least harmful effects to the landform.

**Key words:** landslide hazard, monsoon, GIS, Nepal

5. Mangrove Forest and Its Role in Environmental Protection in Thailand

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Mangrove forests constitute a unique tropical ecosystem, occurring most extensively along coastal shores with muddy and sandy substrates. Ecologically, mangroves represent a sharp transitional gradient between the marine and fresh water environments or so-called "brackish water zone".

In Thailand, mangroves occur on the sheltered muddy shores and low-lying bogs of river and stream estuaries between low and high tides along the banks of the gulf of Thailand and on the west and east coasts of the peninsula. The total mangrove area in the country in 1996 was estimated at 167,582 ha. The most developed natural mangrove forests remain only along the West Coast of the peninsula especially in the provinces of Ranong, Phangnga, Krabi and Trang. The mangroves along the west of the Gulf of Thailand cover only narrow strips and are mainly classified as secondary forests.

Mangroves play a very important role in protecting coastal environments. Their functions include maintaining coastal biodiversity, purifying water pollution, protecting coastal soil erosion, cleaning air, maintaining adjoining ecosystems such as seagrass and coral reefs, protecting wind stress and increasing human security.

**Key words:** mangrove, environmental protection, Thailand

6. Mangrove Plantation as the Trigger of Geo-ecosystem Reconstruction

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Mangrove ecosystem is a unique coastal forest environment. It develops as a buffer or an interactive ecosystem between the sea and land. The total of the area occupies only one to two percent of the tropical forest area in the world. Mangrove forests and the habitats are known as a marine forest ecosystem which plays an important role not only as a timber resource but also as cultivable forest for crustacean and fish and many other fauna. However, these forest and habitats have been destroyed rapidly to produce charcoal, fuel wood production and shrimp ponds construction since the 1970's. The war also had a significant role on the ecosystem destruction.

The ecosystem is considered to be developed and maintained through both the interaction among the land, ocean, biota, and human. These points led us to recognize that the ecosystem has different characteristics from those of the forest ecosystem of the terrestrial one. This means that it is important to consider these factors sufficiently in studying various measures to restore mangrove forests. Looking at the location of the ecosystem, its formation is developed only on the upper half of the tidal zone. The spatial arrangement of the forest community is explained in relation to the series of the environmental gradient influences such as tide level, salinity, sedimentary, erosion, wave
action and tidal current and so on. Mangrove forest itself might influence the related environment. The dense aerial roots system and stems decrease the force of wave and tidal current. The force will have a role of sedimentation. The Forest canopy also has the some role of the environmental control. It is needless to say that the forest has the primary production of the ecosystem. By these special characteristics, we should pay attention to the mangrove forest as the special role of a partner of interaction forces.

The Can Gio district mangrove forest selected to the UNESCO/MAB biosphere reserve in 2001. The fact has an important meaning as the special function of the mangrove reforestation in rehabilitating the environment.

Autonomous, chain and interaction process: The development of mangrove ecosystem takes place in an extremely limited habitat, which is positioned in the upper, half of the tidal zone. The habitat is in a series of the sequence from the coastal freshwater swamp, mangrove, sea grass and coral ecosystem controlled by the sea-level change and coastal plain development. However, mangrove forests can alter their species adapting to changes in the upper half of tidal situation, and this changes the forest dynamics. At the same time, the fauna (living in the environment) can alter adapting the micro environmental changes. This is to say, the interaction between the land and biological forces in the tidal situation, that creates the characteristics of the mangrove ecosystem, is considered to follow the processes as follows. Firstly, land of the mean tide level is formed through some physical process such as sedimentation, natural levee, and tidal flat development. Seeds of the pioneer species (such as Sonneratia alba, S. caseolaris, Avicennia alba, A. marina, Rhizophora stylosa etc.) of mangrove germinate and take root. In their growth process, the trunks, branches, leaves especially dense aerial roots hold the earth, sand and suspension materials in place which slide down because of the tide and river flow. At the same time, the mangrove forest accumulates its leaves and roots at its base and on the land. These stems and roots become not only nourishment for the mangrove forests itself, but also becomes sediments, which forms the ground as an organic material. The blow ground biomass such as roots is relatively important as a role of sediment. When the ground is filled by the process, its level becomes higher and is less affected by the ebb and flow of the tide and river flow. As a result, mangroves alter into another species components (such as Rhizophora apiculata, Bruguiera gymnorrhiza etc.). If the fertility of the forest is high, the forest has larger number of various crustaceans such as crabs, mud lobsters and shellfish around it. When the level of the ground becomes even higher nearly leach to the mean high water and is seldom affected by ebb and flow and sediment transportation, the mangroves again alter into another species (such as Xylocarpus granatum, Ceriops tagal, C. decandra, Lumnitzera racemosa, L. littorea etc.) At this stage, mud lobsters form a large number of mounds by making burrows in the ground. If we observe at the area at high tide, the forest looks as if there are a lots of small islets scattered on the water surface of the forest.

Such series of the sequence of the microenvironment is a process of interaction chain processes between the biological (the force of mangrove trees and crustaceans) and physical (the force of tide, wave and fluvial process). Additionally, the effects of shadow by crown also restraints the evaporation and oxidation of the ground surface. We like to compare the process of mangrove ecosystem development between the natural habitat and the plantation habitat. Are there any similarities or differences. Some field data indicates that the plantations
might trigger ecosystem reconstruction.

**Key words:** mangrove ecosystem, land and ocean interaction, bio-geomorphology, mangrove plantation, Vietnam

7. Mangrove Rehabilitation in Abandoned Shrimp Ponds at Nakhon Si Thammarat, Southern Thailand

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Rehabilitation of mangrove forest under the Green Carpet Project supported by KEIDANREN Conservation Fund (KNCF) and Japan Fund for Environmental Conservation (JEC), was carried out in Nakhon Si Thammarat Province, southern Thailand. The aim of this project was to develop coastal environmental resources by planting mangrove along the coastline, mainly in abandoned shrimp ponds and some new mudflats. Within 5 years the total planned development area was about 1,000 ha. For this study, growth and survival rates of mangrove species planted in abandoned shrimp ponds were monitored and compared with those in the following years. Soil samples for each planting site were also analysed in order to assess the changes in soil properties after planting mangroves. The results for four mangrove species measured in the third year showed that *Rhizophora mucronata* and *Rhizophora apiculata* grew well under this condition (176.6 cm-height; 141 leaves; 3,292 g-biomass for *R. mucronata* and 120.6 cm-height; 900 leaves; 3,000 g-biomass for *R. apiculata*) with high survival rates (90.0% and 73.3% respectively). Among species, *Bruguiera cylindrica* displayed the lowest growth rates (46.0 cm-height; 171 leaves; 156.7 g-biomass) with very low survival rates (26.7%). With respect to soil monitoring, significant increases in organic matter and total nitrogen in soil were detected across planting sites as well as mangrove ages. Other plant nutrients such as phosphorus and sulphur demonstrated inconsistent values with mangrove ages and planting sites, but sharp declines were observed in levels of potassium, calcium, magnesium and sodium contents in the third year.

**Key words:** mangrove rehabilitation, abandoned shrimp ponds, *Rhizophora*, mangrove growth, mangrove soil

8. Coastal Erosion in Southern Part of Thailand

Sin SINSAKUL

Southern part of Thailand where 12 provincial coastal areas are located on the Thai peninsula. It comprises the Andaman Sea coast and Gulf of Thailand coast lie on the west and east coast of peninsula respectively. The geological processes that shape the coast are mainly erosion and deposition of rocks and sediments. The coast is subject to natural changes that operate on time scale varying from the daily change of tides and waves, and seasonal variation in climate between southwest and northeast monsoon.

Changes in sea level over thousands of year in particularly 9,000-1,000 yr. BP during Holocene epoch was created the coastal zone of southern Thailand. Their dynamic nature