthetic adjustment to hydrological conditions of the estuary.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

Restoration of a medicinal mangrove species *Rhizophora mucronata* in Gulf of Mannar Biosphere reserve, South India

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Abstract:

In India, The Gulf of Mannar Marine Biosphere Reserve (GOMMBR) is located in Tamilnadu, on the mainland southeast coast of India. It is the first marine biosphere reserve in Southeast Asia, established on 18 February 1989. The GOMMBR lies between 8° 47' to 9° 15' N latitude and 78° 12' to 79° 14' E longitude. It is estimated that 10,500 km2 of 21 uninhabited islands. Based on the geo-locations islands are divided into four major groups. They are Mandapam, Keezhakarai, Vembar and Tuticorin. The study area Poomarichan is clearly showed the island and its corresponding group. There are no permanent inhabitants in these islands and temporary camping by forest officials and fishermen for a few days is common in some of the islands. Among the 21 uninhabited islands, Vilanguchalli in Tuticorin group and Poovarasanpatti in Vembar group of islands were submerged due to anthropogenic activities in the past and subsequent erosion.

Worldwide concern to conserve mangroves necessitated propagation of mangroves to re-establish them on barren and swampy land along tidal creeks around Poomarichan Island of Tamil Nadu. *A. officinalis*, *A. corniculatum*, *B. cylindrica*, *C. decandra*, *E. agallocha*, *R. mucronata* and *R. apiculata* were vegetatively propagated and planted over 5 ha of degraded salt-marshy wetlands of South Pichavaram in pure and mixed stands depending on the intensity and the frequency of tidal inundation at the experimental site. Survival was significantly high (65%) in *R. mucronata* followed by *A. marina* and *A. officinalis*. *A. marina* recorded the maximum growth in height (1.4 m after 1 year). Growth performance was better with plants in mixed stands than the plantation with single species. This gives us hope to propagate and re-establish mangroves for conservation in scientifically managed plantations in a physiologically arid environment.

IUCN SSC Species Survival Commission Mangrove Specialist Group

ZMT LEIBNIZ CENTRE for Tropical Marine Research

Ethnomedicine and scientific rationale of Indian Mangroves

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Abstract:

India has a long coastline of 7,500 km with exclusive economic zone of 2.02 million km² supporting about recorded 13000 marine species in the most productive ecosystems such as mangroves, coral reefs, estuaries, lagoons and backwaters. About 70% of global mangrove species and 50% of the coral reef species are found in this country.

The bioprospecting is lucrative, but a long expensive process that includes collecting bioresources, extracting and testing their constituents for biological activity, and further developing a product. This provides chances of both failures as well success. It is estimated that only 1 in 10,000 samples may be promising in activity; only 10 % of those may go to clinical trials, and only 10 % of those are likely to reach market. The time and cost of developing new medicines is up to 15 years and about $500-600 million per product. On the other hand, bioprospecting requires careful design and strategic planning in order to maximize non-destructive uses. Clear procedures will substantially reduce risks of those interested in conducting research into development of natural resources. In this regard, The Ministry of Earth Science (erstwhile Department of Ocean Development) initiated a programme on "Drugs from the sea" in 1990 initiated a research programme for exploring the marine biodiversity for medicinal potential and made successfully.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

Mangrove forest in the Pacific coast of Colombia: between climate change scenarios and ENSO dynamics

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Abstract:

Recent assessments of vulnerability of mangrove forests to forecasted climate change suggest that they are predisposed to be either resilient or resistant to most environmental change. However, these assessments focus mainly on sea-level rise, with little consideration about changes in temperature and rainfall regimes, which can influence ecosystem structure and function. Here we a) compare the magnitude of changes in thermal and rainfall regimes expected under climate change scenarios and regime shifts observed during El Niño-La Niña 2015-2017 cycle and b) describe variability in reproduction, recruitment and early development of mangroves (different species) in Bahía Málaga (Pacific coast of Colombia). A multi-model and multi-scenario forecast based on projections of the CMIP-5 indicate a temperature increase of 2.61-2.8 °C and -10% to 10% change in precipitation by the end of the century (2071-2100). In turn, temperature increases by 1.5 °C or decreases by 0.6 °C, and precipitation varies -60% and 27% with respect to historical averages during El Niño-La Niña cycle. No fruit production and recruitment was observed for most species, suggesting that short-term thermal and rainfall shifts can have severe effects on mangrove forests, highlighting the need to reconsider the vulnerability of mangrove forests to long-term changes expected under climate change.

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Opportunities and challenges in mangrove restoration projects in Indonesia and Philippines as adaptation strategy against sea level rise

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Abstract:

The Southeast Asian region, particularly Indonesia and Philippines, hosts the most biodiverse and extensive mangroves in the world. Unfortunately, the mangroves in these countries are also threatened by various natural and anthropogenic activities, primarily occurrences of typhoons, conversion to aquaculture ponds and rapid urbanization. The SE Asian region is also threatened by sea level rise (SLR) which is expected to drown at least 40 % of mangroves by year 2100. Massive restoration programs were implemented since the 1990s primarily as a strategy to restore ecosystem services and protect the coastal inhabitants against natural disasters (i.e. Asian tsunami in 2004 for Indonesia; Super Typhoon Haiyan in 2013 for the Philippines). We evaluated the changes in surface elevation in restored mangroves and compared it with naturally colonized mangroves to assess its adaptation (or vulnerability) against SLR. Our study showed widely varying surface elevation change (ranging from -25 to 10 mm/yr) showing species- and site-specificity. If properly done (choosing appropriate restoration site and species-substrate matching), mangrove restoration program has the potential to cope with SLR. However, continuously doing inappropriately designed restoration programs will just result to false hopes and will not meaningfully contribute to adaptation strategy against SLR.

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Mangroves as nutrient filters: groundwater fluxes versus sediment burial

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Abstract:

There is currently a limited understanding of nutrient sequestration by mangroves and the fate of nutrients in sediments relative to long-term processes such sea level rise and climate change. Here we quantify phosphorus (P) and nitrogen (N) ~100 year burial rate trends, along with nutrient import/export rates via groundwater pathways at six sites covering a broad latitudinal range (~12.4 ˚S to ~38.3 ˚S). Our radium derived estimates of porewater exchange indicate mangroves are minor global contributors to coastal nutrient export. However our radionuclide-derived accretion data indicate that the P and N burial rates are substantial, up to ~3 and 15 g m-2 year-1, respectively. We show that mangroves effectively remove P and N from surface and subterranean estuaries. This nutrient sequestration and burial may be important to surrounding ecotones such as seagrass meadows and coral reefs. The combination of radiometric techniques used in this work, natural radioactive tracers in sediments and groundwater, allowed for an ecosystem scale, comprehensive understanding of the nutrient cycle in mangrove systems.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

Ecosystem carbon stocks of different aged restored mangroves in Asia

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Abstract:

Mangrove forests are being rapidly degraded as demand for economic development grows. In recognition of the multiple benefits of mangrove forests, rehabilitation of degraded and deforested forests is being carried out in many regions through the creation of mono-specific mangrove plantations. Unfortunately, it is unclear how effective mangrove plantations are at restoring mangrove forests and the many ecosystem services that they provide in terms of storing carbon. This study used the SWAMP protocol to assess the potential for different aged restored mangrove forests in Asia to store C. Ecosystem carbon stock (ECS) data were collected from India (5 yrs), Philippines (5, 10 and 25 yrs), Cambodia (17 yrs) and Vietnam (35 yrs), which increased with age 102, 537, 695, 617, 923 and 867 Mg C ha-1, respectively. Earlier reported ECS for Indo-pacific region were 1023 Mg C ha-1. Results suggest it take approximately 25 yrs for aboveground C of mangrove plantation to be equivalent to intact mangrove forest, belowground C stocks appear to be equivalent after 10 years. While conservation of intact mangroves is the most effective way to protect ecosystem services rather than restoration economically. Although mangrove plantations can be effective, eventually storing similar levels of C over time. Additional research is needed to compare other ecosystem services of planted and intact mangroves.

IUCN SSC Species Survival Commission Mangrove Specialist Group

ZMT LEIBNIZ CENTRE for Tropical Marine Research

Global landscape genomics of mangrove plants

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Abstract:

Through the global studies on genetic structure of major component plans of mangroves since 2009, we revealed the rather distinct genetic structures of widespread mangrove plants. Gene flow among populations is less frequent than we expected, and regional populations of mangroves seem to have been structured through geological history, ocean currents or adaptation. Adaptation of mangrove population to local environment is highly important but diffficult to study. If the present mangrove forests are strongly adapted to the local environment, revealing adaptive markers may be useful to predict the change of genetic diversity of mangroves under the global climate change. In 2016, we started an international project on global landscape genomics of mangroves focusing on some widespread mangrove species in AEP and IWP. By using NGS-techniques and landscape genomic analyses, we will identify candidate genetic markers that reflect adaptation of mangroves to local environment. The markers will be used to predict future changes of genetic structure of mangroves and to plan the conservation of local populations.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

Carbon stocks and fluxes associated with land-use and land-cover change in mangrove ecosystems

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Abstract:

Although mangroves are commonly described as one of the most efficient natural carbon (C) sinks on Earth, they also constitute a powerful – but to-date poorly quantified – source of C emissions when disturbed or converted. To address this knowledge gap, this research synthesizes the impact of land-use and land-cover changes (LULCC) on mangrove ecosystems C burial and emissions. The study used a systematic review method to analyze 271 published journal articles on mangrove C dynamics, worldwide. Major outcomes of the review include measured changes in: C stocks and sequestration (i.e., biomass and sediment); atmospheric greenhouse gas emissions (i.e., CO2 and CH4); and particulate and dissolved C fluxes toward coastal systems. The study's presentation classifies the magnitude of C emissions and sequestration rates for each land disturbance and land-use change types identified. Additionally, we share insights on applying systematic review methodology for ecological studies. We report that 51.6 TgC.y-1 (15.57–389.8 TgC.y-1) of the overall mangrove C stock is being affected by LUC, while the mangrove global sequestration rate is estimated at 25.9 TgC.y-1 (16.4–34.4 TgC.y-1). Therefore, we argue that understanding and classifying mangrove emission factors per land use change is fundamental for clarifying the mangrove C budget and developing future climate mitigation strategies.

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ZMT LEIBNIZ CENTRE for Tropical Marine Research

Mangroves – scaling up initiatives to protect and restore a life-saving ecosystem

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Abstract:

Mangroves are greatly under pressure from varying economic interests and development needs. Over-use, unclear legal responsibilities and a lack of appropriate spatial planning belong to the root causes of mangrove forest destruction. Many international and local organizations have put ongoing effort in the protection and restoration of mangroves over the past decades. The overall mangrove cover however decreases continuously. The growing acknowledgment of the capacities of mangroves regarding climate change mitigation and adaptation and their importance for global fishery and biodiversity creates a momentum to up-scale existing efforts. Initiatives like the Global Mangrove Alliance or "Save our Mangroves Now"! aim to establish a global goal for mangrove protection and to better link existing initiatives. Room for awareness rising among political decision-makers has been provided by the UN Ocean Conference and will be given during the Our Oceans Conference in Malta, the UNFCCC COP 23 and further CBD negotiations. Practical protection and restoration efforts should make use of best practices and integrative planning approaches. This necessitates simplified access to relevant knowledge for all involved stakeholders as well as the consistent inclusion of local communities and their rights of use. Otherwise, livelihoods of coastal communities and sustainability of protection measures are at risk.

IUCN SSC Species Survival Commission Mangrove Specialist Group

ZMT LEIBNIZ CENTRE for Tropical Marine Research

The effects of solid waste on mangrove propagules survival in Jamaica

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Abstract:

Wetland forests like mangroves account for 2% of Jamaica's land mass. Jamaica has lost 2000 hectares of mangroves between 1989 and 2010, mostly through land reclamation. Other issues include pollution from solid waste, sewage, industrial waste and oil spills. Solid waste is believed to negatively affect mangrove health and regeneration. Jamaican mangrove surveys have asserted that Port Royal mangroves, located in Kingston Harbour, were generally shorter and less productive than other mangrove forest due perhaps to significantly higher solid waste exposure. An experiment was designed to test the effect of various types and levels of solid waste on propagules. Propagules were covered with four solid waste treatments (wood, plastic bottles, plastic bags, no treatment), with varying densities (low, med, high) over 10 weeks. Seedlings were assessed weekly for root emergence, shoot emergence (including number of leaves) and survival. The treatments were shown to be significantly different (p value < 0.001). Plastic bags had the worst effect on seedling emergence; (no shoot penetration-6 weeks), despite having fair to excellent seedling survival and leaf numbers under the "canopy of plastic, up to week 6. Wood (67% - LD treatment) and plastic bottles (73%-LD treatment) had a negative effect on seedling emergence and number of leaves with an increase in density, while the control plot had 90% of propagules surviving and leaf emergence.

IUCN SSC Species Survival Commission Mangrove Specialist Group

ZMT LEIBNIZ CENTRE for Tropical Marine Research

Local discourses on Effective Mangrove Conservation in Singapore

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Abstract:

In Southeast Asia, the highly biodiverse and highly valuable mangrove forest cover has shown a rapid decline in recent decades. Identifying and analysing discourses (shared ways of perceiving and representing the world) on biodiversity conservation can improve our understanding of what constitutes 'effective' mangrove biodiversity conservation at the local scale, within specific social-ecological contexts. We consider the urban setting of Singapore, where we identify and interpret local discourses on effective mangrove conservation in an urban context. Using Q methodology and narrative evaluation we: (i) delineate and describe mangrove management discourses of varied stakeholder groups in Singapore, (ii) assess the numerical support base in Singapore for the identified discourses. We find a large overlap between local discourses on effective mangrove conservation in Singapore, suggesting that disagreement between various (mangrove) conservation and management stakeholders may not be a prominent inhibitor of future decision making. Proponents of the three identified discourses acknowledge recent improvements in mangrove conservation in Singapore. However, there is still room for improvement of current approaches (rather than diversification per se). The most pessimistic discourse -with the strongest criticism on past and present mangrove conservation management- has the lowest support from Singaporean citizens.

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Mangrove structure and diversity of plants in three new islands in Ngoc Hien District, Ca Mau Province, Viet Nam

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Abstract:

Three new islands, Con Trong, Con Ngoai and Con Moi were established in 1962, 1992 and 2009 respectively on mudflats of Dat Mui National Park as natural biodiversity conservation of Viet Nam. The study focuses on the tree component, species diversity, and composition. Data were collected from 43 sample plots of 100 m^2 (10 x 10 m) in Con Trong, 31 plots in Con Ngoai and 18 plots in Con Moi. In each plot, all tree species were identified, and tree diameter at breast height (dbh) and height were measured. There were 6 species belonging to 3 families in Con Trong, with three dominant species, *Rhizophora apiculata* (54.96%), *Avicennia alba* (29.93%), *Bruguiera parviflora* (7.75%). There were 4 species belonging to 3 families in Con Ngoai with IVI > 5%, namely *Avicennia alba*, *Rhizophora apiculata*, *Bruguiera parviflora*. In Con Moi, 2 species belonging to 2 families with IV index > 5% were *Avicennia alba*, *Rhizophora apiculata*. The Shannon-Wiener index of Con Trong, Con Ngoai and Con Moi is 0.47 ± 0.36, 0.61 ± 0.12 and 0.36 ± 0.19 respectively. The high diversity was on the oldest island with more stable soil. This study provides baseline information for new forests on mudflats, gives the understanding of structure, diversity, the pattern of populations of the tree and helps local people in protection and nature conservation as natural mangrove succession model in Viet Nam.

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Mangrove area/propagule planting targets produce sub-optimal rehabilitation outcomes

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Abstract:

Mangrove rehabilitation projects often fail, or fail to meet their objectives. This study examined village-level restoration planting carried out in eight villages and two supplementary areas (119 rehabilitation attempts at 74 sites) across two countries in Southeast Asia to assess village-level planting success, and identify factors that influenced outcomes.

Mean survival across all site types was 21% with a median of 10%. Mid-mangrove zone projects were more successful (mean 35%) than rehabilitation projects at other elevations. Planting on mudflats achieved only a 0.8% survival rate despite repeated planting – as the literature would predict.

Poor site/species matching on high and low elevation sites was common because *Rhizophora* sp. was used alone or in combination at least 65% of the time, including on mudflats where this species was ecologically very unlikely to establish. Site selection in the Philippines was often driven by the need to achieve 'National Greening Programme' area planting targets, rather than survivorship targets, and thus required large, uncontested areas as planting sites. Although Thailand's mangrove agency field offices had planting targets, villagers' desire to plant also led to inappropriate site choice and poor site/species matching. It was estimated that only 16% of planting attempts were actually necessary.

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A global map of mangrove restoration potential

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Abstract:

Mangrove forests are often seen as the prime exemplar of ecosystems supporting multiple high-value benefits to people. At the same time, their location in often densely populated, fertile coastal plains has led to vast losses, with costs to biodiversity and human society. Mangrove restoration has been attempted in many settings, and with correct methodologies it can be both simple and relatively low-cost. With this work now tried and tested there are growing calls for much wider applications of mangrove restoration. The aim of this work is to develop policy-relevant maps and statistics to support ongoing and accelerating efforts to restore mangrove forests and to foster a change in attitudes and approaches, including funding streams and conservation efforts. This project will undertake a multi-stage mapping approach to develop and subsequently refine a base-map of mangrove restoration locations. The project will combine data layers from a range of disciplines to map the ecological, environmental, social, political and economic drivers of mangrove restorability. The restoration potential maps will be combined with other products estimating the spatial arrangement of ecosystem services associated with mangrove forests. This will enable us not only to identify where mangrove can be restored, but map the potential benefits associated with restoration in terms of property protection from storms, coastal fisheries enhancement and carbon storage. Once completed the maps will be integrated into a range of resources, including scientific publications, decision support tools and policy briefs to influence national and international planning and development.

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Analysis of carbon sinks in wetlands vegetated with different mangrove species

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Abstract:

The saline aquaculture wastewater may be treated by using salt water types of constructed wetlands vegetated with mangroves. Since decomposition of pollutants in the wastewater, some greenhouse gases (GHGs) generated through degradation processes are released into the atmosphere. However, the plants also have a strong ability to sequestrate carbon. Hence, it is necessary to learn if the constructed wetland systems are carbon sinks. In this study, two mangrove constructed wetlands, Datang Constructed Wetland (DCW), discharged with mixture of mariculture wastewater and sewage as influent, and Mangrove Wetland Park (MWP), intaking seawater through high tide, were selected as the studied site. DCW was vegetated with *Avicennia marina* and *Kandelia obovata*, while *Rhizophora stylosa* is the dominant species in MWP. Two natural wetlands of Chiku Wetland (CW) and Danshuei River Estuary Wetland (DREW), where were dominated with *Avicennia marina* and *Kandelia obovata*, respectively, were selected as the studied sites. Carbon sequestrated in DCW, MWP, CW, and DREW were 837, 1144, 651, and 585 g C m-2 yr-1, respectively. However, after considering amounts of GHGs emission, the carbon sequestrated in DCW and MWP were decreased to 128 and 301 C g m-2 yr-1, respectively. However, all four types of wetlands presented carbon sinks.

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Ecosystem Design: when mangrove ecology meets human needs

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Abstract:

Once we missed the chance of preserving an ecosystem from degradation through conservation, restoration is the attempt to return the function of an ecosystem into a state that warrants historical continuity and closely resembles natural conditions. As an alternative to classical restoration, I introduce a new five-steps concept of directed design of novel ecosystems with defined functions and services, intendedly designing novel ecosystems with the aim of providing particular services that are locally or regionally required for the well-being of mankind. Thus, in contrast to conventional restoration, Ecosystem Design places humans and their needs in the center of action. For this, Ecosystem Design first assesses local and regional needs for ecosystem services to be provided. Second, Ecosystem Design defines a set of these services as goals for the establishment of a functioning ecosystem in a degraded area. Third, a toolbox of information on species characteristics and requirements, as well as on the species-specific contributions to service-provisioning, including interspecific interactions under the given environmental conditions, recommends a set of suitable species from the regionally available species pool. The set of initial species will, in a fourth step, be installed in the degraded area, and subsequent natural succession will shape and fine-tune this novel designed ecosystem. Upon installation and subsequent development of the designed ecosystem, long-term monitoring in the sixth step will allow for evaluating the success of the design and intervention if needed. Whereas this approach may in cases contrast efforts to conserve or restore biodiversity on its own sake, Ecosystem Design aligns with the Sustainable Development Goals of the United Nations in warranting human well-being in times of increasing demands for ecosystem services, especially in tropical coastal areas with ever-growing population sizes.

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