

Invasive species in mangrove forests (Bangladesh)

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Mangrove forests are found on the coastline near the equator and are beneficial for both people and wildlife. The mangroves provide ecosystem services and function as a habitat for many species, including some considered endangered. However, mangroves are facing a lot of disturbances and invasive species are spreading fast and altering the forest. A species is considered invasive when it outcompetes other species, causing damage or destabilizing an ecosystem and its functions. They are recognised for their rapid growth, reproductivity, efficient dispersal capabilities, and tolerance to a broad range of environmental conditions (Mukul and al. 2020). They can be categorized depending on their invasiveness : highly/moderate or potentially invasive. The Sundarbans in Bangladesh provide an array of ecosystem services, making them important ecologically, culturally and socioeconomically. Here we will study how invasive species affect the Sundarbans mangrove forests in Bangladesh and the management possibilities we have.

"Mangroves are defined as assemblages of salt tolerant trees and shrubs that grow in the intertidal regions of the tropical and subtropical coastlines" (FAO, 2007). They have a diverse and rough environment, forcing the species to adapt in different ways to cope with the environmental conditions. These species are adapted to the salty, oxygen-poor soil of the land and therefore benefit from the inhospitable conditions. A wide range of factors could harm the mangrove ecosystems and its services, for example deforestation, global warming, and invasive species. For instance, with increased temperatures, the mangrove forests will probably spread further north and south of Bangladesh, exposing them to new species. Mangrove forests act as a multiple-use ecosystem, including different types of ecosystem services. The provisioning services of mangrove forests are resources like timber, fuel wood, fish, thatching materials, honey and waxes (Uddin et al., 2013). Cultural services, on the other hand, are recreational, spiritual and educational. A coastal bioshield is a type of regulatory service provided by the mangrove forests. The last type of ecosystem service is the supporting services. Some of the most important here are their function as nursery ground for fish and habitat for biodiversity, as well as nutrient cycling.

The Sundarbans Reserve Forest (SRF) is located in the south-west of Bangladesh and considered one of the largest mangrove forests in the world. This reserve houses 300 species of flora, 291 species of fish and 425 species of fauna, some of which are threatened or endangered, like the Bengal tiger. More than 3,5 million people living around the SRF are directly or indirectly dependent on the ecosystem services of the forest (Uddin et al., 2013). Clearly, mangrove forests are important for the local and national economy and forest-dependent livelihood, as well as providing food and shelter for different species. It illustrates well the ecosystem services that are generally present in mangrove forests.

The Sundarbans mangroves are facing a lot of natural or human disturbances because of their position as an interface between the marine and terrestrial environment, they are spreading significantly in the mangrove ecosystem, altering it (Biswas and al. 2007). Almost 88% of the area is affected by invasive

species in which 55% severely damaged (Rahman, M., 2020). 23 different invasive species were found of which only 4 are exotic. These data show us the extent of the invasion and that native plant species can gradually become dangerous in their own environment. Several causes explain the presence of invasive species in the Sundarbans. First, mangroves ecosystems are favorable to them. Being between water and earth, they can host “salt- and anaerobic condition-tolerant aquatic and terrestrial species” (Biswas and al. 2018) and be invaded through both environments. Mangrove are also spatially and temporally variable which creates different habitats and so supports different invasive species (Biswas and al. 2018). Second, disturbances (promoting invasion) in the Sundarbans are caused by climate change, natural calamities or anthropogenic activities. Agriculture modifies the living by introducing new fish species, building dams for shrimp farming or causing transport pollution. The tiger prawn culture is increasing the salinity in the Sundarbans, endangering mangrove native species as the dominant tree *Heritiera fomes* and giving way to invasive species. Terrestrial side is also affected by exotic plantation, land-conversion, illegal timber harvesting and overexploitation of forest resources by management authority (Biswas and al. 2007). The latter shows us the impact of the capitalist system where trade takes precedence over the environment. Moreover, disturbance creates canopy openings. Invasive species such as *Eichhornia crassipes*, which develop in sunny sites, could take advantage of it to go beyond forest borders (Biswas and al. 2018). Humans have a role to play here since we know that deforestation leads to opening forests which endanger biodiversity. All these conditions encourage the extension of invasive species which have consequences on non-human and human beings. Changes appear in ecosystem integrity, balance and resilience because invasive species compete native ones. They fight for light, nutrients, water, pollinators and space. For example, *Excoecaria indica*, use allelopathic toxins, poisoning animals and plants for growing. The change in forest species composition impacts the genetic pool creating hybridization and leads to a loss of biodiversity, foraging habitats. For instance, the emblematic Bengal tiger suffers from this habitat loss, not suitable for it anymore (Mukul and al., 2019). Then, economic effects are documented. Economic losses are due to often ineffective management or eradication, a reduction of agriculture yields or revenue earnings from the mangroves. Moreover, invasive species can impact human health through diseases, asthmas, allergies or water contamination. As an example, *Derris trifoliata* provides shelter for pest animals. Furthermore, the presence of invasive species limits the use and management of native species or makes forest no longer sufficient to support livelihood. This devaluation of the forest “can bring about a crisis in knowledge, skills, identity, and occupations” (Thornton and al. 2019). People need to adapt their incomes, which can lead to a dependence on the state food distribution system, on the market and less on ecosystem services.

To respond to these consequences, management can take different forms depending on the invasion stage and the species. First, control and biosecurity are preventing invasion and are a response for the early stages of invasion. We need to collect knowledge about them (how, when, why they become abundant) and that is why Bangladesh Forest Department, supported by the IUCN, has initiated a *Red List of Plants and Management Strategy for the Invasive Alien Species (IAS)* in October 2020 (IUCN, 2020). The Ministry’s

priority is to mitigate species extinction, to improve the forest protection and restoration thanks to native species' identification and actions against IAS. Moreover, in Bangladesh, the Department of Fisheries and Forest shows that invasive fishes which are able to breed naturally, have predatory habits, extremely high fecundity and growth rate were introduced by humans. Indeed, the government made laws to prescribe introduced species only for restricted cultivation in closed ponds but nobody succeeded to maintain it in that way due to flood. This caused 54 indigenous fishes to become threatened within a very short time ([Amin & al., 2010](#)). Second, we saw that invaders established when mangroves face disturbances or habitat alteration (invaders reinforcing this alteration after), so habitat restoration is a key to restore mangroves' environment and allows their development. In the Sundarbans, the USAID's CREL project goes in that direction. It is a mangrove restoration programme in which villagers plant saplings along eroded river banks to protect young trees with fences until maturity. This co-management provides ecological resilience and alternative income for the local communities ([Winrock, n.d](#)). However, managers have to be careful that the restoration species will not turn into invasive as it happens with *Rhizophora mangle* in USA's mangroves. Plus, mechanical removal or biological control can be used in parallel but habitat restoration must precede them "to ensure self-sustained long term ecosystem health" ([Biswas, & al., 2018](#)).

Nevertheless, all the consequences of the invasive species' presence mentioned earlier and the management tools, consider invasive species only through a negative prism. They are described with a discourse of danger and disgust. The researcher Shonil Bagwat promotes instead to accept them as parts of the ecosystems, resources, and create management policies in this sense. For example, *Eicchornia crassipes* is highly invasive in the Sundarbans, causing eutrophication, breeding ground for pests or blocking waterways. Its eradication by chemical, physical or biological means is inefficient and expensive. Indeed, studies showed that *Eicchornia crassipes* could be used in biofuel, human food and animal feed, medicine and industry.

Finally, perhaps the most obvious threat to mangrove forest is human activity. So management practices have to question our behaviors and not only the environmental invasive species' impact. A simple solution to disappearing mangrove forests, is to simply stop cutting it down. However, stopping the expansion of aquaculture, coastal development and farming is easier said than done as we saw lots of people rely on them. One of our biggest threats to mangroves is increased shrimp farming, estimated alone to make up at least 35% of all mangrove losses. Making this particular business sustainable is a huge step in the right direction. An example for others can be Thailand, who implemented strict regulations on new farms to ensure that they don't harm and encroach mangroves ([Ocean Find Your Blue, 2022](#)).

As we have seen, mangrove forests are important for ecological, societal and economic reasons. Sadly, they are facing disturbances and invasive species, like *Eicchornia crassipes*, are spreading fast. Preserving these forests in their natural state is challenging. Managing efforts like preventing overharvesting of wood, including local communities, sourcing only from certified shrimp farms and increased awareness is important. Using invasive species as resources, such as food or biofuel may also be part of the solution. However, these are not the only threats mangroves are facing. Climate change is altering living conditions all

over the world, and more extreme weather, higher sea levels and a rise in temperatures, as well as acidity in the ocean is expected. Climate is one of the most important factors for where species can survive. When we are changing the environment faster than species adapt, we are also making these places uninhabitable for the native species. As a result, niches are opened for invasive alien species, and many of these outcompete even more native species. So, one of the biggest threats, and reasons for the increase in invasive species is climate change. Therefore, managing climate change will be our best long term solution.

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