KOREA FOREST SERVICE

# National Report on Sustainable Forest Management in Korea 2009

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This report described the national trends
and progress in Korea towards sustainable forest
management through criteria and indicators.
Through this report, the readers would not only
understand the state of the forests in Korea
but also recognize our tremendous dedication to
keeping this country green over the past 50 years.

Mountain



## 8,000 plant and 500 animal species

Forests provide a number of essential goods and services to humans such as timber, clean water and air. They also provide wildlife habitats and reduce greenhouse gas which is a great contributor to global warming. However, until recently these benefits of forests have not been recognized and appreciated in Korea.

During the Japanese colonial period in the early 20th century, forests had been severely damaged due to unrestrained exploitation of forest resources. The Korean War in the years following the colonization led to significant loss of forests. When the nationwide rehabilitation project was implemented in the 1970s, many thought that it is a tall order to restore degraded forests and further provide invaluable forest-related goods and services mentioned above.

From the 1970s, the government implemented a series of forest rehabilitation projects. Today, forest covers remarkably increased up to 6.4 million ha and 624 million $m^3$ volume stock. Approximately 8,000 plant and 500 animal species depend on forest ecosystems. Around 19 billion tons of water and 261 million tons of carbon are stored in the forests. Once our forests faced a crisis in the previous decades, its true value was recognized through the crisis.

This report described the national trends and progress in Korea towards sustainable forest management through criteria and indicators. Through this report, I hope the readers would not only understand the state of the forests in Korea but also recognize our tremendous dedication to keeping this country green over the past 50 years.

I appreciate the effort of the agencies, committee and many experts who provided guidance for this report. I look forward to continuing our work on this important initiative for sustainable forest management and conservation.

**Chung, Kwang-soo**
Minister of the Korea Forest Service
October 2009

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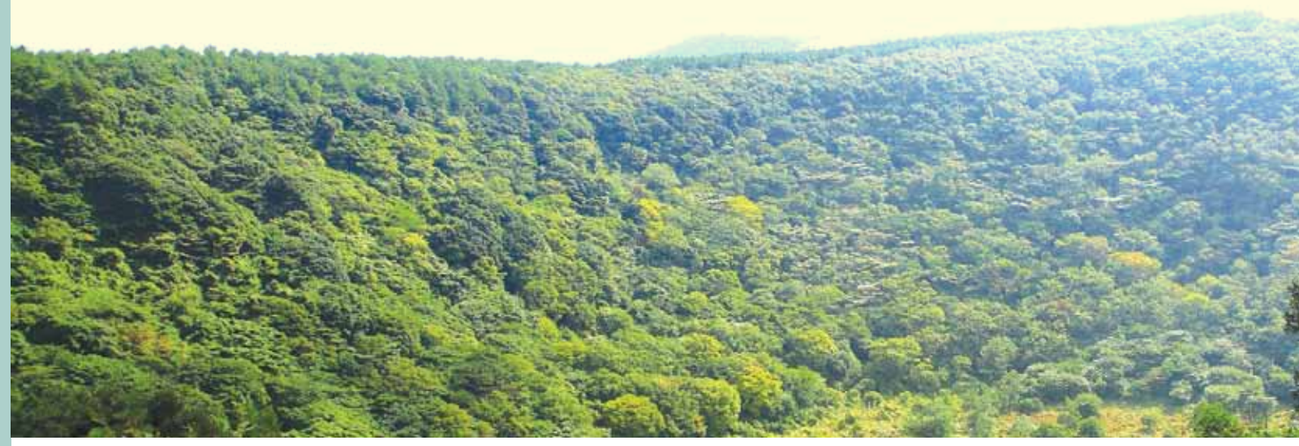
## Summary

### 1. Introduction

This report aims to show the state of forests in Korea and the indicators of national progress towards the goal of sustainable forest management (SFM). It provides scientific knowledge on forest resources in Korea as well as information on the communication process among the public and stakeholders in practicing sustainable forest management in Korea. A basic data set provided here is essential for future planning and making informed forest policy decisions. The indicators of the report reflect public interest in environmental, economic and social conditions of the forests in Korea.

This report covers a full range of up-to-date data and information important for describing indicators associated with sustainable forest management. However, there are few data available for the history of forests, land use and forest management in Korea, due to the absence or loss of data during a period of rapid social change in the early 1900s. Criteria and indicators employed in this report were selected from the Montreal Process, and a set of national-level indicators was adopted based on data available from a national survey.

Today, the Montreal Process Working Group includes 12 countries, namely, Argentina, Australia, Canada, Chile, China, Japan, the Republic of Korea, Mexico, New Zealand, the Russian Federation, the United States of America,



and Uruguay. These countries account for 90% of the world's temperate and boreal forests, 60% of all forests, 45% of international trade in timber and timber products, and 35% of the world's population.

The Forest Principles adopted at the United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, Brazil in 1992 stated the concept of sustainable forest management: forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual human needs of present and future generations. These needs are for forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and for other forest products. Appropriate measures should be taken to protect forests against harmful effects of air-borne pollution, fires, pests and diseases, in order to maintain their full multiple values.

Criteria and indicators are designed to provide a common scientific framework to assess the sustainable management of forests. Measuring indicators, in turn, provides information needed to evaluate a country's progress towards sustainable forest management. In general, 'criteria' characterize essential components of sustainable forest management and 'indicators' provide a way to measure or assess the condition of forest management for the criteria.

In 1995, the Montreal Process endorsed 7 criteria and 67 associated indicators, but in 2006 it revised a set of indicators from 47 to 44 indicators for Criteria 1-6. In 2008, indicators for Criterion 7 were reduced from 20 to 10 totaling 54 indicators. The current set of the Montreal Process criteria with the number of associated indicators are as follows:

Criterion 1. Conservation of biological diversity (9)
Criterion 2. Maintenance of productive capacity of forest ecosystems (5)
Criterion 3. Maintenance of forest ecosystem health and vitality (2)
Criterion 4. Conservation and maintenance of soil and water resources (5)
Criterion 5. Maintenance of forest contribution to global carbon cycles (3)
Criterion 6. Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies (20)
Criterion 7. Legal, institutional and policy framework for forest conservation and sustainable management (10)

At present, reporting all 54 indicators is not possible because of the difficulties in data collection. Therefore, 7 criteria and 28 associated indicators were applied in this report.

This report is the first national report on the criteria and indicators for sustainable forest management, but a pilot report was published in 2004 entitled 'National Report on the Forest Trends and Progress towards Sustainable Forest Management in Korea'. In 2005, the Korea Forest Service developed a comparable set of 7 national-level criteria and 28 associated indicators jointly with the Korea Forest Research Institute. According to the National Forest Plan, a new report will be published in the future, as well as reports on sustainability at the local and national levels.

## 2. Criteria and indicators for sustainable forest management

### Criterion 1. Conservation of biological diversity

This criterion describes area of forests by ecosystem type, successional stage and age class, area of protected forests for genetic resources and seed production, biological diversity, and landscape conditions.

Forest area trends by forest ecosystem type presented a large decrease trend in conifer forests from the mid-1980s, while area of broad-leaved and mixed forests increased. Compared to forest area in 1985, conifer forests cover decreased by 594 thousand ha, while broad-leaved and mixed forests increased by 503 thousand ha, and 38 thousand ha, respectively. Wildlife and plant communities adapted to particular stages of succession. Many of the rare species in Korea inhabit forests of the late successional stage, which is due to the fact that a substantial proportion of the forests is at the early and mid successional stages yet, although percentage of forests is high in total land area.

As the significance of conserving natural environment and biological diversity increases, the area of forests protected by government designation has been growing. Forest policies and legal system have also been improved rapidly. Implementation of the 'Act on Protection of the Baekdudaegan Mountains' and adjustment in 'the Law of Natural Environmental Conservation' are all examples of institutional improvements. In Korea, forests of ecological value and biological diversity are reserved for protected status, such as natural ecosystem reserve. As of 2008, there were 32 sites of ecological and scenic reserve (353km²), 20 sites of wetland reserve (380km²), one wildlife and wild plant reserve (26km²), 76 sites of natural parks including national parks (7,809km²), and many other categories of protected forests such as cultural reserve, forest reserve, wildlife management area, Baekdudaegan Reserve, and development restriction area. Looking ahead, more improvement in the forest policy is required to deal with the complexity of dynamic nature of the forest management at national, local and site levels, such as sustainable management of the Baekdudaegan Mountains.

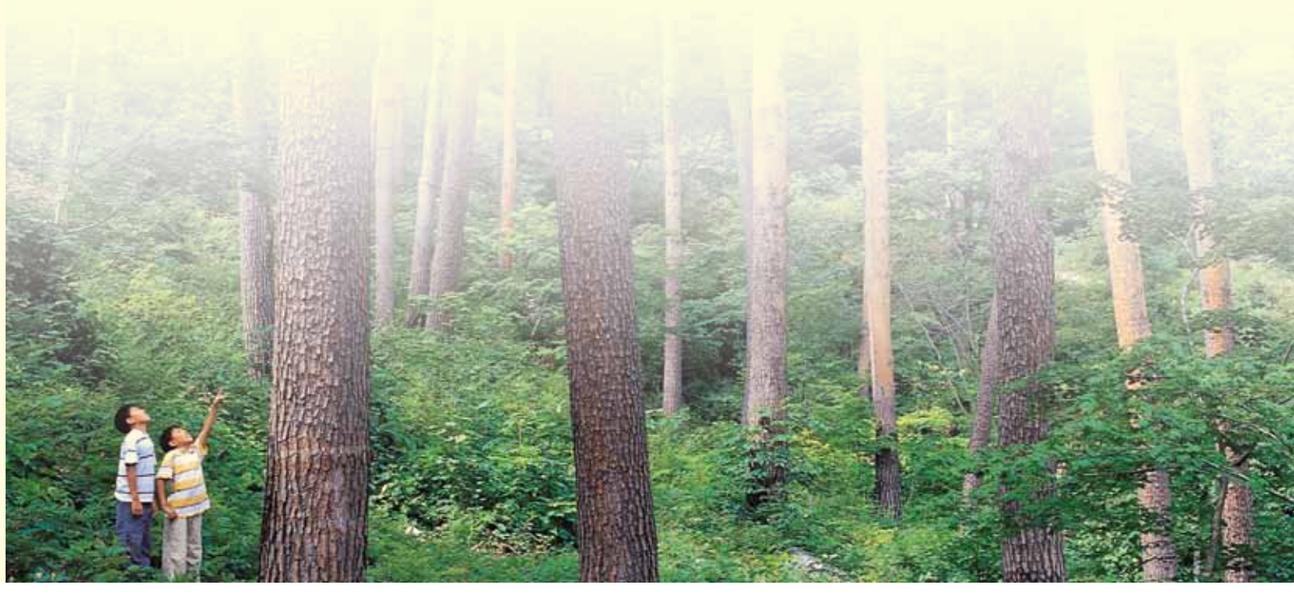
### Criterion 2. Maintenance of productive capacity of forest ecosystems

This criterion provides information on area of forest land available for wood production, area and growing stock of plantations of native and exotic species, annual harvest of wood products and sustained yield, and forest area covered by management plans.

Forest area available for wood production across the country is not documented yet although it is classified on the map of forest function. Thus, the forest stand with harvesting practice except bamboo forests is considered as forest area available for wood production.

Stand age is classified into six classes from age class I (under 10 years) to age class VI (over 51 years). In 2007, age class I covered 6.8% of the total forest area while age classes II, III, IV, V and VI covered 15.3%, 38.6%, 28.8%, 8.1%, and 2.4%, respectively, of the total forest area.

Since 2000, young stands below age class II have been rapidly decreasing while stands over age class III have been noticeably increasing. These trends resulted from the natural growth of forest stands over time and a shift of young forest stands towards older stands, which caused the rise of growing stock of forests.



Plantation area of native species has increased since 1999 due to implementation of new forest policy, the Fourth National Forest Plan (1998 to 2007) that focused on expanding plantation with native species for economic and environmental consequences. Plantation area declines with more reduction in the exotic species than that of the native species. There were six native species recorded in 1998 and it increased to 41 species in 1999.

Over the past five years, average annual growth was approximately 20 million $m^3$ and average annual harvest was about 2 million $m^3$. The harvest to growth ratio was as low as 10% because many of the forest land were not on proper age for harvest.

As the stand age class becomes older, the amount of harvest increases. However, a drop in domestic timber prices keeps the harvest to growth ratio low too.

Forest management plans are renewed every 10 years. However, area of private forest land covered by management plans has diminished since it switched from mandatory to voluntary. Overall, the trends on forest area covered by management plans showed continuous decline.

## Criterion 3. Maintenance of forest ecosystem health and vitality

Maintenance of forest ecosystem health and vitality is critical to ensure forest sustainability. Insect infestation, fire and air pollution are the most important disturbance factors that impact directly forest health in Korea. Recent increase in human economic and social activities to forest ecological conditions has caused influx of invasive species, increase in fire damage and widespread air pollution, all of which pose threats to forest health and vitality.

Forest insect infestations occur through complex interactions within ecological processes, where alteration of forest stand types and weather mainly affect type of species and patterns of insect infestations.

In 1997, pine needle gall midge (*Thecodiplosis japonensis*) became established in Korea and caused extensive mortality to pines. The Korea Forest Service and local governments worked in cooperation to minimize damage from insect infestation, and sucessfully prevented its spreading. In 2005, pine wilt nematode (*Bursaphelenchus xylophilus*) was found across the country and the national scale management efforts had been made to protect forest against its spreading. As a result, the damaged areas decreased from 7,871 ha in 2006 to 6,855 ha in 2007.

In Korea, all forest fires are the result of human activities. Recently fire frequency and intensity are gradually increasing as a result of accumulated fuels in forests. Catastrophic fires occurred at Gosung in 1996 and in east coastal area in 2000 swept through many forests in Baekdudaegan region, which is the core mountain range and watershed line that runs through the Korean Peninsula. Based on this experience, an integrated fire management plan was set up by government and more scientific and effective fire management system was developed.

Research on the potential impact of air pollution on forest ecosystem in Korea set off from 1993. Long-term monitoring is conducted every year for $NO_2$, $SO_2$ and precipitation pH in the atmosphere at 65 monitoring stations across the country. Based on data collected over the last ten years, precipitation pH declined gradually and the concentrations of $NO_2$ and $SO_2$ in the atmosphere were low and indicated a decline, too. Overall, air pollution did not have a significant impact on forest ecosystem in the nation.

## Criterion 4. Conservation and maintenance of soil and water resources

Soil and water are primary components of forest ecosystem and play an important role in nutrient dynamics and element cycling. Natural agents such as landslide and fire, and man-made activities like land conversion and development are the main causes of soil erosion and water pollution. Thus, there are long-term monitoring and research needs for loss and disturbance of soil and water.

Korea started measurement of landslide area from 1976. Before the 1970s, over 10 percent of total forest land area was highly degraded and considerable amount of soil loss and landslide took place in the forest. Efforts to rehabilitate degraded forest through government programs in the 1970s were quite successful to manage erosion risk and today soil erosion from the degraded land does not occur in most cases. However, a series of recent storms and intensive rainfalls led to a considerable increase in landslide particularly after 2002.

Chemical analysis of the soil was conducted from 1984 for soil pH, contents of organic matter, nitrogen, kalium, magnesium and natrium in 915 plots nationwide. The result suggested that forest soil pH was stable to decreasing since 1990, with no significant changes in soil chemical properties except kalium and natrium. However, a total of about 6 thousand ha of forest have been converted to other uses each year since 1999 and the area affected by landslides and fires extends over 100 ha each year. It is necessary to monitor effects of land use change on chemical composition of soil organic matter in the converted region.

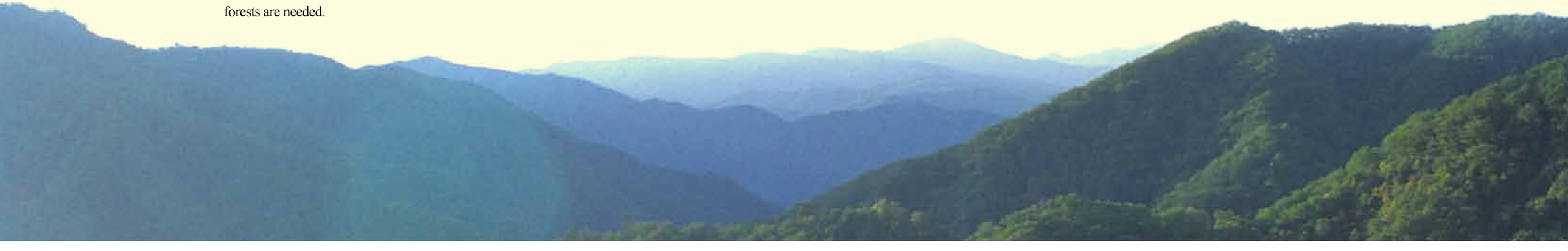
In order to conserve soil and water resources, over 323 thousand ha of forests were designated as protection forests, in which land use conversions or management activities are prohibited. However, the area of protection forests is currently decreasing. More systematic and practical management of protection forests are needed.

## Criterion 5. Maintenance of forest contribution to global carbon cycles

Forest contribution to global carbon cycles could be indicated by total forest ecosystem carbon pools, and carbon budget. Korea is ranked high in the index of greenhouse gas emissions due to robust growth of energy-intensive industries such as steel, oil chemistry, electrical power, automobile, and ship building. In response to current emissions trends, a series of intergovernmental conventions focusing on combating global warming were held since the Rio Earth Summit in 1992. The Kyoto Protocol in 2005 established legally binding commitment for the reduction of greenhouse gases produced by industrialized nations. In Korea, interest in forest carbon sequestration has greatly increased in an effort to mitigate climate change.

Carbon sequestration is the process by which carbon dioxide is taken up by plants through photosynthesis and stored and cycled as carbon in biomass, dead wood, litters and soils. As of 2005, total carbon stocks in forest biomass were estimated to be 261 million tC. Of this, conifer forests account for 44 percent and broad-leaved forests account for 56 percent. Forest carbon budget has been stable and the net removals remained around 37 million $tCO_2$/year, contributing significantly to the carbon balance in Korea.

Now a research is ongoing to develop country-specific emission factors for a number of dominant tree species in Korea, and to improve some statistics related to activity data to prepare measurable, reportable and verifiable GHG inventory.



## Criterion 6. Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies

Forests provide invaluable environmental and ecological benefits as well as a broad range of social and economic services. While other criteria mostly describe sustainability of forest management in terms of environmental condition, this criterion covers sustainability associated with socio-economic benefits of forests. Of them, this report provides a possible set of indicators for monitoring. They are, production and consumption of wood, wood products and non-wood forest products, contribution of the forestry sector to GDP, and recreation and tourism.

Demand for wood has continuously increased in Korea with the rapid economic growth and industrialization from the 1960s. Large portion of the demand mainly came from construction industry and manufactories. In late 1997, it declined temporarily due to national economic crisis but in general increased steadily. As the quality and standard of life have improved, new lifestyle trends increase wood demand rapidly and encourage remodeling of houses and apartments using wood as building material.

Despite increasing wood demand, wood supply is so low because most forests in Korea are young stands, producing small-diameter logs. Free trade in the wood and wood products in the 1970s influenced Korea to be heavily dependent on imports. However, following the economic crisis in 1997, the government launched the national campaign of forest tending including thinning to increase employments and domestic timber supplies. As a whole, forestry sector is still experiencing poor productivity conditions, showing a consistent decline in GDP contribution rate.

While forest industries showed a downward trend, public uses of forests for recreation and tourism grow steadily. Since the Mt. Jirisan was reserved as the first National Park in 1967, natural reserves including national parks are estimated to cover about 512 thousand ha, 8 % of all forest land. In particular, the number of recreational forests is fairly increasing to 126 sites as of 2007, at nearly 135 thousand ha with 6 million visitors.

## Criterion 7. Legal, institutional and economic framework for forest conservation and sustainable management

This criterion is to address forest policy issues associated with current legal, institutional and economic framework for forest conservation and sustainable management. First of all, it is essential to clarify property rights and resolve disputes around the ownership. And the legal and institutional framework should be arranged as a means to implement sustainable management. In doing so, public participation and sharing information with the public is indispensable to improving forest policies and practices.

Ownership of forest lands has regulated through the ‘Framework Act on Forest’ in Korea. Currently about 69% of the forest lands in Korea is owned privately, 23.6% by government and 7.7% by various public sectors.

The hierarchy of forest planning is largely divided into four levels in Korea. National forest plan is placed at the top of the forest plan which is established by the Minister of the Forest Service every 10 years, dealing with basic objectives and agendas of forest policies at the national scale. Province forest plan comes in the second place based on the regional characteristics. The forest comprehensive plan comes the next based on national forest stations and local governments. The lowest level of forest plan is operational plan. While the above three plans are strategic ones toward sustainable forest management, the operational plan described details of the forest operations.

In Korea, various government organizations including the Ministry for Food, Agriculture, Forestry and Fisheries, the Ministry of Environment, the Ministry of Land, Transport and Maritime Affairs, and the Forest Service undertake forest-related tasks, and each organization has legal measures to involve stakeholders in data collection and discussions at national and sub-national levels. Also, there are numerous corporations, private organizations and NGOs associated with forestry sector working for informed forest policy decision-making.

## 3. Conclusions and recommendations for future action

The Montreal Process Criteria and Indicators (MP C & I) have gone through many phases of review and refinement since it was first launched in 1994. In 1995 MP member countries adopted the Santiago Declaration endorsing the 7 criteria and 67 associated indicators for sustainable forest management. In 2006, a set of indicators for Criteria 1-6 was revised from 47 to 44 indicators in order to allow flexibility in applying the MP C&I. In 2008, 20 indicators for Criteria 7 was reduced to 10 indicators resulting in 54 indicators in total.

The MP member countries set up the Technical Advisory Committee (TAC). The TAC is comprised of forest experts from all member countries and provides technical and scientific advice on issues related to data collection, indicator measurement and reporting. In 2004, Korea prepared the pilot national report using the original set of MP C&I and assessed national forest trends and progress toward sustainable forest management. Five years later in 2009, Korea used the revised indicators to prepare this first national report. Because the pilot report was not submitted to the MP Liaison Office and not listed on the MP website. This report would be the first release of national report from Korea and will be available on the MP website.

The next phase of our work would be implementation of criteria and indicators, which means a process that relates knowledge and information learned from forest monitoring, assessment and reporting, to the formulation of forest policies needed to facilitate sustainable forest management. In November 2001, Yokohama, Japan, an International Expert Meeting in support of the United Nations Forum on Forests was held to discuss monitoring, assessment and reporting on the progress towards sustainable forest management. The ultimate objectives of criteria and indicators are to illustrate the progress toward sustainable forest management, to understand data trends through time for individual criteria and indicators, to provide information for policymakers to make better decisions, and to give feedback for the policy making process.

Recommendations for future action are as followings.

First, it is necessary to evaluate the report. Sustainability of forest management could not be indicated by single criterion or indicator, rather it should be considered in the context of all 54 criteria and indicators. For example, current rapid decrease in forest areas in developing countries is a good indication that forest management is not taking place properly. Yet, sustainability should be assessed not by that indicator only, but by all criteria and indicators in relation to social, environmental and economic aspects of sustainable forest management.

Second, it is recommended to use the report as a policy framework. The information and knowledge learned from a series of monitoring, assessment and reporting process following preparation of this report provides a framework for developing policies aimed at supporting sustainable forest management in the next stage. Indicators exhibit the extent of progress against particular or specific objectives. When a single indicator is not enough to measure or describe sustainability, additional criteria and indicators may be required.

Third, it is recommended to compare SFM C&I across countries. While the Montreal Process is basically designed to assess sustainability at the national level, it also provides a basis within and across countries to share the information and knowledge learned and helps to improve our capacities for the assessment and report on forests. Thus, this report will serve as a tool to communicate our efforts to carry out sustainable management of forest to the international community.

Fourth, coordination with forest certification system is necessary. Concerning the application of criteria and indictors, one could strongly argue that sustainability of forest management should be assessed only at national level, not at management site and local levels. However, as Korea expands the forest certification system in national forests, use of the MP criteria and indicators as a complementary measure is increasingly needed. Coordination with the forest certification system should be considered in the course of improving criteria and indicators.

Chapter 1

# State of the forests in the Republic of Korea

Tree

## 1. Geography

Korean Peninsula is located between 33° 7′ and 43° 1′ in northern latitude, and 124° 11′ and 131° 53′ in eastern longitude, sharing a border with China and Russia to the north. It extends for about 1,000 km southward and its width is about 170 km from East to West.

Some 70% of the terrain consists of mountains and uplands separated by deep, narrow valleys, with the highest elevation of the peninsula's mountains lower than 3,000 m. Plains and lowlands constitute only 20% of the total land area and are located primarily along the south and west coasts. Considering the great majority of the population, industry and social infrastructure lie in the plains, it is critical to make the most of the forests as dominant part of the landscape for sustainable development of Korea.

## 2. Climate and soil

Climate is one of the most important factors of tree growth and affects tree species distribution. The annual mean temperature of northern region (between 39° and 43° in northern latitude) is 2.5˚C to 10˚C, 10˚C to 12.2˚C in central region (between 37° and 39° in northern latitude), and 12.5˚C to 15˚C in southern region (between 22° and 37° in northern latitude). Nearly 50 to 60% of all rainfall takes place in summer, with the annual mean precipitation of 1,000 mm to 1,800 mm in southern region and 1,100 mm to 1,400 mm in central region.

The pH scale measures soil acidity. The soil pH in Korea ranges mostly from 3.7 to 8.5, and response and tolerance to soil acidity vary by tree species. For example, *Pinus thunbergii, Pinus densiflora, Picea jezoensis, Abies nephrolepis,* and *Abies firma* show strong tolerance to acid, while *Thuja orientalis, Ulmus davidiana,* and *Celtis aurantiaca* require sub-acid or neutral soil.

## 3. Forest succession in the Korean Peninsula

Located in the Far East Asia with mountainous geography and surrounded on three sides by the sea, the Korean Peninsula has a mix of continental and oceanic climates, which offers a favorable condition for forest ecosystem and biological diversity.

However, low water holding capacity of widespread granite and low rainfall during the vegetation growing months of spring tend to limit germination and sprouting.

Table 1.1 Forest succession in the Korean Peninsula

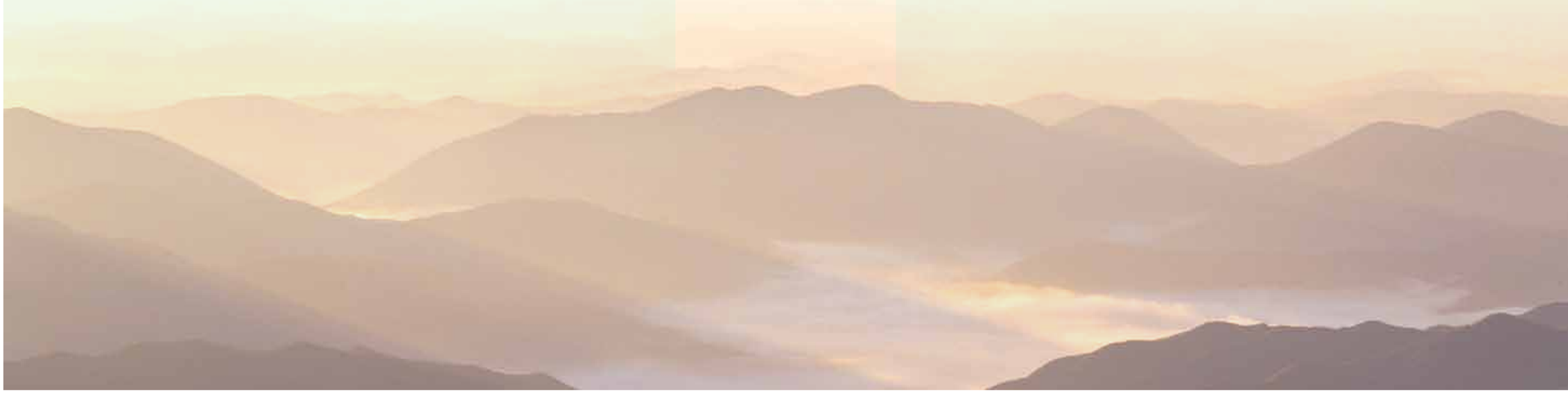
| Period | Forest cover type |
|---|---|
| From 17,000 to 15,000 years ago | *Picea, Pinus,* Soft pines, *Larix kaempferi,* etc. (cold temperature) |
| From 15,000 to 14,000 years ago | Herbs, *Dryopteridaceae* (cold temperature due to late freezing time) |
| From 10,000 to 6,700 years ago | Plants that favor cool temperature conditions were distributed in the central east coast, and plants that favor warm temperature conditions were distributed in the southern region. *Quercus, Pines, Carpinus, Corylus heterophylla,Ulmus davidiana, Juglans* (cold humid temperature) |
| From 1,400 years ago to present | Hard pines, *Loganiaceae* |

It is not easy to trace back the natural history of forests from Paleolithic times onwards but pollen analysis of lake deposits provides information about forest succession in the Korean Peninsula as shown in the table 1.1 above.

Of temperate climate zone, oaks are dominant species, whereas in Korea pines have become the largest single forest cover type as a result of land use change and disturbances for a long period.

With the population increase and agricultural expansion in the Korean Peninsula, growing demand for forest resources and fuelwood, clearing forest land and exploitation of forest biomass brought about lower levels of organic matter and nutrients, which greatly limited variety of broad-leaved species and helped spread the pines capable of growing on low productive soils. Some argue that pines had been protected by law for building materials during the Chosun Dynasty, which played a part in changing broad-leaved forests into pine-predominant forest type.

In the south of the Korean Peninsula, there are native warm-temperate forests, broad-leaved evergreens. But increasing human disturbances put them at risk by changing into mixed forests like broad-leaved deciduous mixed forests, conifer and deciduous mixed forests and pine forests. Warm-temperate forests in Korea are located at the closing line to the north of the warm temperate climate zone, bordering with the temperate climate zone, so that once they are destroyed, it is seriously difficult and slow to get back to the original forest cover type.



## 4. Forest zone

According to the climate zones in relation to its altitude through ecology and botany, Korea lies in a broad band of broad-leaved deciduous forests or conifer and deciduous mixed forests.

Although it is located between 33° 06′ and 43° 01′ in northern latitude, the climate of Korea differs considerably from north to south for it is surrounded on three sides by the sea, with a major mountain range stretching southward in the middle of the country. Taken together, it has a variety of tree species. Forest vegetation in Korea can be largely divided into warm temperate, cool temperate and frigid forest zone (Table 1.2). The cool temperate forest zone is generally divided into three subdivisions, including northern, central and southern regions.

Table 1.2 Forest zone, cover type and tree species in the Korean Peninsula

| Forest zone | Latitude | Annual mean temperature | Forest cover type | Specific tree species |
|---|---|---|---|---|
| Warm temperate forest (broad-leaved evergreen) | Below 35° (coast: 35°30′) | Above 14°C | Native broad-leaved evergreen forests were mostly extinct and changed into broad-leaved deciduous forests, conifer and deciduous mixed forests, and pine forests in many locations | *Quercus acuta, Camellia japonica, Castanopsis sieboldii, Cinnamomum japonicum, Machilus thunbergii, Cinnamomum camphora, Quercus myrsinaefolia, Pittosporum tobira, Quercus salicina, Ilex integra, Euonymus japonicas, Aucuba japonica, Cleyera* |
| Cool temperate forest (broad-leaved deciduous) | Between 35° and 43° except alpine regions | 5~14°C | Native broad-leaved deciduous forests were mostly extinct and changed into pine forests in many locations | *Fagaceae, Zelkova serrata, Pinus densiflora, Betula davurica, Betula schmidtii, Pinus thunbergii, Pinus koraiensis, Abies firma, Cephalotaxus koreana, Pinus thunbergii, Pourthiaea villosa, Platycarya strobilacea, Acer palmatum, Euonymus japonicas, Carpinus laxiflora,* Bamboos |
| Frigid forest (coniferous) | Uplands and alpine regions of Pyeonganambuk-do, Hamgeyongnambuk-do | Below 5 °C | Native coniferous forests were mostly extinct and changed into mixed forests of *Betula platyphylla, Populus davidiana,* and *Populus maximowiczii* | *Picea jezoensis, Abies nephrolepis, Larix olgensis, Pinus koraiensis, Abies firma, Picea koraiensis, Pinus pumila, Taxus cuspidata* |

## 5. History of forest use in Korea

By around 6000 B.C., climate in northeast Asia was characterized by frequent and large rainfalls, which resulted in prevalence of deciduous tree species, including oak (*Quercus spp.*), willow (*Salix spp.*), hornbeam (*Carpinus spp.*) and elm (*Ulmus spp.*). Later, gradual decline in temperature as much as 2-3°C with reduced precipitation tended to favor conifers. The distribution of pines began from approximately 3000 B.C. and 2000 B.C. in the southern and central parts of the country, respectively.

Along with climate changes, introduction of agriculture and population growth from 4000 B.C. led to the condition ideal for great dominance of pines in the original forests. Deforestation and conversion of forests into croplands resulted in the local decline of broad-leaved forests. The societal cultural preference for pine was another important factor in the process of pine distribution. Historical documents recorded many plantations of pines but very little was shown about the broadleaves.

In around 100 B.C., iron working brought changes in many aspects of life, most importantly agriculture. With widespread of iron farming tools, the clearing of forest land had accelerated dramatically. Iron making was especially fuel-intensive, requiring tons of firewood to produce small amount of metal. Until the 13th century, people largely depended on the forests to collect fuelwood and building materials.

In the period of 13th century to 18th century, the Chosun Dynasty developed the management plan of pine forests. During this period, 'Gyeonggukdaejun' and 'Sokdaejun', the Grand Code of Managing the Nation included rules and regulations of managing pine forests. Annals of the Chosun Dynasty documented a number of pine plantations. However, deforestation frequently occurred due to wars and land conversions to agriculture.

During the Japanese colonial period in the early 20th century, forests were excessively overused and devastated, and total wood harvest approximated 500 million $m^3$ (14 million $m^3$/yr). The growing stock decreased significantly from 700 million $m^3$ to 200 million $m^3$ over the colonial period of 1910 to 1945. The Korean War of 1950 to 1953 caused more degradation of forests, which led to frequent events of floods and landslides until the 1970s.



## 6. National forest plan

In the 1950s, forests were left in a state of extreme devastation as a result of excessive cutting during and after the colonial period of 1910-1945 and the Korean war of 1950-1953. In order to rehabilitate destroyed forests, the government initiated a large-scale reforestation program, and set up the national forest plan for every 10 years from 1973 to present.

### 1) The First National Forest Plan: forest rehabilitation project (1973-1978)

In 1973, the first 10-year forest rehabilitation project was launched as a turning point in the evolution of forest policies affecting the management of the nation's forests. Its main goal was to restore one million ha of forests for a short-term period. Action plans included: initiation of a national reforestation campaign and drawing out active participation from the public across the country, building economic blocs in the mountain villages to help increase income of households in the mountain village through production of forest resources and to promote silviculture and forest conservation, rehabilitation of destroyed forests in short-term period with fast growing tree species, and restoration of the field burnt off for cultivation.

As a result, this 10-year project was completed in 1978, four years in advance of its target year 1982. During this project 1,080 thousand ha of forest land was reforested and a remarkable progress was made in the groundwork of forest rehabilitation.

### 2) The Second National Forest Plan: forest rehabilitation project

(1979-1987)

The Second National Forest Plan was devised to establish large-scale commercial forests. To achieve the objective, the government initiated various forest policies regarding improvement of the national rehabilitation project and forest protection, promotion of forest development fund to support private forest management, grouping and expansion of national forests, and implementation of forest conservation project to improve common benefits of forests.
The Second National Forest Plan contributed significantly in building the economic capacity of the forests.

Major achievements in this period were:

- Reforestation of 970 thousand ha with the development of 80 large-scale commercial forests over 320 thousand ha. Continuous management of natural forests and young plantations was carried out. Erosion control works were undertaken in accordance with the principle of regional completion on denuded forests.
- Implementation of forest fire prevention project using helicopters. Also, advanced technology was adopted to conduct aerial control of forest diseases and ecologically based pest prevention.
- Establishment of the Forest Works Training Center to raise the level of mechanization in forest activities and to train forest technicians.

### 3) The Third National Forest Plan: forest resource establishment project (1988-1997)

The objectives of this plan were to harmonize the goals of enhancing economic capacity of forests and improving common benefits of forests, and to promote effectiveness of forest management practices. Although reforestation was nearly completed by the first and the second 10-year forest plans, timber supply still depended on imports for about 90% of the domestic demand. At the same time, there was also an increasing demand for outdoor recreation and conservation of the environment. Therefore, a number of initiatives were made to effectively use forest resources, to build up a foundation for forest land management, to increase forest income sources in rural areas, and to improve the multiple public benefits of the forest.



### 4) The Fourth National Forest Plan (1998-2007)

The primary objective of the Fourth Plan was to establish a foundation for sustainable forest management. Key strategies were developing valuable forest resources, fostering competitive forest industry, and enhancing forest health and vitality.

Major accomplishments were:

- Creation of a foundation of law for applying principles of sustainable forest management. Enforcement of 'Framework Act on Forest' provided the regulations defining sustainable forest management as a principle of forest management. Six strategic functions of forests were formulated to develop forest management plans based on characteristics of forests and to optimize multiple functions of forests.
- Carrying out vigorously the forest management practices, helping improve the value of forest resources, and increasing employment opportunities in the forestry sector. Also, commercial plantation forests were arranged and five-year plan of forest tending was set up. Overall, emphasis of the forest policy was shifted from reforestation to forest tending, which helped enhance the full range of forest values.

### 5) The Fifth National Forest Plan (2008-2017)

The vision of the Fifth Plan is to promote sustainable forest management in order to optimize multiple functions of the forest based on the legal and policy framework created through the completion of the Fourth Plan. The Fifth Plan consists of five strategies and 25 action plans (Table 1.3).

Table 1.3 The strategies and action plans of the Fifth National Forest Plan (2008-2017)

| Five strategies | Twenty-five action plans |
|---|---|
| Integrated management and development of multi-functional forest resources | • Implement sustainable forest management at the national and local level<br>• Expand carbon sinks in response to climate change<br>• Strengthen support system to enhance common benefits of forest<br>• Develop sustainable forest resources<br>• Strengthen infrastructure for the development and management of forest resources |
| Development of forest industry for the use of renewable forest resources, and promotion of industry competitiveness | • Develop environment-friendly wood industry<br>• Strengthen competitiveness of forest resources for short-term returns and establish local-based industry cluster<br>• Increase growth potential of new industries, such as BT and ET<br>• Promote competitiveness of private forest land and establish infra structure for stable income in the forestry sector<br>• Increase export of food from the forest and active response to forest products trade |
| Systematic conservation and management of forest as national terrestrial resources | • Establish forest land management system in accordance with well-balanced land development<br>• Conserve biological diversity of forest and enhance forest health and vitality<br>• Conserve ecological axis of national territory in the Korean Peninsula, such as the Baekdu mountain range<br>• Prevent and response to forest disaster with scientific knowledge<br>• Conserve and promote scenic view of forest |
| Development of green space and environmental services in order to improve the quality of people's life | • Develop green space in urban area<br>• Increase recreational, cultural and hiking services corresponding to public demand<br>• Create amenities available for hiking and other sports activities in the mountain<br>• Enhance social function of the forest and increase employment opportunities in the forestry sector<br>• Strengthen public service functions of national forest<br>• Promote the value of mountain villages in terms of multi-functional living space |
| Reinforcement of international cooperation for resources development and global forest conservation | • Strengthen cooperation initiatives for resource development and broaden overseas plantation<br>• Strengthen and engage in international collaborative networks, such as the United Nations Convention to Combat Desertification (UNCCD)<br>• Strengthen multi-national cooperation<br>• Strengthen inter-Korea forest cooperation by stages, such as forest rehabilitation in North Korea |

**Forest rehabilitation during the last 40 years in the Republic of Korea**

- After the Japanese colonial period of 1910-1945 and the Korean war of 1950-1953, forests were left in a state of extreme devastation, which caused frequent events of landslide triggered by rain infiltration, together with a number of landslide victims and emerged as an urgent social problem.
- In the 1960s, the Forest Law and the Erosion Control Law were enforced to rehabilitate degraded forest and the Korea Forest Service (Formerly the Forest Bureau of the Ministry of Agriculture and Forestry) was established on January 1, 1967.
- The 10-year National Forest Plans from 1973 was set up and forest rehabilitation and forest resource establishment projects were implemented.
- About 730 thousand ha of degraded land was restored and extensive plantation was carried out over 350 thousand ha of forest with about 10 billion trees and succeeded in restoring forest cover nationwide, which was recognized as an exemplary case of forest rehabilitation by the international communities.
- With continuous management of forest resources, the growing stock increased eight times over the last 40 years and forest has been positioned as the most visited recreational setting of the public.

Chapter 2

# National progress towards the goal of sustainable forest management in the Republic of Korea


## 1. Efforts for implementing sustainable forest management

### 1) Background

Since the United Nations Conference on Environment and Development (UNCED) introduced the concept of Environmentally Sound and Sustainable Development (ESSD) in June 1992 in Rio de Janeiro, Brazil, this concept gained increasing international attention as a tool to monitor, assess and report forest trends at national and global levels. As a response to the Rio principles, during three years that followed, Korea made efforts primarily on research, development and promotion of the conceptual framework provided by the UNCED. Laws and regulations for 'Sustainable Forest Management' were established at the end of 1994, and today sustainability is the key objective of forest laws and policies. The Fifth National Forest Plan currently in effect aims to build Sustainable Green Welfare Nation.

### 2) Establishing legal framework

The first law that put into practice the concept of ESSD is the revised bill of the Forest Law (Law No. 4816), commenced on December 22, 1994. In the Forest Law Article 16, it provided regulations defining the duties of the Minister of the Korea Forest Service to promote sustainable forest management. Then on June 23,1995, the Enforcement Decree of the Forest Law were revised enabling the followings. In Article 5, The National Forest Plan is drawn up taking into account the sustainable forest management, and assessment is performed to identify changes in forest resources and associated elements. In Article 22(2), it states "the Minister of Forest Service is in charge of sustainable forest management, balancing the conservation and use of forests." On August 30, 1995, Enforcement regulations of the Forest Law was revised to provide "criteria in evaluating practice of sustainable forest management" in Article 3(2), which created a foundation of law for applying principles of sustainable forest management.

On May 24, 2001, the 'Framework Act on Forest' (Act No.6477) was enacted replacing the existing Forest Law. The main concept of it was stated on Article 2, "forest constitutes the foundation for the conservation of territorial ecosystem and for the production of forest resources." It supports national development

and subsistence of organisms inhabiting the given ecosystem. Proper use and conservation of forest is critical in accomplishing the goal of forest sustainability. Article 3 defined the concept of sustainable forest management, and Article 13 stipulated the criteria and indicators for the sustainable forest management.

In August 2006, the 'Act on Promotion and Management of Forest Resources' (Act No. 8852) was enforced. Article 6 stated that forest is to be managed according to the criteria and indicators for sustainable forest management. Article 7 prescribed that in order to indicate the extent of forest sustainability nationwide, forest sustainability index is to be developed and promoted. Thus, a common legal framework was set to implement sustainability at all levels of forest policy in its work. The following outlines chronologically a series of regulatory reforms that has been carried out to date (Table 2.1).

Table 2.1 Legal and institutional framework for sustainable forest management

| Law | Action | Scale |
|---|---|---|
| Framework Act on Forest Article 2 | Adopt SFM as the principle of the Framework Act on Forest | |
| Framework Act on Forest Article 3 | Define the concept of SFM | |
| Framework Act on Forest Article 5 | State proper use and conservation of forest towards the goal of SFM | National, local |
| Framework Act on Forest Article 11 | Set up the National Forest Plan for SFM | Minister of Korea Forest Service |
| Framework Act on Forest Article 13 | Develop and apply criteria and indicators to evaluate practice of SFM | National, local |
| Framework Act on Forest Article 16 | Enact the Law on Promotion and Management of Forest Resources based on local characteristics towards the goal of SFM | National, local |
| Enforcement Decree of Framework Act on Forest Article 11 | Stipulate the elements consisting of indicators for SFM | |
| Act on Promotion of Forestry and Mountain Villages Article 11 | Purchase SFM-related products | Minister of Korea Forest Service |
| Act on Promotion and Management of Forest Resources Article 6 | Manage forests in accordance with criteria and indicators for SFM | Forest land owners |
| Act on Pomotion and Management of Forest Resources Article 7 | Develop forest sustainability index | National, local |
| Act on National Forest Management | Take up the principle of stable supply of forest resources through SFM | |



### 3) Establishing policy framework

In the Fourth National Forest Plan (1998-2007), the primary objective was to build a foundation for sustainable forest management. Under this objective, the Korea Forest Service (KFS) provided various policies and strategies concerning the development of valuable forest resources, fostering competitive forest industry, and enhancement of forest health and vitality. It developed criteria and indicators appropriate to Korea along with monitoring programs. Introduction of forest management certification was proposed.

The vision for the 21st Century was announced in March 2000, in pursuit of future-oriented forest policy (KFS, 2000). It suggested the same tasks as those of the Fourth National Forest Plan, including developing criteria and indicators, and monitoring plan appropriate to Korea.

Having completed the legal and institutional framework for working on sustainability at the national level through the Fourth National Forest Plan, KFS has drawn up the Fifth National Forest Plan lately for 2008 to 2017. It aims to build Sustainable Green Welfare Nation through practice of sustainable forest management. In detail, current tasks include expansion of application of the SFM criteria and indicators at the local level, facilitation of forest management certification, and development of forest sustainability index in order to evaluate the quality and condition of SFM. KFS plans to improve techniques, human resources and infrastructure to support the sustainable production of forest goods and services.

## 4) Developing criteria and indicators for sustainable forest management

Since the Korea Forest Research Institute (KFRI) raised a need to develop criteria and indicators of SFM in the course of its study on 'sustainable management of forest resources (1993-1994)', many efforts took place to develop criteria and indicators suitable for Korea, involving application of the 7 criteria and 67 indicators of the Montreal Process in the forests of Hongcheon and Pyungchang to find out their adaptability in the country (KFRI, 2002). Workshops in 2004 and an expert review in 2005 were hosted to advance the development of SFM criteria and indicators at the national level, and to examine criteria and indicators of both the Montreal Process and the Pan-European Process. In 2004, KFS finally developed 7 criteria and 28 indicators suitable for Korea and announced them in October 2005 (KFS, 2005). The whole procedure of developing criteria and indicators is described in this chapter item no. 2 'Development of criteria and indicators for sustainable forest management'.

## 5) Development of Forest Sustainability Index

'Forest Sustainability Index'(FSI) is a quantitative score that is being used to indicate the overall quality and conditions of SFM. This takes into consideration environmental, social and economic conditions at the local and national level. The 'Framework Act on Forest' that was enacted in 2001 created a foundation of law for the development and assessment of SFM criteria and indicators. 'The Act on Promotion and Management of Forest Resources' enacted in 2005 stipulated the development and evaluation of FSI. A series of research was conducted accordingly resulting in the publication of reports, such as 'Basic Research on Developing FSI' (KFRI, 2004) and 'Research on Developing Indicators and Indexing for Sustainable Forest Management' (Ministry of Agriculture and Forestry, 2006).

In March 2007, the KFS formed a 'working group for developing FSI' and conducted a case study on the development of FSI in other countries. A detailed methodology was discussed in the working group and a draft of FSI and its indicators were produced. In November 2007, the KFS finalized the national FSI (KFS, 2007). Indicators for developing FSI include 19 indicators of three categories: 6 indicators in forest health, 7 in economic capacity, and 6 in common benefits. In developing FSI, all 19 indicators were used at county level, 11 at metropolitan city, and 17 at province level (Table 2.2).

Table 2.2 Indicators for developing Forest Sustainability Index

| Category | Indicators | Applicable to | | |
|---|---|---|---|---|
| | | County | Metropolitan | Province |
| Forest health (6) | Percentage of forest land | O | O | O |
| | Percentage of mature forests | O | O | O |
| | Percentage of arboretums | O | × | × |
| | Percentage of forests protected for genetic conservation | O | × | × |
| | Percentage of forests tended | O | O | O |
| | Percentage of forests undisturbed | O | O | O |
| Economic capacity (7) | Percentage of forests available for timber production | O | O | O |
| | Growing stock in forests available for timber production | O | × | O |
| | Percentage of forests covered by forest management plan | O | × | O |
| | Amount of forest products | O | O | O |
| | Percentage of cutting volume to annual growth volume | O | × | O |
| | Percentage of expenditures associated with forestry to total budget | O | O | O |
| | Percentage of forest contribution to GDP | O | O | O |
| Public benefits (6) | Percentage of protected forests | O | × | O |
| | Carbon stocks in forest biomass | O | O | O |
| | Carbon balance in forest biomass | O | × | O |
| | Area of forests for recreation and tourism | O | × | O |
| | Percentage of urban forests | O | O | O |
| | Percentage of employment in the forestry sector | O | O | O |
| Total | 19 indicators | 19 | 11 | 17 |

### 6) Extension of Forest Management Certification

Forest Management Certification (FMC) works for a measure to evaluate process of SFM in detail. In order to facilitate FMC, national forests are being certified initially. As of 2008, about 121 thousand ha of national forests were certified by the Forest Stewardship Council (Table 2.3). The Fifth National Forest Plan (2008-2017) currently in effect aims to extend certified area to 300 thousand ha by the year 2017, and plans to develop a national certification system that can be internationally accredited as well.

Table 2.3 Area of forest management certification

| Certified year | Certified forest area (ha) | Managed by |
|---|---|---|
| 2006 | 2,741 | Warm-temperate Forest Research Institute |
| 2006 | 33,696 | Hongcheon National Forest Station |
| 2007 | 35,222 | Inje National Forest Station |
| 2007 | 18,227 | Gangwon-do Forest Research Institute |
| 2007 | 31,376 | Pyeongchang National Forest Station |
| 2008 | 80 | Uljin National Forest Station |
| Total | 121,342 | |

## 2. Development of criteria and indicators for sustainable forest management

### 1) Process of developing criteria and indicators for SFM

Since KFRI raised a need to develop criteria and indicators for SFM in the course of study on “sustainable management of forest resources (1993-1994)”, a lot of efforts has been invested in research for development of criteria and indicators suitable for Korea (Table 2.4).

Table 2.4 Progress in developing criteria and indicators for SFM

| Year | Activities |
|---|---|
| 1993-1994 | Research on sustainable management of forest resource |
| 1995-1997 | Research on criteria and indicators for SFM in Korea |
| 1998-2000 | Research on implementation of SFM |
| 2001-2004 | Research on implementation of SFM and building a monitoring system |
| 2004. 11 | Host a workshop on developing criteria and indicators for SFM |
| 2005. 1 | Expert review on developing criteria and indicators for SFM |
| 2005. 9 | Final expert review and collecting the major view among associated agencies |
| 2005. 10 | Public hearing and release of the criteria and indicators for SFM development |

Having a wide range in natural, social and technical conditions among the member countries, the Montreal Process assumed that there should be differences by countries in applying the original set of criteria and indicators that were agreed upon. So the individual member countries reported the use and adaptability of the Montreal Process criteria and indicators at the national level (Montreal Process, 1997). Korea went through examination about usability of statistics and data on forest resources, and reported the result: 24 indicators of immediate use, 26 indicators to be applied after modifying and improving data to some extent, and 17 indicators to be applied after further research over a long-term period.

Later in establishing action plan of SFM at the local level, Korea evaluated relevance of the Montreal Process criteria and indicators in depth, and developed 7 criteria and 27 indicators that are to be applied on site in 2001. However, only 14 indicators were identified valid at local scale after applying criteria and indicators in the forests located at Hongcheon and Pyeongchang (Unduryeong region) (KFRI, 2002).

Since then a comprehensive review had begun to develop criteria and indicators for SFM that are suitable for Korea. In November 2004, a 'Workshop on Developing SFM Criteria and Indicators' was hosted to determine the standards and method of developing indicators. In January 2005, an 'Expert Review on Developing SFM Criteria and Indicators' was conducted to examine criteria and indicators of both the Montreal Process and the Pan-European Process (6 criteria and 52 indicators), as a reference framework for sustainable forest management, of which climate and forest vegetation conditions are similar to Korea. As a result, 7 criteria and 28 indicators were finally developed and announced in October 2005. Among the 28 indicators, 24 indicators were drawn from those of the Montreal Process, 4 indicators from the Pan-European Process. Also it was suggested that 17 indicators should be adopted with priority in the near future, such as 'the number of forest dependent species' (KFS, 2005).

## 2) Standards and method of developing indicators for sustainable forest management

In order to monitor and evaluate an indicator, it is important to be explicit about what to assess. Therefore, developing indicators take into account policy relevance, customer usability, analytic feasibility and measurability (OECD, 1998). In accordance with this, the Korea Forest Service hosted a 'Workshop on Developing Criteria and Indicators for SFM' in 2004 and decided a number of standards for developing indicators, such as 'credibility and scientific definition', 'viability', and 'feasibility' (KFS, 2004) (Table 2.5).

There are two approaches for developing indicators: bottom-up and top-down. The bottom-up method starts at the statistics available to recognize the characteristics and draws indicators by composing statistics itself and a number of statistical resources. In contrast, the top-down method starts with the final objectives of developing indicators and works downward by decomposing meanings of the objectives in detail and analysis process. Based on the statistics available, bottom-up method appears easy to develop indicators but it can be limited to information and knowledge on hand. For this reason, top-down approach is generally preferred and the Montreal Process criteria and indicators is a good example of top-down method (Ministry of Agriculture and Forestry, 2006). However, in developing criteria and indicators suitable for Korea, bottom-up method was used based on the specific criteria and indicators of the Montreal Process and the Pan-European Helsinki Process.

Table 2.5 Standards for developing SFM indicators

| Standard | Element |
|---|---|
| Credibility and scientific significance | • Suitable: definition of sustainable forest management<br>• Reliable: extent of error caused in analyzing quantitative outcomes of indicators<br>• Responsible: influence of management activities<br>• Sensible: private and time variant tendencies to change<br>• Predictable: degree to which a rational prediction can be made |
| Viability | • Usable: capability of using references<br>• Acceptable: collecting and editing information at reasonable cost |
| Feasibility | • Measurable: quality of being measured and used on a suitable scale<br>• Understandable: easiness to understand for public<br>• Cost-effective: value of information against the cost<br>• Intend to carry out: intention to measure indicators, monitor and report |

Chapter 3

# Criteria and indicators for sustainable forest management


## Criterion 1. Conservation of biological diversity

Covering 64% of the total land area, forests in Korea are essential for the management and sustainable use of natural resources and for the conservation of biological diversity. Over the last 40 years, comprehensive efforts were made to rehabilitate degraded forest, to expand protected land, and to implement sustainable forest management, which provided operational tools for successful restoration of biological diversity.

Following the large-scale plantations and rehabilitation of degraded forests during the 1970s and 1980s and the course of natural succession, pines were dominant as a pioneer species in natural forests. At present, pines are declining much of its range and gradually being replaced by several broad-leaved species, such as *Quercus acutissima, Quercus mongolica*, and *Quercus serrata*. Broad-leaved types have fairly even age distribution of 30 to 50-year of age.

Through time, major threats to biological diversity have shifted from excessive use of forest resources or exploitation of forest land to environmental issues, including forest genetic resources, climate change, environmental pollution, and disasters like forest fire and flood. In response to this, the National Forest Plan for forest biological diversity was established in 2007 to manage the threats to biological diversity, to strengthen on-site and off-site conservation, and to promote sustainable use of forest resources. As a means to adapt to climate change, particular activities are underway to monitor and conserve genetic diversity of native plants and rare plants, especially in the alpine and sub-alpine zones that are expected to decline due to climate changes.

Given the importance of establishing legal and institutional framework to conserve forest biological diversity, Korea put into practice the concept of sustainable forest management in the forest laws and policies in 1994.

Protected forests amount to 10% of the total forest area in Korea. They are reserved in various forms of protected status like national park, protected forest for genetic resources, ecosystem conservation zone, and natural monuments. In the past, protected forests were designated mostly in the mountainous land of high elevation and were likely to remain isolated from other forests. To address

some critical issues regarding forest types, ecological connectivity, and cultural aspects of the region, the 'Act on Protection of the Baekdudaegan Mountains' was established in 2003 to connect major mountain ranges with the Baekdudaegan Mountains as the backbone of terrestrial ecological system (Figure 3.1). In creating protected forests, the government put much effort to reach public agreement, to communicate with interested groups and multi-stakeholders, and to facilitate conflict resolution processes. In 2005, 260 thousand ha of forests were designated as protection areas. Of this, core zone covers 170 thousand ha, which represent 65% of the total protected forest and buffer zone covers 90 thousand ha with 35% of the total protected forest. This estimated the single largest protected area of terrestrial ecosystem constituting 2.6% of the total land area and 4% of the total forest area.

The Baekdudaegan Mountains run through most of the length of the Korean Peninsula. They are the nests of forest biological diversity and are rich in cultural heritage. Protection of the Baekdudaegan Mountains paves the way for ensuring the protection of forest land from indiscreet development and helps preserve the topography and natural features of the mountain range. It also provides a unique opportunity to restore degraded land, introduce environmental-friendly agricultural practices in private land, enhance ecological connection through restoring the forest, and prevent decline of forest biological diversity due to habitat fragmentation. As a whole, the 'Act on Protection of the Baekdudaegan Mountains' will serve as an iconic practice of forest protection, designed to sustain and enhance an array of valuable goods and services of the forest ecosystem.

Figure 3.1 The Baekdudaegan Mountains forming the backbone of the Korean Peninsula and serve as the core of forest biological diversity.



## Indicator 1-1
## Area and percentage of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure

### 1) Definition and importance

This indicator shows the landscape-scale forest structure and ecological diversity, using forest types and the age class distribution. Ecological processes of forest ecosystem and maintenance of its population largely depend on the extent of ecological continuity or some core features of the ecosystem. Wildlife and plant communities are adapted to particular stages of succession. Although occupying a high portion of the entire land area, most of forest lands in Korea are at the early or mid successional stage. Thus, species inhabiting late successional forests have been threatened in Korea.

Based on the area and extent of forest by forest type, this indicator provides information on forest dynamics, timber harvesting, presence of specific wildlife or plant communities, presence of non-timber wood products and the aesthetic or recreational values of forests. Because most species depend on particular successional stages partly or entirely, this indicator can also help estimate biological diversity of forest ecosystem through the measurement of age-class distribution and changes in forest area by age class.

### 2) Status and trend

Forest area increased during the 1960s to 1980s as a result of national rehabilitation project, but moderately decreased lately due to forest conversion and changes in land use for economic development. During 2003 to 2007, an average of 9,142 ha of forests per year (about 0.08% of the total land area) were converted into other land uses, including mine area, road, agricultural land, pasture area, industrial land, school, religious land, and military zone, which accounts for an average of 20,361 events per year. The yearly trend was stable to slight increase. The major type of conversion was industrial land followed by residential area, road, agricultural land and mine are.

Regarding the changes in forest area by forest type, conifer forests were found apparently decreasing from the mid 1980s, while broad-leaved and mixed forests were increasing. As of 2007, the cover of conifer forests decreased by 594 thousand ha since 1985, while broad-leaved and mixed forests increased by 503 thousand ha, and 38 thousand ha, respectively (Figure 3.2).

Figure 3.2 Changes in forest area by major cover type

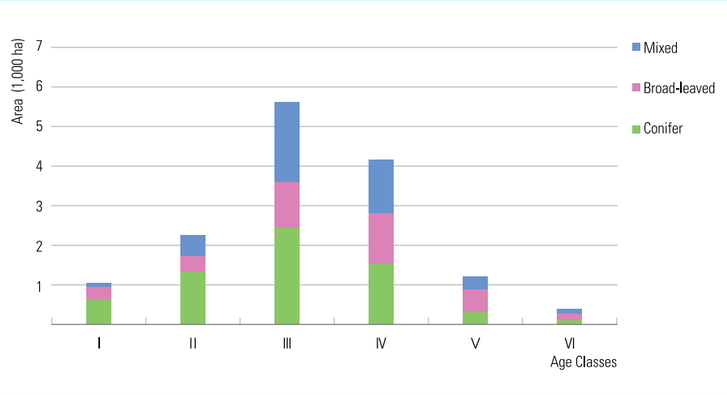

These trends are closely related to recent history of Korea. Following a state of extreme devastation during and after the colonial period of 1910 to 1945 and the Korean war of 1950 to 1953, forests were dominated naturally by pines as a pioneer species. In addition, major tree species planted during the first and the second national reforestation projects in 1973 and 1979 were conifers, including *Pinus densiflora, Pinus rigida, Larix kaempferi, Pinus koraiensis, Chamaecyparis obtusa,* and *Cryptomeria japonica*. Therefore, conifer forests were predominant in Korea by the 1980s. Afterward, conifer forests were gradually replaced by native broad-leaved forests, such as oaks, as a result of natural succession in unsuccessful plantation, large-scale invasions by *Dendrolimus spectabilis, Thecodiplosis japonensis,* and *Matsucoccus thunbergianae* and forest fire. Over the time, diverse types of forests occur across the country.

For the forest area by ownership, as of 2007, national forest stands at 1,509,163 ha accounted for 23% of the total forest area, while public forest at 488,907 ha and private forest at 4,384,379 ha accounted for 8% and 69%, respectively. The area of national forest increased by 51 thousand ha or about 3.6% compared to that of 2003, while private and public forests experienced slight decrease. These changes were caused by the fact that the government continuously purchased forest land from private owners and private forests were converted into other land uses (Figure 3.3).

Figure 3.3 Changes in forest area by ownership

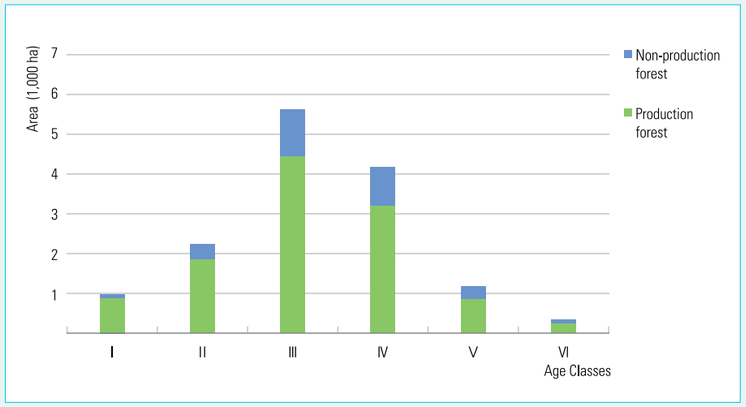

Forest distribution by age class showed a bell-shape, with the highest cover of age class III. In conifer and mixed forests, age class III covered the largest area, while deciduous forest was covered mostly by age class IV (Figure 3.4). The majority of forests of age classes III and IV were the plantations established during the first and the second national reforestation projects over 1973 to 1987. These plantations were comprised largely of conifer tree species, such as *Pinus densiflora*, *Pinus rigida, Larix kaempferi, Pinus koraiensis, Chamaecyparis obtusa,* and *Cryptomeria japonica*.

Figure 3.4 Forest area by major cover type and age class




Area of forests available for timber production was about 4,901 thousand ha, larger than that of non-production forests, 1,308 thousand ha (Figure 3.5). High peaks of age classes III and IV came as a result of plantation during the first and the second national rehabilitation projects.

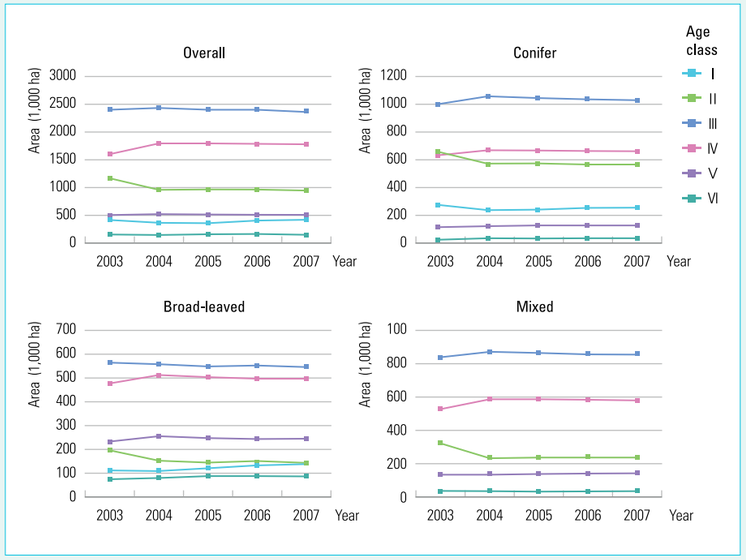
Figure 3.5 Area of production forests and non-production forests by age class




During 2003 to 2007, age classes III and IV covered the largest area of forest. Area of age class II declined slowly, while age classes IV to VI remained steady or was a bit rising. Area of conifer forest declined gradually. As of 2007, the area of age class II decreased the most by 580 thousand ha due to forest succession. The area of broad-leaved forest was rising continuously as a whole, and the area of age class I showed a big rise, which came as result of forest fire, pest invasion, natural succession in pine forest, and regeneration practices in stand of *Pinus rigida*. The area of age classes IV, V and VI in broad-leaved forest increased a

little or remained steady, while age classes II and III decreased as of 2007 by 140 thousand ha and 500 thousand ha, respectively. The area of mixed forest increased largely like that of broad-leaved forest. The area of age classes III and IV in mixed forest increased notably, while age class II decreased steadily (Figure 3.6).

Figure 3.6 Changes in forest area by major cover type and age class






## Indicator 1-2
## Area and percentage of forest in protected areas by forest ecosystem type and by age class or successional stage

### 1) Definition and importance

The area and percentage of forest ecosystems reserved in some form of protected status provide an indication of the emphasis our society places on preserving representative ecosystems as a strategy to conserve biodiversity. Important forest management questions also can be addressed by maintaining information on a network of representative forest types within protected areas. Traditionally, protected areas have been set aside, in part, for their conservation, scenic, and recreational values. The ecosystems in any area might not represent the full range of biodiversity, but if it is part of a national conservation strategy (including rare and endangered species) then some degree of overall protection is available. In the future, forest types and their associated flora and fauna within protected areas will change and must be monitored as part of an overall strategy for conserving biodiversity. Adequate protection of the ecosystems and species in protected areas may also provide more flexibility in forests management for wood production and other uses.

### 2) Status and trend

In Korea, forests of ecological value and biological diversity are reserved for protected status, such as natural ecosystem reserve. As of 2008, there were 32 sites of ecological and scenic reserve (353km$^2$), 20 wetland reserves (380km$^2$), one wildlife and wild plant reserve (26km$^2$), 76 sites of natural parks including national parks (7,809km$^2$), and many other categories of protected forest, such as cultural reserve, forest reserve, wildlife management area, Baekdudaegan Reserve, and development restriction area.

For protected land of international importance, two sites of wetlands, namely Yongneup of Mt. Daeamsan (106 ha) and Wooponeup of Changnyeong (854 ha) were designated by the Ramsar Convention (the convention on wetlands of international importance especially for waterfowl habitat). Four sites were designated for UNESCO Biosphere

Reserve. They are Mt. Seoraksan (3,932km²) and Mt. Hallasan, Joongsangan and Seogwipo Marine Park in Jeju Island (831km²). To reserve a range of forest that is greater than one hectare in size and has an intrinsic value of conserving biological gene, species and natural ecosystem, particular forest is designated for conserving forest genetic resources. It includes primary forest, vegetation in alpine zone, native rare stand, habitat of native rare species, and useful plants.

### (1) Baekdudaegan Reserve

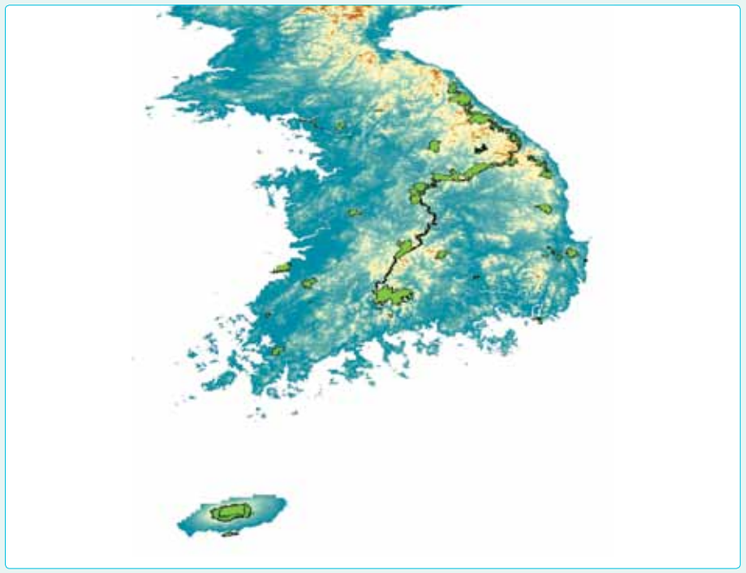
In order to integrate major mountain ranges with the Baekdudaegan Mountains, which form the backbone of the terrestrial ecological system and to provide a tool for effective and systematic conservation and management of protected forest, the Act on Protection of the Baedudaegan Mountains was established in 2003.

In creating protected forest land area, the government put much efforts to reach public agreement, to communicate with interested groups and multi-stakeholders, and to facilitate conflict resolution processes. In September 2005, a total of 260 thousand ha were reserved as protected forest. Of this, core zone covered 170 thousand ha (65% of the total protected forest) and buffer zone covered 90 thousand ha with 35%. This was estimated as the single largest protected area of terrestrial ecosystem, constituting 2.6% of the total land area and 4% of the total forest land area. The Baekdudaegan Mountains run through most of the length of the Korean Peninsula and is the nest of forest biological diversity. It is rich in cultural heritage as well. The topography of Korea and the Baekdudaegan Reserve is shown in Figure 3.7.

Protection of the Baekdudaegan Mountains paves the way for ensuring the protection of forest land from indiscreet development and helps preserve the topography and natural features of the mountain range. It also provides a unique opportunity to restore degraded land, introduce environmental-friendly agricultural practices in private land, enhance ecological connection through restoring the forest, and prevent decline of forest biological diversity due to habitat fragmentation. As a whole, 'the Act on Protection of the Baekdudaegan Mountains' will serve as an iconic practice of forest protection, designed to sustain and enhance an array of valuable goods and services of forest ecosystem.



Figure 3.7 Major forest reserves in the Republic of Korea



### (2) National Parks

Since the Mt. Jirisan was reserved as the first national park in 1967, a total of 20 sites of terrestrial and marine areas were designated for national parks in Korea. They are estimated to cover 658 thousand ha, where terrestrial area is 390 thousand ha and marine area is 268 thousand ha. Of the total 20 national parks, 16 parks are located in the mountainous region, consisting of 80% of the total national park area (Korea National Parks Authority, 2008).

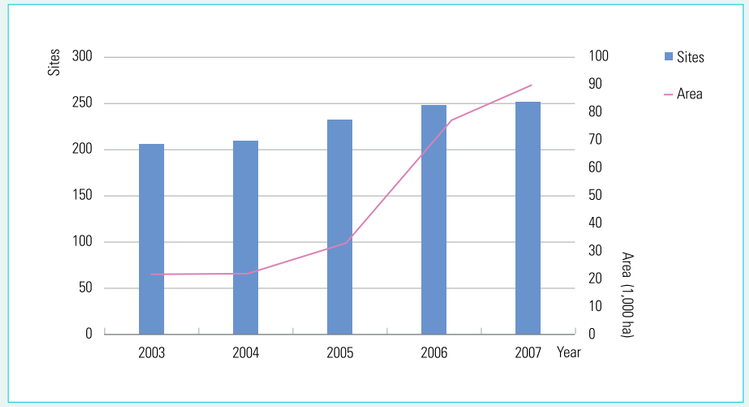
Mt. Jirisan National Park covers the largest area among the national parks located in the mountainous region (44 thousand ha, which is14.1% of the total national park area) followed by Mt. Seoraksan National Park (37 thousand ha) and Mt. Sobaeksan National Park (32 thousand ha). Most National Parks located in Gangwon province covers the vast geographic range.

### (3) Forest Genetic Resources Reserve

Forest Genetic Resources Reserve has been designated in order to conserve the full range of unique forest genetic resources in Korea, including old-growth forests, endangered plan community in alpine zone, forests with intrinsic value, habitat of

rare species or useful plants, forest wetland, and valley stream within a forest. As the significance of conserving biological diversity and protecting forest ecosystem obviously rises, the number of reserves for forest genetic resources continuously increased from 207 sites at 22,106 ha in 2003 to 251 sites at 90,254 ha in 2007 (Figure 3.8). This shows expansion of forest reserve not only for conserving habitat for rare plants and genetic resources, but also for maintaining the ecosystem diversity.

Figure 3.8 Changes in the number and area of protected forests for genetic resources




## (4) Reserves for ecosystem conservation

Up to now, the number of reserves for ecosystem conservation is 10 sites at 242.72km$^2$. Of this, the number of the reserves for forest ecosystem conservation is 7 sites at 199.86km$^2$ (Table 3.1).

Table 3.1 Reserves for ecosystem and landscape conservation in mountainous regions of Korea

| Name | Location | Size (km$^2$) | Feature | Designated year |
|---|---|---|---|---|
| Mt. Jirisan | Mt. Jirisan Region of Simwongyegok Sandong-myeon and Piagol Toji-myeon, Gure-gun, Jeollanam-do | 20.20 | Climax forest (*Abies koreana*, etc.) | 1989/12/29 |
| Mt. Daeamsan | Region of Keunyongneup and Jackeunyongneup of Mt. Daeamsan, Seowha-myeon, Inje-gun, Kangwon-do | 1.06 | The only wetland with high elevation in Korea | 1989/12/29 |
| Mujechineup | Region of Joil-li, Samdong-myeon, Woolju-gun, Woolsan | 0.18 | Forest wetland of rare wildlife and plants | 1998/12/31 |
| Habitat for river otter in Seomjingang River | Region of Toji-myeon, Ganjeon-myeon and Muncheok-myeon, Gurye-gun, Jeollanam-do | 1.83 | Habitat for endangered species, river otter | 2001/12/1 |
| Habitat for copper-winged bat in Gonsanbong | Region of Daedong-myeon, Hampyeong-gun, Jeollanam-do | 8.78 | Habitat for endangered species, copper-winged bat | 2002/5/1 |
| Donggang River | Region of Yeongwol-up, Yeongwol-gun, Jeongseon and sindong-up, Jeongsun-gun, and Mitan-myeon, Pyeongchang-gun | 64.97 | Scenic and geographical value. Habitat for rare wildlife and plants | 2002/8/9 |
| Wangpicheon Stream Watershed | Region of Seo-myeon, Wooljin-gun and Geunnam-myeon, Gyeongsangbuk-do | 102.84 | Scenic and geographical value. Habitat for rare wildlife and plants | 2005/10/14 2006/12/8 |

Source: Ministry of Environment, 2008

### (5) Reserve for forest wetland

As of December 2003, seven terrestrial wetlands of 44.48km$^2$ were designated, and four reserves awong them were classified as forest wetland (Table 3.2), such as Yongneup of Mt. Daeamsan with an area of 1.06km$^2$ (Figure 3.9).

Table 3.2 Reserves for terrestrial wetlands

| Name | Location | Area (km$^2$) | Feature | Designated year |
|---|---|---|---|---|
| Yongneup of Mt. Daeamsan | Region of Keunyong Wetland and Jackeunyong Wetland in Daeam Mountain, Seowha-myeon, Inje-gun, Kangwon-do | 1.06 | The only wetland with high elevation in Korea | 1999/8/9 |
| Mujechineup | Region of Joil-li, Samdong-myeon, Woolju-gun, Woolsan | 0.18 | Forest wetland of rare wildlife and plants | 1999/8/9 |
| Mulyeongari Orum | Namwon-up, Namjeju-gun, Jeju-do | 0.31 | Parasitic volcano | 2000/12/5 |
| Whaum Wetland | Yongyeon-li, Habuk-myeon, Yangsun-si, Gyeongsangnam-do | 0.12 | Forest wetland | 2002/2/1 |

Source: Ministry of Environment, 2008

Figure 3.9 Yongneup of Mt. Daeamsan, a Ramsar site



## Indicator 1-3
## Fragmentation of forests

### 1) Definition and importance

This indicator provides information on the extent to which forests are being fragmented over time by human activities and natural processes. Fragmentation may lead to the isolation and loss of species and gene pools, degradation of habitat quality, and reduction in the forest's ability to sustain the natural processes necessary to maintain ecosystem health. The fragmentation of forest area into smaller pieces changes ecological processes and alters biological diversity. This indicator includes several measures of the extent to which forests are fragmented at several spatial scales of analysis.

### 2) Status and trend

(To be analyzed in the near future using the fourth digital forest map recently developed)

## Indicator 1-4
## Number and population levels of native forest-associated species

### 1) Definition and importance

This indicator provides information on the health of forest ecosystems through the number and population levels of native forest-associated species. The number of forest-associated species in a region will change when species become extinct, new species colonize, and species are merged or split according to shifting taxonomy. While change in the number of species due to swings in taxonomy convention is not related to biodiversity conservation, extinction and colonization can alter ecological processes in ways that affect the kinds and quality of services that humans derive from forest ecosystems. Therefore, the loss or addition of species in an ecosystem can provide valuable insights into the overall health and productivity of that system.

### 2) Status and trend

In 2007, population for bird species was estimated based on 405 permanent plots across the country. A total number of 253 bird species was detected. Of these, 135 species were detected in the mountainous region, 152 species in the hilly forest areas, 167 species in the agricultural land, 131 species in the coastal region and marshland, and 92 species in the residential area. For dominant bird species by habitat type, the share of *Paradoxornis webbianus* was highest in the mountainous region at 14.7% and followed by *Cyanopica cyana* (6.8%), *Emberiza rustica* (6.2%), *Emberiza elegans* (6.0%) and *Carduelis spinus* (5.0%). In the hilly forest areas, the proportion of *Corvus frugilegus* was the greatest at 10.1% and followed by *Paradoxornis webbianus* (9.6%), *Emberiza elegans* (5.7%), *Emberiza rustica* (5.1%) and *Parus palustris* (4.8%).

Total population of mammals monitored nationwide in 2007 was 2,057 individuals of 27 species. For distribution by habitat type, the number of mammals in the mountainous region was 1,124 individuals of 25 species, 658 individuals of 19 species in the hilly forest area, 167 individuals of 14 species in the agricultural land, 72 individuals of 12 species in the residential area, and 36 individuals of 9 species in the coastal region and marshland. For population of mammals by species, *Tamias sibiricus* was the most commonly found in most habitat types at 269 individuals, followed by *Emberiza elegans* (260), *Sciurus vulgariscoreae* (239) and *Nyctereutes procyonoides* (209). *Emberiza elegans*, *Nyctereutes procyonoides, Mustela sibirica, Rhinolophus ferrumequinum,* and *Felis silvestris* were found in all habitat types, and species like *Crocidura dsinezumi, Crocidura suaveolens, Rhinolophus ferrumequinum, Pteromys volansaluco, Microtus fortis,* and *Polyplax serrata* were found only in the mountainous region.

Since 1967, Korea initiated a nationwide program of monitoring wildlife population. Efforts are underway to estimate population levels of wildlife species, geographic distribution, and status of endangered species through long-term monitoring. Based on the information collected from the survey, long-term plan for management and restoration of wildlife habitat and population levels of selected forest-associated species was set up.

For the representative forest-dependent species as a measure of forest genetic diversity, *Phasianus colchicus, Streptopelia orientalis, Garrulus glandarius, Sus scrofa, Rhinolophus ferrumequinum,* and *Sciurus vulgariscoreae* were selected to estimate the population trends (Figures 3.10 and 3.11). As major indicator species,

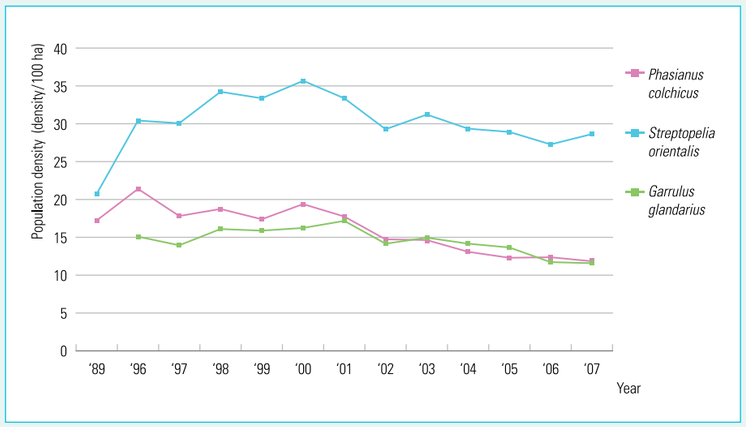
*Dendrocopos kizuki, Hypsipetes amaurotis, Phoenicurus auroreus, Parus major, Emberiza elegans, Turdus pallidus, Oriolus chinensis, Tamias sibiricusbarberi,* and *Nyctereutes procyonoides* were selected to estimate the population trends (Figures 3.12, 3.13 and 3.14).

Between 1996 and 2007, population of *Phasianus colchicus* was steadily declined from 21.3 per 100 ha in 1996 to 14.6 in 2002 and 12.1 in 2007 (Figures 3.10). These trends were influenced by the lack of food during winter, excessive hunting, habitat loss from the disaster like forest fire, and increase number of wild cats and raccoons as predators.

Population of *Streptopelia orientalis* was stable to increasing from 20.7 per 100 ha in 1989 to 35.4 in 2000 but slightly decline to 28 in 2007 (Figures 3.10). *Streptopelia orientalis* are associated with conifer species like *Abies holophylla* and *Pinus densiflora* for nesting and breeding. Increasing populations might be the result of implementation of forest conservation and management projects since the 1980s, which helped improve the habitat conditions of *Streptopelia orientalisin*. Also, more grains dropped from mechanical harvesting in the field and less demand as a game species could be another cause of population increase.

*Garrulus glandarius* is a forest-dependent bird species. Population trends for *Garrulus glandarius* were uneven. From 1996 to 2001, it showed a slight increase from 15.5 to 17.5 per 100 ha yet experienced moderate decrease to 12.1 in 2007 (Figures 3.10).

Figure 3.10 Changes in population of *Phasianus colchicus, Streptopelia orientalis* and *Garrulus glaandarius*






Population of *Sus scrofa* was wavering. Large increase was monitored between 1989 and 1998 from 2.1 to 5.3 per 100 ha. But afterwards populations declined steadily to 3.8 per 100 ha in 2007 (Figures 3.11). Population of *Sus scrofa* is controlled in the context of wildlife damage management, which is a coordinated program directed towards the animals that cause damage to human health, safety and property. At present, *Sus scrofa* has no predators. The number of their competitors decreased leading to temporary increase in their population size. However they can cause damage to agricultural property in autumn. For this reason, the number of *Sus scrofa* became under supervision and over 2,400 *Sus scrofa* were captured in 2004.

Population of *Rhinolophus ferrumequinum* was stable to increasing from 2.4 to 6.4 per 100 ha between 1989 and 2007 (Figures 3.11). *Rhinolophus ferrumequinum* prefers to nest in understory vegetation associated with riparian areas. Due to large decrease of predators, population of *Rhinolophus ferrumequinum* has been rising. However, *Rhinolophus ferrumequinum* is a species of concern for conservation because its geographic distribution is limited to the Korean Peninsula and the Yangtze downstream in China, where populations are declining significantly. So, it is important to manage populations of the Korean Peninsula.

Population of *Sciurus vulgariscoreae* was increasing from 6 to 9.4 per 100 ha during 1996 to 2001 but declined afterwards to 6.1 per 100 ha in 2007 (Figures 3.11). Causes of the increase may include the abundance and improved quality of habitats with the growth of *Pinus koraiensis* which were planted on many

Figure 3.11 Changes in population of *Sus scrofa, Rhinolophus ferrumequinum* and *Sciurus vulgariscoreae*

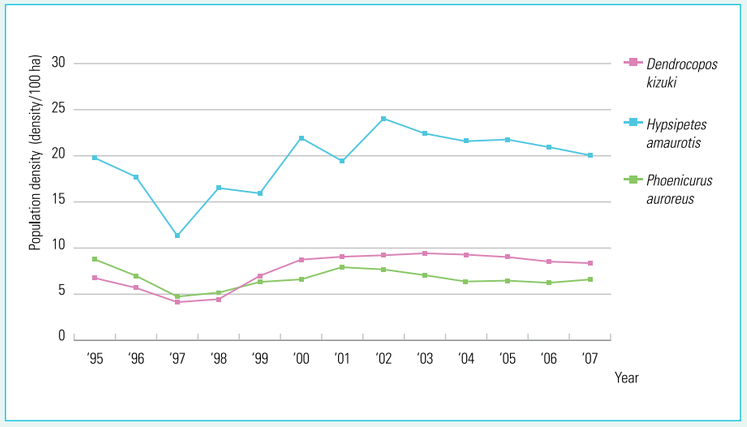
areas since the 1970s. Recently, population of *Sciurus vulgariscoreae* is under supervision through wildlife damage management as they cause considerable damage to production of nuts, like pine nuts and walnuts. Causes of recent population decrease are not well understood. More research is needed on the effect of wildlife damage management and natural population trends.

Population of *Dendrocopos kizuki* was stable to decreasing between 1995 and 1997 from 6.7 to 4.2 per 100 ha but increased to 8.3 in 2007 (Figures 3.12). *Dendrocopos kizuki* is the smallest species among woodpeckers (Picidae). They tend to feed and nest in the hole of a dead tree. Recent population increase may be the result of increasing number of mature forest and dead trees as well.

Population of *Hypsipetes amaurotis* was rising from 11.1 to 23.9 per 100 ha during 1997 to 2002 but decreased moderately to 19.9 in 2007 (Figures 3.12). Population rate was apparently high in Jeju Island because they are southern bird species habiting Japan, Taiwan and the Philippines. *Hypsipetes amaurotisis* is a species of concern as they may move northward when the temperature rises in the Korean Peninsula due to climate change. More research is needed to identify regional distribution and population trends.

Population of *Phoenicurus auroreus* decreased by 1997 to 4.7 per 100 ha but increased to 8.1 per 100 ha in 2001(Figures 3.12). Later in 2007 it experienced decline to 6.6 per 100 ha. *Phoenicurus auroreus* stays together as a pair of male and female and tends to have cavity nesting, such as holes in trees, under trees, and between the rocks and buildings. To keep up with the populations,

Figure 3.12 Changes in population of *Dendrocopos kizuki*, *Hypsipetes amaurotis* and *Phoenicurus auroreus*





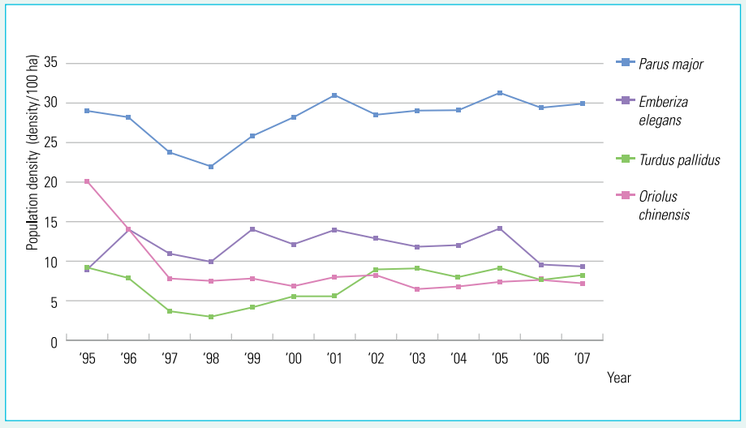

management centers on maintaining standing dead trees and populations of insect prey, such as beetles (*Coleoptera*), butterflies (*Lepidoptera*), bees (*Hymenoptera*), and flies (*Diptera*).

*Parus major* is one of the most commonly found forest-associated species across the country. Trend estimates indicate that populations declined between 1995 and 1998 from 29.1 to 22.2 per 100 ha but increased largely to 30.2 per 100 ha in 2007 (Figures 3.13). *Parus major* feeds on the insects. Availability of insect prey is essential to maintain the health of forest ecosystem.

*Emberiza elegans* is most frequently associated with shrubs. Population trends for *Emberiza elegans* were uneven, from 9 to 14 per 100 ha during 1995 to 2005 (Figures 3.13). Forest practices, such as thinning to provide open spaces, benefit this species. Planting seed plants can also supply food for *Emberiza elegans*.

Populations of *Turdus pallidu* indicated a decrease from 9.5 to 3.2 per 100 ha between 1995 and 1998 but increased steadily to 8.7 per 100 ha in 2007 (Figures 3.13). *Turdus pallidus* is summer migratory birds habiting mature forest. Some *Turdus pallidus* were detected recently in Jeju Island and southern coastal region for wintering. *Oriolus chinensis* is of concern due to population decrease. In 1995 population of *Oriolus chinensis* was documented at 20 per 100 ha, but significant declined to 6.2 in 2003 and slightly increased to 7.1 in 2007 (Figures 3.13). This decline takes place not only in Korea as summer habitat but is associated with deforestation occurring in Southeast Asia as wintering habitat.

Figure 3.13 Changes in population of *Parus major, Emberiza elegans, Turdus pallidus* and *Oriolus chinensis*



*Tamias sibiricusbarberi* is a diurnal mammal and commonly found in forest and city parks throughout the country. Population of *Tamias sibiricusbarberi* experienced large decrease during 1995 to 1997 from 9.0 to 5.8 per 100 ha but increased to 7.7 in 2007 (Figures 3.14). Negative trend for this species might be the result of increased number of wild cats as predators, lack of food in winter due to collecting acorns, and increasing rate of road kill due to road building in the forest.

Population of *Nyctereutes procyonoides* was 4.9 per 100 ha when it was first estimated in 2002 and showed steady increase by 2007 to 4.7 (Figures 3.14). *Nyctereutes procyonoides* is omnivorous and transmits the rabies virus.

Figure 3.14 Changes in population of *Tamias sibiricusbarberi* and *Nyctereutes procyonoides*


## Indicator 1-5
## Number and status of native forest associated species at risk as determined by legislation or scientific assessment

### 1) Definition and importance

This indicator provides information on the number and status of forest-associated species at risk or in serious decline. It can be determined by monitoring the number of native species that have been identified by conservation science or mandated to be at risk for local, regional, or global extinction. As the number of species considered to be rare increases, the likelihood of species extinction also increases. Demographic and environmental events, such as failure to find a mate, disease, disturbance, habitat loss, and climate change, interact to increase extinction risk. Because important ecosystem functions (e.g., productivity, nutrient cycling, or resilience) can be degraded with the loss of species, there is a concern that the goods and services that humans derive from ecological systems will become diminished. For this reason, tracking the number of at-risk species and their status is a measure of the health of forest ecosystems and their ability to support species diversity.

### 2) Status and trend

According to the Ministry of Environment, Korea has 221 endangered plant and animal species. They are 22 mammals, 61 birds, 4 reptiles, 2 amphibians, 18 fishes, 20 insects, 29 invertebrates, 64 land plants, and 1 aquatic plant. Fox, wolf, and *Cervus nippon* have not been observed lately in the wild. *Nemorhaedus goral, Moschus moschiferus,* and *Pteromys volansaluco* are at risk.

Of Class I of the endangered birds, seven species were observed in 2007 including *Aquila chrysaetos, Eurynorhynchus pygmeus, Platalea leucorodia, Falco peregrinus, Platalea minor, Ciconia ciconia,* and *Haliaeetus albicilla*. Of Class I of the endangered mammals, only two species, *Nemorhaedus goral* and *Lutra lutra* were observed. Of Class II of the endangered birds, 29 species were monitored including *Anas formosa, Haematopus ostralegus, Anser fabalis, Grus monacha, Cygnus cygnus, Buteo buteo,* and *Numenius madagascariensis.* Of Class II of the endangered mammals, *Martes flavigula, Felis bengalensis,* and *Pteromys volansaluco* were monitored.

Korea joined the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1993 and has been monitoring the range of wildlife species included in the list of species protected by CITES.

In 2007, a total of 25 CITES bird species were observed in 405 point-count stations across the country. They are *Anas formosa, Platalea leucorodia, Pandion haliaetus, Milvus migrans, Accipiter gentilis, Aegypius monachus, Accipiter soloensis, Accipiter gularis, Accipiter nisus, Buteo lagopus, Buteo hemilasius, Buteo buteo, Circus cyaneus, Falco peregrinus, Falco subbuteo, Falco tinnunculus, Ninox scutulata, Falco tinnunculus, Falco vespertinus Linnaeus, Falco columbarius, Otus scops, Otus bakkamoena, Strix aluco,* and *Pitta brachyura. Circus melanoleucos* and *Circus aeruginosus* have not been observed since 1999, and *Butastur indicus* has not been observed since 2004. *Grus vipio* and *Asio otus* have not been observed during 2006 and 2007. The number of possibly extinct and endangered species is greater among the birds of prey. There is a need for systematic strategies and measures to monitor and secure their population levels. *Nemorhaedus goral, Lutra lutra,* and *Felis bengalensis* were observed as CITES mammals.

Wildlife extinction is a process in which groups of organisms suddenly die in a state of continuous negative impacts, rather than slowly diminish to extinction over long periods of time. In many cases of extinction, it is difficult to measure the last population trends of them. Wildlife can survive and exist in natural ecosystem when the smallest possible size of population is maintained or at minimum viable population size. Otherwise, they face extinction with the accelerating speed. Therefore, conservation plan should start when the population of species is greater than minimum viable size, which enables them to survive for a certain period in the future.



## Indicator 1-6
## Status of on-site and off-site efforts focused on conservation of genetic diversity

### 1) Definition and importance

This indicator provides information that describes on-site and off-site efforts to conserve species diversity. On-site efforts are activities conducted in habitats to safeguard populations of species at risk. Off-site efforts are widely carried out in laboratories, greenhouses, arboreta, nurseries, seed banks, and other facilities. A holistic approach and dedication encompassing on-site and off-site efforts are critical to accomplish the wide-ranging goals of forest sustainability and conservation.

### 2) Status and trend

The Korea National Arboretum currently manages the total number of 237,087 samples of forest biological resources, including living plants, seeds, and specimens (Table 3.3).

Table 3.3 Forest biological resources in the Korea National Arboretum (Unit: species, count)

| Total | Native | | | | Exotic | | | |
|---|---|---|---|---|---|---|---|---|
| | Sub total | Plant and seed | Specimen | | Sub total | Plant and seed | Specimen | |
| | | | Plant | Insect | | | Plant | Insect |
| 237,087 | 222,714 | 8,341 | 125,592 | 88,781 | 14,373 | 6,023 | 7,530 | 820 |

In the 1990s, the government initiated an arboretum expansion project to create 35 botanical gardens and arboretum nationwide. In Chuncheon and Gwangreung, herbaria were established to collect, propagate and conserve 1,825 plant species, including 609 species of edible and medicinal plants, 768 species of ornamental and garden plants, and 448 species of hardy perennial plants. The status of biological resources conserved in botanical gardens or arboretums are given in the table 3.4.

Table 3.4 Number of plant species in arboretums

| Arboretum | Woody species | Herb species | Others | Total |
|---|---|---|---|---|
| Korea National Arboretum | 1,863 | 1,481 | | 3,344 |
| Deagu Arboretum | 576 | 770 | | 1,346 |
| Daejeon Arboretum | 377 | 592 | | 969 |
| Mulhyanggi Arboretum | 974 | 662 | | 1,636 |
| Gangwon Province Arboretum | 468 | 779 | 110 | 1,357 |
| Midngsan Arboretum | 388 | 652 | | 1,040 |
| Keumkang Arboretum | 493 | 557 | | 1,050 |
| Anmyeondo Arboretum | 624 | 472 | | 1,096 |
| Deaa Arboretum | 1,228 | 1,162 | | 2,390 |
| Wando Arboretum | 2,338 | 1,377 | | 3,715 |
| Gyeongsangbukdo Arboretum | 694 | 816 | | 1,510 |
| Gyeongsangnamdo Arboretum | 1,104 | 501 | | 1,605 |
| Hanra Arboretum | 509 | 591 | | 1,100 |
| Hantaek Botanical Garden | 1,220 | 7,400 | | 8,620 |
| Nemunimo Arboretum | 199 | 823 | 50 | 1,072 |
| Korea Botanical Garden | 554 | 1,368 | | 1,922 |
| Chollipo Arboretum | 2,403 | 9,321 | | 11,724 |
| Kohwun Garden | 1,136 | 2,578 | | 3,714 |
| Key-chungsan Botanical Garden | 603 | 1,113 | 26 | 1,742 |

Also, for 9 conifer species and 5 broad-leaved species, forest stands of particular ecological feature and genetic diversity were designated for on-site conservation. There are 39 communities over 2,683 ha (Table 3.5).

Off-site research and management facilities associated with conservation of forest genetic resources include clone banks, seed orchards, variety conservation gardens, and progeny test stands. Also, gene banks were established as an effective measure for off-site conservation of native plant species. As of 2006, a total number of 5,860 sets of seeds of 294 species were stored under low-temperature condition in the gene bank.



Table 3.5 On-site conservation status of forest genetic resources

| Species | Conifer/ broad-leaved | Number of populations | Area(ha) |
|---|---|---|---|
| *Pinus densiflora* | Conifer | 4 | 2,015 |
| *Pinus koraiensis* | Conifer | 2 | 33 |
| *Abies firma* | Conifer | 1 | 30 |
| *Pinus thunbergii* | Conifer | 1 | 14 |
| *Abies koreana* | Conifer | 2 | 32 |
| *Pinus pumila* | Conifer | 1 | 2 |
| *Picea abies* | Conifer | 1 | 9 |
| *Taxus cuspidates* | Conifer | 4 | 110 |
| *Abies nephrolepis* | Conifer | 2 | 28 |
| | sub total | 18 | 2,273 |
| *Quercus mongolica* | Broad-leaved | 9 | 354 |
| *Quercus variabilis* | Broad-leaved | 4 | 31 |
| *Cornus controversa* | Broad-leaved | 2 | 16 |
| *Populus maximowiczii* | Broad-leaved | 4 | 5 |
| *Stewartia pseudocamellia* | Broad-leaved | 2 | 4 |
| | sub total | 21 | 410 |
| Total | | 39 | 2,683 |

For off-site conservation of forest genetic resources, clone banks and variety conservation gardens maintain 163,644 samples of 87 species and 1,718 clones, such as rose of Sharon (*Hibiscus syriacus*) with over 834 ha in 2008. For long-term conservation, seed processing and storage facilities like gene banks hold 5,965 seed genetic resources of 355 species, 257 genera and 109 families, and 685 forest microbial resources of 102 species (mushroom and fungi) at low humidity and temperature condition (Korea Forest Research Institute, 2008) . In order to improve the infrastructure for data and information management of forest biological diversity, the Korea National Arboretum secured 380 thousand samples of forest genetic resources, developed 116 thousand associated databases by 2008, and maintains 83 thousand samples of plant species and 1,800 sets of plant seeds (Korea National Arboretum, 2008).

Table 3.6 Off-site conservation status of forest genetic resources

| | Purpose | Species | Provinance | Population | Combination | Family | Variety | Clone |
|---|---|---|---|---|---|---|---|---|
| Species | Exhibition garden of rare indigenous hebaceous plants | 347 | | | | | | |
| | Exhibition garden of forest species | 272 | | | | | | |
| | Total | 619 | | | | | | |
| Provinance | Provinance test | 4 | 88 | | | | | |
| | Adaptability test forest for introduced species | 16 | | | | | | |
| | Introduced chestnut | 1 | | | | | 18 | |
| | Total | 21 | 88 | | | | 18 | |
| Family | Genetic resources conservation stands | 27 | | 39 | | | | |
| | Progeny test stands | 4 | | | 589 | 632 | | |
| | Hybridization test of insect resistant *Pinus densiflora* | 1 | | | 22 | 42 | | |
| | Chestnut | 1 | | | | | | 88 |
| | Total | 33 | 39 | 611 | 674 | | | 88 |
| Individual | Seed orchards | 45 | | | | | | 1,152 |
| | Clone conservation for commercial tree species | 19 | | | | | | 937 |
| | Variety conservation stands | 22 | | | 10 | 30 | 489 | 100 |
| | Experimental forest | 13 | | | | | | |
| | Tissue-cultured seedlings | 14 | | | | | | |
| | Total | 113 | | | 10 | 30 | 489 | 2,189 |



# Criterion 2. Maintenance of productive capacity of forest ecosystems

Productive capacity of forest ecosystems shows the potential availability of forests to directly or indirectly provide a wide range of goods and services. This criterion implies both environmental and economic aspects. Environmental aspect is an approach to sustain the productive capacity of forest ecosystems through effective use of forest land, while economic aspect is an approach to enhance productive capacity of forest ecosystems through intensive management plan.

To maintain productive capacity of forest ecosystems, annual forest growth should exceed annual harvest of wood and non-wood products from the forest where trees are mature enough to harvest. Preventing depletion of forest products is the key to sustainable production of desired goods and services of the forest.

## Indicator 2-1
## Area of forest land and net area of forest land available for timber production

### 1) Definition and importance

This indicator provides information fundamental to calculating the annual wood production capacity of forests and shows area of forest land where trees are mature enough to harvest by age class, ownership and land use. This also measures area of forest that is potentially available for wood production compared with total forest area. Understanding stand age class structure and ownership status helps improve management capacity to effectively deal with forest resources.

### 2) Status and trend

As of 2007, about 64% of the country's land was covered by forest that is approximately 6,382 thousand ha. The area of forest land available for wood production accounted for 97.3% of the country's forest (6,210 thousand ha) (Table 3.7).

Every year, forest area is gradually decreasing while the growing stock is apparently increasing. Stand age class structure provides details of the trend.

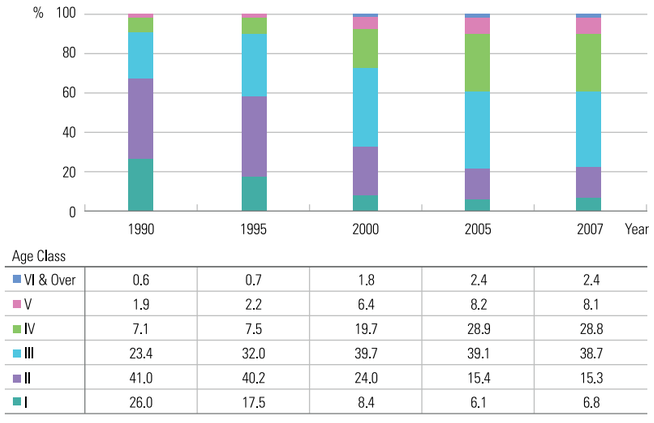
Stand age is classified into six classes from age class I (under 10 years) to age class VI (over 51 years). In 2007, age class I covered 6.8% of the total forest area, while age classes II, III, IV, V, and VI covered 15.3%, 38.6%, 28.8%, 8.1%, and 2.4%, respectively, of the total forest area (Figure 3.15).

Since 2000, young forests of age class II and below have been considerably decreasing while forests of age class III and over have been noticeably increasing. These trends resulted from natural development of the forest over time and a shift in stand age distribution toward older stands, which caused the rise of growing stock of forests.

Table 3.7 Changes in forest area by stand age class (Unit: 1,000 ha)

| Year | Total | Age class I | Age class II | Age class III | Age class IV | Age class V | Age class VI |
|---|---|---|---|---|---|---|---|
| 1990 | 6,278 | 1,633 | 2,572 | 1,470 | 444 | 119 | 40 |
| 1995 | 6,255 | 1,093 | 2,513 | 1,999 | 469 | 138 | 43 |
| 2000 | 6,262 | 525 | 1,503 | 2,487 | 1,233 | 400 | 114 |
| 2005 | 6,232 | 383 | 957 | 2,435 | 1,802 | 508 | 147 |
| 2007 | 6,210 | 421 | 950 | 2,400 | 1,788 | 505 | 146 |

Figure 3.15 Forest area by stand age class

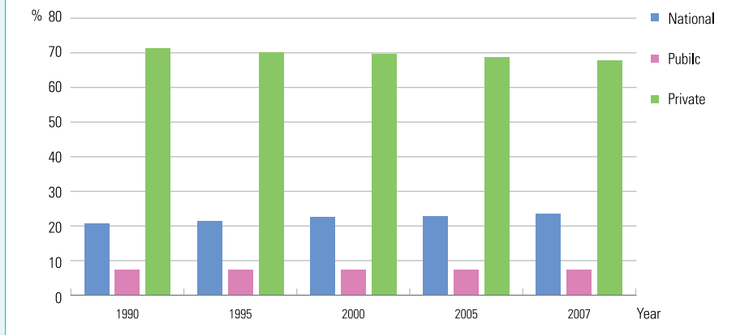



Over the past decade, forest area was steadily decreasing. Annual average loss was 4,979 ha. Forest area by ownership in 2007 was compared to that in 1990 (Table3.8 and Figure 3.16). Private forests comprising the largest category of ownership decreased from 4,495 thousand ha (71.6% of the entire forest land) in 1990 to 4,257 thousand ha (67.8%) in 2007, while the public forests was little changed from 469 thousand ha (7.5%) to 475 thousand ha (7.6%). During the same period, national forests increased from 1,314 thousand ha (20.9%) in 1990 to 1,478 thousand ha (23.5%) in 2007. Continuous acquisition of private forests by the Korea Forest Service has contributed to increase of national forests by 164 thousand ha (2.6%) over the last 17 years.

Table 3.8 Forest area by ownership (Unit: 1,000 ha)

| Year | Total | National forests | Public forests | Private forests |
|---|---|---|---|---|
| 1990 | 6,278 | 1,314 | 469 | 4,495 |
| 1995 | 6,255 | 1,356 | 473 | 4,426 |
| 2000 | 6,262 | 1,404 | 479 | 4,379 |
| 2005 | 6,232 | 1,453 | 477 | 4,302 |
| 2007 | 6,210 | 1,478 | 475 | 4,257 |

Figure 3.16 Trend of forest area by ownership



## Indicator 2-2
## Area and growing stock of plantations of native and exotic species

### 1) Definition and importance

This indicator is a measure of the degree to which forest plantations are being established in response to increasing demand for forest products as well as competing non-timber uses for forest land. The provision of forest products from well managed plantations can enhance the potential range and quantity of goods and services available from the forest. Native species are preferred globally for its contribution to keeping the ecosystem in balance.

### 2) Status and trend

During the early 1980s to the late 1990s, plantation with native species accounted for some 20% of the total plantation area. However, since 1999 it has been apparently increased due to implementation of a new forest policy, the Fourth National Forest Plan (1998 to 2007) that focused on expanding plantation with native species for economic and environmental benefits.

Plantation area steadily declined with more reduction in exotic species than native species (Table 3.9). The number of native species for plantation was 6 species by 1998, yet 41 species were newly added in 1999. Information on native and exotic species associated with plantation area after 2000 will be updated when the fifth National Forest Inventory is done in 2010.

Table 3.9 Plantation area of native and exotic species (Unit: 1,000 ha)

| Year | Total | Native species | Exotic species | Other species |
|---|---|---|---|---|
| 1980 | 165.6 | 43.6 | 117.0 | 4.3 |
| 1990 | 37.4 | 15.8 | 11.0 | 10.5 |
| 1998 | 20.4 | 7.2 | 6.0 | 7.2 |
| 1999 | 21.0 | 13.7 | 6.3 | 1.0 |
| 2000 | 22.1 | 14.8 | 6.3 | 1.1 |



## Indicator 2-3
## Annual harvest of wood products and net growth

### 1) Definition and importance

This indicator compares net forest growth with wood harvest for products on timberland, measuring productive capacity of forest ecosystems through growth and harvest of products over time.

### 2) Status and trend

To increase growing stocks, growth should exceed removals and the ratio between net growth and harvest should be determined by havesting age of a particular species.

Between 2003 and 2006, the average annual growth was approximately 20 million $m^3$ and annual average harvest was about 2 million $m^3$. The ratio of harvested volume to annual growth was as low as 10%, because many of the forest lands were not old enough to harvest (Table 3.10 and Figure 3.17). As the stand age class gets higher, the harvested volume is increasing. However, a drop in timber prices kept the harvesting rate low.

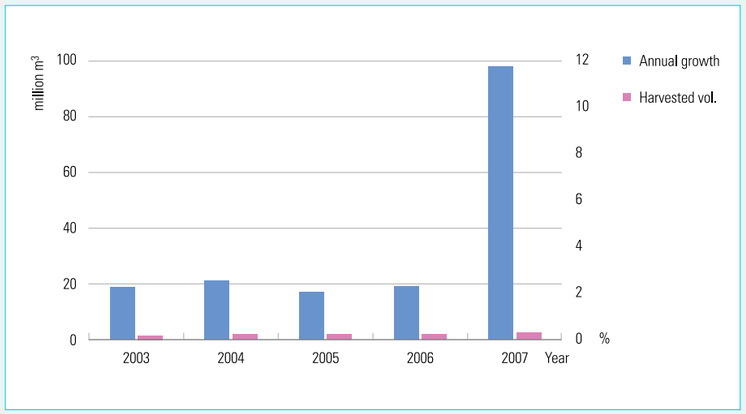
Net growth has increased notably in 2007 compared to that of 2006, which resulted from changes in methodology employed to estimate growing stock. In order to fulfill international requests for more accurate forest statistics, the 5th National Forest Inventory (NFI) is ongoing in Korea and will end up to 2010. Underestimated growing stock in the previous statistics will be recalculated when the 5th NFI is done.

Table 3.10 Forest growing stock and annual harvest (Unit: $m^3$)

| Year | Forest growing stock (A) | Annual harvest (B) | B/A (%) |
|---|---|---|---|
| 2003 | 19,712,110 | 1,634,882 | 8.3 |
| 2004 | 20,893,133 | 1,911,947 | 9.2 |
| 2005 | 17,315,708 | 1,921,844 | 11.1 |
| 2006 | 19,455,660 | 2,075,459 | 10.7 |
| 2007 | 98,565,849[1)] | 2,531,411 | 2.6 |

1) Unusual increase of annual growth in 2007 resulted from the change of estimation method

Figure 3.17 Annual growth and annual harvest




## Indicator 2-4
## Forest area covered by management plans

### 1) Definition and importance

This indicator provides a measure of the extent to which forest is managed in accordance with a management plan. This assesses whether there are management plans to maintain productive capacity of forest ecosystems. This indicator is also related to criteria 3 (maintenance and encouragement of productive functions of forests) of the Pan-Europe Process, MCPFE (the Ministerial Conference on the Protection of Forests in Europe). This is a legislative and on-site operation tool to achieve sustainable forest management in Korea.

### 2) Status and trend

The Korea Forest Service recommends preparation of forest management plans for the forest where forestry practices are permitted, and releases information on the area and percent of forests covered by management plans in the yearbook of forest statistics. Forest management planning is a means of identifying whether forest is being managed under an organized and systematic sequence of activities to accomplish its sustainability goals.

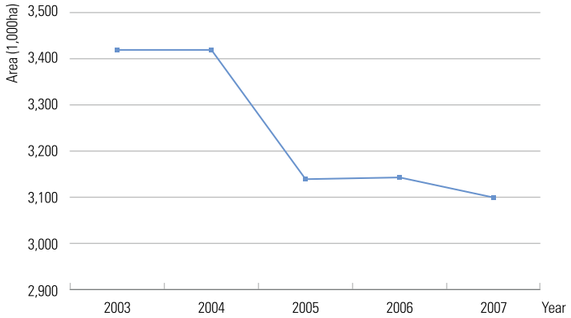
As part of the policy of easing government restrictions in 1998, developing forest management plan for private forest land was amended from mandatory requirement to recommendation because majority of forest landowners is comprised of small-scale owners who tend to keep up ownership of their forest as real estate rather than as property of sustainable management. To address this, the Korea Forest Service is working to develop certain incentives like increasing subsidy on preparing forest management plan and extending forestry businesses.

Forest management plans are renewed every 10 years. However, forest area covered by management plans has diminished since it switched from mandatory to voluntary.

Nationwide, the forest area that is recommended for developing forest management plan is 5,989 thousand ha. Of this, 51% covering 3,100 thousand

ha is managed in accordance with management plans (Figure 3.18). In the national forests, 95% is being managed sustainably according to management plans while in the public and private forests, 1,886 thousand ha (or as low as 40% of them) are subjected to management plans.

Figure 3.18 Forest areas under forest management plans






# Criterion 3. Maintenance of forest ecosystem health and vitality

Forest species and ecosystem have been adapted to environmental conditions such as geology and climate for a relatively long term. However, a rapid change in environmental conditions resulted from natural or human-induced disturbances affects forest ecosystem health and vitality. Especially, an indiscreet human activity inevitably cause negative impacts on forest ecosystem health and vitality, because of expansion of exotic species, air pollution and induction of harmful insects or diseases.

This criterion shows the status of forest ecosystem health and vitality in Korea through the measures of impacts of natural disturbances and air pollutions.

## Indicator 3-1
## Area and percentage of forest affected by processes or agents beyond the range of historic variation

### 1) Definition and importance

This indicator shows impacts and processes of natural disturbances, such as pests, diseases and forest fires, on forest health and vitality. These disturbances have direct impacts on the destruction of forest ecosystem and its health. The disturbed sites would not be recovered in a short period of time. Often, huge amount of time and efforts are required for recovering a destructed site.

### 2) Status and trend

Forest damages by blight/harmful insects and diseases occurred by the interaction between components of forest ecosystems. Patterns of damages by insects are changing because structure of forest ecosystem is changing as well due to increase in forest ages and growing stocks. Also, exotic insects and diseases were introduced through globalization and open market of agro-products, such as sycamore lace bug, flower cicada, and pitch canker.

In 1997, the area of pine forests damaged by pests and diseases, such as pine

gall midge (*Thecodiplosis japonensis*) was estimated approximately 378 thousand ha of Kangwon and Jeonnam provinces. The damage has been gradually decreasing to 243 thousand ha because of the prevention efforts of the Korea Forest Service and local governments.

However, in 2005, a number of harmful insects became rampant again, so the damaged area rapidly increased up to 315,607 ha, and reached the peak in 2006 and 2007 (Table 3.11). This is because pine wilt disease caused by pine gall midge (*Thecodiplosis japonensis*) and pine wood nematode (*Bursaphelenchus xylophilus*). Pine wood nematode was first occurred in 1998, and widely spread across the Korean peninsula recently.

The Korean government has made its effort to combat threat by pine wood nematode and the area of outbreak decreased from 7,871 ha in 2006 to 6,855 ha in 2007. In addition, oak wilt disease and pitch canker caused by climate change have been emerging in recent five years. However, there was no big difference for damaged area.

Table 3.11 Area under outbreak of damages by forest insects (Unit : 1,000ha)

| Year | Total | | Pine leaf gall midge | | Black pine bast scale | | Pine wood nematode | | Others | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Out-break | Control | Out-break | Control | Out-break | Control | Out-break | Control | Out-break | Control |
| 2003 | 254 | 205 | 91 | 51 | 10 | 10 | 3 | 9 | 149 | 134 |
| 2004 | 243 | 181 | 73 | 22 | 11 | 9 | 5 | 14 | 154 | 136 |
| 2005 | 316 | 170 | 149 | 17 | 12 | 3 | 8 | 21 | 147 | 129 |
| 2006 | 390 | 184 | 196 | 26 | 45 | 8 | 8 | 34 | 141 | 115 |
| 2007 | 372 | 202 | 180 | 48 | 47 | 10 | 7 | 29 | 138 | 114 |

In Korea, occurrence of forest fire has been reported since 1960. Depending on the available data, the number of fire occurrence did not show specific trends, and the data varied every year. For recent 10 years, there have been huge amounts of forest resources damaged by fires all over the nation. Especially, huge areas around the Baekdudaegan Mountains in Kangwon province were damaged by several catastrophic forest fires, such as ‘Goseong fire’ in 1996, ‘East coast fire' in 2000 and ‘Yangyang fire’ in 2005. The ‘Yangyang fire’ occurred in 2005 totally destroyed the Naksan temple, a national monument located in Yangyang county.

During the last few decades, sequencing catastrophic forest fires were occurred around the eastern cost side. This area has a vulnerable conditions to forest fire with highly accumulated fuels, high temperature, and low humidity during the fire season. However, recently the number of fires is decreasing with a intensive fire-fighting efforts.

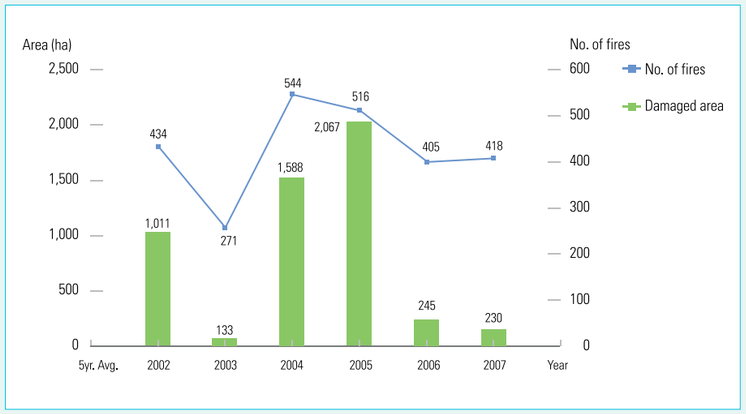
In the last 10 years (1998~2007), 485 forest fires on average were occurred every year and the average area damaged by forest fires was 3,714 ha. Recently, the frequency of forest fire was decreasing (Table 3.12 and Figure 3.19). However, most of forests are threatened by catastrophic forest fires due to the highly accumulated fuels.

The size and intensity of forest fires vary with seasonal rainfall or human activities. In Korea, spring and winter are the fire seasons with dry and windy weather conditions. About 65% of forest fires occurred during the spring (from March to May) and 25% of forest fires during the winter (from December to February). Also, as public demands for outdoor recreation increased, 38% of forest fires occurred during the weekend or holyday.

Table 3.12 Forest area damaged by forest fires

| Year | 1990 | 1995 | 2000 | 2005 | 2007 |
|---|---|---|---|---|---|
| Damaged area (ha) | 175 | 1,013 | 25,607 | 2,067 | 230 |
| No. of fires | 71 | 630 | 729 | 516 | 418 |

Figure 3.19 Area and frequency of forest fires



## Indicator 3-2
## Area and percentage of forest land subjected to levels of specific air pollutants (e.g. sulfates, nitrate, and ozone) or acid precipitation that may cause negative impacts on the forest ecosystem

### 1) Definition and importance

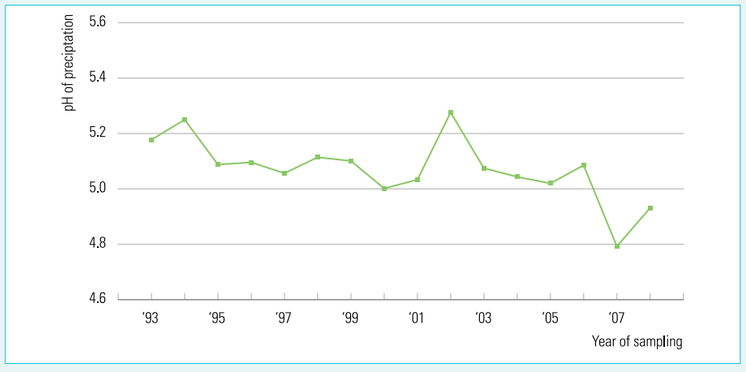
Air pollutants exist in a state of gas, liquid and solid, which accumulate in the forest ecosystems. These affect tree metabolism and decrease the productivity of forest ecosystems. In addition, sulfur dioxide and nitrogen oxide in the atmosphere combine with rain and become acid rain. Acid rain causes cations leaching from the forest soil causing acidification of soil and surface water. For a long period, it changes the structure of forest ecosystem. To investigate the impact of air pollution on the forest ecosystem, long-term monitoring is necessary.

### 2) Status and trend

The damages and changes of forest ecosystem by air pollution or acid rain have been monitored within forest areas since 1993. Sulphur dioxide, nitrogen dioxide, rainfall and soil acidity were annually measured from 65 permanent plots systematically distributed across the nation.

The overall average pH in precipitation was 5.1 and steadily decreased since 1993. Due to the Asian dust, it increased up to 5.3 in 2002 (Figure 3.20). Annual estimates of sulfate and nitrate deposition in forested areas were stable and their average value is not harmful to tree health.

Figure 3.20 Pattern of annual mean pH of precipitation




The concentration of $NO_2$ is lower than 20 ppb in 90% of the plots and even the proportion lower than 5 ppb is increasing. The concentration of $SO_2$ is lower than 20 ppb, which is the standard level of the Ministry of Environment (except 3% in 1994 and 2007) (Tables 3.13 and 3.14). Especially, over 95% of the plots is lower than 10 ppb in forest area.

Table 3.13 Proportion of surveyed area by $NO_2$ concentration (Unit : %)

| Year | Concentration of $NO_2$ (ppb) | | | | |
|---|---|---|---|---|---|
| | <5 | 5-10 | 10-15 | 15-20 | 20< |
| 2002 | 6.3 | 71.9 | 15.6 | 3.1 | 3.1 |
| 2003 | 9.2 | 55.4 | 18.5 | 7.7 | 7.7 |
| 2004 | 15.4 | 50.0 | 27.7 | 3.1 | 3.1 |
| 2005 | 13.8 | 63.1 | 16.9 | 4.6 | 1.5 |
| 2006 | 75.4 | 13.8 | 6.2 | 3.1 | 1.5 |
| 2007 | 75.4 | 13.8 | 4.6 | 3.1 | 3.1 |
| 2008 | 89.2 | 4.6 | 1.5 | 3.1 | 1.5 |

Table 3.14 Proportion of surveyed area by $SO_2$ concentration (Unit : %)

| Year | Concentration of $SO_2$ (ppb) | | | | |
|---|---|---|---|---|---|
| | <5 | 5-10 | 10-15 | 15-20 | 20< |
| 1993 | 0.0 | 80.0 | 15.4 | 3.1 | 1.5 |
| 1994 | 0.0 | 86.2 | 9.2 | 1.5 | 3.1 |
| 1995 | 0.0 | 98.5 | 1.5 | 0.0 | 0.0 |
| 1996 | 0.0 | 96.9 | 3.1 | 0.0 | 0.0 |
| 1997 | 56.9 | 43.1 | 0.0 | 0.0 | 0.0 |
| 1998 | 92.3 | 7.7 | 0.0 | 0.0 | 0.0 |
| 1999 | 73.0 | 25.4 | 1.6 | 0.0 | 0.0 |
| 2000 | 76.2 | 23.8 | 0.0 | 0.0 | 0.0 |
| 2001 | 31.7 | 65.1 | 3.2 | 0.0 | 0.0 |
| 2002 | 82.5 | 15.9 | 1.6 | 0.0 | 0.0 |
| 2003 | 75.4 | 21.5 | 3.1 | 0.0 | 0.0 |
| 2004 | 75.4 | 20.0 | 3.1 | 1.5 | 0.0 |
| 2005 | 81.5 | 15.4 | 1.5 | 1.5 | 0.0 |
| 2006 | 53.8 | 43.1 | 1.5 | 1.5 | 0.0 |
| 2007 | 29.2 | 58.5 | 7.7 | 1.5 | 3.1 |
| 2008 | 56.9 | 38.5 | 3.1 | 1.5 | 0.0 |

# Criterion 4. Conservation and maintenance of soil and water resources

Soil and water resources are essential factors that make up the terrestrial ecosystems. Soil is the shelter of plants and animals; it preserves water and nutrition and purifies pollutants as its physical function. Water resources consist of more than 80% of organisms and are used as solvents of material or conveying passage. Soil and water are important for both humans and wild animals. They have a huge impact on the structure and function of forest ecosystems. The quantity and quality of soil and water influence the composition of forest ecosystems, whose social and economic values will be decided.

The properties of forest soil are being influenced by forest land conversion and forest management activities which often create soil disturbance. Physicochemical soil properties change by artificial factors can be observed by long-term monitoring. Forest activities, such as timber harvesting and associated road construction, can generate soil erosion and can cause soil compaction. The change of water temperature and increase of turbidity decrease water quality and function of hydro-ecosystems.

The change of various functions of soil and water resources can be measured by long-term monitoring system. Comparing permanent plots with healthy forest ecosystems helps one to detect recovery and malfunction of soil and water resources.



## Indicator 4-1
## Area and percentage of forest land with significant soil erosion

### 1) Definition and importance

This indicator assesses the area and percentage of forest land with significant soil erosion. Soil erosion decreases soil productivity, affects forest stream/river ecosystem, and causes risks to humans and their properties. Figure 3.21 shows the districts damaged by landslide and soil erosion in Pyeongchang, Gangwon Province in 2006.

Natural (landslides and forest fire) and artificial (deforestation or forest management) disturbances can lead to over-floods and can cause severe impacts to stream ecosystem. Nutrients of topsoil and organics can be lost as well.

Figure 3.21 Districts damaged by landslide and soil erosion (Pyeongchang, Gangwon Province, 2006)

### 2) Status and trend

Korea used to have devastated forests. However, the forest rehabilitation projects, which started in 1970s, created stocked forest changing the amount of flowing water. Surface landslide was also largely reduced. However, the form of landslide has changed from surface landslide to deep landslide.

In the past few years, landslides have caused greater impact on environment and

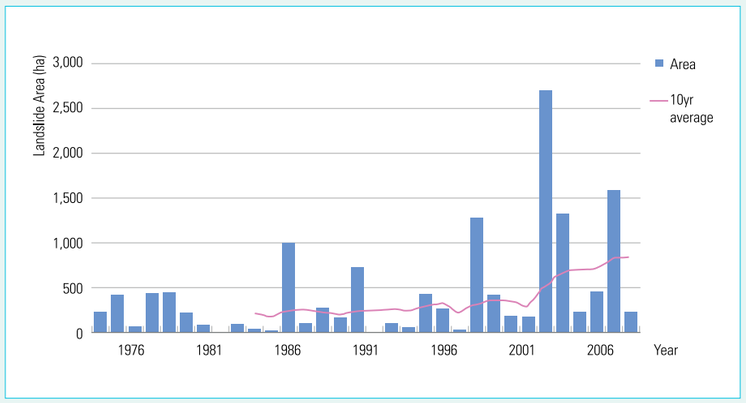
economy despite the national efforts on erosion control, because the torrential rain showers have become more severe due to global climate change phenomenon and indiscreet exploitation of forest land continued. The most serious type of erosion is in mountain areas, especially erosion from unstable and loose geological material that leads to gully erosion and mass movement of soil and rock (Figures 3. 22 and 3.23). In Korea, the statistical data about landslide areas has been investigated since 1976. Figure 3.24 shows the area of landslide every five years.

Especially, recent scale and area of landslide has gradually increased because of the frequent occurrence of typhoon and localized heavy flood. After 2002, it is obvious to have the tendency of growth.

Figure 3.22 Soil erosion by landslide (2002, Gimhae, Gyeongnam Province)

Figure 3.23 Soil erosion after forest fire (2002, Gangneung, Gangwon Province)

Figure 3.24 Changes in area of landslides




## Indicator 4-2
## Area and percentage of forest land with significant diminished soil organic matter and/or changes in other soil chemical properties

### 1) Definition and importance

The stability and productivity of forest ecosystems are related with soil chemical properties. Unsustainable forest management activities can cause the degradation of soil chemical properties.

This indicator is used to determine soil fertility and productivity by comparing the change of soil chemical properties with long-term monitored soil values. Especially, it is essential to understand the dynamics of soil organic matter and acidity in order to maintain and manage terrestrial and aquatic ecosystems in a sustainable manner.

### 2) Status and trend

Before 1990, the average pH of forest soil was 5.48 in Korea. The content of organic matter was the highest in Jeju and the lowest in Chungnam. Total nitrogen content was also the highest in Jeju and the lowest in Chungnam. Available phosphorus content was more than 25ppm in most areas (Table 3.15).

When compared to the forest soil properties before 1990, pH of forest soil decreased in 2004, while the content of organic matters, total nitrogen, exchangeable potassium and magnesium increased a little bit. No changes were found in the other chemical properties (Table 3.16). Especially, there were low pH patterns in Gyeonggi and Jeonbuk areas. In 2008, pH decreased, while available phosphorus, exchangeable potassium and sodium increased. No changes were found in the other chemical properties (Table 3.17). Long term monitoring is required to investigate the change of soil chemical properties.

Table 3.15 Chemical properties of soil A layer by province (1984–1990)

| Province | pH (1:5) | OM[1)] (%) | TN[2)] (%) | Avail. $P_2O_5$ (ppm) | C.E.C ($cmol_c$/kg) | $K^+$ ($cmol_c$/kg) | $Na^+$ ($cmol_c$/kg) | $Ca^{2+}$ ($cmol_c$/kg) | $Mg^{2+}$ ($cmol_c$/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Gangwon | 5.80 | 4.93 | 0.21 | 33.4 | 13.4 | 0.26 | 0.29 | 3.88 | 1.16 |
| Gyeonggi | 5.38 | 4.08 | 0.19 | 34.1 | 11.8 | 0.29 | 0.20 | 2.15 | 0.74 |
| Chungbuk | 5.43 | 3.69 | 0.12 | 17.8 | 11.8 | 0.15 | 0.08 | 2.51 | 0.45 |
| Chungnam | 5.22 | 2.12 | 0.09 | 14.0 | 10.0 | 0.17 | 0.19 | 0.91 | 0.49 |
| Jeonbuk | 5.10 | 5.21 | 0.19 | 25.2 | 12.8 | 0.20 | 0.12 | 1.05 | 0.45 |
| Jeonnam | 5.16 | 4.57 | 0.16 | 16.7 | 12.3 | 0.17 | 0.06 | 0.57 | 0.43 |
| Gyeongbuk | 5.41 | 3.70 | 0.17 | 19.3 | 11.2 | 0.24 | 0.16 | 2.27 | 1.27 |
| Gyeongnam | 5.27 | 3.44 | 0.14 | 19.5 | 10.4 | 0.17 | 0.18 | 1.18 | 0.85 |
| Jeju | 5.30 | 10.40 | 0.43 | 27.4 | 19.7 | 0.34 | 0.46 | 2.07 | 1.97 |
| Average | 5.48 | 4.49 | 0.19 | 25.6 | 12.5 | 0.23 | 0.22 | 2.44 | 1.01 |

1) Organic matter
2) Total nitrogen

Table 3.16 Chemical properties of soil A layer by province in 2004

| Province | pH (1:5) | OM (%) | TN (%) | Avail. $P_2O_5$ (ppm) | C.E.C ($cmol_c$/kg) | $K^+$ ($cmol_c$/kg) | $Na^+$ ($cmol_c$/kg) | $Ca^{2+}$ ($cmol_c$/kg) | $Mg^{2+}$ ($cmol_c$/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Gangwon | 5.14 | 5.39 | 0.25 | 14.02 | 13.46 | 0.42 | 0.07 | 2.56 | 0.79 |
| Gyeonggi | 4.33 | 2.45 | 0.17 | 5.90 | 11.88 | 0.27 | 0.06 | 0.72 | 0.42 |
| Chungbuk | 5.22 | 3.53 | 0.14 | 3.94 | 8.29 | 0.32 | 0.05 | 1.97 | 0.67 |
| Chungnam | 5.18 | 4.07 | 0.21 | 13.41 | 12.23 | 0.35 | 0.04 | 1.85 | 0.82 |
| Jeonbuk | 4.58 | 3.01 | 0.13 | 7.92 | 11.48 | 0.50 | 0.09 | 0.64 | 0.42 |
| Jeonanam | 5.16 | 7.10 | 0.27 | 7.91 | 15.54 | 0.26 | 0.22 | 3.17 | 1.48 |
| Gyeongbuk | 5.09 | 2.51 | 0.13 | 5.60 | 11.69 | 0.43 | 0.12 | 2.82 | 2.25 |
| Gyeongnam | 4.92 | 2.38 | 0.10 | 6.53 | 9.68 | 0.48 | 0.12 | 0.79 | 0.80 |
| Jeju | 5.94 | 11.87 | 0.52 | 6.40 | 25.41 | 0.51 | 0.55 | 5.82 | 3.30 |
| Average | 5.06 | 4.70 | 0.22 | 7.96 | 13.30 | 0.39 | 0.15 | 2.26 | 1.21 |

Table 3.17 Chemical properties of soil A layer by province in 2008

| Province | pH (1:5) | OM (%) | TN (%) | Avail. $P_2O_5$ (ppm) | C.E.C ($cmol_c$/kg) | $K^+$ ($cmol_c$/kg) | $Na^+$ ($cmol_c$/kg) | $Ca^{2+}$ ($cmol_c$/kg) | $Mg^{2+}$ ($cmol_c$/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Gangwon | 5.22 | 4.60 | 0.23 | 12.57 | 14.59 | 0.35 | 0.29 | 2.44 | 0.43 |
| Gyeonggi | 4.20 | 7.79 | 0.31 | 19.63 | 17.38 | 0.21 | 0.04 | 1.57 | 0.50 |
| Chungbuk | 4.96 | 2.00 | 0.07 | 3.22 | 10.21 | 0.23 | 0.24 | 1.06 | 0.42 |
| Chungnam | 4.88 | 3.45 | 0.17 | 12.01 | 16.70 | 0.24 | 0.24 | 1.46 | 0.43 |
| Jeonbuk | 4.58 | 2.07 | 0.11 | 11.19 | 9.52 | 0.17 | 0.26 | 0.81 | 0.32 |
| Jeonnam | 4.80 | 3.73 | 0.18 | 11.51 | 16.73 | 0.25 | 0.28 | 1.35 | 0.63 |
| Gyeongbuk | 5.12 | 3.49 | 0.12 | 2.09 | 10.16 | 0.25 | 0.28 | 2.19 | 1.72 |
| Gyeongnam | 4.82 | 3.21 | 0.15 | 14.44 | 13.54 | 0.20 | 0.28 | 0.76 | 0.35 |
| Jeju | 5.94 | 11.87 | 0.52 | 22.71 | 6.40 | 25.41 | 0.51 | 0.55 | 5.82 |
| Average | 4.95 | 4.69 | 0.21 | 12.15 | 12.80 | 3.03 | 0.27 | 1.35 | 1.18 |

## Indicator 4-3
## Area and percentage of forest land with significant compaction or change in soil physical properties resulting from human activities

### 1) Definition and importance

This indicator measures the total forest area by soil disturbance, harvesting and land use conversion. Soil of good quality consists of about 45% mineral, 25% air, 25% water and 5% organic matter. Disturbance, which can affect soil characteristics, reduces the growth of plants after changing the component ratio. This indicator quantifies the changes of soil traits that are negatively affecting soil fertility, nutriment, water circulation, and other ecological processes.

### 2) Status and trend

Some of the factors that affect forest soil physical properties are land use conversion and forest management activities, such as timber harvesting and associated road construction.

Few construction of forest road was established until 1985, but it had increased since 1986. From 1991 to 2000, new construction of forest road had established more than 70% of whole forest roads, which was 12,212km. Since 2001, new forest road of about 200km has been built every year. The total length of forests road is longer in private forests rather than national forest (Table3.18).

In addition, land use conversion of forest occurred at about 5,954ha on annual average (Table 3.19). Residential uses such as house and road accounted for 57% of entire conversion. Exclusive conversion to agricultural land decreased during 2000s. Conversion to recreational uses such as park or playground has increased which accounted for 11% in 2007.

Recently, recreational uses became another big contributor for soil compaction. As recreational demands are increasing, it is necessary to monitor and report the effects of recreational activities on soil compaction in the future.

Table 3.18 Length of forest roads (Unit : km)

| Year | National forest | Private forest | Total | Accumulated length |
|---|---|---|---|---|
| -1975 | 160 | 0 | 160 | 160 |
| 1976-1980 | 65 | 0 | 65 | 225 |
| 1981-1985 | 42 | 204 | 246 | 471 |
| 1986-1990 | 560 | 1,550 | 2,110 | 2,581 |
| 1991-1995 | 2,192 | 4,363 | 6,555 | 9,136 |
| 1996-2000 | 921 | 4,736 | 5,657 | 14,793 |
| 2001 | 26 | 244 | 270 | 15,063 |
| 2002 | 19 | 274 | 293 | 15,356 |
| 2003 | 12 | 142 | 154 | 15,510 |
| 2004 | 10 | 90 | 100 | 15,610 |
| 2005 | 20 | 195 | 215 | 15,825 |
| 2006 | 11 | 212 | 223 | 16,048 |
| 2007 | 0 | 219 | 219 | 16,267 |

Table 3.19 Area of forest land conversion to other land uses (Unit : ha)

| Year | Total | Agriculture | Grazing | Residential | Recreational | Others |
|---|---|---|---|---|---|---|
| 1999 | 6,083 | 1,285 | 528 | 3,368 | 181 | 721 |
| 2000 | 5,558 | 1,062 | 244 | 3,026 | 265 | 961 |
| 2001 | 6,021 | 776 | 231 | 3,391 | 506 | 1,117 |
| 2002 | 6,383 | 680 | 188 | 3,830 | 375 | 1,310 |
| 2003 | 5,751 | 590 | 229 | 3,622 | 375 | 935 |
| 2004 | 5,772 | 420 | 143 | 3,847 | 348 | 1,014 |
| 2005 | 6,528 | 630 | 202 | 3,443 | 592 | 1,661 |
| 2006 | 4,594 | 396 | 141 | 2,287 | 526 | 1,244 |
| 2007 | 6,812 | 711 | 139 | 3,927 | 726 | 1,309 |

## Indicator 4-4

# Percentage of water bodies in forest areas with significant variation from the historic range of variability in pH, dissolved oxygen, levels of chemicals, sedimentation, and temperature

### 1) Definition and importance

This indicator measures the percentage of water bodies in forest areas with significant variation of chemical properties by natural/artificial disturbances, such as landslide, forest fire and land use conversion. This shows indirectly the changes in the quality of mountain stream around the forest.

When raining heavily, natural/artificial damages make nutriment or floating matters excessively flow out from the forest. So it negatively affects aquatic living things, such as fish, because it increases water temperature and worsens the quality of water in the downstream. For forest management activities, careful attention is required because construction of forest road or clearcutting can cause a lot of outflow of organic matter and soil erosion.

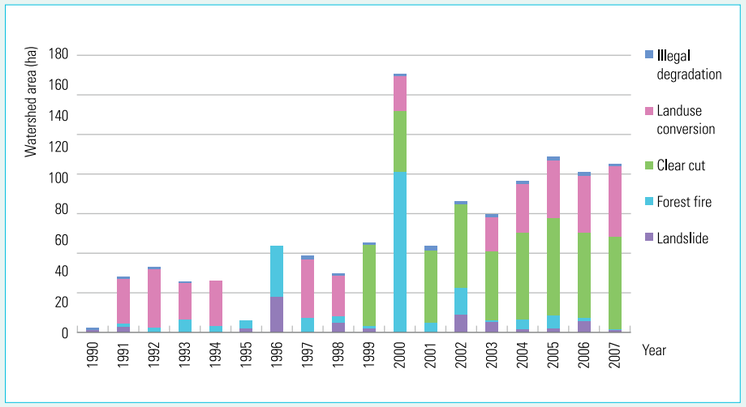
### 2) Status and trend

There should be monitoring consistently in the valley, river and reservoir in order to get direct data related to this indicator, because there has been no example of investigation about the mountain stream or the area of lake which has big changes around forest in Korea.

Now, the stream water quality has greatly improved by stocked forests. However, wildland fires greatly deteriorate water quality. Severe soil erosion and landslide caused by typhoon and heavy rainfall would change the stream length, bury reservoir, and worsen water quality.

Chemical properties change increased in the area of mountain stream within the forest as clearcutting and land use conversion areas increased in 2000s.
To maintain the chemical properties of forest stream, specific planning and monitoring must be done. Figure 3.25 shows the size of the watersheds with changes of chemical properties.

Figure 3.25 Size of the watersheds with changes of chemical properties




## Indicator 4-5
## Protected forests

### 1) Definition and importance

This indicator measures the percent or the area of forests which designated for conservation. While soil erosion control activities for reducing soil outflow or natural disasters have decreased since 1980s, other activities for preventing forest fires and landslides or for protecting water source are increasing recently. This indicators introduced the status and changes of protected forests designated for specific purposes.

### 2) Status and trend

There are several kinds of protection forests assigned for various purposes. Protection forest for conservation of watershed has increased, but those for other purposes have decreased since 2000 (Table 3.20 and Figure 3.26). At present, there is a need to specify the type of protection forests according to their functions. Also, it is necessary to strictly manage the protection forests and expand the area continuously with specific management plan.

Table 3.20 Area of protection forests

(Unit: ha)

| Year | Total | Soil erosion | Sand and coast | Water reservation | Fish habitat | Landscape | Others |
|---|---|---|---|---|---|---|---|
| 1990 | 206,947 | 8,968 | 1,059 | 160,634 | 6,207 | 30,047 | 212 |
| 1995 | 200,194 | 6,629 | 1,082 | 157,531 | 4,776 | 30,086 | 90 |
| 2000 | 320,230 | 2,780 | 1,015 | 284,288 | 4,031 | 28,035 | 81 |
| 2005 | 341,415 | 2,127 | 891 | 306,647 | 3,852 | 27,833 | 65 |
| 2007 | 323,363 | 1,653 | 886 | 292,472 | 3,745 | 24,596 | 11 |



Figure 3.26 Changes in the area of protection forests between 1997 and 2007

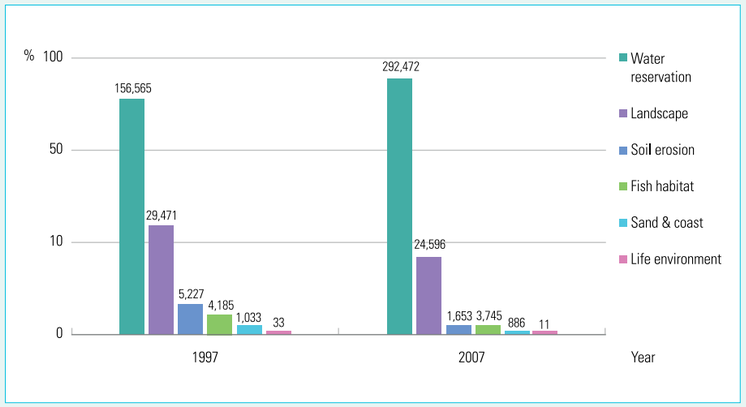


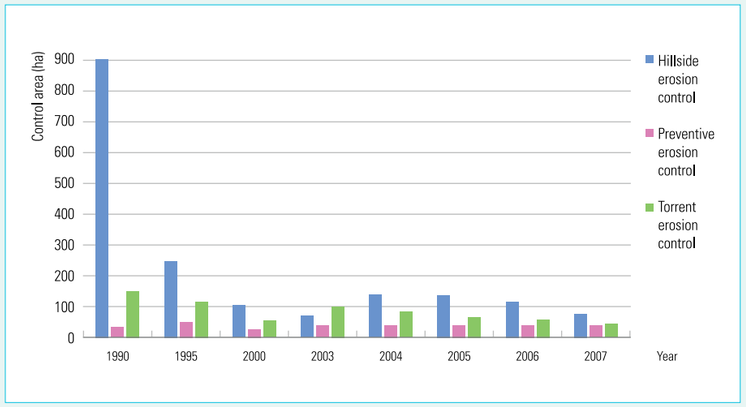

Table 3.21 Area of riparian buffers and water source protection zones

| Year | Total(ha) | Water source protection zones | | | Riparian buffers (ha) |
|---|---|---|---|---|---|
| | | No. | Area(ha) | Residents (person) | |
| 1990 | 126,653 | 324 | 126,653 | - | - |
| 1995 | 120,100 | 383 | 120,100 | 130,038 | - |
| 2000 | 125,307 | 386 | 125,307 | 58,109 | - |
| 2004 | 226,144 | 357 | 124,692 | 52,243 | 101,452 |
| 2007 | 240,926 | 351 | 127,871 | 47,053 | 113,056 |

Erosion control activities for reducing soil outflow and natural disaster have decreased since 1980s, while prevention activities for forest fires or landslide have increased recently. Protection activities for forest watershed have also increased.

Erosion control can be divided into 3 activities: hillside erosion control, preventive erosion control, and torrent erosion control. As shown in the figure 3.27, hillside erosion control activities have more portion than other activities. All the activities had decreased by the early 2000s, but temporarily increased between 2004 and 2005 and then decreased again.

Figure 3.27 Area of erosion control activities




## Criterion 5. Maintenance of forest contribution to global carbon cycles

Since the 1992 Earth Summit in Rio de Janeiro, Brasil, climate changes and its effects such as Arctic ice melting, droughts, floods and ecosystem degradation, have been one of the most critical global issues. To cope with the crisis, the international community launched the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol took effect on February 16, 2005.

In Korea, since the main industries include steel, petrochemical, power plant, machine, ship building, and vehicles that are main sources of greenhouse gases (GHG), Korea becomes one of the major GHG emitters in the world. In contrast, forests, which account for 64% of the total land area, have played a significant role of carbon sinks.

The Korea Forest Service established 'Green 7 Strategies' to address climate change in 2008 (Figure 3.28).

Figure 3.28 'Green 7 Strategies' to address climate change in forest sector

# Indicator 5-1
# Total forest ecosystem biomass and carbon pool

## 1) Definition and importance

This indicator shows the total carbon stocks of the forest ecosystem in a country, including forest biomass, litters, dead wood, and soils. Plants sequester carbon dioxide that they absorb through photosynthesis and release oxygen to the atmosphere. Carbon can be part of plants resulting from this photosynthesis process and can also move to litters or soils. Therefore, forest management to increase carbon stocks can help remove carbon dioxide from the atmosphere and can also influence other environmental functions as well as economic functions.

## 2) Status and trend

In 2005, the total carbon stocks in forest biomass in Korea was estimated to be 260,772 thousand tC. Among the total carbon stocks, 44% was stored in conifer forests and 56% in broad-leaved forests (Table 3.22). Recently, the average annual increase of carbon stocks in forest biomass was about 10 million tC, which is being sequestered by forest ecosystems, meaning that Korea forests play an important role of sinks in carbon cycle. Korea forests are still young and the biomass loss from harvesting is much smaller than the biomass gain from forest growth.

Some emission factors including biomass expansion factors are essential to estimate carbon stocks in forests. Now a research is ongoing to develop country-specific emission factors for dominant tree species in Korea and to improve some statistics related to activity data to prepare measurable, reportable and verifiable GHG inventory.

Table 3.22 Carbon stocks in forest biomass in Korea (Unit : 1,000 tC)

| Year | Total | Coniferous | Broad-leaved |
|---|---|---|---|
| 1990 | 125,601 | 57,063 | 68,538 |
| 1991 | 132,522 | 59,418 | 73,104 |
| 1992 | 138,906 | 61,662 | 77,244 |
| 1993 | 145,503 | 64,554 | 80,949 |
| 1994 | 151,576 | 67,508 | 84,068 |
| 1995 | 158,443 | 70,479 | 87,964 |
| 1996 | 166,285 | 73,690 | 92,595 |
| 1997 | 175,849 | 77,557 | 98,292 |
| 1998 | 186,936 | 82,194 | 104,742 |
| 1999 | 198,488 | 87,055 | 111,433 |
| 2000 | 209,787 | 91,659 | 118,128 |
| 2001 | 220,397 | 95,941 | 124,456 |
| 2002 | 230,691 | 100,602 | 130,089 |
| 2003 | 241,079 | 105,176 | 135,903 |
| 2004 | 250,851 | 109,719 | 141,132 |
| 2005 | 260,772 | 113,994 | 146,779 |

## Indicator 5-2
## Contribution of forest ecosystem to the total global carbon budget

### 1) Definition and importance

Forests can be carbon sinks or carbon sources. This indicator shows the carbon budget in the forest within a given period. Korea adopted the annual carbon budget in living biomass for this indicator.

### 2) Status and trend

In 2005, the net removals in Korean forests were about 36,377 thousand $tCO_2$, the emissions were about 5,205 thousand $tCO_2$, and the total removals were about 41,582 thousand $tCO_2$ (Figure 3.29 and Table 3.23). Recently the net removals remain stable around 37 million $tCO_2$/yr, because the emissions and the total removals have no big changes.

Figure 3.29 Trend of carbon budget in forest biomass in Korea

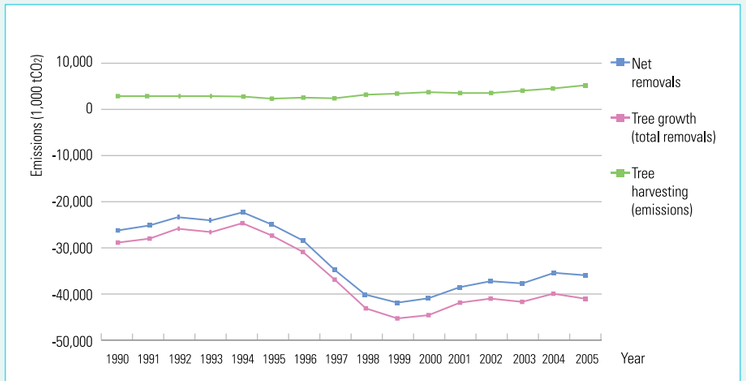



Table 3.23 Yearly carbon budget in forest biomass in Korea

| Year | Total removals (1,000 $tCO_2$) | Net removals (1,000 $tCO_2$) | Emissions (1,000 $tCO_2$) |
|---|---|---|---|
| 1990 | 29,110 | 26,237 | 2,873 |
| 1991 | 28,478 | 25,378 | 3,099 |
| 1992 | 26,095 | 23,410 | 2,685 |
| 1993 | 26,840 | 24,187 | 2,653 |
| 1994 | 24,838 | 22,268 | 2,570 |
| 1995 | 27,475 | 25,178 | 2,297 |
| 1996 | 31,251 | 28,755 | 2,496 |
| 1997 | 37,350 | 35,068 | 2,282 |
| 1998 | 43,674 | 40,654 | 3,020 |
| 1999 | 45,893 | 42,356 | 3,537 |
| 2000 | 45,222 | 41,431 | 3,791 |
| 2001 | 42,420 | 38,905 | 3,515 |
| 2002 | 41,383 | 37,742 | 3,641 |
| 2003 | 42,196 | 38,091 | 4,105 |
| 2004 | 40,367 | 35,831 | 4,536 |
| 2005 | 41,582 | 36,377 | 5,205 |

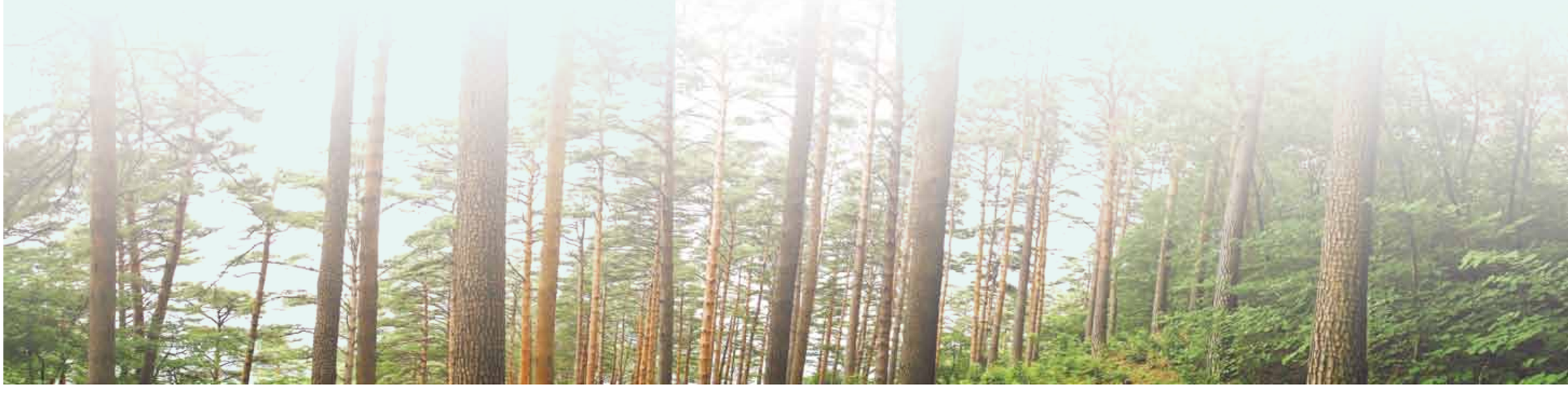
## Criterion 6. Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies

Forest ecosystem could be sustained when its reproduction, ecological stability, biological elements, and adaptation to environmental changes are ensured. During the last century, forest ecosystem were threatened due to rapid increase of population and social demands for development. Much portion of forest lands were deforested and transferred to human uses. This trend would not be changed if human beings pursued economic benefits without any concern on ecological or environmental sustainability. Today, sustainable forest management becomes an inevitable management option, especially in the region of temperate or boreal forest that have provided enormous socio-economic benefits to human beings historically. Moreover, maintenance of long-term multiple socio-economic benefits could be achieved through the maintenance of forest ecosystem and its natural components. Here are the general examples of socio-economic benefits expected from the forests:

- biodiversity, visual quality, and historic/religious/cultural value
- recreational opportunities, such as eco-tourism, hiking, camping, lodging, etc.
- genetic resources for medicinal use, food, gardening, etc.
- daily essentials, such as food, fuel, and medicines
- provision of clean water and air
- and carbon sequestration

For achieving the benefits mentioned above, it is required to consume a lot of forest resources, labor, costs, and other intermediate products. Therefore, the quantity and quality of socio-economic benefits depend on the level of investments in forest sector.

Criterion 6 deals with the economic and social aspects of forest management, while other criteria focus more on environmental or ecological aspects. Criterion 6 of the Montreal Process involves a number of indicators, classified into the following five sub-categories: production and consumption, investments in the forest sector, employment and community needs, recreation and tourism, and cultural, social, and spiritual needs and values. In this report, the status of only six indicators measurable in Korea was introduced: value and volume of wood and wood products, value and quantity of non-wood forest products, supply and consumption of wood and wood products, supply and consumption of non-wood forest products, value of forest products as percentage in GDP, and area and percentage of forests managed for recreation and tourism in relation to the total forest lands.



## Indicator 6-1
## Value and volume of wood and wood products, including value added through downstream processing

### 1) Definition and importance

Earning income from wood and wood products is the primary objective of forest management and provides financial payoffs for management activities. Value and volume of wood and wood products are affected by several factors, such as economic condition of local communities, customers' preference, and environmental/social issues regarding forest management. Thus, this indicator shows the measure of economic status and the scale of wood products in Korea.

### 2) Status and trend

The volume of total roundwood harvests increased from 845 thousand $m^3$ in 1970 to 1.5 million $m^3$ in 1987, but then decreased to 1 million $m^3$ in 1997 (Figure 3.30). Since 1997, when the economic crisis occurred in Korea, the roundwood harvest increased again due to the decline of imports of wood products.

As MDF production became active in the early 1990s, a large volume of coniferous roundwoods, which is the source material of the MDF products, was supplied to the domestic markets. In 1998, forest tending including thinning has been implemented across large forest lands for offering more job opportunities and supported the demand of coniferous roundwoods for MDF production. The production of total coniferous roundwoods steadily increased and reached 2.7 million $m^3$ in 2007.

MDF production also increased to 1 million $m^3$ in 2001 and 1.7 million $m^3$ in 2007. For the MDF production, a half of the raw materials were obtained from wastes of lumber production and the rest from coniferous roundwood products.

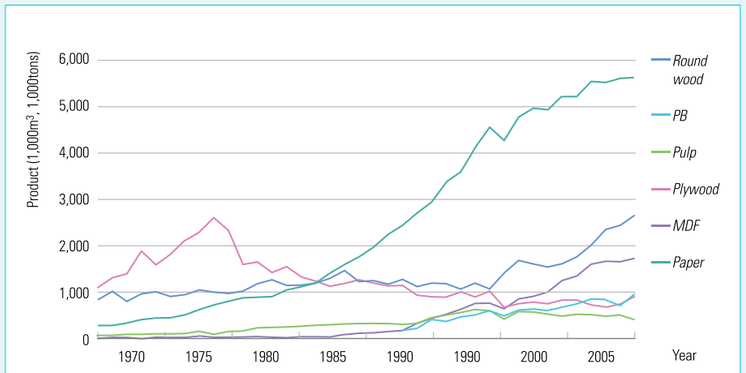
The board production rapidly increased from 1961, when the government supported board industries and encouraged the export to overseas market. As a result, the volume of board products reached 2.6 million $m^3$ in 1978, and approximately 70% of board products were exported during the 1970s. In the 1980s, many southern Asian countries, including Indonesia, began to regulate their roundwood exports. Due to the lack of roundwoods, the volume of board products decreased to 1 million $m^3$ in 1990 and 764 thousand $m^3$ in 2007.

The particle board production began to increase from the mid-1980s and reached 700 thousand $m^3$ in 1997. Even though there was economic crisis, the volume of particle board products increased steadily to 955 thousand $m^3$ in 2007. For the particle board production, recycled wooden materials were used: 10% from wastes of lumber production, 75% from construction, and the rest from others. Rising of production costs and increment of imported products could be the challenging issue in Korea.

The pulp production increased from 80 thousand tons in 1970 to 610 thousand tons in 1997. The pulp production fluctuated during the last decade, but became stable to 418 thousand tons in 2007. Most of the pulp products in Korea are chemical pulps. Mechanical pulps had been dominantly used for newsprints until they were substituted with recycled papers. Because most paper industries used chemical pulp for their products, mechanical pulp rarely produced now.

Paper production in Korea shows a significant increment since 1970. The paper production increased from 246 thousand tons in 1970 to 5.6 million tons (approximately 23 times) in 2007. Such rapid increment of paper production brought an oversupply since the late 1990s. Currently, printing paper occupied over 40% and newsprints occupied 30% in the paper market. Craft paper was one of the primary products (over 20%) in the 1970s, but it occupied only 3% of the overall paper products in 2007.

Figure 3.30 Volume of wood and wood products




Unit: Roundwood, PB, Plywood and MDF – 1,000m³; Pulp and Paper – 1,000tons

## Indicator 6-2
## Value and quantity of non-wood forest products

### 1) Definition and importance

This indicator shows the measure of value and quantity of non-wood products from the forests. There are various kinds of non-wood products, but only a few major products were considered here because the value of other products was not measurable nor much meaningful in the market. Non-wood products make an important financial contribution to forest owners or local communities, because the wood production was not much profitable in Korea. Also, it help to provide safe and healthy foods, such as fruits, nuts, mushrooms, wild vegetables, and medicinal herbs.

### 2) Status and trend

There are many kinds of nuts and fruits produced in Korea, but chestnuts, walnuts, jujubes, pine nuts, dried persimmons, gingko nuts, acorns, raspberries, wild grapes, tara vine, prickly ashes, and anise pepper were considered in this report. The production of nuts and fruits increased steadily from 4.1 thousand tons in 1970 to 45.5 thousand tons in 1980, 95.8 thousand tons in 1990, and 161.3 thousand tons in 2000. Afterward, it declined to 109.6 thousand tons in 2003, but then increased up to 186.6 thousand tons in 2007. The value of products also steadily increased from 3 million US$ in 1974 to 35 million US$ in 1980, 115 million US$ in 1990, 300 million US$, and 368 million US$ in 2007.

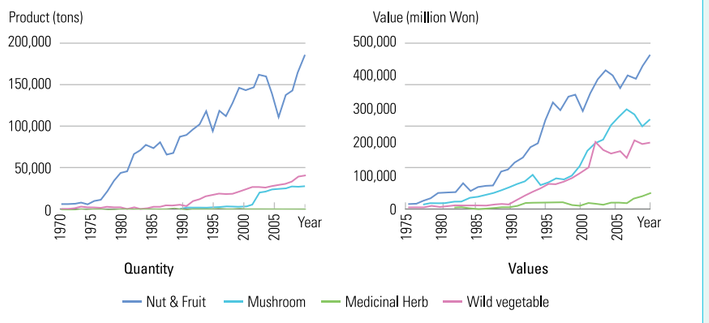
Mushroom is another important non-wood product in Korea. There are several kinds of mushrooms counted in this report: oak mushroom, pine mushroom, black fungus, oyster mushroom, *Sarcodon aspratus*, woolly lespedeza, and others. The production of mushroom was only 3 thousand tons in 1990, but increased up to 21 thousand tons in 2000 and 28 thousand tons in 2007. The value of mushroom products also increased from 1.2 million US$ in 1974 to 12.6 million US$ in 1980, 49.5 million US$ in 1990, 155 million US$ in 2000, 232 million US$ in 2004, and 213 million US$ in 2007.

Wild vegetables including fernbrakens, lance asiabells, angelica shoots, and aster scabers also occupy a large portion of non-wood products in Korea. The

production of wild vegetables was less than 1.5 thousand tons in the 1970s, but increased to 3.7 thousand tons in the mid 1980s, 25.6 thousand tons in 2000, and 40.9 thousand tons in 2007. The value of products increased from 307 thousand US$ in 1974 to 692 thousand US$ in 1980, 19.4 million US$ in 1990, and 154 million US$ in 2000. It declined to 111 million US$ in 2004, but then increased up to 152 million US$ in 2007.

Although medicinal herb occupied relatively a small portion of non-wood products. Its production increased from 728 tons in 1970 to 1,832 tons in 1993 and 3,216 tons in 2007. The value of medicinal herb products also steadily increased from 461.5 thousand US$ in 1974 to 1.2 million US$ in 1980, 8 million US$ in 1990, 8.8 million US$ in 2000, and 37 million US$ in 2007 (Figure 3.31).

Figure 3.31 Value and quantity of non-wood products




## Indicator 6-3
## Supply and consumption of wood and wood products

### 1) Definition and importance

This indicator shows the balance between supply and demand of wood and wood products in Korea. Consumption of a product is also a good indicator of nation's preferences for the products because it response to the price of the product, prices of substitutes, environmental benefits, possibility of recycling, and level of incomes. Wood production could be influenced by many factors, including investment, management objectives, and forest regulation. Thus, these factors could affect the supply of wood and wood products as well.

### 2) Status and trend

Consumption of wood and wood products has rapidly increased since 1960s, when industrialization and urbanization began in Korea. Most of wood and wood products were consumed for construction and wood industries. Although there was a temporary decline during the economic crisis in 1997, consumption of wood and wood products steadily increased during the last few decades. Recently, demands of improving residential environments increased, and reconstructions of apartments and houses became active. Thus, a large consumption of wood and wood products is expected.

Consumption of roundwoods increased to 10.4 million $m^3$ in 1978, but declined to 7 million $m^3$ during the 1980s, and reached 9 million $m^3$ (Figure 3.32). As lumber and board industries consumed most of the roundwoods, overall consumption of roundwoods is parallel to lumber and board production. Consumption of roundwoods for lumber and board production reached its peak, 9.5 million $m^3$ in 1978, but declined to 6 million $m^3$ during the 1980s when southern Asian countries regulated their exports of roundwoods. Currently, it remained stable around 8-9 million $m^3$.

Plywood was mainly used for production of building or furnishing materials until the late 1980s. Consumption of plywood products was 1 million $m^3$ in the mid 1980s and 2 million $m^3$ in the early 1990s. However, as particle board and MDF substituted plywood for building or furnishing materials, its consumption no longer increased and became stable around 2 million $m^3$ recently (Figure 3.32).

Particle board (PB) used for production of furnishing materials of kitchen. Consumption of PB products began to increase from mid-1980s and steadily increased until recently. It was 100 thousand $m^3$ in 1985, 1 million $m^3$ in 1995, and 1.7 million $m^3$ in 2007 (Figure 3.32).

MDF production bacame active in the late 1980s and its consumption steadily increased afterward. It increased from 100 thousand $m^3$ in the late 1980s to 1 million $m^3$ in 1999, and 2.1 million $m^3$ in 2007 (Figure 3.32). MDF was mainly used for the production of furnishing materials initially. It substituted plywood, which was dominantly used for production of furnishing materials. Now, a half of MDF was still consumed by furnishing industries, but the other half by electronic or automobile industries.

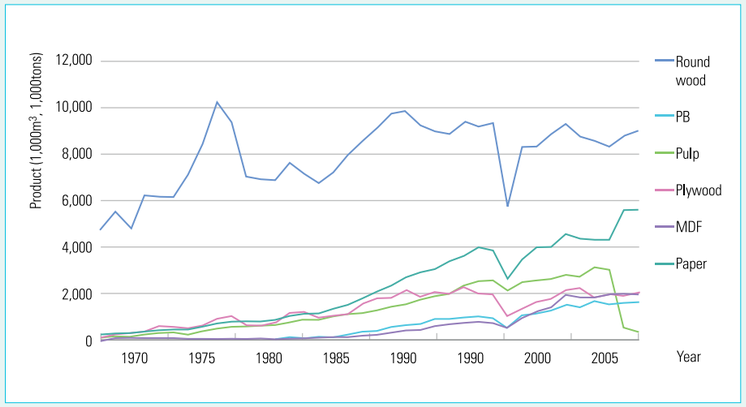
Consumption of pulp increased steadily from 250 thousand tons in 1970 to 3 million tons in 2005 (approximately 12 times increase). However, the annual increment rate of pulp consumption decreased from 11.2% in the 1970s, to 8.7% in the 1980s, 7.1% in the 1990s, and 3.8% in 2001 (Figure 3.32). Chemical pulp occupied 64% of the total pulp consumptions in 1970, but increased to 97% in 2005. Mechanical pulp, which was dominantly used once for newsprints, occupied only 3% of the total consumptions in 2005.

Increment of paper consumption was significant during the last few decades. It increased from 264 thousand tons in 1970 to 4.3 million tons in 2005. However, the annual increment rate decreased from 12.5% in the 1970s to 11.2% in the 1980s, 6.6% in the 1990s, and 4.1% in 2001.



In fact, the supply of domestic roundwoods was insufficient for the wood production in Korea. Because many portions of forests are still young, it is hard to balance the supply and demand of wood products without imports of roundwoods.

Figure 3.32 Consumption of wood and wood products




Unit: Roundwood, PB, Plywood and MDF – 1,000$m^3$; Pulp and Paper – 1,000tons

## Indicator 6-4
## Supply and consumption of non-wood forest products

### 1) Definition and importance

This indicator shows the balance between supply and demand of non-wood forest products in Korea. High consumption of non-wood forest products indicated nation's preferences for non-wood products. There is a large regional variation in consumption of non-wood forest products. Thus, this is also a good indicator reflecting the economic status of a local community.

### 2) Status and trend

Consumption of non-wood products steadily increased during the last few decades along with rapid industrialization and urbanization. Progress of cultivation techniques contributed to such a large consumption of non-wood products in Korea.

Chestnut is one of the most consumed non-wood products in Korea. Its consumption steadily increased between 1980 and 1997 from 50 thousand tons to 100 thousand tons. The annual increment rate was 22% over this period. However, since 1998, consumption of chestnuts declined to 12% annual rate due to its low productivity. In 2007, consumption of chestnuts was 64 thousand tons (Figure 3.33).

Traditionally, pine nut is consumed during major holiday seasons in Korea. However, as it is being introduced as a good well-being food, it has been heavily consumed recently. Consumption of pine nuts increased from 525 tons in 1980 to 3 thousand tons in 2005. Imports of pine nuts also increased from 36 tons in 1995 to 320 tons in 2005. In 2007, the overall consumption of pine nuts 3.9 thousand tons (Figure 3.33).

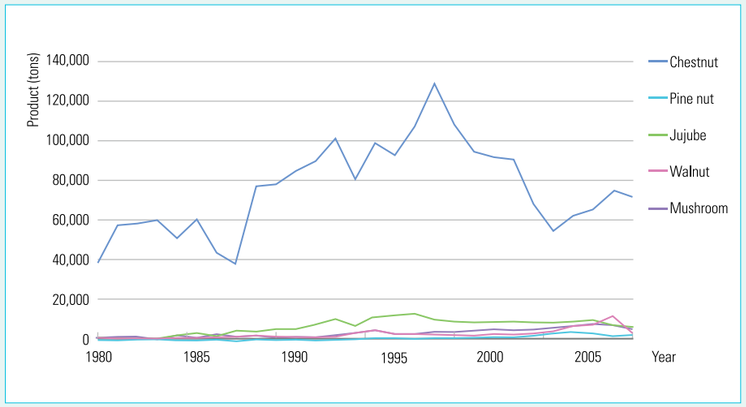
Consumption of jujube also rapidly increased from the mid 1980s, when the improved breed was introduced and cultivated. Its consumption increased from 641 tons in 1980 to 14 thousand tons in 1996, but then declined to 8.1 thousand tons in 2003. As the amount of imports were increasing, consumption of jujube increased again and reached 8.4 thousand tons in 2005 and 9 thousand tons in 2007 (Figure 3.33).



Walnut was not much consumed, but rapidly increased when imports of walnuts increased in the early 1990s. Its consumption increased from 2.1 thousand tons in 1992 to 5.3 thousand tons in 1994, 7.9 thousand in 2005, and 8 thousand tons in 2007 (Figure 3.33).

Consumption of oak mushrooms was also in a steady increment. Its consumption increased from 285 tons in 1985 to 974 tons in 1990, 2.7 thousand tons in 1995, 6.3 thousand tons in 2003, 7.8 thousand tons in 2005, and 8.8 thousand tons in 2007 (Figure 3.33). Imports of oak mushrooms also contributed to such a large consumption. In 2005, 2.3 thousand tons of oak mushrooms were imported.

Figure 3.33 Consumption of major non-wood products




## Indicator 6-5
## Value of wood and non-wood products as percentage of GDP

### 1) Definition and importance

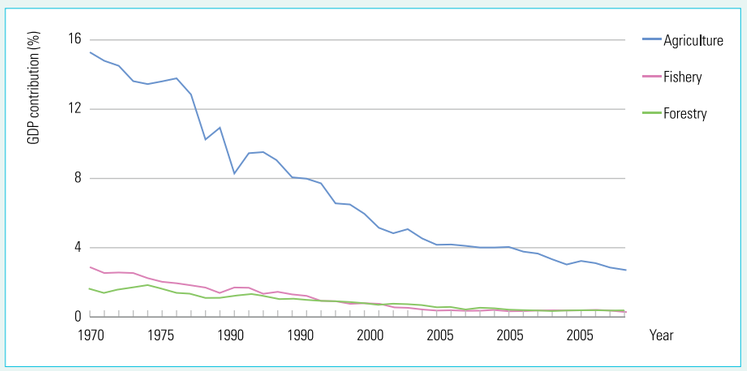
Gross domestic product (GDP) represents the total value of all goods and services produced by a country in one year. This indicator shows how forest sectors contribute to the overall production in Korea. The contribution rate of the forest sector in GDP was estimated using the total value of wood and non-wood products. The local contribution rate in GDP also shows the dynamic of forest sectors in the community.

### 2) Status and trend

In Korea, the productivity of wood and non-wood industries is quiet lower than those of other industries due to its longer cycle of production, and a large costs are generally required for wood harvesting and other management activities. For these weaknesses of forest production, overall percentages of forest sectors in GDP are continuously decreasing.

Due to the rapid industrialization and urbanization since 1970s, primary industries, such as agriculture, forestry and fishery, became inactive and took a little portion of GDP in Korea. The percentage of the primary industries in GDP decreased from 19.9% in 1970 to 3.2% in 2007. Forestry took only 2.8% of GDP in 1970, 2.1% in 2000, and 0.15% in 2007 (Figure 3.34).

Figure 3.34 Contribution of forestry sector in GDP






## Indicator 6-6
## Area and percentage of forest land managed for general recreation and tourism in relation to the total area of forest land

### 1) Definition and importance

This indicator measures the extent to which forest is being managed for recreation or tourism. Along with industrialization and urbanization during the last few decades, there was degradation of residential conditions while recreational demands dramatically increased. As public demands for well-being increase, more emphasis is given to this indicator.

Forest is the most desirable place for the outdoor recreation. To strengthen its recreational or educational functions, a number of forests as natural parks, recreational forests, green bathing forests, and arboreta has been designated and managed in Korea. This indicator shows the current status of these types of forests.

### 2) Status and trende

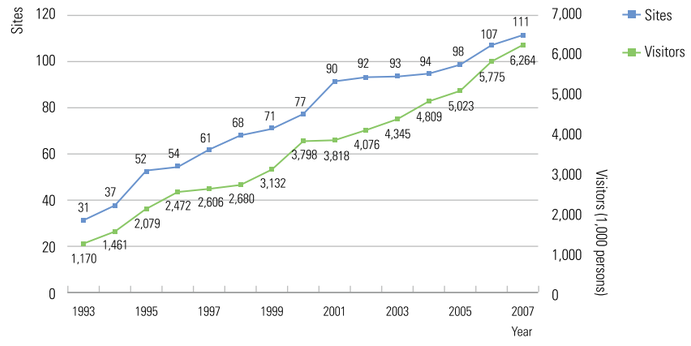
Forest recreation is generally defined as “outdoor recreational activities based on or using forest.” To offer various recreation opportunities, natural park

system, including national parks, province parks and county parks, was adopted in Korea. In addition, recreational forests, green bathing forests, and arboreta also played an important role in providing various recreational or educational opportunities.

Natural park system was adopted to preserve a unique ecosystem or a scenic forest. Also, it was expected to promote the sustainable use of forest resources and to enrich public health and leisure. There are three types of natural parks in operation: national parks, province parks, and county parks. The first national park was established in Mt. Jirisan in 1967, and now totally 20 national parks are in operation. The overall areas of national parks are approximately 390 thousand ha (about 4% of the entire lands) except the marine areas. Also, a number of province parks have been designated since Kumo Mountain was first designated in 1970. Currently, there are 23 province parks occupying 78 thousand ha areas. In addition, 33 county parks were designated occupying 45 thousand ha areas. The first county park was established at Mt. Gangchunsan in 1981 (Table 3.24).

Recreational forests are regulated under the government law, the 'Forest Culture and Recreation Acts'. A recreational forest could be permitted when the forest has a convenient location for visitors and high potentials for recreational or educational opportunities. Its size is also regulated, e.g., 30 ha of minimum size are required for a public recreational forest and 20 ha for a private recreational forest. Moreover, it is mandatory to evaluate the potentials of recreational forests through the assessment process.

Figure 3.35 Number of recreational forests and visitors



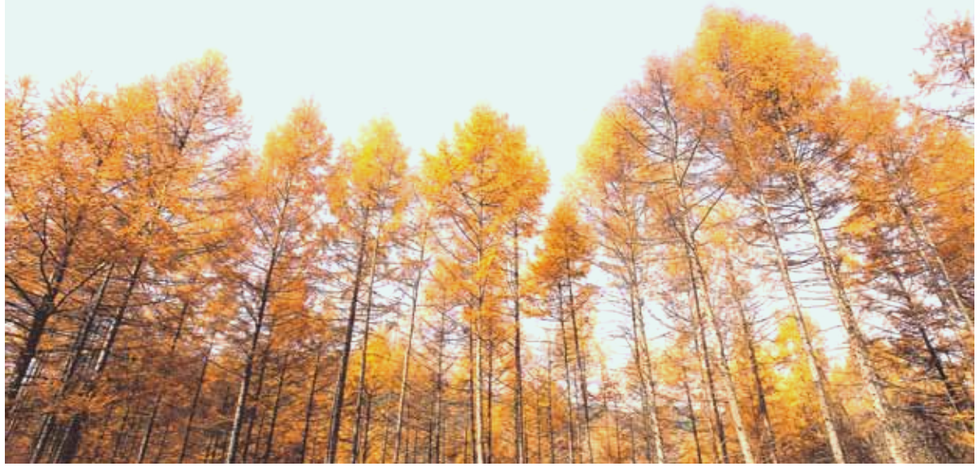

Three recreational forests including Mt. Yoomeongsan were first established in 1988. The number of recreational forests steadily increased up to 126 forests (135 thousand ha) in 2007 (Table 3.24). 38 recreational forests are located in national forests covering 116 thousand ha, 86% of the total area of recreational forests. Visitors to recreational forests also rapidly and steadily increased during the last decade. In 2007, 111 recreational forests were in operation and 6.3 million people visited (Figure 3.35). The recreational forest now becomes one of the most preferred places for outdoor recreation in Korea.

Table 3.24 Area and percentage of forests managed for recreation and tourism

| Classification | | Area (ha) | Ratio (%) | | No. of Sites |
|---|---|---|---|---|---|
| | | | From entire lands | From entire forest lands | |
| Natural park | National park | 389,895 | 3.91 | 6.11 | 20 |
| | Provincial park | 78,382 | 0.79 | 1.23 | 23 |
| | County park | 44,148 | 0.44 | 0.69 | 33 |
| | Subtotal | 512,425 | 5.14 | 8.03 | |
| Recreational forests | | 135,481 | 1.36 | 2.12 | 126 |
| Others | Green bathing forest | 7,261 | 0.07 | 0.11 | 122 |
| | Arboretum | 6,746 | 0.07 | 0.11 | 39 |
| | Subtotal | 14,007 | 0.14 | 0.22 | |
| Total | | 661,913 | 6.64 | 10.37 | |

Besides natural parks and recreational forests, a green bathing forest could be another good option for outdoor recreation in Korea. The green bathing forest is a forest in which calm and relaxed recreation activities are promoted with trails, exercising sites and educational facilities. Generally it is located nearby urban areas and its size is relatively small (less than 10 ha). In fact, there is no big difference between recreational forests and green bathing forests. However, the green bathing forest is distinguished by prohibiting lodging that is allowed in recreational forests. The number of green bathing forests increased from 6 sites to 122 sites between 1994 and 2007. Currently, the total area of green bathing forests is about 7 thousand ha.

Arboreta are worth saving a rare, endangered or threatened species as well as for forest education and recreation. Historically, the Changkyung Palace was probably the first arboretum in Korea where many kinds of flora and fauna, including rare species, were planted and exhibited in 1907. A modern type of arboretum was established in the Gwangreung Experimental Forest, which was originally developed for seedling plantation. In 1999, the Gwangreung Experimental Forest was designated as the first national arboretum in Korea, and a government law, the 'Arboretum Development Acts', was established to regulate its designation and operation. Currently, there are 39 arboreta (6,700 ha) in operation (Table 3.24).





## Criterion 7. Legal, institutional and economic framework for forest conservation and sustainable management

Criterion 7 deals with laws, institutions, policies, and plans regarding sustainable forest management. They take into consideration a number of social and environmental demands, often constrain management activities, and in turn, influence the economic benefits from forest management. On the other hand, they can enhance the sustainability of forest management by promoting management activities implemented within a legal boundary.

There are a number of indicators comprising Criterion 7 in the Montreal Process, but only five indicators are available to explain the legal or political framework of sustainable forest management in Korea: 'clarifies property rights, provides appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides a mean of resolving property disputes by process' (Indicator7-1), 'provides periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors' (Indicator7-2), 'provides opportunities for public participation in public policy and decision making related to forests and public access to information' (Indicator7-3), 'provides periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors' (Indicator7-4), and 'provides public involvement activities and public education, awareness, and extension programs, and makes available forest-related information' (Indicator7-5). A number of forest laws, actions, and forest plans were introduced to describe the status of the above five indicators.

## Indicator 7-1

## Clarifies property rights, provides appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides a means of resolving property disputes by process

### 1) Definition and importance

This indicator shows the extent of establishment of laws related to property rights, ownership and resolving property disputes: 'Forest Law', Article 3 (verifying forest ownership) and Article 4 (effective range of ownership rights); and 'Enforcement Decree of Forest Law', Article 4 (rights delegation).

Clarifying property rights and resolving property conflicts are essential to achieve sustainable forest management. When the ownership of a forest or access to forest resources is clarified, people who depend on forest for their living are likely to conserve the forest. This will help establish sustainable forest management.

### 2) Status and trend

Land ownership is clearly stated and strictly regulated by laws in Korea. Processes or means of resolving property disputes are also declared in the law. Acquisition or any changes in the ownership of a real estate should be registered under the law. Owners cannot claim their ownership without registration. Table 3.25 shows the ownership status of forest area in Korea.

Table 3.25 Ownership status of forest area

| Classification | Entire land area | Forest area | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | National forest | | | Public forest | | | Private forest |
| | | | Sub-total | Forest Service | Other ministry | Sub-total | Province | County | |
| Area (1,000ha) | 9,972 | 6,382 | 1,509 | 1,376 | 133 | 489 | 154 | 335 | 4,384 |
| Proportion to total and area (%) | - | 64.0 | 15.1 | 13.8 | 1.3 | 4.9 | 1.5 | 3.4 | 44.0 |
| Proportion to total forest area (%) | - | - | 23.7 | 21.6 | 2.1 | 7.6 | 2.4 | 5.2 | 68.7 |



## Indicator 7-2

## Provides periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors

### 1) Definition and importance

This indicator presents periodic forest-related planning, assessment, and policy review that recognize the wide range of forest values, including coordination with relevant fields.

### 2) Status and trend

The establishment of forest planning system operates with big four steps: National Forest Plan, Provincial Forest Plan, Forest Comprehensive Plan, and Forest Management Plan (Table 3.26).

Table 3.26 Forest planning system in Korea

| Classification | Ownership | Spatial scale | Planning period | Planning subject |
|---|---|---|---|---|
| National Forest Plan | All | Nationwide | 10 years | Minister of Forest Service |
| Provincial Forest Plan | National | Forest Service, Regional Office | 10 years | Head of Office |
| | Public & Private | Metropolitan/ Province | 10 years | Governor |
| Forest Comprehensive Plan | National | National Forest Management Station | 10 years | Director of Station |
| | Public & Private | City/ County | 10 years | Mayor |
| Forest Management Plan | National | Management Unit | 10 years | Director of Station |
| | Public & Private | Management Unit | 10 years | Forest Owner |

National Forest Plan is a basic and nationwide strategic plan with a long management period regulated by the 'Forest Law' (Article 10). It provides a vision and action plans for forest management in Korea. It contains basic principles, primary

goals and a number of action plans for forest resource management, conservation of forest ecosystems, enhancement of public benefits of forests, prevention/recovery of natural disasters, production/distribution of forest products, construction of forest roads, and so on.

Similar to the National Forest Plan, Provincial Forest Plan is a basic and strategic plan with a long management period, but with a smaller spatial scale. According to the 'Forest Law' (Article 11), it is required to establish the Provincial Forest Plan based on the National Forest Plan, with a consideration of regional conditions. Its overall contents are similar to those of the National Forest Plan.

Forest Comprehensive Plan is also a basic and strategic plan, but it is established by the forest manager who actually implements management activities in the field. As being applied to the actual management activities, the Forest Comprehensive Plan is quite important to achieve the local level of sustainable forest management. Thus, it contains a direction for consultation with local communities and stakeholders, promoting the local economy, and among others. It is mandatory to establish Forest Comprehensive Plans for national forests, while voluntary for private forests.

Forest Management Plan is the lowest level of forest planning system in Korea. It is a tactical or operational plan for implementing management activities in the field, such as planting, tending, harvesting, road construction, and so on. The size, period, and location of management practices are specified in this level of plan. It is mandatory for national forests by the 'Act on National Forest Management' (Article 8), while recommended for private forests by the 'Forest Resource Management Act' (Article 13).

## Indicator 7-3
## Provides opportunities for public participation in public policy and decision making related to forest and public access to information

### 1) Definition and importance

For this indicator, existing laws associated with the process of public participation in policy decision making related to forest are introduced. Public participation in the decision making process will help people to understand forest management strategies and goals, and to support management activities. To achieve sustainable forest management, it is appropriate to encourage participation of the public who feels responsible for forest management.

### 2) Status and trend

There are a number of ways in which public participation in the forest planning process are available:

- Forest policy council: an organization for consultation, consisting of less than 20 committees from government agencies and forest experts recommended by the Forest Service or NGOs. The members of the council are appointed by the Minister of Forest Service and responsible for review and assessment of the National Forest Plan.
- Public hearing or formal objection: hearing public opinion is requested for establishing or changing the Forest Management Plan. Especially when property rights or values are affected by management plans or activities, it is important to put an objection in a formal manner.
- Association of local community: national forest management stations open a meeting with local communities to improve their understanding of local management issues and to hear their opinions.

## Indicator 7-4
## Undertake and implement periodic forest-related planning, assessment, and policy review, including cross-sectoral planning and coordination

### 1) Definition and importance

This indicator shows a measure of performance of periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors.

### 2) Status and trend

Basically, forest plan was established through an adaptive planning procedure in Korea. Once a forest plan was established, its performance should be monitored and evaluated to make a better plan in the subsequent management period. This planning procedure is legally required for National Forest Management Plans (Laws of National Forest Management Plan, Article 12).

The director of the National Forest Management Station is responsible for establishing a Forest Management Plan and monitoring and evaluating its performance. The results of monitoring and evaluation should be reported annually to the head of the Forest Service Regional Office.

Then, the head should conduct an intermediate assessment every five years based on the annual reports. The head should also report the result of the assessment to the Minister of Forest Service. Economic, social, and ecological aspects as well as local issues would be the concerns in the intermediate assessment. If any critical problem is found and if the goals of National Forest Management is not achieved, the head should revise the Forest Management Plan. If necessary, the head could collaborate with directors and staffs of National Forest Management Stations in monitoring or assessment of the plan.

Finally, the head conducts a final assessment at the end of the management period. Overall achievement and performance of Forest Management Plans are evaluated in the final assessment and reported to the Minister of the Forest Service. Based on the results of the final assessment, the Minister could create visions or goals of National Forest Management, and generate new guidelines or directions for the subsequent management plan.

## Indicator 7-5
## Provides public involvement activities and public education awareness and extension programs, and makes available forest-related information

### 1) Definition and importance

This indicator introduces public involvement activities and educational or informative programs. Educational or informative programs could be worth for increasing public awareness and supporting the sustainable forest management. Thus, forest-related institutions should make an effort to encourage public involvement and to provide sufficient information to the public. Sustainable forest management could be stable by collaborating with the public and by hearing their opinions and ideas.

### 2) Status and trend

According to the Statistical Yearbook of Forestry, a number of forest-related organizations were active in 2007: two special corporations, 77 corporation aggregates, 6 foundations regulated by the Civil Law, and 4 foundations regulated by the 'Foundation Development Act'. These organizations are working to introduce forest management activities, encourage public participation, operate forest education or training programs, develop new forest-related techniques, and provide information for the public.

National Forestry Cooperatives Federation was organized as a corporation aggregate in 1949, but transferred to a special corporation in 1962 when the 'Forest Law' was revised. Now, it has nine regional offices and 144 branches. Many forest technical instructors are employed and working for various forest projects.

The Korean Federation of Forest Science and Technology Societies was organized for promoting technical and academic cooperation between forest-related research institutes. 18 research institutes or organizations are involved: Korea Forest Society, Korea Society of Wood Science Technology, Korean Forest Economics Society, Korean Society of Forest Resources Measurements, Korean Society of Forest Policy, Korean Technical Association of the Pulp and Paper Industry and so on. Besides, there are a number of organizations working in the forestry field to promote various activities (Table 3.27).

Table 3.27 Forest association status

| Classification | Association |
|---|---|
| Special corporation (2) | National Forestry Cooperatives Federation, Korea Forest Conservation Movement |
| Corporation aggregate (77) | Forest Nurseryman Association of Korea, Korea Wood Panel Association, Landscaping Tree Association, Korea National Poplar Commission, Korean Society of Forest Policy, Korean Technical Association of the Pulp and Paper Industry, National Natural Recreation Forest Office, Korea Forest Products and Fuel Association, Korea Wood Chip Association, Korea Wild Orchid Association, Green Ranger, Korean Bonsai Growers Cooperative, Society of Locust Research, Korea Quarrying Association, Korea Tree Protection Research Center, Korean Wild Florist Association, Korea Mountains and Watershed Preservation Association, Korea Mushroom Producer Corporation, Korea Society of Forest Environment Research, Society of Korean Foresters, Korea Wood Construction Association, National Association of Forest Protection, Wild Plants Corporation, Korea Forestry Mechanization Association, Korea Forest Natural Build Association Corporation, Forest for Life , Korea Wild Plants Preservation Association, Korea Forest Products Carbide Association, Korea Forest Organic Resources Association, Korea of Medicinal Plant Association, Forest for Peace, The National Flower Rose of Sharon Movement Cooperative Federation, Forest Interpreters Association, Northeast Asian Forest Forum, Korea Forest Engineers Association, Korea Wooden Structure Engineer Association, Forest Community Foundation, Association of Gwangnung Forestry Preservation, Korean Association of Botanical Gardens and Arboreta, New Millennium Life Movement, Korea Press Flower Association, Korea Art Flower Association, Korea Paper Mulberry Association, Korea Chestnut Cultivator Association, Korea Tree Sap Association, Society of Korea Nurse Tree Preservation Research, Korea Ski Mountaineering Association, Korea Wood Preserving Association, Korea Lacquer Tree Association, Wood Culture Forum, The Korean Federation of Forest Science and Technology Societies, Korea Pyogo Sawdust Mushroom Cultivator Association, Korea Society of Forest Engineering and Technology, Society of Korea Private Forest Development Research , Institute of Korea Forestry Recreation, Korea Forest Compound Manager Association, Korea Alpine Culture Association, Korean Forest Society, National Tree Hospital Association, Korea Shrimp Orchid Association, Society of Korea Plant Miniature Research, Forest Ecology Leader, Society for Forest and Culture, Korea Mountain Horse Riding Association, Wild Ginseng Society, Korea Mountaineer Association, Korea Mushroom Association, Korean Forest Economics Society, Institute of Forest Culture Contents, Korea Forest Enterprise Corporate Association, Forest Campus, Recreational Forest Association, Korean Society of Coastal Forest, Association of Old Growth Tree, Baekdudaegan Promotion Association, Institute of Baekdudaegan, Corean Alpine Club, Korea Forest Therapy Forum |
| Forestry foundation-the Civil Law (6) | LG Evergreen Foundation, Evergreen Farming Foundation, Seoul Green Trust, Gyeong Gi Green and Agriculture Foundation, Hwacheon-gun Association for the Advanced Clean Industry, Korea Green Promotion Agency |
| Forestry foundation-Foundation Development Act (4) | Soho Culture Foundation, Chollipo Arboretum Foundation, Korea Forest Foundation, Umyeon Mountain National Trust |

Chapter 4

# Forest Sustainability Index

Timber

Forest Sustainability Index (FSI) is a quantitative score to indicate overall forest sustainability, taking into account economic, social and environmental aspects at the local and national level.

'Framework Act on Forest' that was enacted in 2001 created a foundation of law for sustainable forest management. Also, the Fourth National Forest Plan (1998-2007) and the Fifth National Forest Plan (2008-2017) aimed at supporting sustainable forest management (Table 4.1).

Thus there was a need to develop a common conceptual tool to assess progress toward sustainable forest management. In 2005, the Korea Forest Service enforced the 'Act on Promotion and Management of Forest Resources' stipulating "the central government develops and announces Forest Sustainability Index, taking into account ecological, physical, social and environmental aspects of forest" on Article 7, and set up a legal context on FSI.

Table 4.1 Forest policy associated with Forest Sustainability Index

| Act on Promotion and Management of Forest Resources | Enforcement Decree of the Act on Promotion and Management of Forest Resources |
|---|---|
| • The central government can develop and announce Forest Sustainability Index to indicate overall forest sustainability taking into account the ecological, physical, social and environmental aspects of forest.<br>• The central and the local governments establish and implement a plan to maintain and improve Forest Sustainability Index, based on forest types and characteristics. In the event of dramatic decline or decline prediction of the Forest Sustainability Index, they work out a counterplan to recover the Forest Sustainability Index. | • The Minister of Forest Service should reflect forest management conditions and criteria and indicators for sustainable forest management according to 'Framewolk Act on Forest' Article 13-1 and Enforcement Decree Article 11, in developing Forest Sustainability Index in accordance with Article 7-1<br>• The Minister of Forest Service should maintain and manage the course of research and development, monitoring, assessment and feedback process, in order to support and promote the use of the Forest Sustainability Index. |

## 1. Background of developing Forest Sustainability Index

### 1) Technical aspect

Practice of the 7 criteria and 28 indicators for sustainable forest management developed in 2005 is ongoing but as a matter of fact, the indicators are designed professional oriented so that public awareness and the forestry sector involvement remain low. In addition, it is difficult for the most part to apply criteria and indicators in developing a specific plan because they deal with extensive elements of sustainable forest management.

As public's attention and demands on forests increase, it is essential to develop index, that is, quantitative score that informs public of forest trends and conditions with ease.

### 2) Economic aspect

Dramatic changes in social and economic conditions in the last century caused a significant exploitation in forest land and forest resources. Without some comprehensive tools, it is unlikely to meet the various demands for forests, from public and local communities. Developing a system and method for prioritizing tasks for sustainable forest management can help address current issues related to forest resources and put forest policies in the order of importance.

Over time, concerns about forest management have shifted from economic value of forests such as production of wood and non-wood products, to long-term multiple benefits of forests based on sustainable forest management.

### 3) Social aspect

Indexing integrates a range of numeric and descriptive indicators about forest values into a single index number that can be used to enhance public interest and support, and environmental education, contributing to promotion of overall public awareness of forest values.

Forest management can move forward in more desirable and sustainable ways when it is cooperated with local community. Therefore, Forest Sustainability Index can provide a basis for discussion and communication among public and stakeholders and improve exchange of information and mutual understanding in pursuit of sustainable forest management.



## 2. Process of developing Forest Sustainabilit Index

### 1) Discussions on methodology to develop Forest Sustainability Index

The Korea Forest Service, the Korea Forest Research Institute and external experts associated with forestry gathered to establish a comprehensive plan for methodology and process of developing index such as indicator system and composition, index by category, standards to select indicators, standardization and method to calculate weight.

### 2) Examination and selection of indicators

The Ministerial Conference on the Protection of Forest in Europe (MCPFE) and the Montreal Process were examined as comparable sets of national level criteria and indicators, of which climate and forest vegetation conditions are similar to those of Korea. As a result, 7 criteria and 28 indicators were finally selected in 2005.

### 3) Evaluation of the selected indicators

Against all indicators selected, representativeness, simplicity, credibility, and possibility to access reliable data were examined based on the principles of indicators. Particular focus was put on data availability, time series, policy relevance, representativeness, sensibility and redundancy.

### 4) Categorizing the indicators

Indicators were categorized by different aspects of forest such as environmental and economic aspects and labeled on each category.

### 5) Collecting views and supplementing

Various opinions were obtained from local governments, academic institutes, public, PCRM (Policy Customer Relationship Management), and so on, for supplement.

### 6) Weight assignment

Three hundred seventy-seven forestry experts in academia, research and administration sectors were surveyed to prioritize categories and indicators under the categories. Based on the result of survey, weight assignment was done through pairwise comparison method.

### 7) Collecting data and index analysis

Data over the past ten years (1995-2005) were collected to develop category index and composite index.

### 8) Collecting and analyzing views from stakeholders

Regarding the index developed, feedbacks were obtained from stakeholders such as local governments and the Korea Forest Service officials.

### 9) Determination of index and announcement

Forest Sustainability Index developed with 19 indicators of 3 categories were finally determined and announced to local governments.



## 3. Structure of Forest Sustainability Index

### 1) Index system and composition

Forest Sustainability Index (FSI) consists of three stages such as composite index, category index and indicators. There are 19 indicators under 3 categories; forest health, economic capacity of forest, and public benefits of forests. Six indicators are under forest health, 7 under economic capacity of forest, and 6 under public benefits of forests.

### 2) Weight by indicators

By category, 35.2% of weight was assigned to forest health, 29.9% to economic capacity of forests and 34.8% to public benefits of forests. By indicators, 7.2% of weight was assigned to ‘percentage of forest land’, 6.9% to ‘percentage of forests tended’, 6.7% to ‘percentage of urban forests’, 6.5% to ‘percentage of mature forests’, and 6.5% to ‘carbon stocks of forest biomass’, and so on (Table 4.2).

### 3) Application of Forest Sustainability Index

FSI is assessed by the extent of increase and decrease in composite index, category index and indicators, compared to those of the base year 2000. At national level, FSI of the year 2000 is set to 100 and each index and indicators of the current year are compared to see the trends.

At local government level, the rate of the changes in composite index and category index of the current year, comparing with those of the last year, was estimated. The efforts of the local governments to raise forest sustainability were assessed based on moving average with weights over the last three years with the following equation.

$$\left(0.5 \times \frac{I_t - I_{t-1}}{I_{t-1}} \times 100\right) + \left(0.3 \times \frac{I_{t-1} - I_{t-2}}{I_{t-2}} \times 100\right) + \left(0.2 \times \frac{I_{t-2} - I_{t-3}}{I_{t-3}} \times 100\right)$$

Table 4.2 Weights of indicators for the Forest Sustainability Index

| Category (Weight) | Indicators | Weights for the category FSI | | | Weights for the composite FSI |
|---|---|---|---|---|---|
| | | County | Metropolitan | Province | |
| Forest health (0.353) | Percentage of forest land | 0.204 | 0.277 | 0.239 | 0.072 |
| | Percentage of mature forests | 0.185 | 0.253 | 0.217 | 0.065 |
| | Percentage of arboretums | 0.117 | - | 0.140 | 0.041 |
| | Percentage of forests protected for genetic conservation | 0.149 | - | - | 0.053 |
| | Percentage of forests tended | 0.196 | 0.267 | 0.230 | 0.069 |
| | Percentage of forests undisturbed | 0.149 | 0.203 | 0.174 | 0.053 |
| | Sub total | 1.000 | 1.000 | 1.000 | 0.353 |
| Economic capacity (0.299) | Percentage of forests available for timber production | 0.171 | 0.311 | 0.171 | 0.051 |
| | Growing stock in forests available for timber production | 0.186 | - | 0.186 | 0.056 |
| | Percentage of forests covered by forest management plan | 0.127 | - | 0.127 | 0.038 |
| | Amount of forest products | 0.141 | 0.232 | 0.141 | 0.042 |
| | Percentage of cutting volume to annual growth volume | 0.119 | - | 0.119 | 0.036 |
| | Percentage of expenditures associated with forestry to total budget | 0.127 | 0.227 | 0.127 | 0.038 |
| | Percentage of forest contribution to GDP | 0.129 | 0.230 | 0.129 | 0.039 |
| | Sub total | 1.000 | 1.000 | 1.000 | 0.299 |
| Public benefits (0.348) | Percentage of protected forests | 0.152 | - | 0.152 | 0.053 |
| | Carbon stocks in forest biomass | 0.186 | 0.374 | 0.186 | 0.065 |
| | Carbon balance in forest biomass | 0.162 | - | 0.162 | 0.056 |
| | Area of forests for recreation and tourism | 0.192 | - | 0.192 | 0.056 |
| | Percentage of urban forests | 0.183 | 0.373 | 0.183 | 0.067 |
| | Percentage of employment in the forestry sector | 0.125 | 0.253 | 0.125 | 0.064 |
| | Sub total | 1.000 | 1.000 | 1.000 | 0.348 |
| Total | | | | | 1.000 |



## 4. Forest Sustainability Index in 2007

### 1) Composite index

Against the base year 2000, forest sustainability increased continuously by 2007; 100 in 2000 to 139.1 in 2007, and this means an average annual increase of 4.82% (Table 4.3).

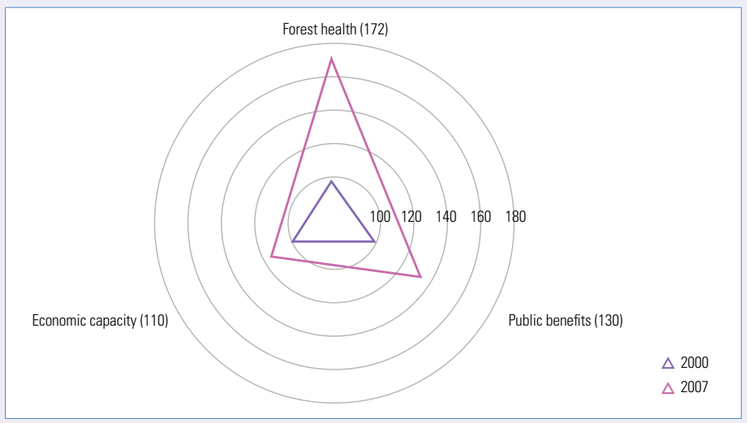
- Except the year of 2001, forest sustainability index steadily increased since 2000. Reduction of management activities and employment led to decrease in 2001.
- Among the 19 indicators, 10 indicators increased, 2 indicators decreased, and 7 indicators showed little change (Table 4.4).
- No categories showed decrease, but increase 172.28 in forest health, 130.08 in public benefits of forests and 110.42 in economic capacity of forests.

Table 4.3 Forest Sustainability Index (2000-2007)

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| FSI | 100 | 98.27 | 102.79 | 107.66 | 109.76 | 114.27 | 128.59 | 139.10 |

### 2) Trend by category

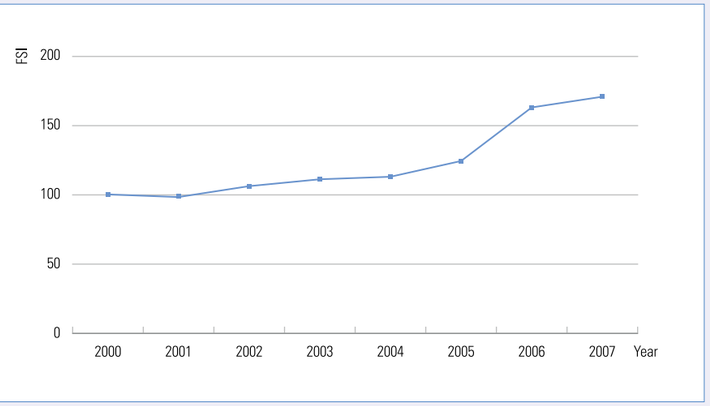
Figure 4.1 Trend of Forest Sustainability Index for 3 categories



### (1) Forest health

Under the forest health category, 3 indicators increased, and 3 indicators remained steady (Table 4.4). The FSI increased from 100 in 2007 to 172.8 in 2007, and showed an annual increase of 8.08% (Figure 4.2).

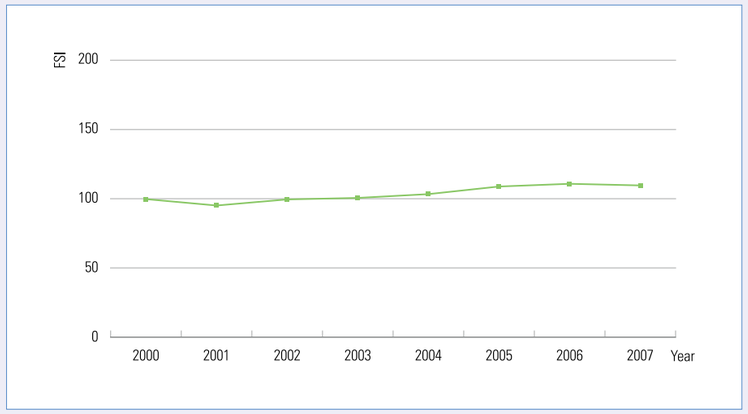
Figure 4.2 Changes in Forest Sustainability Index for forest health




### (2) Economic capacity of forests

Among the 7 indicators assessed, 3 indicators increased, 2 indicators decreased and 2 indicators remained steady (Table 4.4). The FSI increased from 100 in 2007 to 122 in 2007, and showed an annual increase of 2.93% (Figure 4.3).

Figure 4.3 Changes in Forest Sustainability Index for ecomomic capacity of forests




### (3) Public benefits of forests

Public benefits of forests showed steady increase by 2006 and a big jump in 2007. This notable increase resulted from the change of method of growing stock estimation which, in turn, affected estimates of carbon stocks in forest biomass. Therefore, this notable increase might not reflect a real change of the index. Among the 6 indicators assessed, 4 indicators increased and 2 indicators decreased (Table 4.4). The FSI increased from 100 in 2007 to 130.82 in 2007, and showed an annual increase of 3.82% (Figure 4.4).

Figure 4.4 Changes in Forest Sustainability Index for public benefits of forests

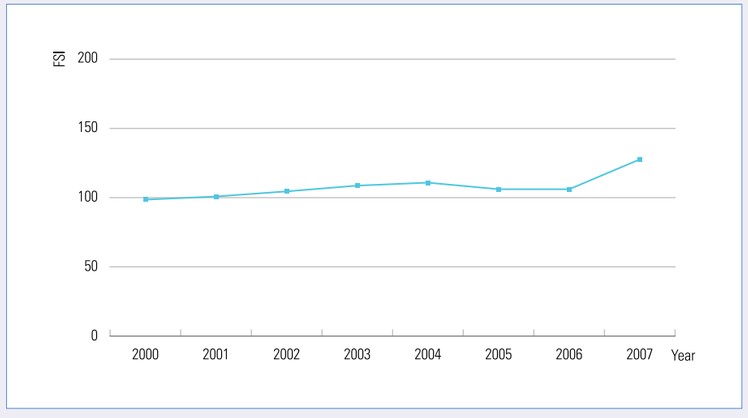


Table 4.4 Trend of indicators for the Forest Sustainability Index in 2000 and 2007

| Category | Indicators | Year 2000 | Year 2007 | Changes |
|---|---|---|---|---|
| Forest health (6) | Percentage of forest land (%) | 64.57 | 64.00 | → |
| | Percentage of mature forests (%) | 8.00 | 10.21 | ↗ |
| | Percentage of arboretums (%) | 0.10 | 0.11 | → |
| | Percentage of forests protected for genetic conservation (%) | 0.26 | 1.41 | ↗ |
| | Percentage of forests tended (%) | 4.29 | 4.77 | ↗ |
| | Percentage of forests undisturbed (%) | 94.31 | 94.18 | → |
| Economic capacity (7) | Percentage of forests available for timber production (%) | 77.31 | 78.87 | → |
| | Growing stock in forests available for timber production ($m^3$/ha) | 63.25 | 100.04 | ↗ |
| | Percentage of forests covered by forest management plan (%) | 61.74 | 61.59 | → |
| | Amount of forest products (1,000 won) | 313.66 | 346.68 | ↗ |
| | Percentage of cutting volume to annual growth volume (%) | 8.21 | 6.91 | ↘ |
| | Percentage of expenditures associated with forestry to total budget (%) | 0.53 | 0.76 | ↗ |
| | Percentage of forest contribution to GDP (%) | 0.51 | 0.28 | ↘ |
| Public benefits (6) | Percentage of protected forests (%) | 4.99 | 5.07 | → |
| | Carbon stocks in forest biomass (tC/ha) | 32.24 | 46.37 | ↗ |
| | Carbon balance in forest biomass (tC/ha/yr) | 1.74 | 3.58 | ↗ |
| | Area of forests for recreation and tourism (ha/1,000capita) | 11.02 | 10.87 | → |
| | Percentage of urban forests (%) | 0.60 | 0.63 | ↗ |
| | Percentage of employment in the forestry sector (%) | 0.06 | 0.08 | ↗ |

## 5. Use of Forest Sustainability Index and actions needed

Forest Sustainability Index can assist the central and provincial governments in making decisions for sustainable forest management. Followings are examples of using the index as references; to formulate forest associated policies, to evaluate the progress of sustainable forest management, to allocate the differentiated budget based on outcomes, to set up forest management plan, to promote public awareness regarding forest sustainability, and to prepare statistical report.

Several actions are recommended for supplementing the weaknesses of the Forest Sustainability Index. Most of all, it is necessary to increase the number of indicators so that they can capture the many dimensions that characterize sustainable forest management. To do this, more indicators can be drawn from those of the Montreal Process and the national criteria of sustainable forest management, through new data collection and statistical analysis.

Also, criteria and indicators of the Forest Sustainability Index are required to correspond with those of the Montreal Process, where member countries provide national reports on sustainable forest management every five years.

Current index do not indicate the present phase of the forest toward the goal of forest sustainability, but provide scores and trends of individual indicators, category index and composite index.

Conditions and trends of forests should be more objectively evaluated through improved understanding of social, economic and environmental conditions of forests, and development of specific goals for each indicator.

Forest Sustainability Index need to be refined to represent site-level conditions, and to provide a local level framework for developing policies and plans.

Chapter 5

# Issues and actions

Animal

The Montreal Process Criteria and Indicators (MP C & I) have gone through many phases of review and refinement since it was first launched in 1994. In 1995, MP member countries adopted the Santiago Declaration endorsing the 7 criteria and 67 associated indicators for sustainable forest management. In 2006, a set of indicators for Criteria 1-6 was revised from 47 to 44 indicators in order to allow flexibility in applying the MP C&I. In 2008, 20 indicators for Criteria 7 was reduced to 10 indicators resulting in 54 indicators in total.

The MP member countries set up the Technical Advisory Committee (TAC). The TAC is comprised of forest experts from all member countries and provides technical and scientific advice on issues related to data collection, indicator measurement and reporting. In 2004, Korea prepared a pilot report using the original set of MP C&I and assessed national forest trends and progress toward sustainable forest management. Five years later in 2009, Korea used the revised indicators to prepare this first national report. Because the pilot report was not submitted to the MP Liaison Office and not listed on the MP website. This report would be the first release of national report from Korea and will be available on the MP website.

The next phase of our work would be implementation of criteria and indicators, which means a process that relates knowledge and information learned from forest monitoring, assessment and reporting, to the formulation of forest policies needed to facilitate sustainable forest management. In November 2001, Yokohama, Japan, an International Expert Meeting in support of the United Nations Forum on Forests was held to discuss monitoring, assessment and reporting on the progress towards sustainable forest management.

The ultimate objectives of criteria and indicators are to illustrate the progress toward sustainable forest management, to understand data trends through time for individual criteria and indicators, to provide information for policymakers to make better decisions, and to give feedback for the policy making process. This report serves to meet the first phase of the objectives described above. However, some difficulties and issues emerged in preparing the report. Looking ahead to the near future, here are the four actions that should be taken in implementing criteria and indicators in Korea.

First, it is necessary to evaluate the report. Sustainability of forest management could not be indicated by single criterion or indicator, rather it should be considered in the context of all 54 criteria and indicators. For example,

current rapid decrease in forest areas in developing countries is a good indication that forest management is not taking place properly. Yet, sustainability should be assessed not by that indicator only, but by all criteria and indicators in relation to social, environmental and economic aspects of sustainable forest management.

As the 2009 national report is the fist trial of collecting data through all criteria and indicators employed, it is essential to understand forest sustainability of the country within an integrated and broader context of criteria and indicators. In preparing the report, the majority of data was collected from the government records, but when it comes to evaluation process, this report seeks to inform and engage broad community of forest agencies, organizations and individuals, and to improve the quality of forest-related information.

Second, it is recommended to use the report as a policy framework. The information and knowledge learned from a series of monitoring, assessment and reporting process following preparation of this report provides a framework for developing policies aimed at supporting sustainable forest management in the next stage. Indicators exhibit the extent of progress against particular or specific objectives. When a single indicator is not enough to measure or describe sustainability, additional criteria and indicators may be required.

To apply criteria and indicators to forest policy, it is necessary to understand the objective and trends of indicators. If not, one could not evaluate objectively the data obtained by the measurement of those indicators.

Third, it is recommended to compare SFM C&I across countries. While the Montreal Process is basically designed to assess sustainability at the national level, it also provides a basis within and across countries to share the information and knowledge learned and helps to improve our capacities for the assessment and report on forests. Thus, this report will serve as a tool to communicate our efforts to carry out sustainable management of forest to the international community.

Today, about 150 countries are engaged in international processes for SFM C&I. They provide a common ground for member countries to assess each countries' national forest trends and progress toward sustainable forest management. Korea has long been maintaining a close relationship with many countries for the development of international cooperation and the promotion of sustainable forest management. In doing so, Korea will make a good use of the MP C&I.

In comparing countries' criteria and indicators, one should consider demographic and physical conditions. For example, characteristics of forests in Korea differ significantly from those of forests in the Russian Federation, Canada, the United States of America, and China that have a vast expanse of forest. The percentage of forest area in total land area of Korea is the highest among the member countries, yet total growing stock in forest is not that high.

During the economic development period of 1960s to 1970s, Korea made

a success in national forest rehabilitation projects. Nevertheless, 95 percent of demand for timber still depends heavily on imports due to immature stage of most forests and unfavorable economic conditions for timber production such as high wages and low timber prices. This is a unique history of forest management in Korea. But it is difficult to reflect these national circumstances with the MP.

Forest tending has been another key national forest project in Korea, yet it is also not easy to measure this effort with the MP C&I. Policy evaluation system in Korea makes it tricky to take on the MP C&I, too. As the MP criteria and indicators can be readily served as the overall framework for sustainable forest management, development of methodologies to integrate the MP C&I into evaluation process of national forest project is required.

Fourth, coordination with forest certification system is necessary. Concerning the application of criteria and indictors, one could strongly argue that sustainability of forest management should be assessed only at national level, not at management site and local levels. However, as Korea expands the forest certification system in national forests, use of the MP C&I as a complementary measure is increasingly needed. Coordination with the forest certification system should be considered in the course of improving criteria and indicators.



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# Appendix

## The Montreal Process Criteria and Indicators

| Criterion | Indicators |
|---|---|
| Conservation of biological diversity | Ecosystem diversity<br>a. Area and percentage of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure<br>b. Area and percentage of forest in protected areas by forest ecosystem type, and by age class or successional stage<br>c. Fragmentation of forests<br>Species diversity<br>a. Number of native forest associated species<br>b. Number and status of native forest associated species at risk, as determined by legislation or scientific assessment<br>c. Status of in situ and ex situ efforts focused on conservation of species diversity<br>Genetic diversity<br>a. Number and geographic distribution of forest associated species at risk of losing genetic variation and locally adapted genotypes<br>b. Population levels of selected representative forest associated species to describe genetic diversity<br>c. Status of in situ and ex situ efforts focused on conservation of genetic diversity |
| Maintenance of productive capacity of forest ecosystems | a. Area and percentage of forest land and net area of forest land available for wood production<br>b. Total growing stock and annual increment of both merchantable and non-merchantable tree species in forests available for wood production<br>c. Area, percentage, and growing stock of plantations of native and exotic species<br>d. Annual harvest of wood products by volume and as a percentage of net growth or sustained yield<br>e. Annual harvest of non-wood forest products |
| Maintenance of forest ecosystem health and vitality | a. Area and percentage of forest affected by biotic processes and agents (e.g. insects, disease, invasive alien species) beyond reference condition<br>b. Area and percentage of forest affected by abiotic agents (e.g. fire, storm, land clearance) beyond reference condition |
| Conservation and maintenance of soil and water resources | Protective function<br>a. Area and percentage of forest whose designation or land management focus is the protection of soil or water resources<br>Soil<br>a. Proportion of forest management activities (e.g. site preparation, harvesting) that meet best management practices or other relevant legislation to protect soil resource<br>b. Area and percentage of forest land with significant soil degradation<br>Water<br>a. Proportion of forest management activities that meet best management practices, or other relevant legislation, to protect water related resources such as riparian zones, water quality, quantity and flow regulation<br>b. Area and percentage of water bodies, or stream length, in forest areas with significant change in physical, chemical or biological properties from reference condition |
| Maintenance of forest contribution to global carbon cycles | a. Total forest ecosystem carbon pools and fluxes<br>b. Total forest product carbon pools and fluxes<br>c. Avoided fossil fuel carbon emissions by using forest biomass for energy |
| Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies | Production and consumption<br>a. Value and volume of wood and wood products production, including primary and secondary processing<br>b. Value of non-wood forest products produced or collected<br>c. Revenue from forest based environmental services<br>d. Total and per capita consumption of wood and wood products in round wood equivalents<br>e. Total and per capita consumption of non-wood products<br>f. Value and volume in round wood equivalents of exports and imports of wood products<br>g. Value of exports and imports of non-wood products<br>h. Exports as a share of wood and wood products production and imports as a share of wood and wood products consumption<br>i. Recovery or recycling of forest products as a percentage of total forest products consumption<br>Investment in the forest sector<br>a. Value of capital investment and annual expenditure in forest management, wood and non-wood product industries, forest-based environmental services, recreation and tourism<br>b. Annual investment and expenditure in forest-related research, extension and development, and education<br>Recreation and tourism<br>a. Area and percentage of forests available and/or managed for public recreation and tourism<br>b. Number, type, and geographic distribution of visits attributed to recreation and tourism and related to facilities available<br>Cultural, social and spiritual needs and values<br>a. Area and percentage of forests managed primarily to protect the range of cultural, social and spiritual needs and values<br>b. The importance of forests to people<br>Employment and community needs<br>a. Employment in the forest sector<br>b. Average wage rates, annual average income and annual injury rates in major forest employment categories<br>c. Resilience of forest-dependent communities<br>d. Area and percentage of forests used for subsistence purposes<br>e. Distribution of revenues derived from forest management |
| Legal, institutional and economic framework for forest conservation and sustainable management | 1-a. Legislation and policies supporting the sustainable management of forests<br>1-b. Cross-sectoral policy and programme coordination<br>2-a. Taxation and other economic strategies that affect the sustainable management of forests<br>3-a. Clarity and security of land and resource tenure and property rights<br>3-b. Enforcement of laws related to forests<br>4-a. Programmes, services and other resources supporting the sustainable management of forests<br>4-b. Development and application of research and technologies for the sustainable management of forests<br>5-a. Partnerships to support the sustainable management of forests<br>5-b. Public participation and conflict resolution in forest-related decision making<br>5-c. Monitoring, assessment and reporting on progress towards sustainable management of forests |

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The criterion team members composed of following individuals authored technical documents and the summaries for each indicator:

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- Maintenance of production capacity of forest ecosystems: Sung-ho Kim (KFRI), Chong-chan Kim (KFRI), Hyun-kyu Won (KFRI) and Jong-hwan Lim (KFRI)
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This report is the first national report on the criteria and indicators for sustainable forest management in Korea, but a pilot report was prepared in 2004, entitled ‘National Report on the Forest Trends and Progress towards Sustainable Forest Management in Korea’. Although modification of the indicators has been made since the pilot report, it inspired in many ways to initiate the reporting process.

We do our best to explain the status of sustainable forest management in Korea with various data sources, but we also have several limitations in data collection and analysis. To implement SFM in Korea, the Korea Forest Service and the Korea Forest Research Institute keep working on improving the SFM criteria and indicators and developing associated policies and strategic plans. Therefore, more detailed information will be available in the next report.

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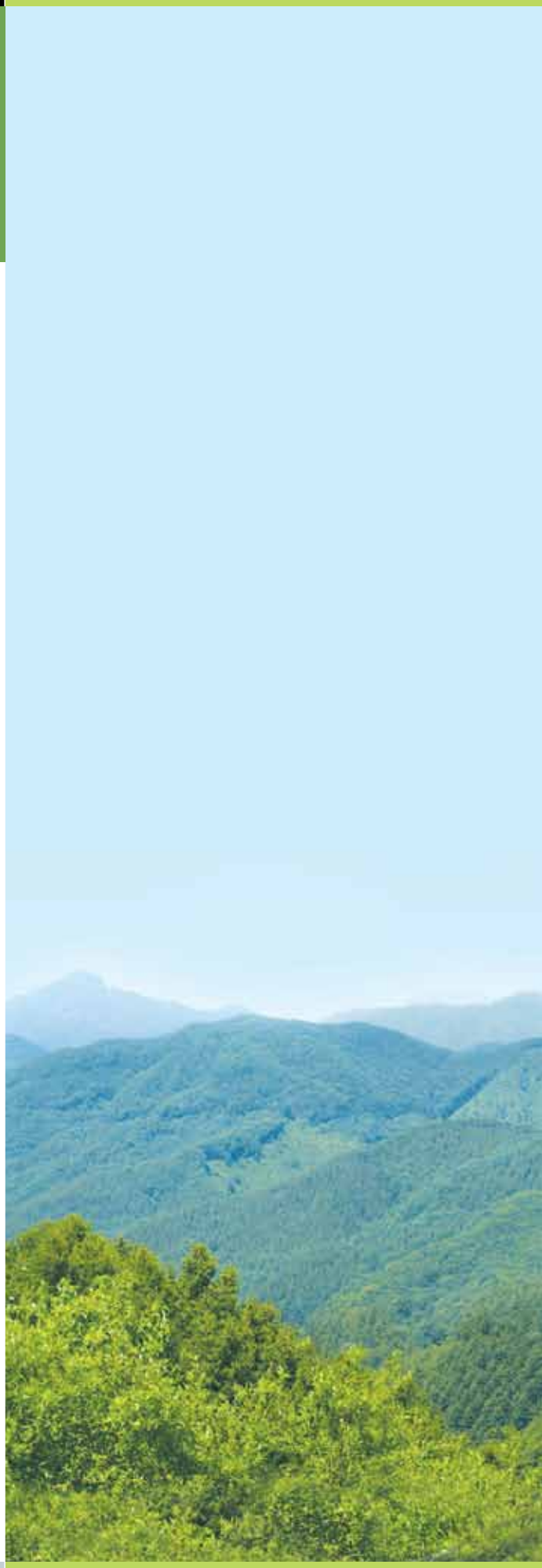



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