

An Overview of the Long-Term Ecological Research (LTER) Activities in Korea

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ABSTRACT: This paper was prepared to have an overview of the Long-Term Ecological Research (LTER) activities in Korea in order to facilitate further development of Korea LTER Network in the coming 21th century. After the background for the development of the Korea LTER network was reviewed, the network activities of Korea as well as of the world were introduced for sound management and conservation of ecosystems, which can be ultimately carried out by the long-term ecological researches whose results can secure comparability in the dimension of time and space.

INTRODUCTION

Over the last 40 years, Korea's landscapes have been dramatically changed by intensive efforts toward afforestation while people convert from firewood to fossil fuel sources. Land area has been largely revegetated and the condition of vegetation is improving over time. Meanwhile, Korea has experienced degradation of the natural environment caused by intensive developmental activities and subsequent pollution. These activities include industrialization, urbanization, the construction of roads and golf courses, fossil fuel consumption, discharge of wastes to water systems, mineral extraction, land-clearing, and water control.

As evidence of environmental degradation emerges slowly over decades, most of the people do not sense the symptoms with any precision. Hence extensive collection and careful analyses of relevant data over long time periods are required for better understanding and management of biotic components and the environment of Korea. Although some scientists have realized the importance of studying long-term phenomena in ecology, major advancement in long-term ecological research has not yet been made in Korea.

This overview was prepared to facilitate the development of Korea LTER Network by introducing the perspective, history, and activities of LTER in Korea in the coming 21th century. In the era of depletion of resources and environmental pollution, as the sustainability of the future generation became the central theme of the world, the rationale for carrying out long-term ecological research was provided for sound management and conservation of ecosystems. Throughout this paper, the author tried

to maintain that long-term ecological researches whose results secure comparability in the dimension of time and space will provide a basis for sound management and conservation of ecosystems in Korea in the 21st century.

NECESSITY FOR THE DEVELOPMENT OF LTER

The concepts of long-term ecological research and ecosystem study were not widely practiced to ecologists in Korea. Few studies on LTER were carried out in the past, which is ascribed to the uncertainty and instability of the society. In the past, continued social disturbances including Korean War deprived the people of the rationale for carrying out long-term activities. Only recently, LTER had the basis to be carried out as the society becomes stabilized. The more industrialized the society becomes, the more severely natural habitats and the conditions of environment destroyed and deteriorated. Whence the necessity for LTER has been strongly supported by the public in these days.

As was put in the Rio Declaration on Environment and Development in 1992, maintaining sustainability of ecosystems became a key factor for sound management and conservation of ecosystems in the next century. As the sustainability is a matter of concern in the future and sound management and conservation of ecosystem can be attained from the application of ecological knowledge to ecosystems, ecosystems should be managed and conserved on long-term basis, where the rationale for carrying out long-term ecological research in ecosystems is sought.

In order to show the necessity to carry out LTER, it is illustrated by the Fig. 1 to 3. In Fig. 1, the changing trend of drought simulated for

last 10 years on Mt. Hallasan, Cheju Island, was shown (Kim 2000). When we have only 10 data on the soil moisture condition for a site, we can be misled that the drought in 1996 is very severe and it can become worse in the new century. If we have the data for about 30 years, we can say that there is certain cyclic fluctuation in drought and we can find that there were a few similar droughts in the early-1970s as was shown in Fig. 2. Furthermore, if we have data for more than 70 years, we can say that the drought in 1942 is far worse than that of 1996 (Fig. 3). By observing the drought for longer period, we can be prepared to far worse droughts that can be happened in nature beyond our imagination. With such a perspective, we can devise effective measures to avoid the disastrous consequences that can happen any time in the future. This perspective is very important in the age of the depletion of natural resources and biodiversity and the deterioration of environment and sustainability for future generations to come.

LTER ACTIVITIES IN THE WORLD

In order to facilitate cooperation among scientists engaged in long-term ecological researches, international network of LTER was organized in 1993 (U.S. LTER Network 1993). In the international network, five topics were chosen to be important for future development of LTER programs, which were suggested as follows:

- communication and information access for LTER researchers worldwide;
- developing a global directory of LTER research sites;
- developing LTER programs worldwide;
- scaling, sampling, and standardization of measurement; and
- education, public relations, and relationships with decisionmakers.

This international network is expanding world wide. For those who are interested in the international activities of ILTER, internet access, with the server address <http://ilinternet.edu/>, is available for further information. In the server, more precise information on the national activities of some countries is easily accessible. In Table 1, the names of the programs of representative countries for the development of ILTER are suggested.

Among the nations, the United States is leading the International LTER Network after their long history for about 20 years by showing the people why they are doing LTER programs,

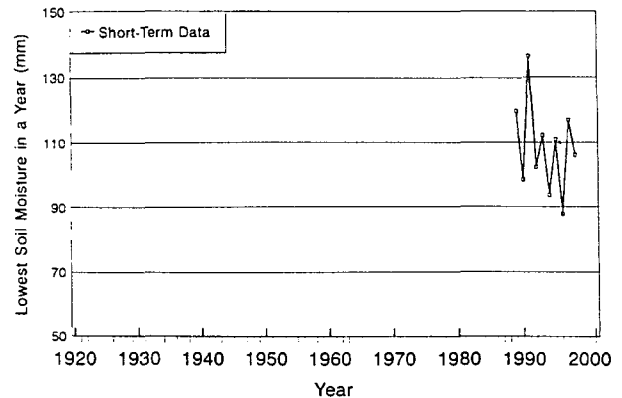


Fig. 1. Drought observed with short-term data, with the number of years less than 10. Interpretation derived from such observation can be misled due to low predictability and comparability for the results. (Fig. 1 is the same as Fig. 3).

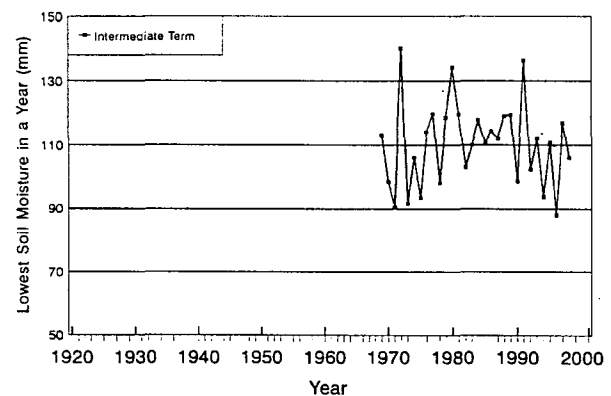


Fig. 2. Drought observed with intermediate-term data, with the number of years less than 30. Interpretation derived from such observation can be reasonable but unpredictable for some catastrophic or stochastic events. (Fig. 2 is the same as Fig. 3).

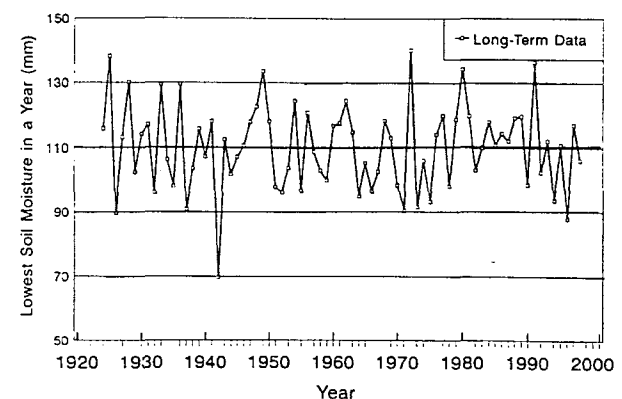


Fig. 3. Drought observed with long-term data, with the number of years more than 30. Interpretation derived from such observation can be reasonable and, sometimes, predictable for catastrophic or stochastic events.

Table 1. ILTER Program names of the countries that are accessible in internet

Australia: Environmental Resources Information Network (ERIN)
Argentina: IFEVA
Canada: Ecological Monitoring and Assessment Network
China: Chinese Ecological Research Network (CERN)
Costa Rica: Organization for Tropical Studies
Hungary: Hungarian Science Information Network
Korea: Korea Long-Term Ecological Research (KLTER) Network
Switzerland: Forest Condition Inventory and Long-Term Monitoring
Taiwan: Taiwan Ecological Research Network (TERN)
U.K.: Ecological Change Network (ECN)
United States: U.S. LTER Network

how should the LTER be performed, what the LTER can and should do for the contribution to society as well as the advancement of science, and what are the outcomes of the LTER. In the United States, 24 sites were designated as official LTER sites and their LTER activities are supported by the U.S. National Science Foundation (NSF).

For the development of LTER program, the U.S. LTER Network Office located in Albuquerque, New Mexico, play the key roles for the effective management of the network, which can be summarized as follows:

- facilitation of communication among the LTER sites and between the LTER program and other scientific communities;
- support of the planning and conduct of collaborative research efforts, including provision of some technical support services;
- facilitation of intersite scientific activities;
- provision of a focal point and collective representation of the LTER Network in its external relationships; and
- development of linkages with other relevant long-term research programs, site networks, and science and technology centers.

LTER ACTIVITIES IN KOREA

Recently the Korea Forest Research Institute (KFRI) included Long Term Ecological Research (LTER) as a major project in forestry research, and three sites were officially designated for long-term ecological research and biodiversity conservation and monitoring. The first LTER site in Korea is Kwangnung Experimental Forest, which represents the oldest natural forest in Korea. Some parts of the forest have been protected for more than 500 years. The other two are the forests of Mt. Kyebangsan and Mt. Keumsan. Although LTER is in its early stages

in Korea, promotion and encouragement of ecologists' activities will help to ensure the sound development of the Korean LTER program in the future.

Description of program, objectives, and core areas

As the program in Korea LTER is in early stage of development, efforts are made to establish the central and nationwide program to publically support and coordinate researches in official and potential LTER sites in Korea. Meanwhile, in order to facilitate communication, coordination, and cooperation among the scientists in ecology and related disciplines, Korea LTER Committee (KLC) has been established in 1997. One of the prerequisites for the development of Korea LTER Network is the establishment of the program and network office supported by the governmental organizations such as the U.S. LTER Network Office supported by the US NSF.

The objective of most of the research is to investigate the dynamics of structure and function of ecosystems related to the changes of environment, which is ultimately related to monitoring biodiversity and global change.

All the LTER sites have common themes, called core research areas, which must be investigated and can be compared to each other. The core research areas include primary production, population dynamics, nutrient cycling, impacts of environmental stress and disturbances, and environmental changes.

Characteristics of the sites

Three official sites (Kwangnung Experimental Forest, Mt. Kyebangsan Forest, and Mt. Keumsan Forest) which are managed by the Korea Forest Research Institute, as well as three potential sites (Lake Soyang, Mt. Jumbongsan, and Mt. Hallasan) are introduced. Mt. Chirisan, Mt. Soraksan, Mt. Namsan, and Demilitarized Zone (DMZ) are potential sites. In addition to these sites, intensively investigated sites monitored by the Ministry of Environment as a nationwide nature and environment census program can be strong candidates for LTER sites in Korea. The locations of the sites are illustrated in the map of Korea LTER Network (Fig. 4).

1) Kwangnung Experimental Forest/Kyonggido Province, Korea

- Principal contact/Institute - Dr. Jeong Soo Oh, Director General of Department of Forest Environment/the Korea Forest Research Institute, 207, Chongnyangni 2-dong, Tongdaemun

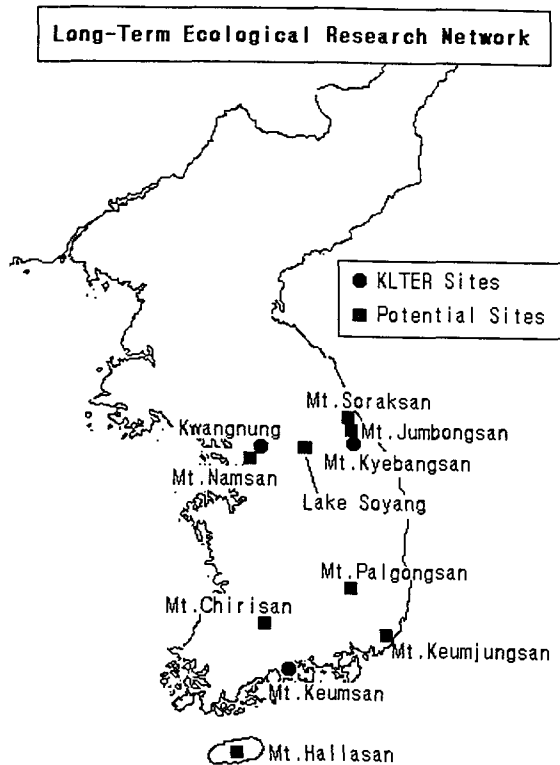


Fig. 4. Map showing the Korea LTER sites.

gu, Seoul 130-012, Korea

- Latitude, longitude, elevation, size (ha) - 37° 48' N, 127° 11' E, 300~537 m, 500ha
- Principal biome/main communities - Mixed - hardwood temperate forest/*Quercus*, *Carpinus*, *Prunus*
- Research topics - Forest stand dynamics; Water cycling; Nutrient cycling; Change of biodiversity and microclimate
- History of site/type of data collected - Mausoleum (King Sejo, the 7th King of Chosun Dynasty) designated as Experimental Forest in 1913. Kwangnung Arboretum and Forest Museum were established in 1987. Comprehensive introduction to the Experimental Forest was published by the Korea Forest Research Institute. Hydrological data were collected for twenty years. Ground survey on biodiversity was conducted from 1994. The long-term ecological research site was established in 1996.
- Key references - Oh, J.S., B.C. Lee, J.H. Shin, S.W. Oh, and S.I. Kim. 1991. Community classification and stand structure of Kwangnung Natural Reserve Forest. Research Report of Forestry Research Institute 42:36-56. (in Korean with English abstract)

2) Mt. Kyebangsans Forest/Kangwondo Province, Korea

- Principal contact/Institute - Dr. Jeong Soo Oh, Director General of Department of Forest Environment/the Korea Forest Research Institute, 207, Chongnyangni 2-dong, Tongdaemun-gu, Seoul 130-012, Korea
- Latitude, longitude, elevation, size (ha) - 37° 44'N, 128° 29' E, 900 - 1577 m, 440 ha
- Principal biome/main communities - Mixed - hardwood temperate forest/*Quercus*, *Betula*, *Kalopanax*, *Tilia*, *Acer*, *Abies*
- Research topics - Forest stand dynamics; Air pollution; Change of biodiversity; Climate change and monitoring
- History of site/type of data collected - The site was designated as Reserve Forest for research in 1991. Ground survey on biodiversity was conducted in 1995. The long-term ecological research site was established in 1996.
- Key references - Shin, J.H., B.C. Lee, H.J. Cho, S.W. Bae, C.I. Ryu, H.C. Park, J.H. Shim, and S.H. Chun. 1991. Biodiversity of forest ecosystems in Mt. Gyeong and Ulreung Island. Forestry Research Institute Research Report 121. 367 pages. (in Korean).

3) Mt. Keumsan Forest/Kyungsangnamdo Province, Korea

- Principal contact/Institute - Dr. Jeong Soo Oh, Director General of Department of Forest Environment/the Korea Forest Research Institute, 207, Chongnyangni 2-dong, Tongdaemun-gu, Seoul 130-012, Korea
- Latitude, longitude, elevation, size (ha) - 34° 30'N, 127° 59' E, 100~700 m, 300 ha
- Principal biome/main communities - Mixed - hardwood temperate forest/*Quercus*, *Carpinus*, *Acer*, *Pinus*
- Research topics - Forest stand dynamics; Change of biodiversity especially in warm temperate forest
- History of site/type of data collected - The site was designated as Experimental Forest in 1983. Ground survey on biodiversity was conducted in 1994. The long-term ecological research site was established in 1996.
- Key references - Shin, H.C. and K.Y. Lee. 1990. A comparative study on the structure of forest vegetation at the southern and northern slopes of Mt. Kum in Namhae. Journal of Korean Forestry Society 79(3): 245~254.

4) Mt. Jumbongsan Nature Reserve, a part of Mt. Soraksan Biosphere Reserve UNESCO MAB (potential site)/Kangwondo Province, Korea

- Principal contact/Institute - Dr. Dowon Lee/Graduate School of Environmental Studies, Seoul National University, Seoul 151-742, Korea
- Latitude, longitude, elevation, size (ha) - 38°00' ~38°03'N, 128°26'~128°30'E, 900~1424 m, 2,049 ha
- Principal biome/main communities - Mixed-hardwood temperate forest/Quercus, Kalopanax, Fraxinus, Carpinus, Acer, montane stream
- Research topics - Distribution of vascular plant; Soil fauna and nutrients; leaf litterfall and decomposition; Stream invertebrate; Avian ecology; Integration of ecosystem model and geographic information system
- History of site/types of data collected - The site has been included in a Biosphere Reserve in UNESCO Man and the Biosphere Program and designated as Natural Forest Reserve by the Administration of Forestry, Korea in 1980s. Geology, vascular plants, birds, insects, fishes and amphibians, reptiles, and mammals were partially investigated in 1983. Vascular plants, leaf litterfall and decomposition, soil and stream invertebrates, and birds have been monitored since September 1994, soil temperature since December 1995 and air temperature, precipitation, wind, LAI and soil respiration since March 1998.
- Key references - Lee, D., D. Cho, J. Lee, and C. Park. 1997. Analyses of ecological structure and function of natural forest reserve in Mt. Jumbong for conservation of biodiversity. Vol. 3. Korea Science and Engineering Foundation (KOSEF). Korea (in Korean with English abstract)

5) Mt. Hallasan National Park or Mt. Hallasan Nature Reserve (potential site)/Chejudo Province, Korea

- Principal contact/Institute - Dr. Eun-Shik Kim, Department of Forest Resources, Kookmin University, Seoul 136-702 Korea (or Director, Hallasan National Park Management Office, Cheju City, Chejudo Province, 690-200 Korea)
- Latitude, longitude, elevation, size (ha) - 33° 19'15"N~33° 25'30"N, 126° 27'59"E~126° 37'38" E, 800~1950 m, 15,131 ha
 - Principal biome/main communities - Mixed-hardwood temperate forest and subalpine coniferous forest/Quercus, Pinus, Carpinus,

Abies

- Research topics - Distribution of vascular plant; Forest dynamics and biodiversity; Growth decline of Korean fir; Climate change and global warming; Transboundary transport of air pollutants; Impact assessment of human activities and wild deers to ecosystem; Restoration of biodiversity; Hydrological modeling
- History of site/types of data collected - Mt. Hallasan was designated as Nature Reserve in 1966 and as National Park in 1970. Various studies on climate, geology, soil, vegetation, invertebrates, amphibians, reptiles, birds, and mammals were carried out in 1985 and intermittently thereafter. Growth data of Korean firs are quantified until recent days and temperature and precipitation data are available in nearby cities. Air pollution and acid precipitation data are also available on the same basis.
- Key references - Chejudo Province. 1985. Report of the Academic survey of Hallasan (Mountain) Natural Preserve. (in Korean); Kim, E.S. 1994. Decline of tree growth and the changes of environmental factors on high altitude mountains. Korea Science and Engineering Foundation (KOSEF). 89 pages. (in Korean with English abstract)

6) Lake Soyang (potential site)/Kangwondo Province, Korea

- Principal contact/Institute - Dr. Bom-Chul Kim/ Department of Environmental Science, Kangwon National University, Chunchon, 200-701 Korea. bomchkim@cc.kangwon.ac.kr
- Latitude, longitude, elevation, size - dam is at 127° 40'E, 37° 90'N, flood level 198 m, maximum surface area 70km², maximum depth 120 m, axial length 60km, watershed 2700 km², water capacity 2.9×10⁹ m³
- Principal biome/main communities - warm monomictic circulation, mesotrophic phytoplankton community, no littoral zone, water level fluctuating
- Research topics - Productivity and structure of phytoplankton community; Zooplankton community structure; Distribution of nutrients, input and output of nutrients; Ecosystem modeling
- History of site/type of data collected - Lake Soyang is the deepest and largest reservoir in Korea. Research team in Kangwon National University have been monitoring primary productivity, phytoplankton community, nutrients distribution. In 1990s more data of zooplankton community, nutrients loading

from watershed, DOC distribution are being collected.

- Key references - Cho, K.-S., B.-C Kim, W.M. Heo, and S.J. Cho. 1989. The succession of phytoplankton in Lake Soyang. *Korean J. Limnol.* 22(3):179-189

Network management and principal financial sponsors

The Korea LTER Committee plays a major role in improving LTER program and activities in Korea. The committee consists of five members and meets quarterly to discuss major activities of research and implement. At this moment, the Korea Science and Engineering Foundation (KOSEF) plays an important role as a sponsoring agency for hosting international conferences and supporting joint research, exchange programs, and domestic LTER activities in Korea. In addition, the Forest Research Institute of Korea continues to be the institute which tries to set the basic framework for LTER activities in Korea. The Committee found it needed to invite several financial sponsors to activate the LTER program in Korea, however.

Partnerships

The Korea LTER Committee actively pursues cooperative partnerships with the Korea Forest Research Institute and the Korea Science and Engineering Foundation along with the National Park Authority (NPA), local governments, and universities. These partnerships facilitate communication and cooperation among the scientists, managers, and policy makers in ecology and related disciplines.

Collaboration among networks

Collaboration among the regional networks is made through regular biennial Regional Conference. In April of 1995, the first Asia-Pacific Regional Conference was held in Taipei, Taiwan. The second conference was held in Tsukuba, Japan, in March of 1997. The third conference was held in Seoul, Korea, in October of 1999. The fourth conference is scheduled to be held in Ulaanbaatar, Mongolia in 2001. Collaboration among the global networks will be mainly facilitated by internet, whose address is <http://klter.kookmin.ac.kr>.

Special activities

The Korea LTER Committee hosted an International Workshop on LTER in the East Asia-Pacific Region in 1998 and the 3rd International Conference on LTER in the East Asia-Pacific Region, jointly with the Ecological

Society of Korea in 1999. These events were organized by Kookmin University and the Korea Forest Research Institute. Before the Conference, a bilateral Korea-U.S. Joint Seminar to identify and address key questions on up-to-date LTER issues in regional as well as global scale was held as a satellite meeting supported by both the Korea Science and Engineering Foundation and the U.S. National Science Foundation, which will facilitate future cooperative research among the scientists of the countries and provide a firm stepping stone for the development of the national LTER network in Korea.

In addition, three Korean sites were included in the GTNET NPP Demo Project of the Global Terrestrial Observing System (GTOS) coordinated by the Network Office of US Long Term Ecological Research. Collaboration among the global networks is facilitated via the internet, whose address is <http://klter.kookmin.ac.kr>.

Application of LTER

Outcomes of LTER are useful tools for detecting environmental changes such as regional pollution and global warming and managing natural resources such as forests, lakes, and rivers. Education program will be further included when much information is collected.

CONCLUSIONS

While sound management and conservation of ecosystems is a central theme, depletion of natural resources and degradation of biodiversity will be the biggest challenge for the discipline of ecology in the 21st century. Throughout this paper, the author tried to maintain that long-term ecological researches whose results secure comparability in the dimension of time and space will provide a basis for sound management and conservation of ecosystems in the 21st century. Efforts should be further exerted in networking the long-term ecological researches in Korea, which will provide the basis for international exchange of ecological information for sound management and conservation of ecosystems in the region as well as in the world.

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