

# **The Ecosystem Approach for Sustainable Forest Management: An Introduction of Ongoing Research Project in Peninsular Malaysia and Further Development of Network in Asian Countries**

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## **Abstract**

Deforestation in tropics in the last few decades was 11- 15 million hector per year. The rate has never been calmed down this century and degradation of forest ecosystem has become even more serious than before by illegal logging and the logging operation in an unsustainable manner. The deforestation and degradation are no longer local issues in the tropical regions, but global issues considering the great loss carbon sinks and bio-resources. However, socio economical development in the tropical regions is often related tightly to the intensive natural resource exploitation. Throughout the practice of the various natural resource management projects, we have learned ignorance on this type local and regional issue will never solve ecosystem degradation problems, but instead, it will sometimes cause serious conflicts between stakeholders. In these respects, harmonization of usage and conservation of forest resources is definitely needed and therefore ecosystem approach aiming at the optimization of ecosystem service values and goods should urgently introduce for the forest and landscape management. NIES together with FRIM, UPM, UTM and Forest Department in Negeri Sembilan and Malacca and other collaborating agencies and universities, has promoted the study on biodiversity and forest management in tropical rain forests in Malaysia since 1991. In this paper, we summarize this research collaboration which have mainly been carried out at Pasoh Forest Reserve and give a view how we can incorporate what we learn throughout the research collaboration to the practice of ecosystem management.

## **Introduction**

The goal of ecosystem management is to formulate land-use and natural resource–use plans that maintain a healthy ecosystem and are acceptable to local communities, while balancing the needs of society, the economy, and the environment. As such, ecosystem management is an appropriate tool for assessing and managing tropical deforestation and forest degradation. A key attribute of ecosystem approach in tropical forests is the incorporation of intensive and scientifically rigorous information on ecosystem services and goods provided by various types of landscapes. These studies can reveal both conflicting and compatible demands of

stakeholders (e.g., biodiversity, carbon sequestration, and timber production). Such information helps researchers predict the environmental risks of land-use changes and logging activities and ultimately provides the underpinnings for management strategies that facilitate many other ecosystem services derived from the forest beyond the use of timber products alone.

Since 1991, we have conducted a joint Japanese-Malaysian research project, representing collaboration between the NIES, Universiti Putra Malaysia (UPM), Forest Research Institute Malaysia (FRIM), Universiti Teknologi Malaysia (UTM), and Forest Department of Negeri Sembilan and Malacca (FD), is conducting research on ecosystem management in Peninsular Malaysia, primarily in the Pasoh Forest Reserve. Studies conducted within long-term monitoring plots, including the 50-ha Pasoh Forest Dynamics Plot, ecological plot (established in 1970s under IBP), the 40-ha plot for tree phenology observation, 6-ha plot in regeneration plot and many other monitoring plots and sites elsewhere and outside the reserve such as in the oil palm plantations, rubber plantations, fragmented secondary forests, have provided basic information on ecosystem services and rehabilitation of degraded ecosystems (e.g., baseline data on recruitment, mortality, growth, and distribution of trees).

This workshop summarizes the past and ongoing studies and future plans of the joint project and explore the possibility of future collaboration with Asian countries. The workshop consists of the following sessions, namely “Evaluation of Ecosystem Service and its changes”, “Scaling-up Tools for the evaluation of ecosystem services” and lastly “General discussion aiming the prospective study and further collaboration in Asian network employing ecosystem approach”. The summary of ongoing project and further development of study is as listed below, but detail contents of the selected topics will be provided by individual modulator.

### **1. Impacts of logging and landuse changes upon the ecosystem services**

We have studied the effects of selective logging on canopy and stand structure and tree species in the Pasoh Forest Reserve. Canopy height based on triangulation using aerial photographs was significantly greater in the primary forest (the 50-ha plot; mean height = 27.4 m) than in the regenerating forest in this reserve, which was logged in the late 1950s (mean = 24.8 m, Okuda et al., 2003a). The mean canopy surface area in the primary forest was nearly 1.5 times the value in the regenerating forest, and the mean crown size of canopy-layer trees in the primary forest was more than twice that in the regenerating forest. The species diversity index (Fisher's  $\alpha$ ) differed for the two forests, indicating that tree species diversity had also been affected by the logging. Stem densities and basal areas were similar between the two forests, but the number of stems per hectare and the basal areas of medium-sized trees (10–30 cm DBH) were distinctly higher in the regenerating forest, whereas large trees (> 90 cm) were much less abundant in the regenerating forest. The estimated total aboveground biomass of the logged forest was 274 Mg ha<sup>-1</sup>, which was significantly smaller than that of the primary forest

(310 Mg ha<sup>-1</sup>; Okuda et al., 2004). Thus, the average basal area and stem density in the regenerating forest that had been selectively logged about 40 years earlier had recovered to levels similar to those in the primary forest; however, the regenerating forest had a more homogeneous canopy structure composed of medium-sized trees growing at high density.

The logging activities also resulted in distinct changes in the fauna of the regenerating forest. The species composition of understory butterflies and micro-arthropods differed between the primary and regenerating forests (Fukuyama et al., 1998). Based on a photo-trapping survey, the species composition of medium-sized and small mammals and birds were also found to differ between the two types of forests (Miura and Ratnam, 1998; Nagata et al., 1998; Yasuda, 1998). The number of mammal species in the primary forest was higher than that in regenerating forest, forest edges, and fragmented forest. The observed changes in the canopy structure and the lack of an emergent layer may have been responsible for these changes in the animal composition and distribution in the regenerating forest. Thus, the structural aspects of the canopy layers may be indicators of the dynamics and regenerative status of a forest, as well as its species richness and distribution of wildlife.

In addition to these biological surveys, we studied carbon sequestration and soil respiration in the Pasoh Forest Reserve (Hoshizaki et al., 2001; Adachi et al., 2001). The carbon balance of the primary forest is nearly at equilibrium (CO<sub>2</sub> assimilation = emission), whereas the regenerating forests are still actively growing and act as carbon sinks. Soil respiration rates were not significantly different between the two forests, but this rate did show large spatial variation within each forest. Studies of litter decomposition revealed high heterogeneity within the primary forest plot. Soil carbon and nitrogen contents, soil water content, and root biomass explained 20–50% of these spatial variations.

## **2. A trial for the evaluation of ecosystem service**

To analyze the conversion of a forested area into agricultural lands, namely a large-scale oil palm plantation, and its impacts on the forest, we studied landscape changes in the Pasoh Forest region (ca. 60 × 60-km area) (Okuda et al. 2003b). From 1971 to 1996, about 50% of the forested area had been converted to oil palm or rubber plantations.

Based on calculations of the ecosystem service values within this area, we estimated that the economic loss by carbon stock reduction after forest clearing was not large enough to overcome the cash value derived from operation of the oil palm plantation; thus, land-use practices in the region are moving toward agriculture. This economic perspective, however, arises primarily because the ecosystem service value of the forested areas has been evaluated as much less than the agricultural economic value (i.e., essentially ignored; Costanza et al., 1997). Other potential ecosystem services of the forest, such as biodiversity and recreational values, are viewed by many in the region as unlikely to bring financial gain. These potential services, however, should be considered when analyzing the values of land-use changes.

Timber production in forests has an obvious cash value, but monetary profits tend to be concentrated in specific sectors and groups. The oil palm plantation, in contrast, appears to upgrade the employment opportunities, income, and other quality-of-life measures of whole communities. The plantation also involves many downstream industries that make palm oil products. According to our conjoint analyses of land-use profiles based on interviews with people living within the Pasoh Forest region, locals were much more willing to protect the landscape of the plantation than that of the production forest (Washida et al, 2001).

### **3. Tools for Scaling-up and risk assessment**

The studies mentioned above have allowed us to compile a database of ecosystem service values and goods, which we will use for more detailed studies in the future. Below, we discuss two particular future goals of the joint project.

Scenario analyses of long-term economic changes in services and goods from tropical forest ecosystems. To assess the long-term effects of logging and land-use changes on the values of forest goods and services, we are building an economic assessment tool for evaluating tangible and intangible values of forest and agricultural land uses in relation to local and global economies. Using economic valuation data and the ecological database described above, we are developing a PC-based risk-assessment system coupled with GIS to provide information on the potential benefits and environmental risks of proposed developments. Cost-benefit analyses were conducted based on the present and future land-use framework. With this framework, we will perform scenario analyses that correlate local socioeconomic and ecological data related to primary forests, production forests, and agricultural landscapes and incorporate models of the global economy.

However, in order to evaluate the spatial heterogeneity of ecosystem services and its chronological changes as well as to provide landscape zoning optimizing the ecosystem services, we need a scaling up tools that can extrapolate “pin-point observation on ecological events” towards broad spatial regions. As supporting system for scaling up, database prepared in this project will be of good use which facilitates the analyses of the relationship between ecological/biological events of forest and structural configuration of the landscapes. For these objectives, we are now establishing the methodology for the estimation of total above ground biomass, canopy structure, tree species composition, soil erosion process and risks, evaluation of biodiversity with employing satellite and air-borne remote sensing technology. These are all based upon the tree census data and its database. These databases and scaling up tools will allow the development of a risk assessment program, a landscape zoning plan, and other planning instruments that play important roles in ecosystem management.

Besides these researches, as a part of framework of ecosystem management, we are conducting a research on traditional knowledge by local and indigenous people, focusing how these knowledge's and skills will work for the encouraging local participation in ecosystem

management. The participation of local communities has significant implications for land-use and forest management. Indeed, without consensus building with local people and communities, land-use plans and forest management strategies will be meaningless. As a part of this project, we are investigating the sociological and ethnic values regarding forests by interviewing local community members to discern their attitudes toward forest products and commodity rights. We are focusing on indigenous people who live near forests managed under different landscape plans and logging regimes in the vicinity of the Pasoh Forest Reserve.

### **For further collaboration and networking**

Based upon these materials as mentioned above, and we will discuss the following issue in the workshop, aiming further development of networking for the promotion of ecosystem approaches.

- Problems and significance of evaluation tools for ecosystem management (evaluation methodology, monitoring and scaling up tools)
- Prospective study and Further collaboration in Asian network employing ecosystem approach

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