



Effect of Mangrove Forest Depletion on Biological Diversity

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Abstract

Mangroves provide a range of species with a rare opportunity for a home as well as essential commodities and services for people. They are one of the planet's richest maritime ecosystems. Climate change and direct anthropogenic influences are causing mangrove ecosystems to deteriorate at an alarming rate. We compared disturbed and undisturbed mangrove forests in terms of meiofaunal richness, benthic biomass, prokaryotic heterotrophic output, and trophic status to determine the consequences of mangrove habitat degradation on benthic biodiversity and ecosystem performance. We demonstrate that benthic biodiversity declined by 20%, four phyla went extinct locally, microbially driven decomposition rates dropped by 80%, and benthic biomass and trophic resources declined by 80% in degraded mangrove environments. According to the study's findings, mangrove forests must be protected and those that have been damaged must be rejuvenated to ensure the delivery of products and services necessary to preserve biodiversity and the operation of a substantial section of tropical ecosystems.

Keywords: Mangroves, Ecosystem, Biodiversity, Mangrove Forests.

Introduction

Mangrove habitats are essential to the planet's ecological and economic well-being. They cover 15,000,000 acres and are highly valuable both economically and in terms of biomass. Several commercial species of terrestrial and marine animals, especially young reef fish, use these woodlands at the land-sea interface as food sources, breeding sites, and nurseries. Because mangrove forests' primary production rates are comparable to those of tropical, wet evergreen forests, they are incredibly productive ecosystems. The carbon is stored in the biomass of trees, the majority of which is lost through decomposition. Since mangroves are widely utilized for food, lumber, fuel, and medicine, they play a significant role in human sustainability and livelihoods. They can lessen coastal erosion while protecting against significant calamities including tidal bores, tropical storms, and tsunamis (Carugati et al., 2018).

On a global basis, mangroves are vanishing at a rate of 1% to 2% every year; in the previous 20 years, the rate has increased to 35%. This is although they are important. Mangrove ecosystems are most at risk from climate change and human activities. Usually, habitat loss is associated with losses in biodiversity. Theoretical ecology assumes that biodiversity may influence how ecosystems operate, despite the contradicting findings of manipulative experiments and correlative research. The functioning of maritime ecosystems is frequently linked to biodiversity because biodiversity loss may impact ecosystem functioning and, as a result, the capacity of such ecosystems to deliver goods and services to humans. This is particularly true for tropical ecosystems like mangroves, which are among those where the effects of climate change would be felt most immediately and which also house a significant quantity of coastal species. Due to tidal impacts, sea level rise is the key issue, but it's also critical to make changes in temperature, salinity, and greenhouse gas concentrations into account. Studies have shown that variations in precipitation may also affect the amount of salt and water in the soil, which can alter the growth of mangroves and the species that make them up (Yando et al., 2021).

Searmid crabs, significant keystone engineers in many forests, consume a sizeable amount of the algal and leaf biomass in mangrove environments. Detritivorous, bacterivorous, and deposit feeders are found in the benthos and transport organic matter and energy to higher trophic levels in an extremely varied, dynamic microbial cycle. Therefore, regardless of the phylum under investigation, a decline in marine benthic biodiversity may result in several diminished ecological services. High species diversity, high abundance, rapid generation, and sensitivity to environmental changes are characteristics of meiofauna. Meiofaunal species have crucial ecological functions in the mangrove environment by promoting prokaryotic activity, preserving the mangrove food web, hastening the re-mineralization of organic materials, and consequently nutrient regeneration. These traits make them a possible tool for identifying a benthic assemblage's swift and obvious response to environmental changes, as well as their strong relationship with sediments as long-term dwellers of the benthos (Wang, Fu, Lee, Fan, & Wang, 2020). In the current study, we compared undisturbed and disturbed mangrove forests to examine the impacts of mangrove habitat degradation on trophic status and food heterotrophic production and benthic biomass as indicators of ecosystem health and meiofaunal richness as a proxy for overall benthic biodiversity. In contrast to an availability, biodiversity, and on ecosystem processes. We employed prokaryotic undisturbed mangrove region, we predicted that the damaged mangrove zone would have less biodiversity and different biological processes.

Mangrove Forests

Mangrove trees come in more than 80 distinct species. All of these trees thrive in low-oxygen soil areas with slowly moving rivers that encourage the buildup of small particles. Since mangrove trees cannot thrive in subfreezing conditions, they can only be found close to the equator in tropical and subtropical latitudes. A common way to identify mangrove forests is by the tangled mass of prop roots that give the trees the appearance of being lifted above the water. The majority of mangroves experience flooding at least twice every day due to the web of roots that helps the trees withstand the tides' continual rise and fall. The tidal flows are also delayed by the roots, which leads to a buildup of debris on the bottom and a thickening of the muddy layer. By halting erosion brought on by storm surges, currents, waves, and tides, mangrove trees protect the shoreline. Fish and other creatures seeking food and safety from predators are drawn to mangrove forests because of their extensive root systems (Idrus, Syukur, & Zulkifli, 2019).

Mangroves are trees with roots in saline soils that frequently grow underwater near tropical beaches. Mangroves are perennial plants that blossom similarly to seagrasses, however unlike seagrasses, most of their lives are spent underground. In contrast to the top stem, which is completely above the water's surface along with all of the branches and leaves, the lower trunk and extensive network of aboveground roots of a mangrove tree are often immersed in seawater. This structure creates a complicated network of habitat for a broad variety of amphibious and marine species. Mangroves, one of the few coastal plants that can endure in saltwater, cover the shoreline in dense clusters known as mangrove forests or swamps when conditions are favorable. The principal species involved in mangrove forests require extremely warm, wet conditions, hence mangrove forests can only flourish in tropical and mild temperate latitudes. Particularly large numbers of mangrove forests may be found in places like Thailand, Mexico, and Indonesia (Corte, Checon, Shah Esmaeili, Lefcheck, & Amaral, 2021).

Mangroves are ecosystem engineers because they create their environment and support a broad variety of species. They resemble the organisms that create coral reefs. When mangroves get established as dense mangrove forests, they have even been known to form whole islands. Mangroves have huge root systems that may trap large volumes of soft silt. During powerful tropical storms, networks of these sediment-trapping trees operate as a barrier against wave-induced erosion, protecting coastal ecosystems and people. Before moving on to coral reefs and other ecosystems, mangrove forests serve as crucial nurseries for a range of fish and invertebrate species, including some that are valuable to the fishing industry. Adult populations of these species suffer, as do the fishermen who depend on their harvest, without the protection that mangrove forests offer to the young populations of these species. Many different species of seabirds, ducks, and even terrestrial animals call mangrove forests their major home (Sofian, Kusmana, Fauzi, & Rusdiana, 2019). One of the most significant ecosystems in the world

is the mangrove forest, which serves as a habitat for species with high economic value and as a means of coastal protection. Sadly, they are disappearing quickly, much like many other coastal and marine regions. Due to pollution, timber exploitation, and clear-cutting for coastal development projects, mangrove forests are in danger across their range. Over the next century, at least one-third of all mangrove ecosystems will have vanished. Mangrove forests might perish in certain locations if drastic measures aren't taken to stop the deteriorating trend and protect this system. Such a departure would cause enormous ecological and economic damage in coastal areas (Savari, Damaneh, & Damaneh, 2022).

Biodiversity

The variety of organisms that make up our natural world, such as animals, plants, fungi, and even tiny species like bacteria, are examples of biodiversity. These many different species and critters collaborate in complex ecologies that resemble webs to keep the balance and support life. Everything in nature that we require for survival, such as food, clean water, medicines, and shelter, is supported by biodiversity. As people put increasing pressure on the environment by exploiting and consuming more resources than ever before, we face the risk of upsetting the balance of ecosystems and losing biodiversity. The number of mammals, fish, birds, reptiles, and amphibians has largely fallen since 1970, according to the WWF's 2022 Living Planet Report. The Intergovernmental Platform on Biodiversity and Ecosystem Services historic Global Assessment Report, published in 2019, states that more animal and plant species are at risk of extinction today than at any other time in recorded human history (Brown, Pearce, Leon, Sidle, & Wilson, 2018). 75% of the terrestrial environment and around 66% of the ocean environment have undergone significant alteration. More than a third of the world's productivity now comes from agriculture and animals. The effects of various stressors on the environment and human welfare are made worse by climate change. The overfishing of the ocean, logging, water pollution, and climate change are all results of human activity. Even in the most remote places, like our own backyards, our acts have an impact on biodiversity everywhere in the globe. Even the most significant biodiversity hotspots in the world are not immune to pressure from humans. Around 1,400 distinct animal species and at least 15,000 different plant species may be found on Borneo, a sizable island in Southeast Asia. The tallest tropical trees on earth live with well-known creatures including orang-utans, pygmy elephants, clouded leopards, rhinoceroses, and probosci monkeys. Pitcher plants come in more than 50 distinct kinds. Up to 3,000 different varieties of orchids, flying, color-changing frogs, and dart-firing snails may all be found in the wild (Chakraborty, 2019).

The abundance of natural resources in Borneo, however, has drawn more tourists than simply those who like the outdoors. The island's hardwood trees, coal, rubber, gold, diamonds, and other resources have been the subject of a decades-long conflict between powerful, worldwide interests. To create room for lucrative palm oil plantations, forests are cleared. Even the unique flora and animals of Borneo are hunted, harvested, and used for commerce. Due to all of this strain, a dynamic environment is created that nature cannot adapt to. In just 40 years, Borneo's forests have lost 30% of their original cover. Half of all Bornean orangutans, which are critically endangered, have perished in only the past 20 years. Even the *Nepenthes rajah*, the largest known carnivorous pitcher plant, is in danger. Our removal of its strands is causing the biodiversity web to begin to disintegrate. However, one of the most attractive features of biodiversity is persistence. If you ease the pressure on the environment, use resources sensibly, and give it time, it will adjust. Nature and biological variety will recover. WWF is currently working towards achieving this in Borneo (Ahmed & Glaser, 2016).

Effect of Habitat Degradation on Trophic State and Food Availability

Between the undisturbed and damaged mangrove ecosystems, we found significant differences in the quantity and quality of sedimentary organic matter in the current research. Even though both of these values were within the range of past studies, the concentration of biopolymeric carbon and total phytopigments in the sediments of the undisturbed mangrove zone was around five times higher than those reported for the sediments of the damaged mangrove region. Our results show that the main constituent of OM in mangrove ecosystems were carbohydrates, which normally make up the majority of organic matter in all vegetated systems and may contribute as much as 66% of plant organic carbon. There were considerably more organic matter components and fresh autotrophic biomass indicators in

the sediments of the undisturbed mangrove than in the disturbed one, which may act as the building blocks of benthic food webs and sustain the guild of detritus feeders. The higher ratio of proteins to carbohydrates seen in the disturbed area may be the result of a complex interaction between biological systems that prevent protein breakdown and environmental variables. It has recently been demonstrated that some labile compounds may persist for decades as opposed to only a few weeks because they require co-metabolism with another substance or reside in microenvironments where enzyme access is restricted. Our findings unequivocally show that the loss of the mangrove environment caused these systems' capacity to create OM to collapse. Even though this result was expected, the damaged forest's ability to store organic material in surface sediments was much lower than the undisturbed forest by almost 80% (Cannicci et al., 2021).

The Effects of Mangrove Habitat Degradation on Biodiversity

In mangrove sediments, meiofaunal abundance is usually substantially lower than that of the nearby soft-bottom systems. These discrepancies are frequently attributed to the significant organic enrichment that has preserved the fauna in the upper few centimeters of oxygenated layers. In the current study, we discovered that the disturbed zone's meiofaunal richness and diversity had reduced. These results cannot be attributed to a lack of oxygen and are most likely a result of the harsh climatic conditions in the disturbed area as well as the scarcity of organic materials. We further show that the meiofaunal diversity in the disturbed mangrove sediments was much lower than in the undisturbed mangrove sediments. Due to the absence of Cladocera, Kynorincha, Priapulida, and Tanaidacea species known to be sensitive to the changes brought on by habitat loss, there was a difference between the undisturbed and disturbed sample locations. In actuality, a number of these species exhibit a predisposition for colonizing vegetative systems as dwellings and utilizing vegetal waste as sustenance. Since they vanish in polluted or changed sediments, using kynorincha as an impact sentinel has also been considered (Su, Friess, & Gasparatos, 2021).

The undisturbed mangrove ecosystem was also unique due to a higher level of spatial variability, as demonstrated by improved beta diversity discovered in several locations. This discovery points to the presence of numerous substrate types, even at the smaller spatial scales, including leaf litter, bare sediments in varying stages of decomposition, and biotic surfaces that may sustain a wide range of flora and microenvironments. This type of heterogeneity is typically seen at extremely tiny geographic scales in soft-bottom habitats. Even at scales of a few millimeters, these-ecosystems typically exhibit significant environmental variation. These results collectively imply that habitat degradation resulted in a loss of biodiversity of around 20% at the level of higher taxa and an average 40% fall in individual abundance (Katili, Ibrahim, & Zakaria, 2017).

Effects of Habitat Degradation on Ecosystem Processes

The ability of the system to carry out organic matter degradation and convert the primary output into biomass was represented by prokaryotic biomass, heterotrophic production, and meiofaunal biomass, which were employed in the current study as the three main proxies of ecosystem functioning. Three times fewer bacteria were present in the damaged mangrove zone than in the undamaged one. In disturbed mangrove sediments, prokaryotic heterotrophic organism production was five times lower. Meiofaunal biomass reflects the accumulation of vegetative biomass, labile organic compound concentrations, and organic detritus. Higher meiofaunal biomass levels were detected in the undisturbed zone at each location examined. These variations imply that disturbed sediments may lose around 80% of their capacity to absorb and degrade carbon resources and about 40% of their capacity to sustain faunal biomass when compared to undisturbed ones (Gaines et al., 2020).

Conclusions

All things considered, our findings show that disturbed mangrove sediments differ from undisturbed ones in having different organic matter diagenesis and altered biogeochemical cycles, as shown by the notable decline in sedimentary organic carbon, the potential for OM degradation by microbial metabolism, and the biomass and biodiversity of meiobenthic assemblages. These findings suggest that mangrove degradation may have significant effects on adjacent ecosystems and functions, as well as meiofaunal biomass, the primary food supply for the juvenile reef fishes, which are abundant in all mangrove systems. The importance of future research into the impacts of anthropogenic and natural

stressors on mangrove ecosystems is emphasized by our study. To ensure the provision of goods and services as well as the associated ecological and economic benefits they provide, more work is needed to manage human activities within the mangrove catchment, conserve and sustainably use mangroves, and, in the event of habitat loss, restore such important ecosystems.

References

1. Ahmed, N., & Glaser, M. (2016). Coastal aquaculture, mangrove deforestation and blue carbon emissions: is REDD+ a solution? *Marine Policy*, 66, 58-66.
2. Brown, M. I., Pearce, T., Leon, J., Sidle, R., & Wilson, R. (2018). Using remote sensing and traditional ecological knowledge (TEK) to understand mangrove change on the Maroochy River, Queensland, Australia. *Applied Geography*, 94, 71-83.
3. Cannicci, S., Lee, S. Y., Bravo, H., Cantera-Kintz, J. R., Dahdouh-Guebas, F., Fratini, S.,..... Porri, F. (2021). A functional analysis reveals extremely low
4. Carugati, L., Gatto, B., Rastelli, E., Lo Martire, M., Coral, C., Greco, S., & Danovaro, R. (2018). Impact of mangrove forests degradation on biodiversity and ecosystem functioning. *Scientific reports*, 8(1), 13298.
5. Chakraborty, S. K. (2019). Bioinvasion and environmental perturbation: Synergistic impact on coastal-Mangrove ecosystems of West Bengal, India. *Impacts of invasive species on coastal environments: coasts in crisis*, 171-245.
6. Corte, G. N., Checon, H. H., Shah Esmaeili, Y., Lefcheck, J. S., & Amaral, A. C. Z. (2021). Mangrove fragments as key coastal reservoirs of taxonomic and functional biodiversity. *Biodiversity and Conservation*, 30(5), 1573-1593.
7. Gaines, L. A. G., Olds, A. D., Henderson, C. J., Connolly, R. M., Schlacher, T. A., Jones, T. R., & Gilby, B. L. (2020). Linking ecosystem condition and landscape context in the conservation of ecosystem multifunctionality. *Biological Conservation*, 243, 108479.
8. Idrus, A., Syukur, A., & Zulkifli, L. (2019). The diversity of fauna in mangrove community: Success replanting of mangroves species in South Coastal East Lombok, Indonesia. Paper presented at the *Journal of Physics: Conference Series*.
9. Katili, A. S., Ibrahim, M., & Zakaria, Z. (2017). Degradation level of mangrove forest and its reduction strategy in Tabongo Village, Boalemo District, Gorontalo Province, Indonesia. *Asian Journal of Forestry*, 1(1), 18-22.
10. Savari, M., Damaneh, H. E., & Damaneh, H. E. (2022). Factors involved in the degradation of mangrove forests in Iran: A mixed study for the management of this ecosystem. *Journal for Nature Conservation*, 66, 126153.
11. Sofian, A., Kusmana, C., Fauzi, A., & Rusdiana, O. (2019). Ecosystem services-based mangrove management strategies in Indonesia: a review. *Aquaculture, Aquarium, Conservation & Legislation*, 12(1), 151-166.
12. Su, J., Friess, D. A., & Gasparatos, A. (2021). A meta-analysis of the ecological and economic outcomes of mangrove restoration. *Nature Communications*, 12(1), 5050.
13. Wang, W., Fu, H., Lee, S. Y., Fan, H., & Wang, M. (2020). Can strict protection stop the decline of mangrove ecosystems in China? From rapid destruction to rampant degradation. *Forests*, 11(1), 55. xviboid
14. Yando, E. S., Sloey, T. M., Dahdouh-Guebas, F., Rogers, K., Abuchahla, G. M., Cannicci, S., Adams, J. B. (2021). Conceptualizing ecosystem degradation using mangrove forests as a model system. *Biological Conservation*, 263, 109355.