POLICY BRIEF 2019/1

The Future of Mangroves in Penang, Malaysia: Bridging Science, Policy & Perspectives

SUMMARY

Mangrove forests provide a wealth of important ecosystem functions and services. They are highly productive and support biodiversity, serve as nurseries for fish and crustaceans, and provide coastal protection against storms and erosion. As a source of income for local fisher communities, they offer fish, crabs, shrimps, and mussels, raw materials for building, and medicinal resources. Rapid urbanization on Penang Island over the last few decades has caused the destruction and fragmentation of mangroves on the east coast. Along the western shorelines mangroves remain less fragmented. As coastal and offshore development is encroaching into fishing grounds, there are on-going conflicts between developers and fisher communities whose livelihoods depend on mangroves.

Our study provides scientific basis for integrating urban mangroves into Penang´s coastal protection, land use, and marine spatial planning policies. Information was gained through field and household surveys, interviews and a stakeholder workshop. We

- examined land use in mangrove catchment areas,
- provide baseline data on biodiversity and density for mangrove trees and crustaceans,
- evaluated the functioning of these mangrove areas as nursery sites for economically important species,
- integrated perspectives from stakeholders and knowledge about the services mangroves supply to local communities in peri-urban and urban mangrove sites.

KEY RESULTS

- Mangrove forests in Penang are larger along the west than the east coast. They have a total of 14 tree species and are dominated by *Avicennia marina* (Api-api jambu). Tree community composition and density are similar at urban and peri-urban sites.

- The small urban mangrove area in the Free Trade Zone has a relatively high crab diversity and is a nursery site for mud crabs (*Scylla* spp.).

- Fisher communities are strongly in favour of conserving mangrove spaces, including sparse and densely forested sites.

- Deforestation has been attributed to state-level institutional fragmentation of policy and land use priorities, rather than community-level resource exploitation.

RECOMMENDATIONS

- Smaller fragmented mangrove sites are valued and worth protecting, in addition to the larger sites on the west coast.

- Connectivity of crab populations between sites should be considered in decision-making processes for protected areas. Mangrove rehabilitation can enhance connectivity and biodiversity.

THE CONTEXT

Penang´s mangrove histories

Flanked by the Straits of Malacca, Penang is situated on the northwestern coast of Peninsular Malaysia. Comprising both an island as well as a mainland, it spans 322 km² and has diverse ecosystems in a heavily urbanized and densely populated setting. Historical topographical maps show that Penang´s post-war urbanization and industrial development has intensified from the 1970's. This made way for the construction of a Free Trade Zone, real estate developments for housing and commercial use, garbage dumpsites, together with the creation of new aquaculture shrimp farms. Much of Penang Island´s coastlines were originally covered by mangrove forests. Today, over 30% of the island's shorelines are artificial.

Traditionally, mangroves have provided direct and indirect income for local fisher communities (*nelayan*) through food subsistence, the provision of raw materials for building, medicinal resources and biofuels, and the enrichment of fish nurseries. They have also served as sites that bear important cultural, spiritual, aesthetic and recreational values. Coastal communities dependent on sea-based livelihoods also remain aware of the protective functions of mangroves, particularly with regard to foreshore erosion and storm surges. Local spiritual meanings associated with mangroves remain just as visible as their utilitarian, resource-driven values.

Mangrove conflicts

Mangrove destruction affects local biodiversity, food webs, supply chains, water quality and ultimately will impact on cost of living and quality of life. There is on-going conflict between the developers and coastal communities whose livelihoods depend on the mangroves. This conflict has become more apparent in the last two decades with coastal development fast encroaching into fishing grounds and affecting sources of

income. Fishermen now travel further out to sea for fishing and this incurs higher expenditure on diesel and boat maintenance. Private sector efforts at providing livelihood-based compensation were often critiqued as being limited.

Existing mangrove forests

Mangroves on the west coast of Penang Island remain in Permatang Pasir, Balik Pulau (Figure 1), Sungai Burung, and Pulau Betong but they are increasingly being destroyed for aquaculture activities. Only small patches or several trees can be found on the east coast of the island at the dump site along Jelutong Expressway and at the mouth of the river Sungai Kluang. A small mangrove occurs near the Free Trade Zone. On the mainland, the mangrove north of Teluk Air Tawar is an important bird sanctuary.

Figure 1: Study sites in urban (JEL, FTZ, SS) and peri-urban areas (PP, BP, TAT) of Penang and Peninsular Malaysia.

RESEARCH METHODS AND RESULTS

Land use changes between urban and peri –urban areas

We used open access satellite imagery to classify the land use in each study site as mangrove forest, natural non-mangrove forest, agriculture, shrimp farms, cleared or urban area (Figure 2). Land use varied between urban and peri-urban sites. The most prevalent land use type for peri-urban sites was agriculture, whilst industry had a large contribution to land use in urban areas.

Mangrove diversity in urban and peri-urban areas

The diversity, community composition and density of mangrove trees and crabs were studied at three urban and three peri-urban sites (Fig. 1). Additionally, abundances, biomass and catch per unit effort (CPUE) were determined for the commercially important mud
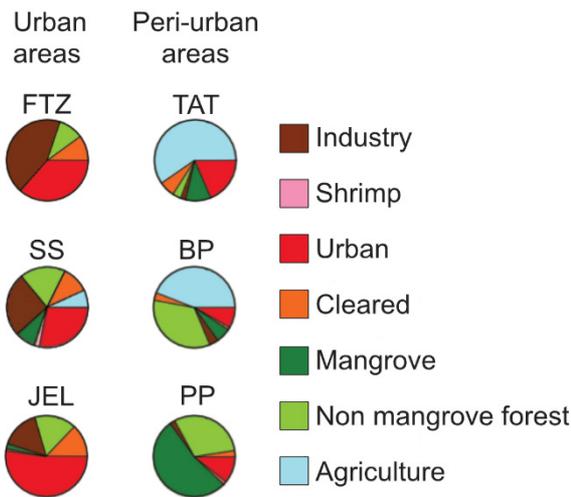
Figure 2: Study sites and their land use classifications (%) on Penang, Malaysia. For site abbreviations see Figure 1.

crabs *Scylla* spp. at FTZ and TAT. In total, 14 mangrove tree species were recorded of which *Avicennia marina* (Api-api jambu) was predominant with 89% of all adult trees and 95% of all seedlings. Tree community composition and tree density were similar at urban and peri-urban sites. The same applies for crab communities. Average species richness and crab density were similar at urban and peri-urban sites. However, the maximum of 9 species was recorded at two urban sites (Sungai Sembilang, Free Trade Zone) and one peri-urban site (Permatang Pasir).

The crab community was mainly composed of the two superfamilies Grapsoidea and Ocypodoidea with a total of 13 species and 11.5 individuals per square metre. The crab community composition was related to land use patterns like the proportion of mangrove forest, urban areas, cleared areas and industrial areas. Abiotic parameters like salinity, pH, dissolved oxygen, temperature, soil texture, were less influential. The highest mangrove degradation was recorded at the urban site Jelutong.

At the urban site FTZ, the CPUE for mud crabs *Scylla* spp. was high. This site also showed a dominance of juvenile crabs. That indicates the importance of inland connectivity to a mangrove area south of the Penang Airport, which has no fishing pressure. This result shows that urban fragments of mangroves provide valuable nursery sites, and connectivity between sites needs to be considered in the decision-making process for the designation of protected areas.

The two urban sites Sungai Sembilang and Free Trade Zone showed comparably high tree and crab diversity. These sites are valuable nursery sites for crabs and it is highly recommended to protect these small fragmented mangroves in addition to the mangroves at the west coast of Penang Island.

Mangrove associated resources

The social science component of the study aimed at exploring the importance of mangrove forests for Penang's coastal communities. We employed a mixed methods approach combining a quantitative household survey (n=80). Semi-structured qualitative group and oral history interviews were conducted with 25 participants spanning three villages selected for divergent mangrove uses and histories across spaces that were more densely urbanised and/or forested. Interviewees were typically male and identified themselves as Malay, with 10% comprising Chinese and Indian ethnicity. Households contained on average 5-6 members, and mean monthly expenditure was about 240-360 USD (Penang´s average monthly household expenditure was around 1,000 USD in 2016). Almost 94% had lived in Penang all their lives, with a smaller proportion having migrated from Padang Benggali, Betong, and Kedah. All reported fishing as their primary source of income, with little livelihood diversification among male respondents.

Target organisms requiring highest CPUE were mud crabs, catfish, prawn, *balitong* (shell), and baitworm. However, highest commercially valued target organisms (in order of importance) were mackerel, grouper, prawn, threadfin, snapper and silver-white pomfret. Flower crabs were among those that were least important (only to 2.5% respondents) followed by catfish. Timber was amongst the least harvested resource (Figure 3). No generational differences were found in resource harvest practices, CPUE or preferred types of fishing gear.

Ninety percent of those interviewed showed high dependence on boats for fishing, and only 6% indicated they owned their own vessel. There was a strong relationship between type of gear used and harvesting of flower crabs, mackerel, prawn and silver-white pomfret. The second and third most significant livelihoods (within an average fishing household) derived from small-scale trading and retail employment (64%), and those that were tourism related (16%).

All respondents revealed that their market access was mediated entirely by middlemen. The majority interviewed were members of cooperatives. Those who were cooperative members were also more likely to access and harvest mangrove resources. Irrespective of age, location, income and harvested target species, all respondents stated they believed mangrove resources had depleted over time.

Narrative interviews further revealed that coastal fishing communities were strongly in favour of conserving mangrove spaces. The local state as well as private property developers and aquaculture farm owners were blamed for mangrove clearance.

Two of the three sampled villages placed less emphasis on the potential of mangrove spaces for recreation and tourism. Yet respondents stated they preferred to restore mangrove spaces and maintain those that were healthy, while cautioning against converting existing mangrove spaces into built environments.

Summarized, our data show that fisher communities rely directly or indirectly on mangroves as they are habitats or nursery sites for economically important target species. Therefore, it is important that the mangroves will be protected and conserved.

To discuss perspectives, conflicts and potential solutions, a stakeholder workshop including state-level decision-makers, scientists, private-sector spokespersons from real estate development and tourism, local representatives from civil society organizations entailing NGOs, fisheries associations, and media was conducted in April 2017. The workshop results were summarized in the policy recommendations below.
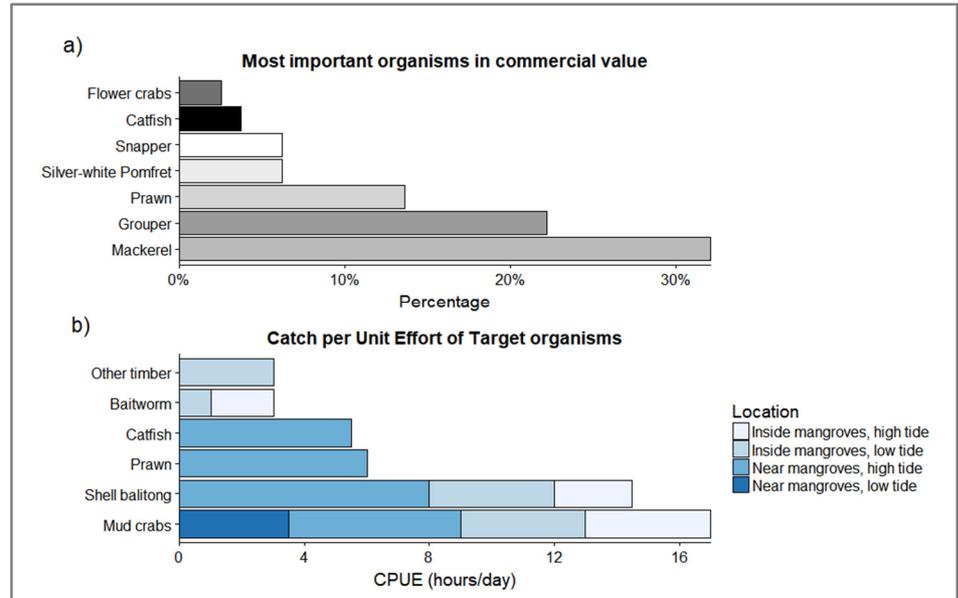
Figure 3: a) Top seven commercially valued target organisms. b) CPUE of target organisms per location (inside or near mangroves) and tide (low or high).

POLICY RECOMMENDATIONS

- The socio-economic importance and cultural values of urban biodiversity need **official state recognition.**
- Most fishers are members of a cooperative. **Awareness raising and conservation efforts** should therefore be channeled through existing institutional structures.
- **A harmonization of state and local authority policies and implementation processes** with respect to the encroachment and protection of existing mangrove spaces is needed.
- Colonial **legislature on land use practices and for coastal spatial planning** needs to be amended.

- The setbacks required for infrastructural development around mangrove forests need to be assessed carefully. **Buffer zones** should increase from 40 meters to 100 meters.
- We suggest the development of a **Master Plan for mangrove planting** across Penang. This should take biological, social and economic values into account that would be archived in an open-access database.