

Long-term Ecological Research Programme in Forestry Research Institute, Korea

Oh, Jeong Soo, Joon Hwan Shin and Jong Hwan Lim

Department of Forest Ecology, Forestry Research Institute, Seoul 130-012, Korea

ABSTRACT: Forest vegetation in Korea can be largely divided into warm temperate, cool temperate and frigid forest zone. The cool temperate forest zone of them occupies the largest part of the Korean peninsula and it is generally divided into three subdivisions such as northern, central and southern subzone. The Forestry Research Institute established three long-term ecological research sites at Kwangnung Experiment Forest in the central subzone of the cool temperate forest zone, at the Mt. Kyebangsan Forest in the northern subzone of the cool temperate forest zone, and at the Mt. Keumsan Forest in the warm temperate forest zone. The objectives of long-term ecological research in the Forestry Research Institute, Korea are to study long-term changes of the forest ecosystems in energy fluxes, water and nutrient cycling, forest stand structure, biological diversity, to quantify nutrient budgets and fluxes among forest ecosystem compartments and to integrate ecological data with a GIS - assisted model. To achieve the objectives, forest stand dynamics, environmental changes in soil properties, stream water quality, nutrient cycling, air pollution and biological diversity have been investigated and plant phenology as an indicator of climate change has been monitored in the LTER sites.

Key Words: Korean peninsula, Kwangnung Experiment Forest, LTER, Mt. Keumsan, Mt. Kyebangsan.

INTRODUCTION

Korea is located from 33° 06' N to 43° 01' N and from 124° 11' E to 131° 53' E and is a peninsula country in the east Asia, bounded on most of its northern border by China and partly by Russia. On the southern part of Korea, the Korean Strait separates the peninsula from Japan.

The Korean peninsula has a temperate climate characterized by wet monsoon in summer season and by continental climate in winter season with freezing weather. During the summer time it is hot and humid with frequent rain showers, while it is cold and dry in winter. Seasonal changes are gradual but distinctive; spring and autumn are relatively short while summer and winter are rather long. The annual mean temperature extends from 3°C to 16°C and the annual precipitation ranges from 600 to 1,600 millimeters (Fig. 1). Due to its diverse distribution of climate conditions and its topographic complexity, Korea exhibits various types of forests.

Forest vegetation in Korea can be largely divided into warm temperate, cool temperate and frigid forest zones (Fig. 2). The warm temperate forest zone covers the area south of the 35th parallel of north latitude, a part of the southern coastal region, Cheju island and a large number of southern islands where the annual mean tem-

perature is higher than 14°C. Evergreen broad-leaved forests are typical in this zone, but the majority of natural forests were destroyed by over-exploitation and forest fires and subsequently have been changed to deciduous broad-leaved forests, mixed forests or pine forests. Dominant species are *Quercus acuta*, *Castanopsis cuspidata* and *Camellia japonica*.

The cool temperate forest zone is located between 35° and 43° of north latitude except for mountainous highlands. The annual mean temperature ranges from 6°C to 13°C. This zone is generally divided into three subdivisions such as northern, central and southern temperate forest subzone. Deciduous broad-leaved forests are representative in this zone, but quite large forests were destroyed and were altered into pine forests. The resultant pine forest has usually developed into a sub-climax stage. Further destruction of some forests has provoked problems of soil erosion. The dominant tree species of this zone are *Quercus*, *Acer*, *Carpinus*, *Betula* and *Pinus*.

The frigid forest zone, called the coniferous forest zone, covers the northern part of the Korean peninsula and the mountainous highlands where the annual mean temperature is below 5°C. The coniferous forests are representative in this zone. When the forests are disturbed by over-exploitation or forest fire, they are usually cha-

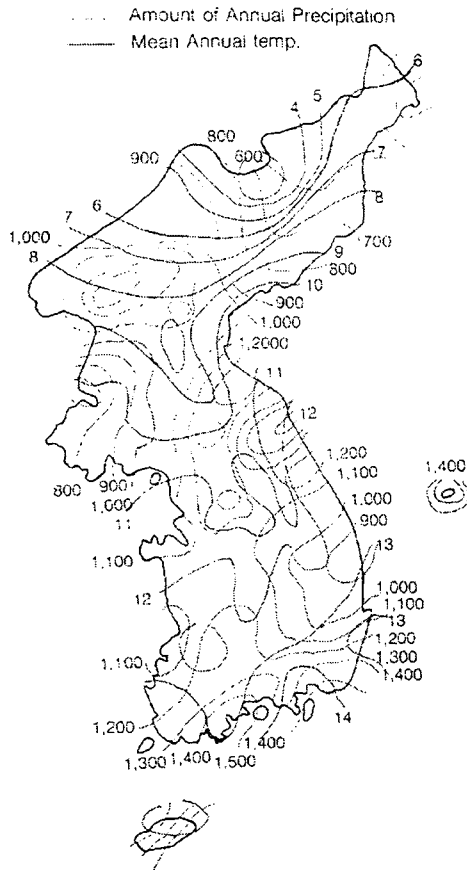


Fig. 1. Annual precipitation and temperature.

nged to deciduous broadleaved forests which are composed of *Betula*, *Populus*, *Larix* and so on. The dominant species are *Abies nephrolepis*, *Picea jezoensis*, *Larix gmelini* var. *principis-ruprechtii* and *Betula platyphylla*.

LTER SITES

The Forestry Research Institute established long-term ecological research sites in three forest zone, namely, the Kwangneung Experiment Forest (KEF) in the central temperate forest subzone of the cool temperate forest zone, the Mt. Kyebangsan Forest in the northern temperate forest subzone of the cool temperate forest zone, and Mt. Keumsan Forest in the warm temperate forest zone.

Kwangnung Experiment Forest (KEF)

The Kwangnung area had been protected as a royal tomb forest for the 7th King Sejo of Chosun Dynasty since 1468. Most of the originally protected area was designated as KEF in 1913 whose area is 2,240 ha. The area of Kwangnung Natural Reserve Forest is about 1,200ha, which is

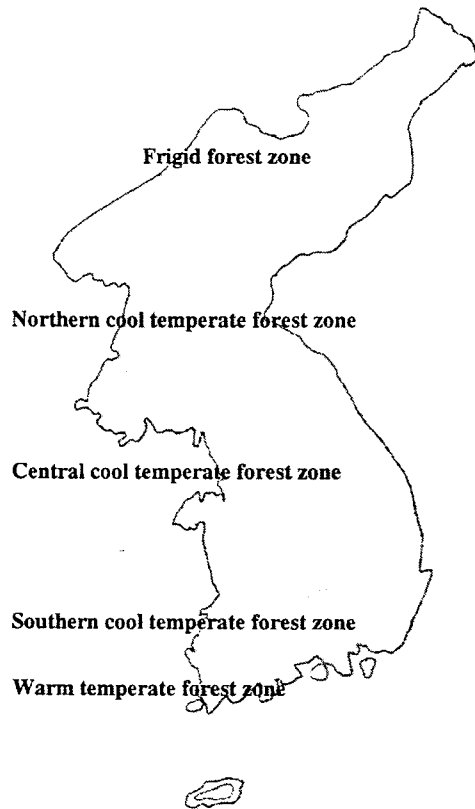


Fig. 2. Forest vegetation zone of Korean peninsula.

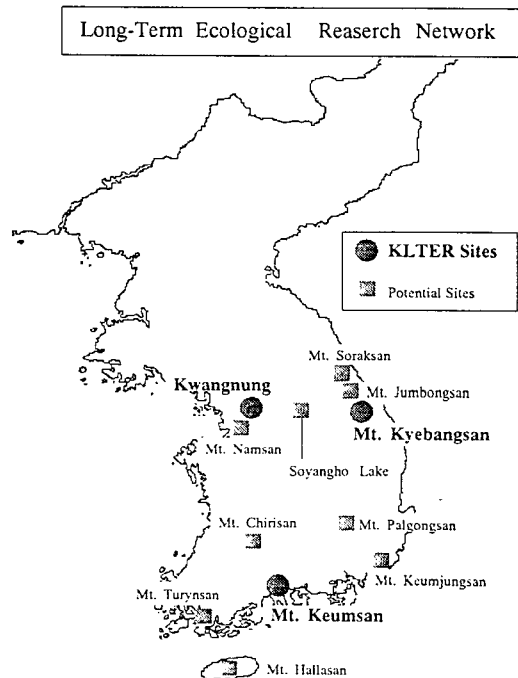


Fig. 3. Long-term ecological research sites.

located at the Soribong peak and has been protected from human activities. Elevation of Kwangnung range from 90 m to 600 m. The highest peak is Mt. Chugyopsan (600.6 m). There are Mt. Soribong (536.8 m), Mt. Yongamsan (476.9 m), and Mt. Cheonkyunsan (393.1 m) that make this area topographically rugged. Annual mean air temperature is 11.3°C, and precipitation is 1,365 mm.

The forest mainly consists of unique old-growth forests composed of broad-leaved trees in the middle zone of temperate forest in Korea. It is known that about 800 native plant species are growing in this area (FRI Korea 1994), which is dominated by typical tree species of middle temperate zone in Korea such as *Quercus* spp., *Carpinus* spp., *Cornus* spp., *Acer* spp. and *Pinus densiflora* (Lee et al. 1990, Oh et al. 1991).

The vegetation of Soribong area was identified as *Carpinus laxiflora* community group and the group was classified into typical *Carpinus laxiflora* community, *Acer mono-Staphylea bumalda* community and *Pinus densiflora* community by Braun-Branquet table method of Z-M school (Oh et al. 1991). The vegetation of Mt. Chugyop area was also *Carpinus laxiflora* community group and the group was classified into *Cornus controversa-Alangium platanifolium* var. *macrophyllum* community and *Rhus trichocarpa-Atractylodes japonica* community.

To investigate the changes in forest stand structure in time, 1 ha permanent plot was established at the KEF reserve forest area from 1998 to 1999. At the plot, all of the trees larger than 2 cm in DBH were labeled, and location,

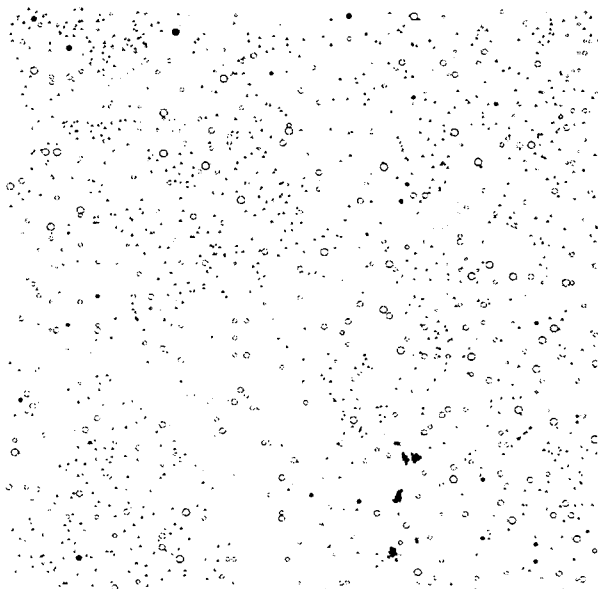


Fig. 4. Stemmap of KEF LTER site (100 m x 100 m).

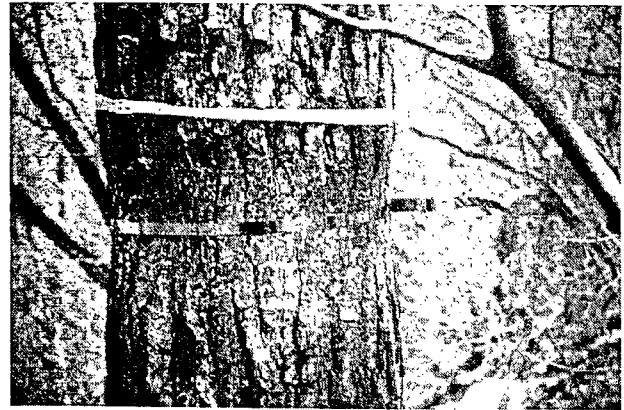


Fig. 5. A diameter growth measuring band on a *Pinus densiflora* tree.

DBH, height and crown width were measured. Standing dead trees larger than 5 cm in DBH were also labeled and the location and DBH were measured, and wood debris on the floor larger than 5 cm in diameter were drawn (Fig. 4). The density of the trees was 1,473 per ha, total biomass 261 tons/ha, and basal area 28 m²/ha. Dominant tree species are *Quercus serrata* which occupies 51% in basal area, and followed by 23% of *Carpinus laxiflora*, 7.8% of *C. cordata*, and 3.9% of *Acer mono*. *Q. serrata* is dominant

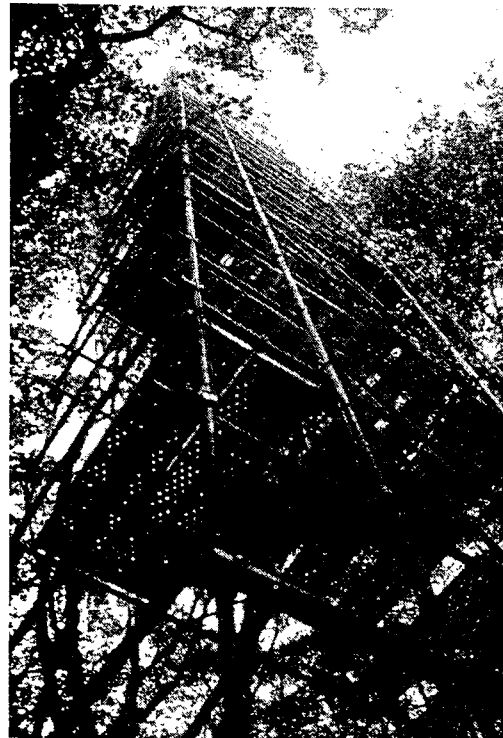


Fig. 6. A tower for canopy access and measuring fluxes of energy and water vapor by eddy covariance method in KEF LTER site.

at the canopy layer, but at the sub-canopy and suppressed tree layers are dominated by the two *Carpinus* species.

Mt. Kyebangsan Forest

The Mt. Kyebangsan Forest is located in a mountainous highland from 900 m to 1,577 m above sea level. The dominant species of the forest are *Quercus mongolica*, *Betula schumidtii*, *Kalopanax pictus*, *Tilia amurensis*, *Pinus densiflora* and *Abies holophylla*. The site was designated as Reserve Forest for research in 1991. Ground survey on biological diversity was conducted from 1995 to 1997. The research site is located at the ecotone between the northern cool temperate forest and sub-alpine forest.

Mt. Keumsan Forest

The Mt. Keumsan Forest is located in a land-tied island with bridge to the south coast of the Korean peninsula. The dominant species of the forest are *Quercus*, *Carpinus*, *Acer* and *Pinus*. The site was designated as Experiment Forest of the Forestry Research Institute in 1983. Ground-survey on biological diversity was conducted in 1994.

DESCRIPTION OF THE RESEARCH PROGRAMME

The objectives of long-term ecological research in the Forestry Research Institute are to study long-term changes of the forest ecosystem in energy fluxes, water and nutrient cycling, forest stand structure, biological diversity, to quantify nutrient budgets and fluxes among forest ecosystem compartments, and to integrate ecological data with a GIS-assisted model. To achieve the objectives, we have investigated the following items

- ① Forest Stand Dynamics: measure every 5 years for 1 ha permanent quadrat
 - Trees larger than or equal to 5 cm in DBH: labelling, identifying species and measuring DBH, height, crown widths, and location
 - Trees smaller than 5 cm in DBH: identifying species and measuring height
 - Diameter Growth: monthly measuring diameter growth for sample trees
 - Sub-alpine Forest (Mt. Kyebangsan from 1996: *Quercus mongolica*, *Pinus densiflora*, *Kalopanax pictus*, *Betula schumidtii*)

- Cool Temperate Forest (KEF from 1998: *Quercus serrata*, *Carpinus laxiflora*, *Carpinus cordata*)
- Warm Temperate Forests (Mt. Turyun-san from 1998: *Camellia japonica*, *Quercus acuta*, *Dendropanax morbifera*)

② Environmental Changes

- Forest Micro-Meteorology: air/soil temperature, relative air/soil humidity, wind direction and speed, (KEF from 1999, Mt. Kyebangsan from 1999)
- Fluxes of Energy and Water (Fig. 6, KEF from 1999, and CO₂ from 2001): eddy covariance system, soil heat flux.
- Soil and Site Survey
- Stream Water Quality
- Carbon and Nutrients Cycles: above ground and processes in soil
- Air Pollution: pH of rain and SO₂ concentration in air by month

③ Changes of Biological Diversity

- Plant Population Dynamics
- Vertebrate (fishes, amphibians, reptiles, birds, mammals)
- Invertebrate (in soil, on forest floor, on air, in canopy, in water)
- Microbes (mushrooms, mycorrhizae, lichens)

④ Monitoring as an Indicator of Climate Change

- Measuring bursting of buds and expansion rate of leaves for the sample trees at the designated dates in the spring

LITERATURE CITED

- Forestry Reserch Institute. 1994. Kwangneung Experiment Forest. Utkomunhwasa, Seoul. 910 p. (in Korean).
- Lee, K.J., J.C. Jo, B.C. Lee and D.S. Lee. 1990. The structure of plant community in Kwangneung forest (I): Analysis on the forest community of Soribong area by the classification and ordination techniques. J. Kor. For. Res. Soc. 79: 173-186 (in Korean).
- Oh, J.S., B.C. Lee, J.H. Shin, S.W. Oh and S.I. Kim. 1991. Community classification and stand structure of Kwangneung Natural Reserve Forest. Res. Rep. For. Res. Inst. 42:36-56 (in Korean).
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