# FOREST RESOURCE MANAGEMENT

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## Summary

Forest has been regarded as a type of ecosystem. The conservation, restoration, and sustainable use of forest ecosystems and biodiversity are the basic issues for forest resource management. A century ago, a large area of forests disappeared worldwide, because timber production was the major goal for forest resource management during that time, and only a few people were concerned about the sustainability of forest resources. There are two different point of views concerning forest: one sees the forest as a product by human activity, that “people may conquer nature”; the other regards the forest as a natural product, the construction and usage of which should comply with the natural rules of forest dynamics. The latter concept is now accepted by most scholars. Although the sustainable use of forest resources in forest ecosystem management has been debated continuously, it is still an important strategy for forest management. There was 35–40 million $km^2$ of forest area in the world estimated by FAO in 1995 and WCMC in 1996. The increasing loss of forest areas encourages people to consider how to manage the remaining forests worldwide. Humanity faces serious environmental problems, and deforestation is one of the major elements affecting human survival. The establishment of protected areas of representative forest ecosystem in bioregions is a critical method to guarantee ecosystem service for benefiting present and future generations. Forest management has to maintain the stability, natural dynamic, and

health of forests. Timber production is a core goal for forest management, but clear-cutting, over-harvesting, and selective logging severely reduces the quantity and quality of natural forests. Many countries ban timber harvesting in old growth forests or natural forests, and may provide alternative sources of timber supply by establishing new plantations.

The management of non-timber products, such as grazing, wildlife conservation and hunting, medicine, food, and recreation is constrained by the external and internal variables, which decide the production possibility for any forest products. The restoration and rehabilitation of forest resources are based on the theories of community ecology, population biology, and ecology. The concept of community forestry is that any activity participated in by organized local people including afforestation and production of forest products has to meet the requirements of farmer households and villages, and at the same time protect the existing environment. Recently, agroforestry has been adopted to produce timber, fuels, food, and forest products to meet the demands of local people and reduce the pressure on natural forests.

## 1. Introduction

The forest is a living system composed of many species of flora, fauna, and microorganisms interacting together and environment in which they occur. Thus, forest has been regarded as a type of ecosystem, which is an important component of life support systems. These plants, animals and micro-organisms in a forest ecosystem provide forest products desired by economic development. Trees together with shrubs and herbs under the trees in the forest provide not only timber, but food, shelter and habitat for wildlife. Living organisms in the forest ecosystem can be used for fuel, food, medicines, herbages, etc. The forest ecosystem service is of great benefit to humanity, particularly for improvement of our living environment, and providing recreational and aesthetic experience. For all of these reasons, the forest should be managed as a system if all the functions and products are expected. However, sometimes there are conflicts when production of one product causes the destruction of others, such as timber production with a clear-cutting approach. No single forest stand is able to fulfill the concept of sustainability in every respect of multiple use at all times; therefore, the long-term development of an entire forest is of more significance than the state of a specific forest stand at any one time. The goal should be that all forest areas are managed for sustainable multiple use if possible. Thus, different management approaches of various forest types will be adopted according to the forest functions and sustainable utilization desired by society. The total state of the use of national forests over the decades can be viewed as implicit evidence that forest resource management of multiple objectives has been reasonably successful.

## 2. Historical Review of Forest Resource Management

The utilization and management of forest resources has a long history. Agriculture was the major economic activity before the sixteenth century and a large amount of forest areas throughout Europe, Northern America, and Asia were converted into arable lands and grasslands for grazing. Often people viewed the forest as a hindrance to the development of agriculture and animal husbandry, so management could be ignored.

Wood from the forests were prepared for use in fuel, building, means of transportation, and productive tools. The rapid development of the industries of iron-smelting and glass, which demanded large amounts of charcoal in several European countries during the sixteenth and seventeenth centuries, meant that forests were increasingly being destroyed. Since then, large amounts of timber have been needed for industrial development and population growth. The Industrial Revolution developed social productivity at an unprecedented rate, with the demand of timber for industry increasing rapidly. As a result, forest resources were destroyed on a wide scale from the middle of eighteenth century through the nineteenth century. During that period, when the United Kingdom was experiencing the beginning of the Industrial Revolution, 90 percent of timber was imported from other countries; a timber risk also occurred in Germany. Large areas of forest in the southern part of Sweden decreased to considerable extent and forests in the western part of Sweden were almost exhausted. The original forests in the southern and western parts of Finland and on the west coast of Norway also began to be destroyed. Forests in Asia and Australia were being cut. Only the vast extent of natural forests in the United States, Canada and Tsarist Russia were maintained, where the forest resources were the richest. Lately, wars have destroyed economic development and accelerated the rate of deforestation worldwide.

The core issue of forest management during the later part of the nineteenth century through to the middle of the twentieth century was timber production, with the aim being to obtain the most economic benefits possible. During this period, a series of forestry policies encouraged tree plantation, regulated the use of wood products and consumption patterns, and emphasized forest management in accordance with the law. Several countries had adopted the strategy of importing timber from other countries and ignoring the restoration of their own forests. This rapid loss of forest worldwide reminded us that people should consider the strategy of forest resource management. There are two different points of view concerning forest: one deems the forest as a product of human activity, according to the concept that “people may conquer nature”; the other regards the forest as a natural product, arguing that the building and utilization of forests should comply with the natural rule of forest dynamics, avoiding additional energy. The latter concept is now generally accepted by most scholars; the trilogy of economic, social, and ecological benefits must be harmonized, but the question of how to sustainably manage forest resources with multiple objectives based on natural rule has been debated continuously.



## 3. The Status of World Forests

According to FAO and WCMC estimates of 1995-1996, there are 35–40 million $km^2$ of forest areas on Earth, occupying 27% of land area, including natural forests and forest plantations. Among the world’s forests, North America, Russia, and South America each maintained over 8 million $km^2$ of forest areas; the sum of these three regions had more forest area than all the others. Africa had the next largest forest area, with over 5 million $km^2$; the least-forested area was the Caribbean region with about 50 000 $km^2$. In total, Europe and Continental South and South-East Asia possessed 1.8 million and 1.7 million $km^2$ of forest area, respectively. The total forest areas of Australasia, Insular South-East Asia, and the Far East extended to over 1.4 million $km^2$ each.

The decline of world forests (estimated at 50 million $km^2$ by the FAO at mid-twentieth century) has been rapid mainly because of the severe destruction of large areas of tropical forests. About 16 800 $km^2$ of tropical rainforest in the Amazon were destroyed in 1998 (reported by official sources of Brazil), and 550 000 $km^2$ of tropical rainforest (with 10 percent of total areas of certain forests) disappeared during the period 1978–1998. The forested land cleared in the Amazon has been used as cattle range, with the Brazilian government planning to develop a further 2.2 million ha of forests for commercial logging. The forest coverage of Malaysia reached 59%, but the tropical forest in Borneo and Sumatra were denuded and nearly 800 000 ha of forest per year were harvested. Massive deforestation was taking place as well in dry forests and woodlands, especially in tropical Australia, and 500 000 ha of forested land have being cut each year mainly for cattle grazing. Thus, the deforestation rate in Australia has grown; official estimates in December 1997 show that 5 million ha of land had been cut from 1983 to 1993. The annual cutting rate in Queensland was 262 000 ha during the period 1991 to 1995.

Although the forest coverage of Europe and China is increasing, old growth forests, natural forests, and other forests with high biodiversity values have almost disappeared, except for forests in some protected areas. Some of the remaining forests are also suffering from interference in various areas. Fire caused by nature or human being is a critical factor in forest damage. The largest areas of forest burned are in Brazil and Indonesia. In Brazil, over 2 million ha of forests in 1997, and over 600 000 ha of forest in 1998 were burned by fire. Huge fires raged out of control for several weeks in summer and autumn 1997-1998, destroying up to 2 million ha of forests in Indonesia. A large amount of tropical forests in the Philippines, Thailand, Chile, Mexico, and Central America, and at least 250 000 ha of forest in Florida, USA were burned. Fires also threatened the temperate forests in Khabarovsk Krai, Russia; 85 percent of forest fires were human-induced. Two-thirds of forests in Sakhalin Island were affected by fires. More than 150 000 ha of coniferous forest were burned in various parts of Greece in 1998. Frequently, fires threaten the remaining temperate and subtropical natural forests of China. In recent times, the worst years for forest fires worldwide were 1997 and 1998.

Mining activities are increasing and these have impacts on forests with the most abundant biodiversity in the world. There are five mining hotspots in some of the world's richest forests: the tropical moist forests in the Guyanan and Andean regions of Latin America; the Congolean forests in Western Central Africa; the boreal forests in the Far East and Siberian Russia; in Northern Canada; and the moist and dry forest, mountain and lowland forests and mangroves in the Pacific Rim. Mining severely threatens the largest remaining tropical forests in the Congo Basin of Africa, and the world's largest iron mine in Brazil—carved from Amazon forests—affected about 900 000 $km^2$ of forests, with 55 to 60 percent being destroyed or seriously degraded by 1996, and 2 000 $km^2$ of forests flooded for hydro-electric power. Many national parks and nature reserves with high biodiversity value are threatened by small-scale and illegal mining. It has also been known for some mines to encourage legal and illegal logging for construction of access roads and power lines. In fact, the benefits from mining are obtained mostly by developed countries, with developing countries often

carrying the cost—forest loss, energy use, and pollution (air pollution is extending throughout the world, damaging the forest's health).

Since deforestation is one of the major elements affecting human survival and economic development, the present situation of the world's forests has forced us to protect, rationally manage, restore, and rehabilitate global forest resources.

## 4. Approaches of Forest Resource Management

Scientists recognize that ecology is the theoretical basis for forest resource management, since the forest ecosystem is characterized by diverse biota, multiple layers, and functional diversity. The forest ecosystem contains hundreds to thousands of species with diverse richness, population structure, distributed patterns, and life cycle. There are three major components of the food chain in an ecosystem—producer, consumer, and decomposer; the food chain reveals one of the interactions amongst organisms. Each organism participates in a number of interactions, both with other organisms and with factors in the physical environment.

Other major kinds of interactions include competition, plant–herbivore, plant–parasite, and prey–predator, etc. Competition in plants is manifested largely through struggle for light to obtain enough energy for photosynthesis, and plants that grow in the shade of others have evolved mechanisms for carrying on photosynthesis at low light intensity. The competition for water and nutrients is important for plants as well. Plants are able to use light energy, water, and nutrients to manufacture their own foods—this is autotrophic production within the ecosystem.

Competition in animals is a struggle for food, habitat, or territory. Animals that feed on plants are herbivores, or primary consumers. Animals that feed on other animals are secondary consumers—predators, carnivores, and parasites. Decomposers obtain energy from litter and debris through decomposition.

A multiple-layered structure of a forest ecosystem consists of tree, shrub, herb, and litter layers. The tree layer in most natural forests can usually be divided into 2–3 sublayers, or 3–5 sublayers of canopy for tropical rainforest. The shrub and herb layers under the canopy occupy the lower space; different species find their own niche. The litter layer is the most critical place for nutrient cycling; this is the habitat for most of the decomposers, such as fungi, bacteria, earthworms, and other invertebrates. Multiple-layered forest provides more food, shelter , and habitat for wildlife as well.

Forest resource management should consider not only the components of an ecosystem, but also the ecosystem processes. If people over-harvest one component of an ecosystem, it might affect the others—for example, the interaction among biota and with their abiotic environment—eventually affects the entire ecosystem. Thus, the holistic ecosystem approach to forest resource management is being put in practice. Although a widely-accepted theory of forest ecosystem management has not been defined, forest ecosystem management refers to maintaining the basic structure and function of ecosystems through time for sustainable multiple use, and to enhancing the quality of the environment to best meet the needs of society.

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**Biographical Sketch**

**Lingzhi Chen** was born on 20 January 1933, in Shanghai, China, and graduated from the Department of Biology, Fuda University in 1954, and as a visiting scholar working in the Institute of Terrestrial Ecology, Merlewood Research Station, UK from 1979–1981. Since 1986 she has been Professor of Plant Ecology at the Center of Plant Ecology and Biodiversity Conservation, Institute of Botany, Chinese Academy of Sciences (CAS). Her relevant work experiences are in the following fields: the characteristics of mountainous vegetation types and their distribution role in Chinese temperate regions; planning the development of agriculture, forestry, animal husbandry, and sideline production; research on biomass, energy flow, water and nutrient cycling, and litter decomposition of forests; conservation of biodiversity; and studies on the effect of contaminated material on plant and soil and protection of the natural environment in the mountainous regions of temperate zone China. Several monographs have been published, including *The Ecology of Beijing Tianjin Region* (1990), *Biodiversity in China* (1993), *Study on Regressive Ecosystem in China* (1995*), Nutrient Cycling of Forest Ecosystem in China* (1997), *Forest Diversity and Its Geographical Distribution in China* (1997), *Studies on Structure and Function of Forest Ecosystem in Warm-temperate Zone* (1997), and *The Effect of Human Activity on Ecosystem Diversity* (1999). More than 80 papers have been published, including "Studies on Chinese Arbevitae (*Platycladus orientalis*) Forest and Its Biomass in Beijing" (1986), "The Chemical Element of Planted Forest of *Pinus tabulaeformis*" (1987), "The Ordination, Quantitative Classification of Montane Coniferous Forest in Warm-temperate Region" (1992), and "Frontiers in Biodiversity Science" (1997 et al.). Professor Chen is the "Biodiversity Expert" of the Global Environment Facility, Scientific and Technical Advisory Panel, UNEP; a member of the Biodiversity Committee CAS; a standing member of the Editorial Board of "Chinese Vegetation Map at 1:1 million"; a member of the Editorial Board of *Acta Phytoeologica Sinica*; and was the member of Chinese Council for International Cooperation in Environment and Development, Biodiversity Working Group. Professor Chen is also a standing member of the Council of Chinese Botanical Society, Editor-in-Chief of *Acta Phytoecologica Sinica*; and Vice Editor-in-Chief of *Chinese Biodiversity*.