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PLANTING MANGROVES ON INTERTIDAL MUDFLATS: HABITAT RESTORATION OR HABITAT CONVERSION?

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Abstract

After decades of wide-spread mangrove destruction and degradation, an increasing effort is being made by authorities, donor projects, environmental organisations and universities throughout the Asia-Pacific region to rehabilitate and restore mangrove forests. Among these encouraging developments, there are a substantial number of restoration projects in which mangroves are planted on intertidal mudflats. The choice of mudflats for the mangrove planting has the advantage of avoiding conflicting claims over land ownership and development, as would arise in efforts to restore mangroves in abandoned shrimp farm areas or former logging areas. However, the use of the terms "restoration" or "rehabilitation" in such cases is inappropriate, since intertidal mudflats have not been covered in mangrove forests before. Such efforts should therefore rather be termed "afforestation". Although generally poorly acknowledged outside the scientific community, these intertidal mudflats represent a rich and productive ecosystem in themselves, providing an important habitat that supports high densities of intertidal benthic invertebrates and fulfilling a range of key ecological functions. During low tides, the intertidal mudflats serve as important feeding grounds for large concentrations of migratory shorebirds, while in many areas the mudflats are exploited by humans for bivalves and crabs, contributing substantially to their income and food. This therefore suggests that planting mangroves on mudflats would represent a form of "habitat conversion", in other words changing one valuable habitat into another. Even if the afforestation is successful, the net gains in such a situation are likely to be less than in the case of restoration efforts in degraded former mangrove areas and abandoned shrimp ponds. The present paper attempts to raise concern over the large-scale planting of mangroves on intertidal mudflats by evaluating the limited success rates of such efforts, and by emphasizing the ecological importance and economic attributes of intertidal mudflats. It is argued that in the site-selection for mangrove restoration, a full environmental assessment should be made of the potential social and environmental impacts. The important ecological and socio-economic attributes of intertidal mudflats indicate that mangrove afforestation in these areas does not constitute a plaudible form of wise use of resources.

Introduction

The widespread loss and degradation of mangrove forests throughout South East Asia over the past three decades is well documented. Logging and conversion for aquaculture are among the most frequently cited causes of this degradation, which appears to have come as a result of pressures from increasing population, food production and industrial and urban development. Over the years, the awareness regarding the ecological and economic importance of mangroves has grown. As a result, countries in the region are increasingly engaged in efforts to restore this valuable resource, as reflected by an increasing number of publications and workshops dedicated to this subject (e.g. JAM, 1994; Khemnark, 1995; Field, 1996).

The goals and objectives of mangrove rehabilitation programmes vary widely from case to case, including for commercial forestry purposes, restoring fisheries habitat, shoreline protection, sustainable multiple community use purposes and ecological restoration (Field, 1996; Lewis, 1998[1]). In the case of mangrove replanting programmes for commercial forestry objectives, the choice of species has usually been limited to a few commercially important species (notably *Rhizophora* spp.) resulting in virtual monospecific plantations, without consideration of the wider ecological and socio-economic importance of mangrove forests in support of biodiversity and fisheries production and as a support base for sustaining the livelihood of coastal fishing families.

In the site-selection for mangrove planting, numerous site characteristics should be considered, including the stability of the site, rate of siltation, soil characteristics, degree of exposure to waves and tidal currents, depth of tidal inundation, height of water table, availability of freshwater, presence of pests, availability of propagules, signs of natural regeneration, etcetera (Field, 1996). Unfortunately, many mangrove restoration projects move immediately into planting of mangroves without determining why natural recovery has not occurred (Lewis, 1998[2]). Mangrove planting efforts in the Southeast Asian region have been conducted both in degraded former mangrove areas (restoration or rehabilitation) as well as in areas where mangroves have not previously occurred (afforestation). Intertidal mudflats have often been targeted as areas for mangrove afforestation attempts, either for shoreline protection against storm and cyclone damage, or in attempts to expand the mangrove area seawards believing that mangroves have the capacity of land-building (Saenger and Siddiqi, 1993).

The view is increasingly established that mangroves follow areas of mud accumulation rather than causing them, but that their establishment leads to more rapid accretion because the mangrove roots and pneumatophores effectively slow water movement and act as efficient sediment trappers (Woodroffe, 1992). However, mangrove shorelines can, and often do, undergo erosion. In his review on geomorphology and sedimentology of mangroves, Augustinus (1995) concludes that mangroves favour deposition and stimulate soil stability. Nevertheless, their role in sedimentation and land-building is dominated by the role of the geomorphological processes. The resulting morphological developments cause changing habitat conditions and hence, changing mangrove patterns. It therefore appears that the function of the mangrove vegetation is subordinate to the geomorphological development. But, although the mangroves follow areas of mud accretion, their establishment leads to a more rapid accumulation as compared to areas without vegetation (Augustinus, 1995). Not all scientists agree on the issue of mangroves as supposed land builders. However, the earlier theory of Chapman (1976) that zonation patterns in the mangrove forest reflect successional patterns that are a result of the mangroves building land have now proven wrong and are no longer accepted (Smith, 1992).

Mangrove Planting Efforts on Mudflats

Besides the obvious choice of degraded former mangrove areas as sites for mangrove rehabilitation, mangroves can also be established through afforestation on unvegetated intertidal flats and other areas where they would not normally grow. There have been numerous afforestation programmes on such mudflats in the Southeast Asian region over the past decades for different objectives and with varying degrees of success.

Perhaps the most impressive mangrove afforestation programme on accreting mudflats has been in Bangladesh (Saenger and Siddiqi, 1993; Choudhury, 1994; Siddiqi and Khan, 1996). The coastal areas of Bangladesh suffer severe annual storm and cyclone damage, and in 1970 a particularly violent storm caused the deaths of more than 300,000 people. Most of the 710 km coastline of Bangladesh is dominated by deltaic deposits of the Ganges-Brahmaputra-Meghna Rivers, which constitute the largest estuarine tide-dominated delta in the world. Originating in the Himalayas, this river complex carries an estimated annual sediment load of about 2.5 billion tonnes per year. These sediments contribute to the building up of newly formed deltaic deposits, locally known as "char" lands. To protect the lives and properties of the coastal communities from cyclone and storm damage, an area of 120,000 ha of this newly accreted land has been afforested between 1980 and 1990 with major World Bank funding (approx. 20 million US dollar for the planting costs alone). Out of the 27 species of mangroves that occur in Bangladesh, only two species, *Sonneratia apetala* and *Avicennia marina*, both of them of limited economic value for timber or pulp production, showed encouraging survival rates on the mudflats. Because of the highly dynamic nature of the Bangladesh coastline, survival of the planted mangroves was generally poor and repeated replacement planting often had to be carried out for periods of up to 3 years. Survival rates of the planted mangroves after 5 years ranged from 29 to 52% for *Sonneratia* and from 30 to 60% for *Avicennia* (Saenger and Siddiqi, 1983). Best results were obtained on char sites with a scattered growth of the pioneering grass *Oryza coaractata* (Choudhury, 1994). Among the problems encountered were insect pests, burial or smothering of mangrove seedlings due to high sedimentation rates and wave action, and winnowing and erosion of the sediment (esp. along plantation margins) causing the loss of mangroves from the plantations. During an intense cyclone in April 1991, many of the mangrove plantations were damaged, but later on showed signs of recovery, indicative of a self-repairing system. Nevertheless, despite the problems and limitations, the afforestation seems to have benefited the people of Bangladesh, notably in terms of stabilisation of the new accretions and coastal protection (Field, 1996). In a follow-up coastal embankment rehabilitation project supported by the World Bank, which started in 1993, over 60% of the approx. US$ 80 million budget was allocated for civil works (mainly repair and improvements of coastal embankments), while only 7% was set aside for afforestation of a 50 to 200 m wide belt of mangroves on the foreshore to reduce cyclone damage and embankment maintenance costs (World Bank, 1993).

In Hong Kong, an intertidal mudflat area of 1,000 m^2 was replanted with *Kandelia candel* mangroves during 1990-1991 as mitigation measure for damage from coastal construction activities (Chan, 1993). Costs amounted to a total of HK$ 1,000. The survival rate of the small area of planted mangroves was reported as "high"

Chan et al. (1988) reported on silvicultural efforts in restoring mangroves in degraded coastal areas in Malaysia. Rehabilitation of former logged-over mangrove forest areas were generally very successful. Several trials on restoring a belt of mangroves (*Avicennia officinalis*) on the exposed mudflats seaward of the eroding shoreline in Selangor during 1986, however, were not successful. All transplanted *Avicennia* saplings died within 9 months due to uprooting by strong waves and partly by sun scorching, barnacle infestations and the inability to produce new roots. They concluded that along eroding shorelines, mangrove restoration efforts in the exposed foreshore yields very poor results. Only in areas where the receding scarp is protected with structural solutions, such as interlocking concrete structures can planting be successful (Chan et al., 1988).

In the Philippines, the Central Visayas Regional Project-1, Nearshore Fisheries Component, a US$ 3.5 million World Bank project, targeted 1,000 ha of mangrove planting (largely mudflats and some denuded mangrove areas) between 1984-1992. An evaluation of the success of the planting in 1995-96 by Silliman University (1996) indicated that only 18.4% of the mangroves planted (i.e. *Rhizophora apiculata* and *R. mucronata*) in 492 ha had survived. For similar reasons, another planned 30,000 ha planting effort (Fisheries Sector Program 1990-1995) funded by a US$ 150 million loan from the Asian Development Bank and the Overseas Economic Cooperation Fund of Japan was cut short after 4,792 ha were planted (Ablaza-Balayut, 1995).

In Thailand, a massive 5-year mangrove replanting programme was launched by the Thai Government during 1991-1996 with a total budget of 750 million Baht (approx. US$ 30 million) targeting to replant 40,000 ha (Havanond, 1994; Suwannodom et al., 1998). In 1987, 21,202 ha were found to be suitable for reforestation, among which 19,642 ha were degraded forest and 1,560 ha were mudflats (ADB, 1987 in Aksornkoae, 1993). According to Suwannodom et al. (1998) the massive mangrove reforestation programme cannot be evaluated as successful, except in a few cases in Southern Thailand where a community-based management approach was followed. Recently, in an ongoing 5-year mangrove replanting project in Nakhon Si Thammarat Province in Thailand, assisted by the Japan Keidanran Natural Conservation Fund with a budget of 150 million yen (approx. US$ 1.2 million), 8,250 rai of former prawn farms and new mudflats are being replanted with mangrove trees (Sukpanich, 1999). More specific case-studies of mangrove afforestation efforts on mudflats in Thailand were reported by Angsupanich and Havanond (1996) and Bamroongrugsa (1997)

Angsupanich and Havanond (1996) reported on the survival of mangrove seedlings planted in a new mudflat area at Ban Don Bay in Southern Thailand. Rapid sedimentation in the Ban Don Bay area had resulted in the development of new mudflats which had not yet been occupied by any plant species. An area of 1800 m^2 was planted with *Avicennia alba*, *Rhizophora mucronata* and *Sonneratia caseolaris* seedlings in June 1995. All seedlings of *A. alba* and *S. caseolaris* seedlings died within 8 months of transplantation, while the R. mucronata died within a year. Seedling mortality was attributed to severe infestation with barnacles, which attached to the stems of the seedlings in densities of up to several hundreds of barnacles per individual seedling. They concluded therefore, that new mudflats, immersed in seawater for long periods, are not suitable for transplantation of these three mangrove species in areas where the seawater contains large numbers of barnacle nauplii (Angsupanich and Havanond, 1996). Experimental mangrove afforestation was carried out during 1990-1993 in small test plots on newly-formed mudflats built up by the sedimentation of Pattani River around the mouth of Pattani Bay in Southern Thailand (Bamroongrugsa and Yuanlaie, 1995). Due to high mortality rates of seedlings after initial planting, dead plants in the plots had to be replaced several times. The study revealed high mortality of *Excoecaria agallocha* and *Bruguiea cylindrica* seedlings (5-18% survival after 3 years), while *Ceriops tagal* and *Rhizophora* spp. seedlings showed 30-34% survival after 3 years. Best results were obtained with *Avicennia marina* seedlings, which showed 56% survival after 3 years.

Rhizophora mucronata seedlings planted during 1994-95 in experimental line transects on new mudflat areas in Samut Songkram Province, Thailand, showed 39% survival after 1 year (Havanond et al., 1997). In this study, seedlings were planted among natural mangrove seedlings in the upper sections of the mudflats fringing the mangrove forest. In another government-funded project during 1993-1996, an area of 800 ha of new mudflats in Samut Songkram, Thailand, was planted with seedlings of *Rhizophora mucronata* and *Aegialites rotundifolia* (Sakunathawong, 1995). Survival was low (very low for *Rhizophora*), and the high mortality of seedlings was attributed to damage to the plantations from push-net boats, predation of seedlings by crabs, infestations of barnacles settling on the seedlings and choice of unsuitable species for planting on the mudflats.

Bamroongrugsa (1997) reported on the results of mangrove afforestation on newly accreted mudflats at Pak Phanang Bay in Southern Thailand. Annual sediment delivery from rivers into this bay amount to 1.2 million tonnes of sediment per year, resulting in significant accretion of the mudflats. An area of 8 ha was planted with seedlings of *Rhizophora mucronata, R. apiculata, Bruguiera cylindrica, Ceriops tagal, Sonneratia caseolaris* and *Avicennia officinalis*. Evaluation twenty months after planting showed that approximately 40% of the seedlings had survived. Seedling mortality was attributed to invasion of small fishing boats into the plots during high tide, excessive sedimentation, poor adaptability of some species and ineffective planting techniques. Best results were obtained with *S. caseolaris* and *A. officinalis*, species of least economic importance but with greatest survival rates on the mudflat areas.

An area of about 580 ha of muddy tidal flat on the seaward side of a sea dike in Ha Tinh Province, Vietnam, was planted with mangroves between 1989 and 1993 sponsored by various NGOs, to achieve a sustainable greenbelt for coastal protection against natural surges and erosion (Hong, 1994). The main species chosen for the replanting was *Kandelia candel*, but other species were tried as well, such as *Rhizophora stylosa, Bruguiera gymnorrhiza* and *B. sexangula*. Survival rates were around 40% (Hong, 1994) but more detailed data are lacking. Earlier on, some districts in Vietnam, unaware of the adaptation of different mangrove species, destroyed young *Avicennia alba* pioneer forests and tried to replace them by the economically more attractive species of *Rhizophora apiculata* on the newly accreted land deeply flooded by the tide and failed (Hong, 1994).

The examples of mangrove afforestation efforts on mudflats described above are summarized in Table 1. A more elaborate overview of other attempted plantings of mangroves (incl. on mudflats) around the world is given in Lewis (1982). Comparison of the different studies is not easy because they do not all report the same type of data and differ also in the level of detail, which makes it difficult to draw general conclusions from these examples. For instance, it is hard to generalise about the success rate of these efforts, as this has been varyingly reported as ranging from "poor" or "good" in some studies (without any further details), while others quote the exact percentage of survival per species measured a certain number of years after initial planting. Furthermore, the issue of success itself is highly subjective, and may relate to different objectives from one study to another. The examples do, however, show that there have been a significant number of mangrove afforestation efforts on mudflat habitat throughout the South East Asian region. Although the surivival rates vary widely, virtually all studies reported problems and substantial seedling mortality. Most studies also reported that the only species that showed promising results for planting on mudflats were pioneering species of low economic value, such as *Avicennia* spp. and *Sonneratia* spp.

It remains, however, a point of debate as to whether the observed rates of survival of the artificially planted mangrove seedlings are actually higher than natural colonization of pioneering mangroves would have achieved if no planting had been conducted on the mudflats at all. Obviously, the first question one may ask before planting mangroves on mudflats is "why are there no mangroves growing here naturally?". Only on accreting mudflats would it make ecological sense to expect mangrove growth with time, and one may argue that the artificial afforestation will speed things up a little. There is, however, no experimental evidence from comparative research to support this view. In some cases, however, such as in Bangladesh, the objective of shoreline protection of people and their property against cyclone damage rightfully justifies any efforts of coastal defense, even if the implementation is expensive and difficult.

An additional point of concern in the longer term may come from the issue of sea-level rise as a result of global warming. With predictions by the Intergovernmental Panel on Climate Change of sea-level rise of 0.3 to 0.5 m by 2050, and 1 m by 2100, many mangrove forests may not be able to keep up (Ellison, 1993). Some low island mangrove areas in Bermuda already show signs of die-back as a result of rising sea-level starting with erosion at the seaward edge of the forests (Ellison, 1993). It seems likely that mangrove plantations artificially established on intertidal mudflat areas at the seaward side of natural mangrove forests are likely to be among the first sites to experience such die-back problems in future.

Ecological Importance of Mudflats

Intertidal mudflats are usually found in estuaries, i.e. in flat areas where rivers meet the sea. Here, substantial amounts of sediment are deposited by rivers and from nearby eroding shores. Distribution of the deposited material depends on the pattern of currents created by the river flow the tides and the interaction with waves in the sea. Tidal flats are in fact a relatively scarce habitat. In Europe, for example, they cover less than 0.1 % of the land surface (Barnes et al., 1997). Estuarine mudflats are very important for many shorebird populations during winter and migration, many species of which feed almost exclusively on intertidal benthic invertebrates at low tide. In temperate regions, species diversity of intertidal benthic invertebrates may be relatively low, but sediment that is rich in organic content may support exceedingly high densities - molluscs and polychaete worms can exceed 10,000 individuals per m^2 (Barnes et al., 1997). In tropical regions, the biodiversity of benthic macrofauna on intertidal mudflats is much higher and (Alongi, 1990). An equivalent biomass of macrofauna on mudflats in the tropics produces a rate of biomass turn-over (productivity) ten times faster than in temperate intertidal habitats (Ansell et al. 1978, in Alongi, 1990).

These mudflats form a vary important feeding habitat for migratory shorebirds and other waterbirds throughout the world. It is estimated that in the Asia Pacific Flyway alone, up to 5 million shorebirds migrate annually from their breeding grounds in the northern hemisphere towards the southern hemisphere, where they spend the winter season (Wells and Mundkur, 1996). When migrating, these shorebirds need to accumulate fat and muscle protein for their flight and as reserves for the early stages of breeding. To achieve this they need abundant supplies of food, particularly in spring (March-May), and notably the smaller shorebird species may need to feed unimpeded throughout periods of tidal exposure. Restriction of feeding opportunities by land-claims on upper parts of feeding grounds can jeopardize their ability to take sufficient reserves to breeding grounds to breed successfully, or even jeopardize their own survival (Davidson and Evans, 1988). On mangrove-fringed coasts, the numbers of smaller shorebird species may be limited by the few areas of mangrove-free mudflat for feeding close to the high tide (Dann, 1987). The shorebirds that feed in intertidal areas roost in flocks at high tide, moving out to feed as the tide ebbs. At low tide, when the mudflats are exposed and the shorebirds have dispersed, the different shorebird species are not distributed in a random manner but show significant preferences for particular zones on the mudflats. These preferences are due to different feeding adaptations (morphological and behavioural) in relation to the type, size and behaviour of their prey. This also reduces interference between species, which may be particularly important when mudflats are first exposed by the tide, and all birds are feeding in a very small area (Dann, 1987).

The magnitude of importance of intertidal mudflats for shorebirds becomes more clear when we look at a few examples. The Waddensea in Denmark, Germany and the Netherlands, for instance, with 4000 km^2 of tidal flats with a biomass of about 25 g AFDW m^{-2} is visited by nearly 2 million birds each year (Smit and Wolff, 1981). The Banc d'Arguin National Park in Mauretania, West Africa, one of the best studied tropical tidal flats with a surface area of 491 km^2 and a macrobenthic biomass of 14.5 g AFDW m^{-2}, is visited by over 2 million shorebirds each year, feeding on the intertidal flats at high densities of up to 40 birds per ha (Ens et al., 1990). Recent studies in the Inner Gulf of Thailand by Wetlands International and the Bird Conservation Society (Erftemeijer et al., 1999) indicate that the intertidal mudflats, salt pans and abandoned shrimp ponds in this area are visited by an estimated 80,000 - 100,000 shorebirds each year. Many of these birds depend for their survival on the biomass of macrobenthic animals in the intertidal mudflats on which they feed during low tides.

In his review on the conservation of migratory waterbirds and their wetland habitats in the Philippines, Custodio (1996) states that habitat alteration in the wake of unabated increase in human population is still the most important threat to the shorebirds. Some of the alteration, however, has been due to activities which were of good intention. An example of this is the mangrove "reforestation" programme which covered the feeding grounds of shorebirds in Puerto Rivas (Bataan) and parts of Olango Island (Custodio, 1996).

Intertidal mudflats can also of considerable importance for the livelihood of coastal villagers who collect shell-fish and other products from the mudflats at low tide. Nielsen et al. (1998) report on a detailed study of the local exploitation of bivalve molluscs and crabs at the Cua Day Estuary in the Red River Delta in Vietnam, an area inhabitated by approximately 39,000 people. They estimated that in a year at least 200,000 man days were spent on collecting 1,600 tons of bivalves and 30 tons of crabs from a 3,350 ha area. This annual catch of bivalves and crabs was sold for US$ 421,000, corresponding to a return of US$ 126 per ha of intertidal mudflat (Nielsen et al., 1998). Similar exploitation of benthic molluscs and crabs can be found in other areas around the region, including at an area such as Don Hoi Lot in the Inner Gulf of Thailand (Chulalongkorn University, 1996).

The (secondary) productivity of intertidal mudflats in the tropics is generally high, but shows considerable variations from site to site. In an overview by Alongi (1990), annual production estimates for tropical soft-bottom benthic systems range from less than 2 g DW $m^{-2}yr^{-1}$ to over 1 kg DW m^{-2} yr^{-1}. Studies by Edwards (1973, in Alongi, 1990) in Venezuela showed that as much as 70-90% of the macrobenthic production was consumed by demersal fishes. In his review, Alongi (1990) showed a clear relationship between benthic biomass and productivity and demersal fish catch in the tropics. He states that "it is undeniable that many, if not most, species of demersal fishes and crustaceans feed on benthic organisms". In general, rich demersal fisheries and abundant benthic communities tend to coincide (Alongi, 1990). This can clearly be seen in the case of the Banc d'Arguin National Park, the largest area of tidal flats in Africa, which reportedly plays a critically important role in maintenance of offshore fisheries, which in 1980 contributed 77,100 metric tonnes of fish and US$ 34.3 million to the national economy (Barbier et al., 1997).

In Japan and other Asian nations, the loss of tidal flats to development projects has become a big issue. The 4th nation-wide survey of marine environments in Japan during 1989-1992 revealed a total loss of 3,857 ha of tidal flat habitat (7% of total) since 1978 (in: Ramsar, 1998). Similarly, 350 square kilometres of intertidal flats in the Wadden Sea in north-west Europe have been lost to agriculture and coastal-defense engineering between 1963 and 1982 (Barnes et al., 1997). The awareness of the importance of mudflats for fisheries production, biodiversity conservation and wildlife support is now gradually increasing in the region. Perhaps the most impressive example of this is the recent "mudflat initiative" in the Philippines. In April-May 1999, the Philippine Government launched a draft recommendation to the signatory nations of the Ramsar Convention at their COP7 meeting in Costa Rica to protect mudflats (Anonymous, 1999). This "Mudflat Initiative" was drawn up by the government under pressure from non-governmental organisations in the Philippines that felt an urgent need to protect the mudflats, pushing with the government to stop reclamation and other detrimental development activities and move to conserve the remaining mudflat habitat in the country.

Conclusions

The rather elaborate overview given above of the wide-spread mangrove afforestation efforts throughout South East Asia on the one hand, and the ecological and socio-economic importance of intertidal mudflats on the other, is useful to draw a number of conclusions which may in themselves sound rather general and obvious, but which may have significant implications for the planning and design of future mangrove rehabilitation programmes.

The first observation is that mangrove afforestation on mudflats is not easy, it is often characterized by high mortality rates caused by factors such as barnacle infestation, smothering or burial from excessive sedimentation, wave action and so forth. Furthermore, it seems to be only the species of low economic value that are able to survive on the mudflats. The varying but often low success rate of the afforestation efforts on intertidal mudflats are not a complete surprise, as it appears unlikely that artificially planted mangrove seedlings would be able to survive where there have not been any mangroves able to develop naturally. In areas where sedimentation is substantial and mudflats are accreting, such as in the case of Bangladesh and some localized estuaries, success rates are likely to be higher. However, pioneering mangrove species have the ability to colonize and develop on these new areas naturally. The most efficient, economic and rapid mangrove planting and restoration efforts are those that supplement rather than duplicate natural recovery and/or colonization processes, as suggested by Cintron-Molero (1990). There is currently no comparative scientific evidence which proves that artificial afforestation of mangroves on mudflats is faster and more successful than natural colonization (at the same site). This is an area that future research should aim to address.

A second observation is that intertidal mudflats constitute an important habitat in themselves, supporting a high biodiversity and biomass of benthic invertebrates, sustaining productive fisheries, providing important feeding grounds for millions of migratory shorebirds throughout the region, and supporting the socio-economic livelihood of many coastal villagers who collect shellfish and crabs. Afforestation of mangroves on these mudflats therefore clearly is a form of habitat conversion, turning one valuable habitat into another. It is like having a golf course and deciding to turn it into a shrimp farm. You gain a shrimp farm, but at the same time you loose a golf course. For every hectare of mangroves afforested on intertidal mudflats, you gain 1 ha of mangroves (if successful at all), but you loose 1 ha of valuable mudflat habitat and with it the associated values for shell-fish collectors, shorebirds, demersal fishes and other wildlife. In many countries in South East Asia, there are hundreds of thousands of hectares of abandoned aquaculture ponds in former mangrove areas available for mangrove replanting (at no net loss of habitat). The potential conflicting interests over land tenure and land ownership in such areas (often illegally converted for quick but short-term economic returns from shrimp farming) should not be allowed to prevail as a reason to redirect the mangrove planting efforts to the less suitable mudflat areas, over which apparently no-one seems to claim ownership.

The important issue to remember, therefore, is to carefully evaluate the various ecological and social attributes of any area of intertidal mudflats before allocating it for mangrove afforestation. Putting the mangrove afforestation (usually justified by good and noble objectives) into a wider integrated framework of coastal zone management and development planning would be a way to ensure that the environmental and social implications of the programme are properly assessed and that the gains of the - often expensive - mangrove planting are carefully weighed against the potential losses of the various benefits and values of the mudflat habitat. We therefore maintain that mangrove afforestation on intertidal mudflats is not recommended except perhaps in cases where shoreline protection from frequently occurring severe cyclone damage form the main justification for the mangrove afforestation efforts.

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