The rehabilitation of mangroves in Southeast Asia

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Introduction
Mangroves have peculiar attributes such as aerial roots standing upright and crawling on the floor. They are valued by humans for diverse and huge economic benefits from them, e.g., wood, honey suckled sugar, medicines (Yamada, 1998), and their role in providing protection to human life and property from catastrophic oceanic processes. Despite of this age-old recognition of direct and indirect values of mangrove ecosystems, degradation and conversion of mangroves is widespread. In this paper, I introduce some issues related to degradation and rehabilitation of mangrove ecosystems in Southeast Asia.
**Mangrove ecosystems**

Local names of mangrove vegetation/ecosystems reflect their key biological features. Mangrove vegetation has been named after major species in many regions, e.g., “Utan Bakau” in Indonesia and Malay, “Pa Kongkang” in Thailand or as red tree (*Rhizophora* spp.) vegetation in China. Some local names for mangroves derive from their ecological characteristics. “Utan Pasang Surut” in Indonesia and “Pa Chai Len” in Thai mean “forest growing between up and ebb tide”, and “mud coast forest”, respectively. “Ahk” at Pohnpei in Micronesia literally means, “What is that?” pointing to unexpected arrival of propagules by sea current. Species diversity in mangrove vegetation is quite low. Extreme dominance of a species such as *Rhizophora* spp. is quite common. Low species richness is indicative of evolution of eco-physiological traits enabling survival in a unique environment in a few taxa (Watson, 1928; Tomlinson, 1986).

Mangroves are distinguished for their high biological productivity. Hence, they are also significant from the point of their capacity to sequester carbon in the form of huge standing plant biomass together with accumulation of peat. Twilley et al. (1992) estimated average aboveground and belowground biomass of mangrove forests as 178 and 146 t ha$^{-1}$, respectively, and total carbon accumulation in mangrove biomass in the world as 4.03 Gt C. However, Fujimoto et al. (1999) estimated carbon stored in peat (down to 2 m depth) as 1300 t ha$^{-1}$ in a mangrove stand established on coral reef, and as 1900 t C ha$^{-1}$ (down to 3.5 m depth) in estuary mangroves in Pohnpei, Micronesia.

Mangrove ecosystems are highly productive but are also extremely fragile. Except a few species, mangroves are intolerant to less aerated condition even though they are found in waterlogged sites. Large scaled mortality of mangrove trees is common where high sedimentation leads to low respiration as a result of burying of pneumatophores. Intensive extraction of biomass is another cause of irreparable damage to mangrove ecosystems. Loss of mangroves from Gili Petagan island located at offshore of east Lombok Island, Indonesia occurred as a result of intensive extraction of fuel-wood for coral burning to make lime as the construction material during 1970s.
Present status of mangroves

Estimates on spatial extent of mangroves in the world vary from 165,000 to 198,800 km$^2$. Mangroves of south-east Asia are spread over an area of 60,000 km$^2$ and account for more than 35% area of global mangrove vegetation. It is believed that area under mangroves, on a global scale, is shrinking by 1,000 km$^2$ annually. Among south-east Asian countries, mangrove area has reduced from 4,000 km$^2$ to 1,600 km$^2$ in Philippines and from 5,500 km$^2$ to 2,470 km$^2$ in Thailand during 1961-1986 period (Spalding et al., 1997). According to Kongsanchai (1994), about 50% of mangrove area in Thailand was converted to other land uses before 1991. Even in Malaysia, a country quite rich in mangrove management experience, about 12% of original 5,053 km$^2$ area of mangroves has been lost during 1980-90 period. The loss occurred in all provinces except Malacca (Chan et al., 1993). Data available on changes in mangrove vegetation are inadequate to draw trends for south-east Asian region as a whole.

Figure 1. Change in shrimp cultivation area in Thailand by Region 1976-1996

About 65% area of mangrove was lost due to expansion of aquaculture, 26% due to coastal zone development, 6% due to establishment of salt farms and 3% due to mining (Aksornkoae et
Area under shrimp culture in Thailand during 1976-1995 period is shown in Figure 1. The area under shrimp culture in central region increased from about 100 km$^2$ to 220 km$^2$ during 1976-79 period. It was maintained at this level except for some minor and short term fluctuations in 1988/1989. In southeast region, shrimp farming expanded from 1980 onwards reaching a level of about 300 km$^2$ area in 1991. The trend of expansion in the east coast of peninsula was broadly similar to that in southeast region. Shrimp farming in the west coast expanded after 1990 and was not as extensive as in central, southeast and eastern region.

![Figure 2: Relationships between extend of shrimp pond and number of shrimp farmers in Thailand](image)

Figure 2 shows variation in number of shrimp farmers in relation to total area under shrimp farming in different regions of Thailand. Number of farmers per unit area of shrimp farm in the eastern region was about three times higher than that in the central region. Farmers in the central region are richer and hence can sustain investments required for maintaining large ponds compared to farmers in other regions. In all regions, shrimp farming was initially concentrated around big urban centers and gradually expanded in remote mangrove regions. Besides establishment of new shrimp ponds in natural mangrove vegetation, a number of shrimp farms have been
abandoned. Spatial extent of abandoned farms is not known. Over the last two decades, there has been a loss of 981 km² of mangrove vegetation due to shrimp cultivation. Central/eastern region show the highest loss (34% of total).

**Rehabilitation of degraded mangrove ecosystems**

A large number of agencies are involved in development of planting techniques for rehabilitation of mangrove vegetation in degraded areas. Planting mangroves belonging to Rhizophoraceae (which exhibit viviparity) is not so troublesome if site conditions match the species requirements. Though germination is not a problem in viviparous species, potted seedlings may be advantageous in that mortality due to shellfishes, insects and monkeys is reduced. Nursery establishment is more critical for promoting regeneration of non-Rhizophoraceae species, which produce tiny seeds. Production and transport of healthy planting material to rehabilitation sites at proper time is a key requirement for successful rehabilitation.

Promotion of regeneration after harvest of biomass for charcoal making has been a common strategy for rehabilitation of mangrove ecosystems in Malaysia and Thailand. The concessionaires of charcoal kiln have to establish plantation if natural regeneration after harvesting were too poor to satisfy the requirements of sustainable management. Thus, tree plantation is felt necessary when natural regeneration of trees is poor. Private sector, non-government organizations and government organizations all have made significant efforts towards rehabilitation, though with minor differences in their approaches. Charcoal kiln owners have done extensive plantation in E-Sarn district, Samut Songkhram Province near Bangkok, seemingly from the point of increasing the scale of charcoal production but it also worked effectively for the recuperation of biodiversity and ecosystem services. Goal of rehabilitation is observed to vary from simply ‘re-greening’, serving only the environmental goal to a mix of plantation and fish/shrimp farming serving both environmental and economic development goals.

In Vietnam, rehabilitation of national land extensively damaged during war was considered as a prime and urgent task. Rehabilitation of mangroves carried out by the government at Mekong Delta is specifically noteworthy. Over a period of 20 years (1977-97), about
20,638 ha of degraded mangrove ecosystems were rehabilitated (Miyagi, 2003). However, the recent shrimp culture boom seems to be a major threat to rehabilitated as well as intact vegetation. The acreage of shrimp ponds has increased by almost three times during 1990-98 period (from 96,060 ha in 1990 to 249,394 ha in 1998) (Ajiki, 2003). Area of mangroves lost due to expansion of shrimp ponds is much larger than the area that was rehabilitated. Thus, one needs to address not only rehabilitation of mangroves but also protection of intact natural mangrove ecosystems.

In Karawang, north coast of West Java (Indonesia), ‘Perhutani’, a government forestry organization raised mangrove plantation in abandoned farmland. Plantation technologies were so effective that average tree height of 8 to 10 m was achieved over a ten-year period. There were, however, no plans for sustainable use and conservation of rehabilitated areas. Vegetation once recovered was again lost due to unsustainable extractions by local people. Rehabilitation will succeed only when people get sustainable benefits from the rehabilitated systems.

Conclusions

Mangroves are highly valuable resources from the point of both direct and indirect benefits to mankind. Large scaled degradation of mangrove ecosystems occurred in different parts of the world either in the past or ongoing in the present. Yet, there are many pockets where these ecosystems were little disturbed and where technological/policy interventions succeeded in recuperating ecological/economic function in degraded mangrove ecosystems. There is a need of an integrated strategy for rehabilitation of degraded ecosystems together with conservation of more or less undisturbed pockets such that rehabilitation/conservation improves livelihoods of local communities.

References


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