

Management and Conservation of Mountain Forests in KOREA

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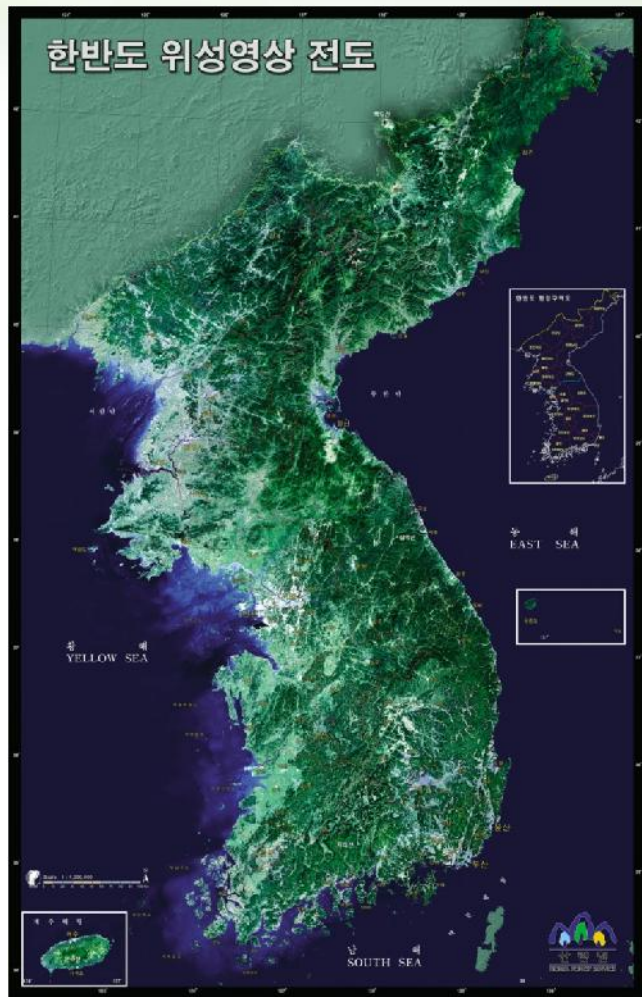
VI. Climate change adaptation



Intorduction



Korea – a Country of Mountains & Forests



✓ Greening Korea

- Korea, a mountainous country with 64% of its land in forests, has a long history of its people living in close relationship with forests.
- Throughout the long history of Korea, the wise management of forests and water resources has been high on national agenda.
- During the first half of 20th century, severe deforestation had occurred across the Korea, due to widespread illegal cuttings and overcutting practices.
- Since the early 1970s, rehabilitation activities of forest lands have been strongly propelled in order to green the country again.

www.forest.go.kr

Environment of Korea Peninsula

✓ Geography

- ☉ Latitude : 33°06' ~ 43°00', Longitude : 124°11' ~ 131°53'
- ☉ Average Elevation : 420 m
- ☉ Land area : 221,000 km² (South Korea : 99,660 km², 45%)
- ☉ Forest area : 70% of total land area (South Korea : 65%)

✓ Climate

- ☉ Annual mean Temperature (four different seasons)
South : 12-14°C, Central : 10-12°C, North : 5-10°C

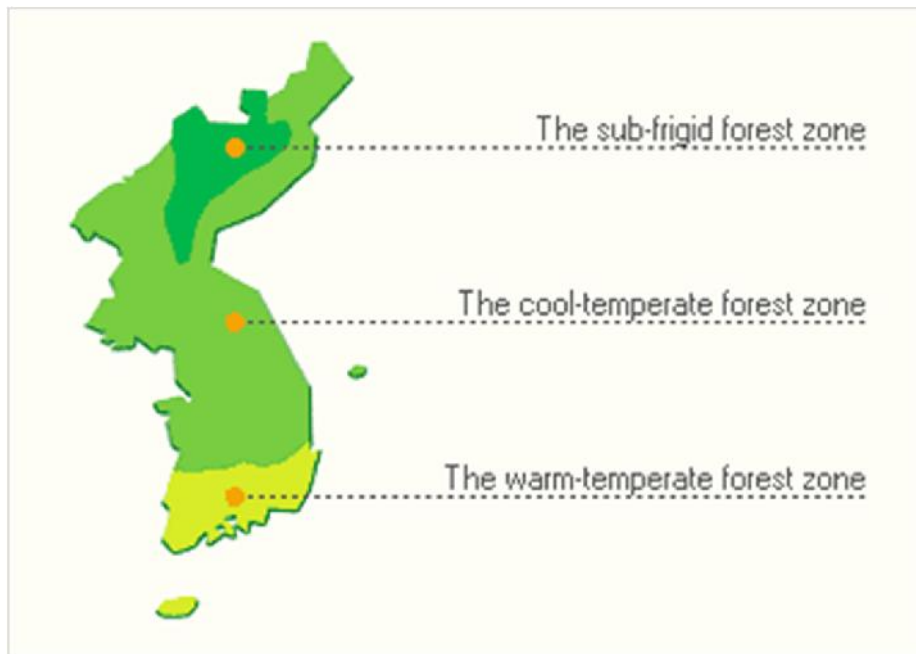




Forest Status



Forest Vegetation Zones



► Sub-frigid Forest

- Average Temp. : 5°C and lower
- *Abies*, *Picea*, *Larix*
Juglans mandshurina
Betula platyphylla

► Cool-temperate Forest

- Average Temp. : 6-13°C
- *Quercus*, *Zelkova*, *Fraxinus*
Pinus densiflora
Pinus koraiensis

► Warm-temperate Forest

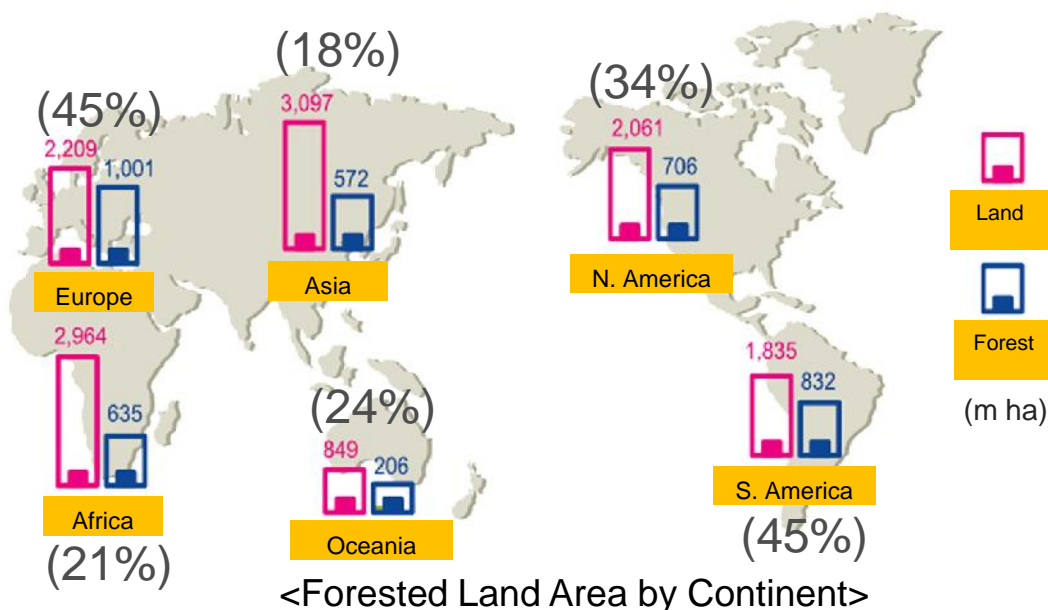
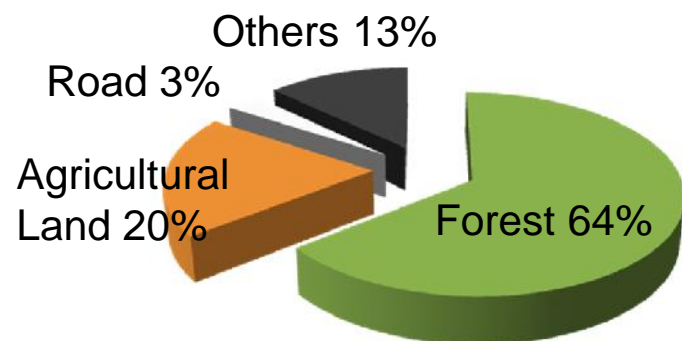
- Average Temp. : 14°C and higher
- *Quercus acuta*, *Castanopsis*
cuspidata, *Camelia japonica*

Forest Resources

World's total forest area: over 4 billion ha (31%)

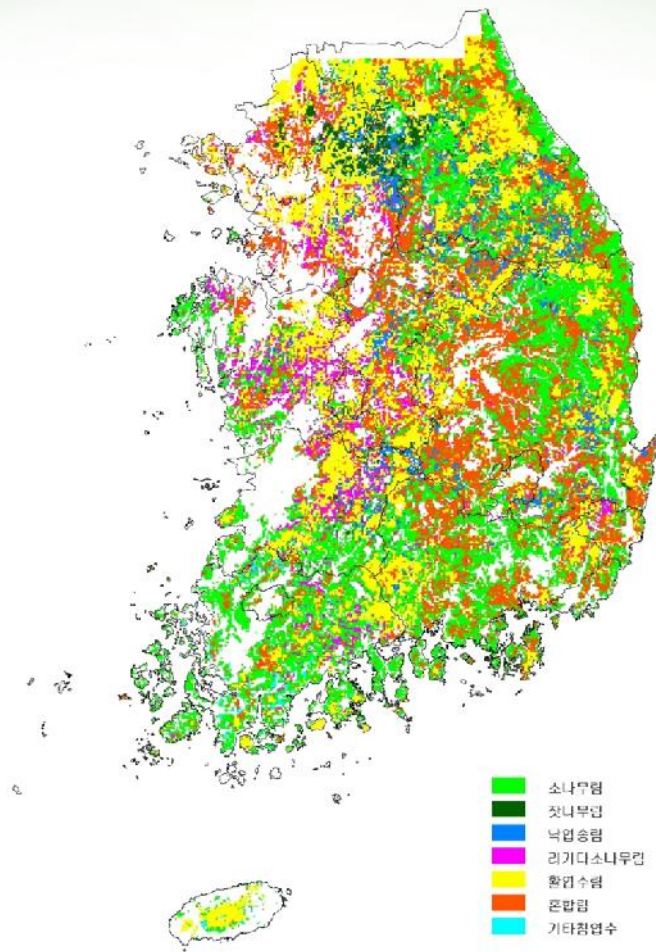
0.6 ha per capita

Five most forest-rich countries: Russia, Brazil, Canada
USA, China



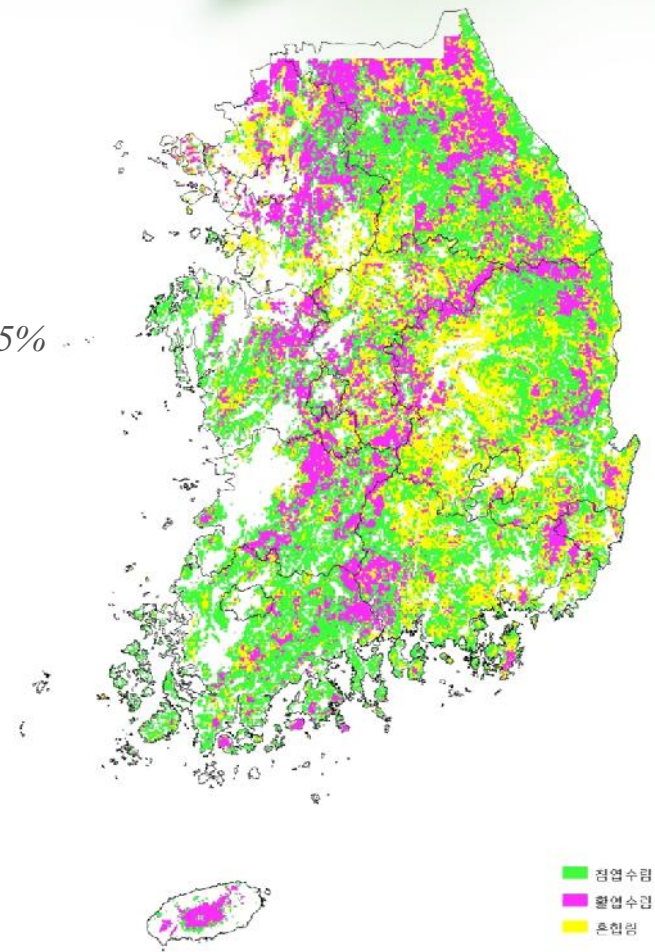
- ▶ Forested land area : 6,369,000 ha (64% of the total land area)
- ▶ Total Growing Stock : 800million m³ (125.6m³/ha)
- ▶ Protected forest area : 410,000 ha (6%)
- ▶ Protected trees : 13,165 trees

Distribution of Forest Resources



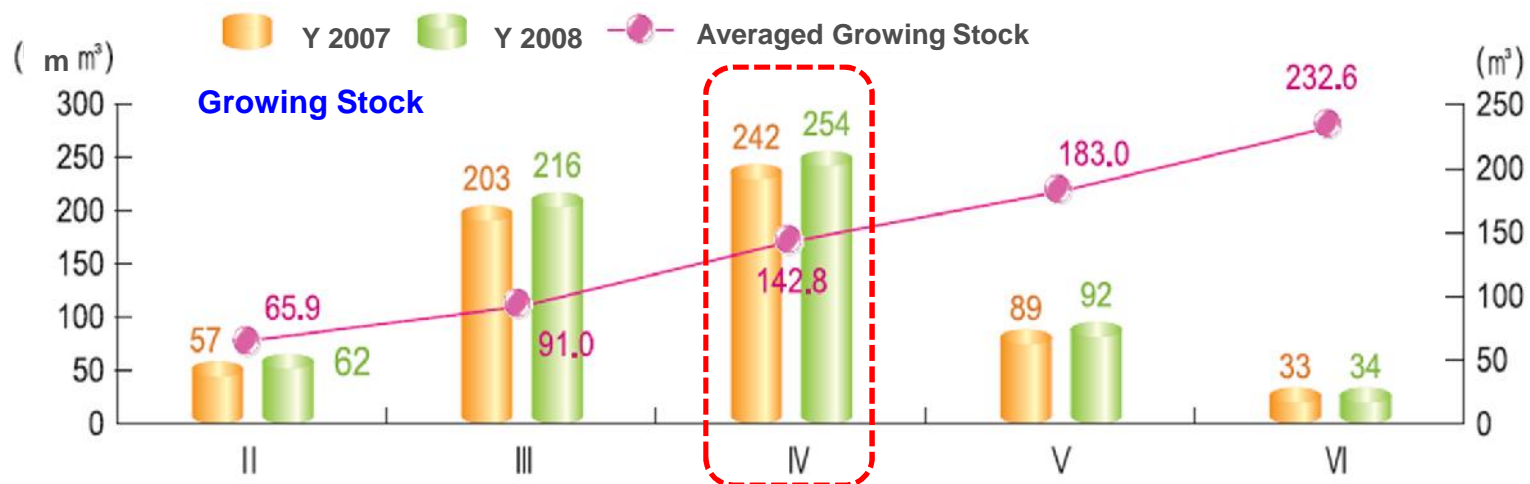
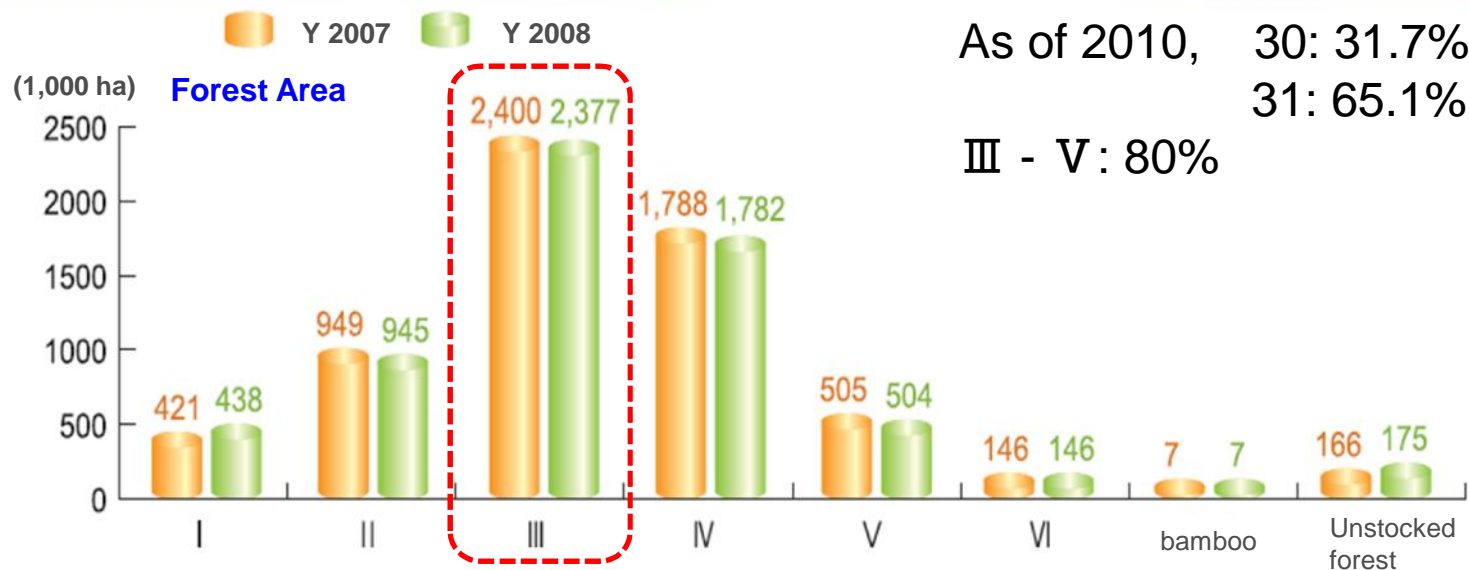
Major Species

Coniferous forest : 40.5%
Broadleaf forest : 27%
Mixed forest : 29.4%

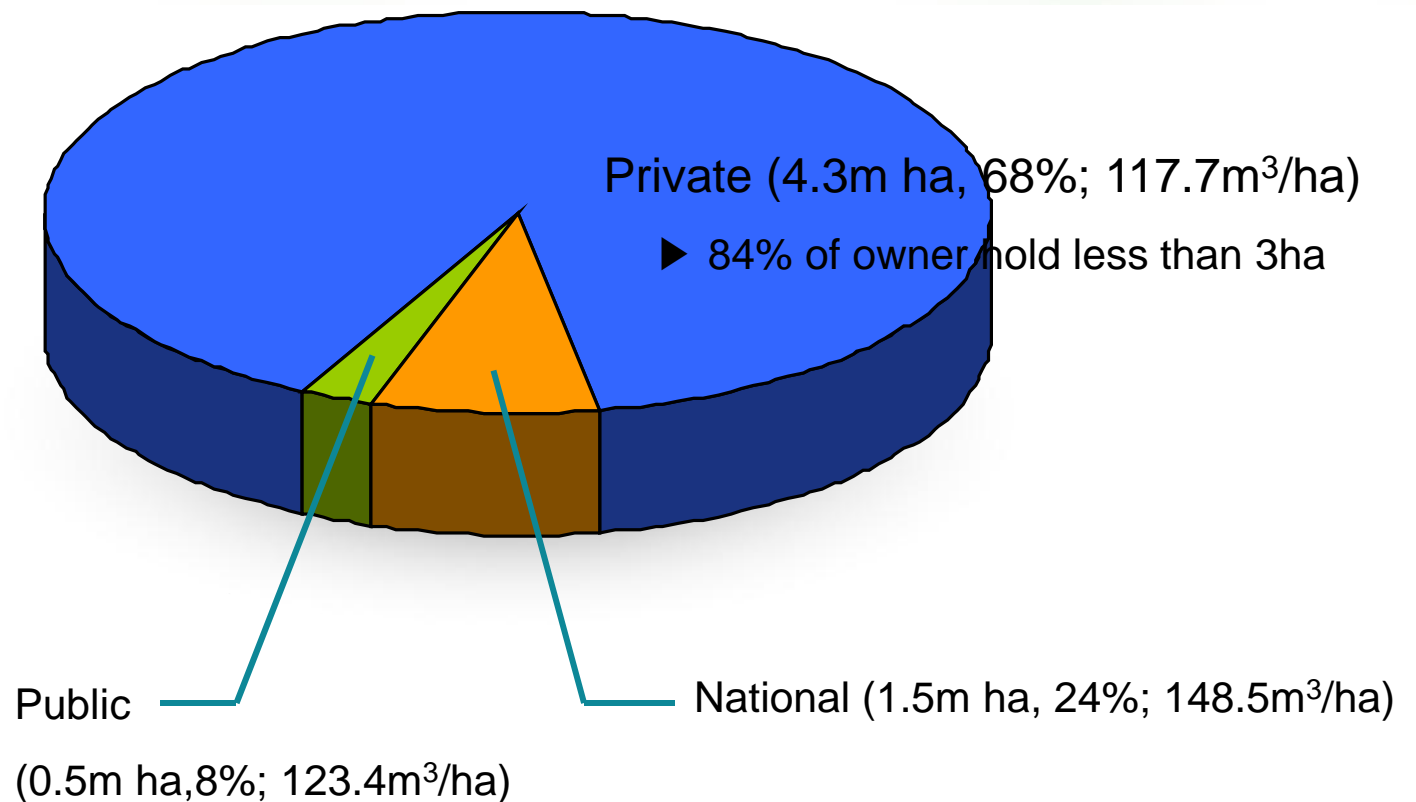


Conifers & Broadleaved

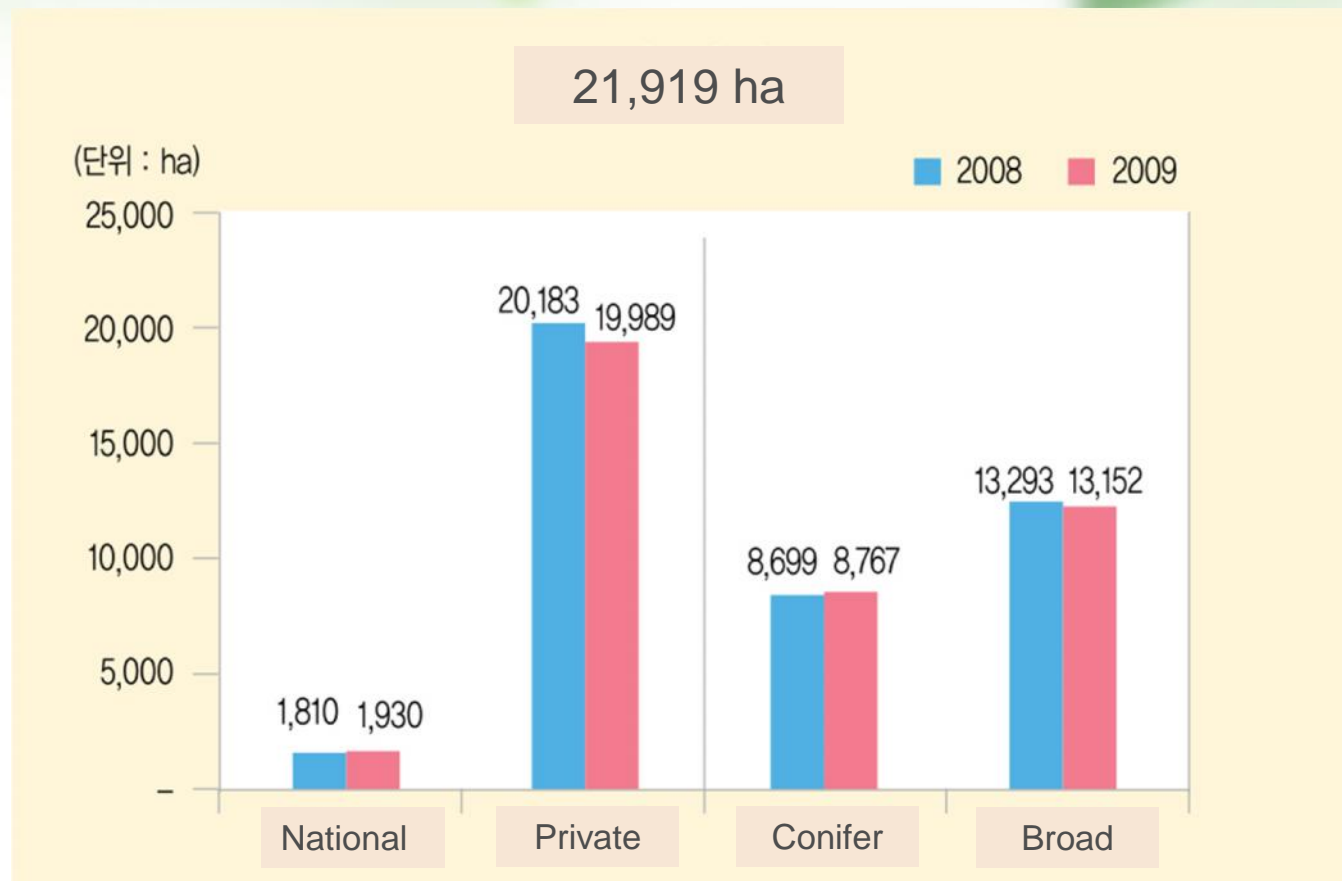
Forest Resources by Age Class



Forest Ownership



Afforestation



Overseas plantation: 27,796 ha

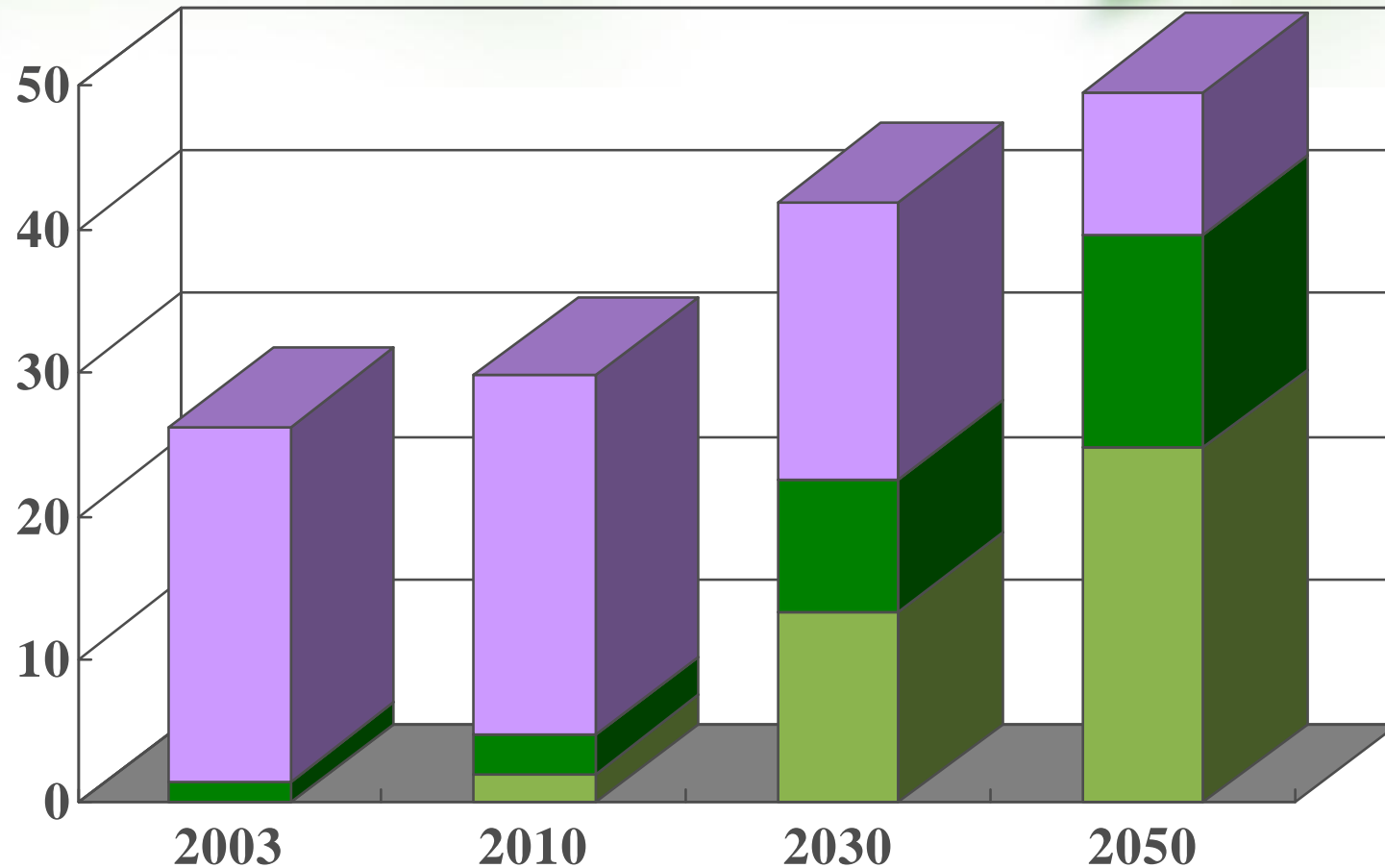
Indonesia: 23,541 ha, China: 1,500 ha, Vietnam: 1,143 ha



Trade of Forest Products



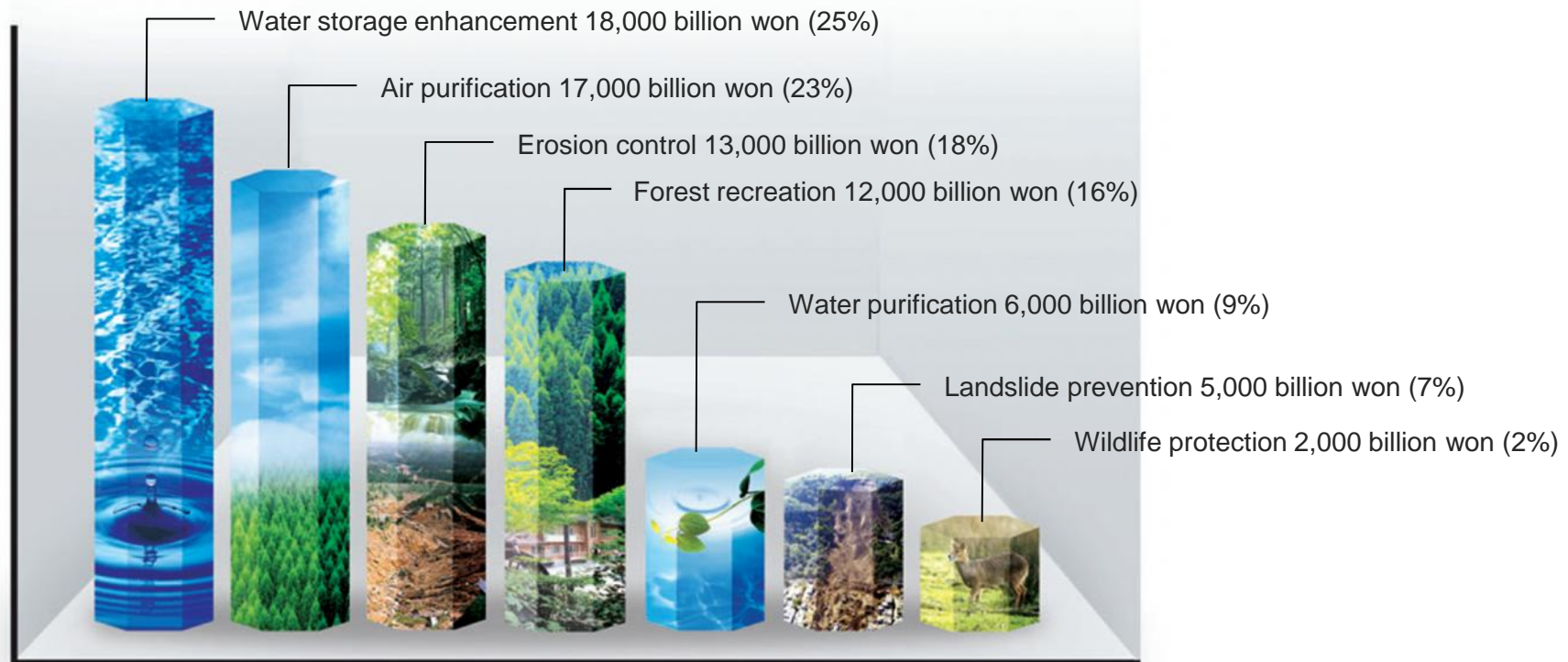
Timber Supply and Demand



■ Overseas plantation ■ Domestic supply ■ Imported supply

Environmental Benefits of Forests

 Total assessed value: 73,000 billion won (1 US\$ \approx 1,200 won)
1.51 million won/person





Forest Policy & Forest Management






Korea Forest Service

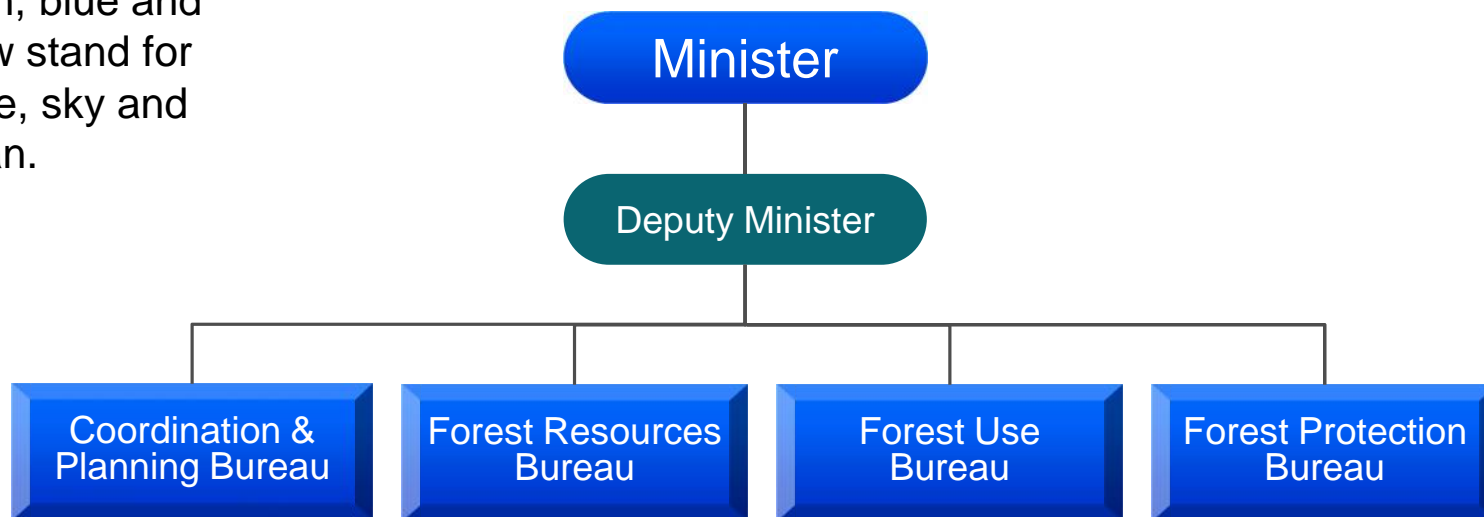


Green, blue and yellow stand for nature, sky and human.

 The KFS has the overall responsibility for establishment and implementation of forest policies and laws.

 Primary mission

- Development of forest resources
- Conservation of forests
- Forest management
- Utilization and development of forest products
- Research, education, etc.



Korea Forest
Research Institute

National Natural
Recreation Forest Office

National
Arboretum

Forest Human Resources
Development Institute

Forest Aviation
Headquarters

Regional
Forest Service



National Forest Plan

Definition

- Strategic plan that guides the Korea Forest Service in delivering its mission
- Guidelines for forest management at central- and local-government level
- Comprehensive plan for developing forest resources and fostering forestry and wood industry

The 1st & 2nd National Forest Plan (1973 -1987)

Goals

- Greening the country again
- Establishment of economic forest

Achievements

- Restoration of 0.77 million ha
- Reforestation of 2.16 million ha
- Intensive erosion control
- Formation of 80 large scale commercial forest zones (0.33 million ha)

Devastation of forests during the social turbulence era in 1950-1960

- Korean war, illegal logging and excessive cutting practice
- Stock volume in the 1960s : 5.7m³/ha



Slope Grading



Terrace Making



Sodding

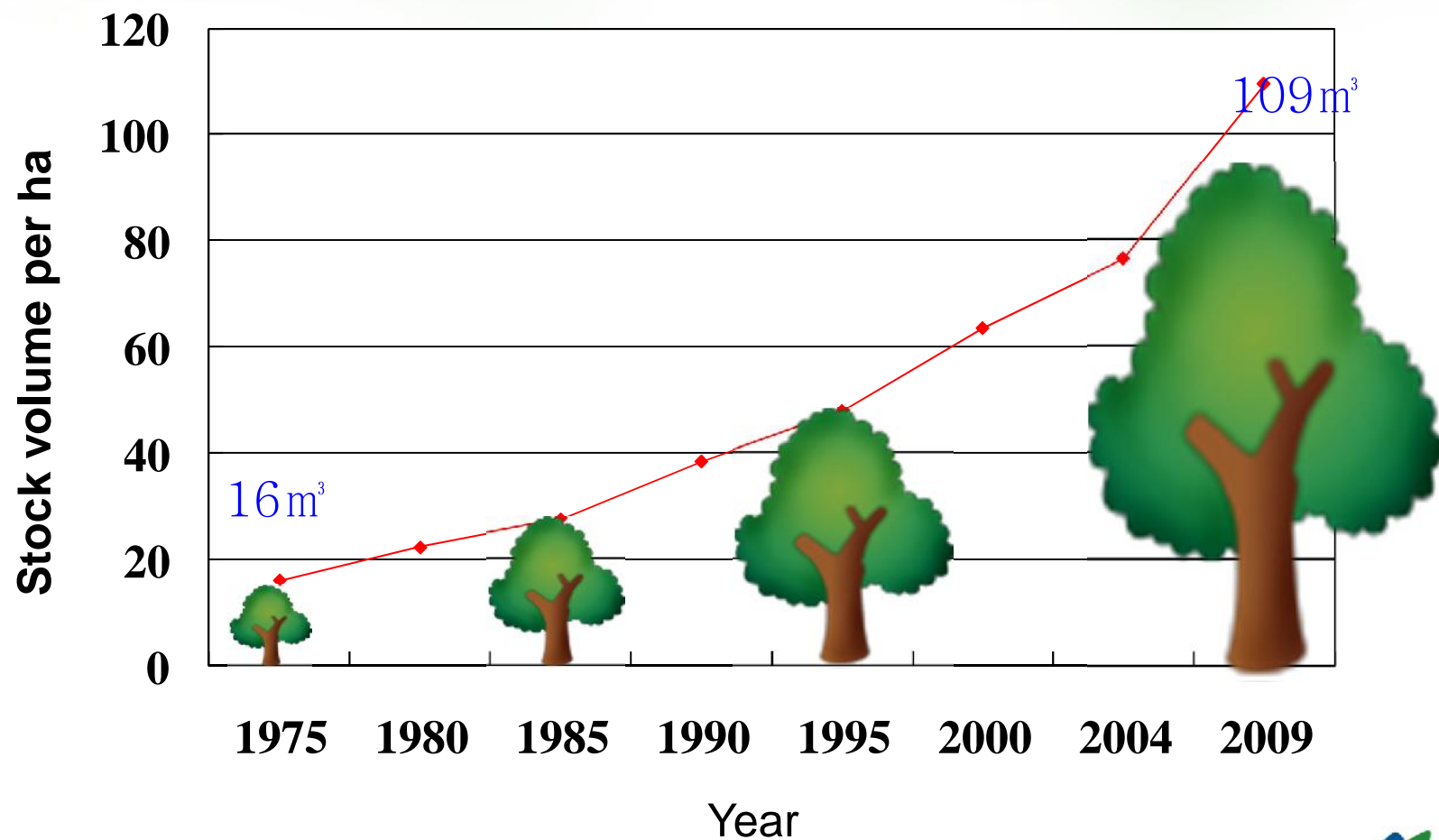


Planting

Before and After Rehabilitation Programs



Changes in Growing Stock



Worldwide Recognition

FAO Unasylva (1981)

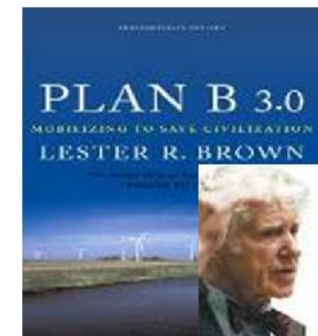
- The Republic of Korea embarked on a four-fold programme in 1973. . . The programme succeeded beyond expectations.



Lester Brown (2008)

- S.Korea is a reforestation model for the world. We can reforest the earth.

Achim Steiner (2008)

- Highly praised the successful rehabilitation in Korea (Executive Director of UNEP, 10th Ramsar Convention)





The 3rd National Forest Plan (1988 -1997)



Goals

- Harmonizing economic benefits with public interests

Achievements

- Commercial forests : 0.32million ha
- Forest tending : 3.03million ha
- Expansion of recreation forests
- Development of income sources for mountain villages
- Reclassification of forestland use system by function and purposes





The 4th National Forest Plan (1998 -2007)


Goals

- Sustainable forest management
- Growing valuable forest resources
- Fostering competitive forest industry
- Promoting healthy & pleasant forests for people to enjoy

Achievements

- Introduction of multiple-purpose management system
- Promotion of forest and wood industry
- Conservation of forest ecosystem
- Effective forest fire control system
- Urban forest management
- Development of mountain villages
- Increase of overseas plantation





The 5th National Forest Plan (2008 -2017)

Sustainable Green Welfare Nation

Integrated management and development of forest resources

Enhancement of carbon sinks in forests

Promotion of forest industry and competitiveness

Conservation and management of forest ecosystems

Urban forests and forest recreation

Strengthening International cooperation



Forest Science & Technology Development





Korea Forest Research Institute



Mission

- KFRI's mission is to develop technologies that sustain the health, diversity and productivity of nation's forests for both present and future generations.
- KFRI is also responsible for (1) raising public awareness, (2) sharing research outcomes, (3) encouraging public engagement and dialogue, (4) disseminating knowledge, and (5) providing high-quality public services.

Brief History

- 1922.02. The Forestry Experiment Station was founded.
- 1987.12. The Station was reorganized into the Korea Forest Research Institute.
- 1998.08. The Forest Genetic Research Inst. was merged into KFRI as the Dept. of Forest Genetic Resources.
- 1999.01. The Forestry Training Institute was merged into KFRI as the Dept. of Forestry Training.
- 2001.01. KFRI was transformed to "Executive Agency".
- 2006.01. The Dept. of Forestry Training was separated from KFRI and reorganized as the Forest Human Resources Development Inst. under the Korea Forest Service.

KFRI's Major programs and key projects

Forest Resources and Information

Forest resources inventory

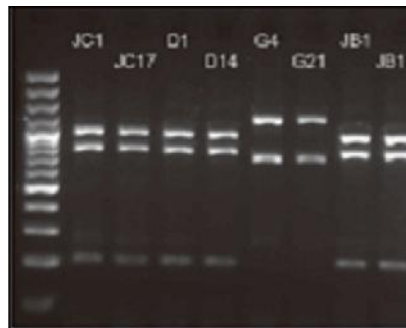
Conservation and utilization of forest genetic resources

Forest ecology

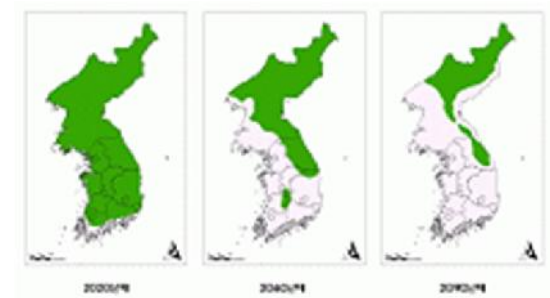
Physiology of forest trees and phytoremediation



Establishment of the prototype of Forest Spatial Data Warehouse



mtDNA variation of *Picea jezoensis* in South Korea



Prediction of habitat change In *Pinus densiflora*

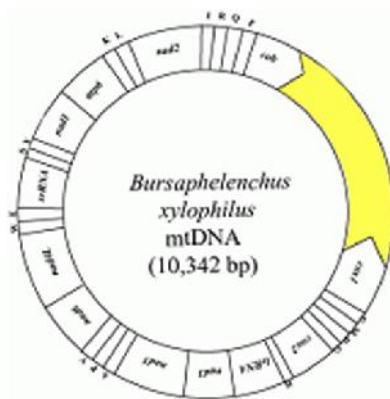
Forest Protection and Healthy Forests

Forest insect pests and diseases control and prevention

Forest fire suppression and rehabilitation of burnt forests

Forest soil and water conservation

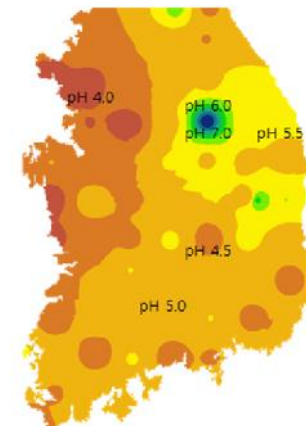
Diagnosis of forest health



Mitochondria genome of Pine nematode



Prediction of sedimentation range of debris flow based on Random Walking Model



Construction of forest soil pH map



Sustainable Forest Management and Utilization

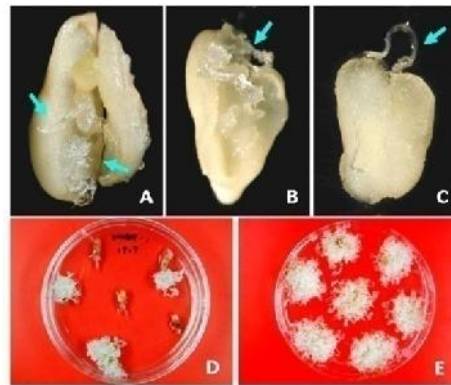
Forest resources management and forest land use

Tree breeding and biotechnology

Development of short-term income sources



Development of a model
for forest land use



Culturing of embryos from
immature Korean fir embryos



Breeding of a new chestnut
variety resistant to cold damage

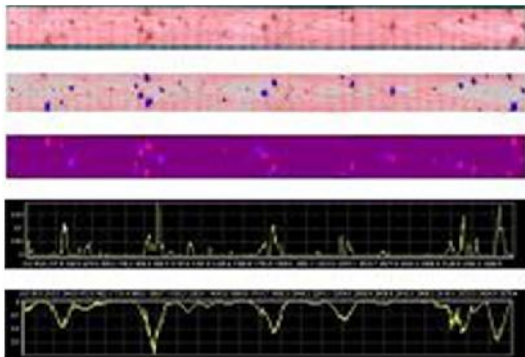


Forest Products and Wood Engineering

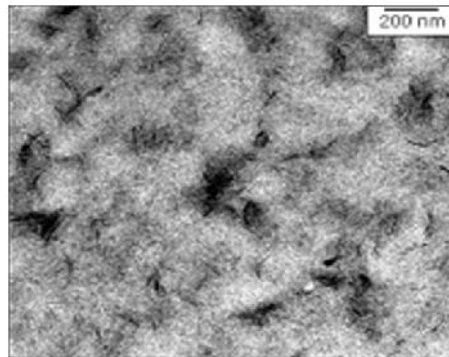
Efficient and sustainable use of wood resources

Conversion of wood components

Forest bioenergy



Evaluation of mechanical performance of structural lumber using nondestructive technique



Production of wood and plastic composites using nanoclay



Supercritical water saccharification unit for the production of ethanol from lignocellulosic materials

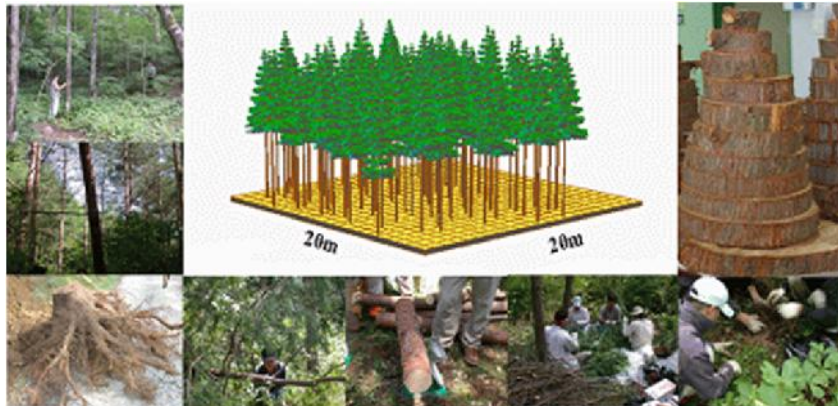


Forest Policy and Socioeconomics

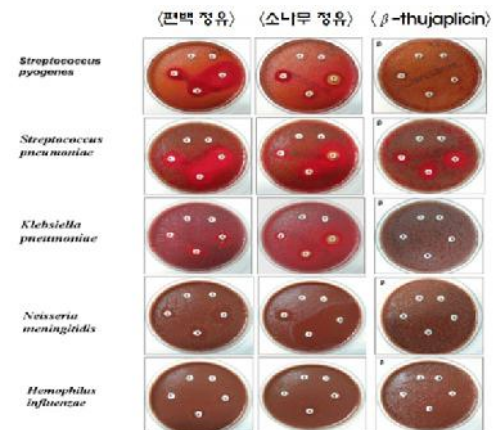
Forest value assessment and forest policy development

Forest recreation, culture and human health

International issues of forests and forestry



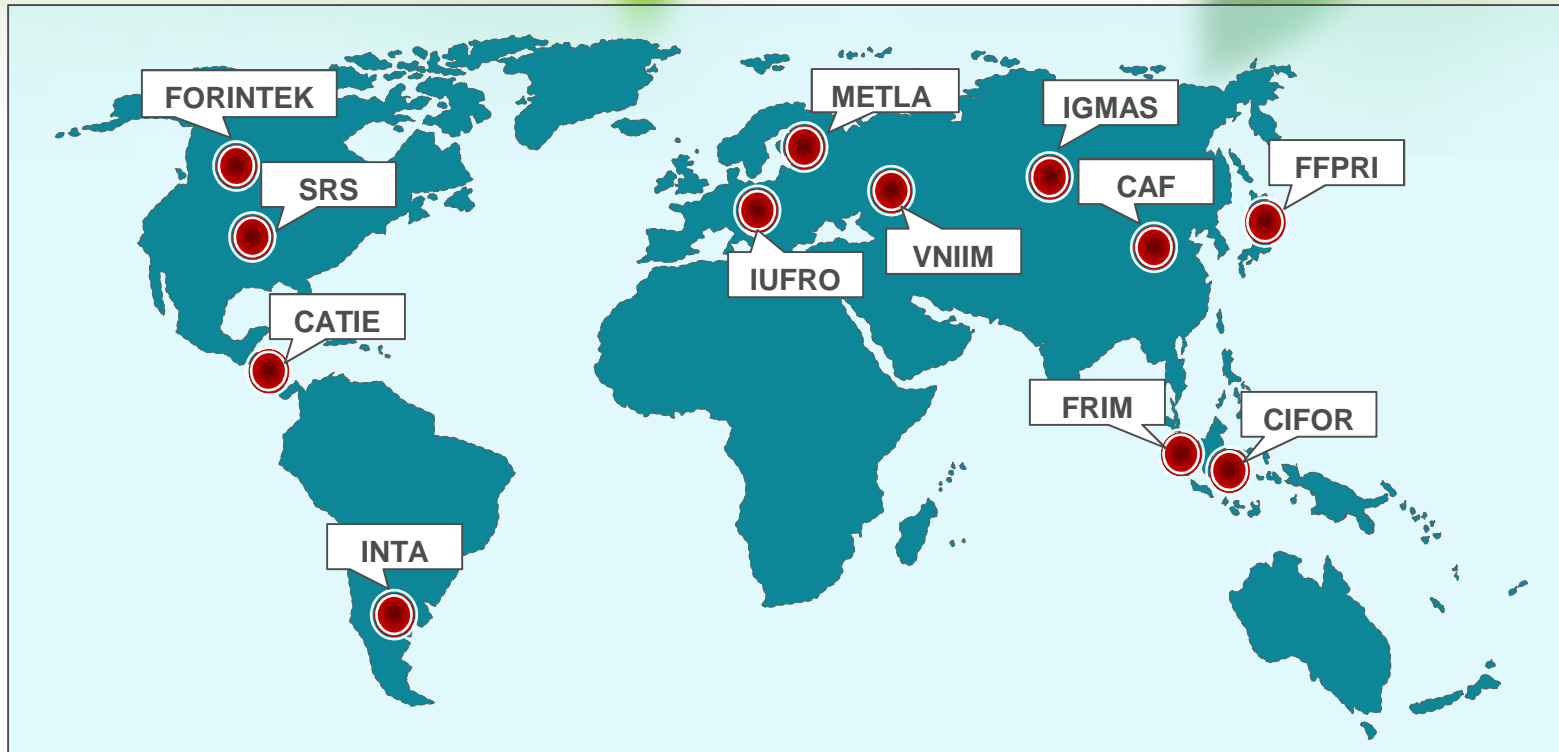
Analysis of forest biomass and soil carbon



Effects of phytoncide on the control of germs

International Cooperation

Establishment of MoU



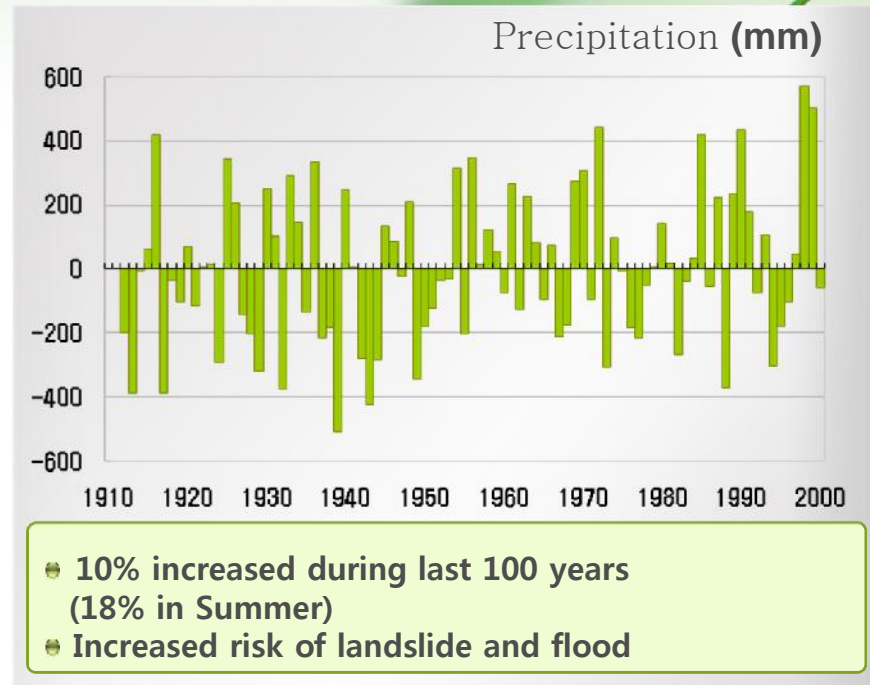
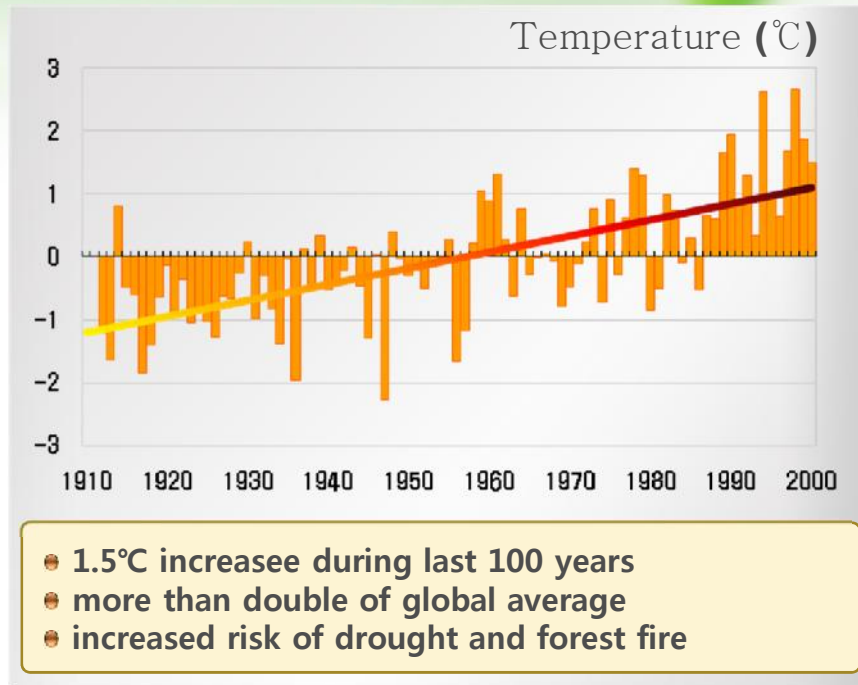
- By means of providing financial support, the KFRI is also actively participating in projects, programs and conferences run by international organizations such as CIFOR and IUFRO.
- The KFRI has been operating the Post-doctoral Fellowship Program for Foreign Researchers since 2006 aiming to accelerate the internationalization of Forest Science & Technology.



Climate Change Impacts

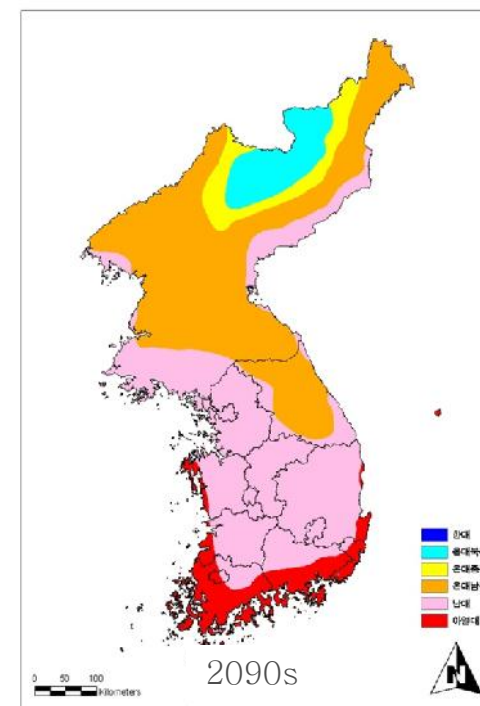
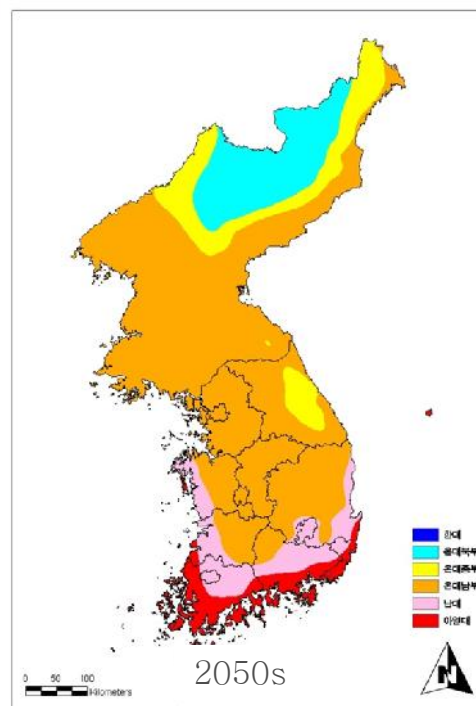
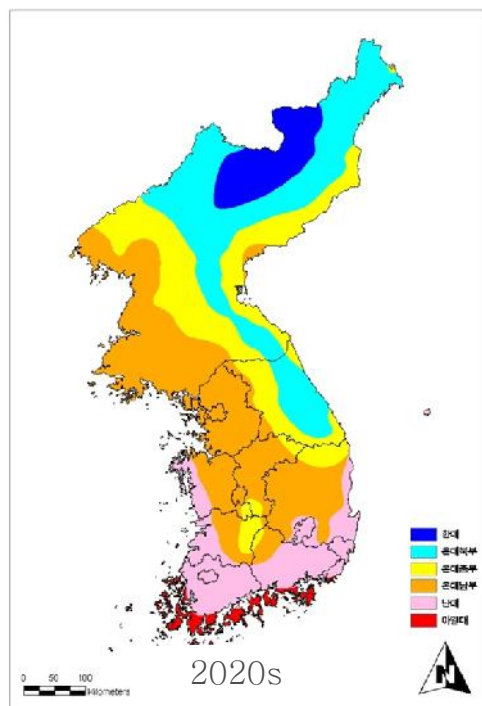



Climate Change in Korea





- Climate change alters ecosystems and also ecosystem dynamics in response to climate change affect the climate system.
- Dangerous consequences of climate change such as landscape change, losses of wildlife habitat, increased risk of natural disasters may result in economic losses.

Shifts of Vegetation Zones




 Cold temperate

 Southern cool temperate

 Northern cool temperate

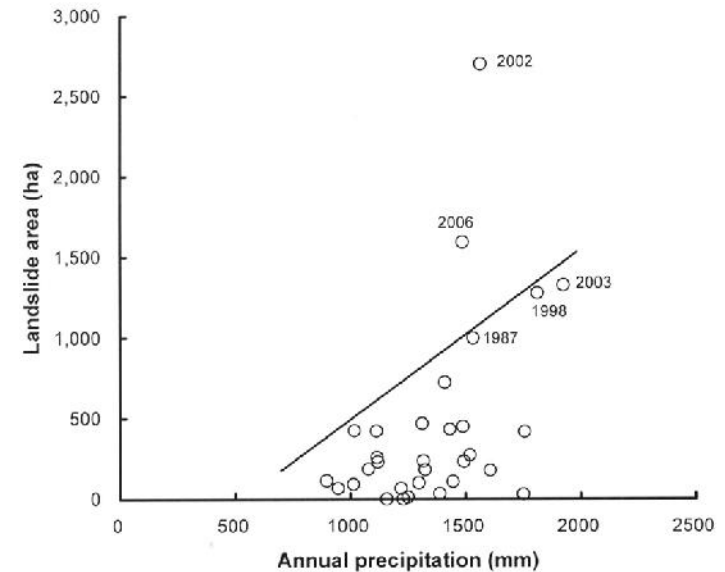
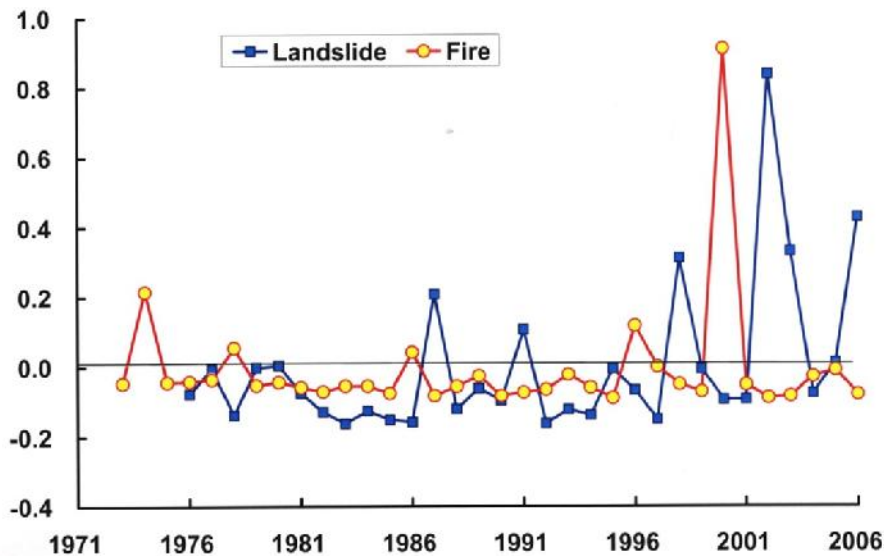
 Warm temperate

 Central cool temperate

 Subtropical

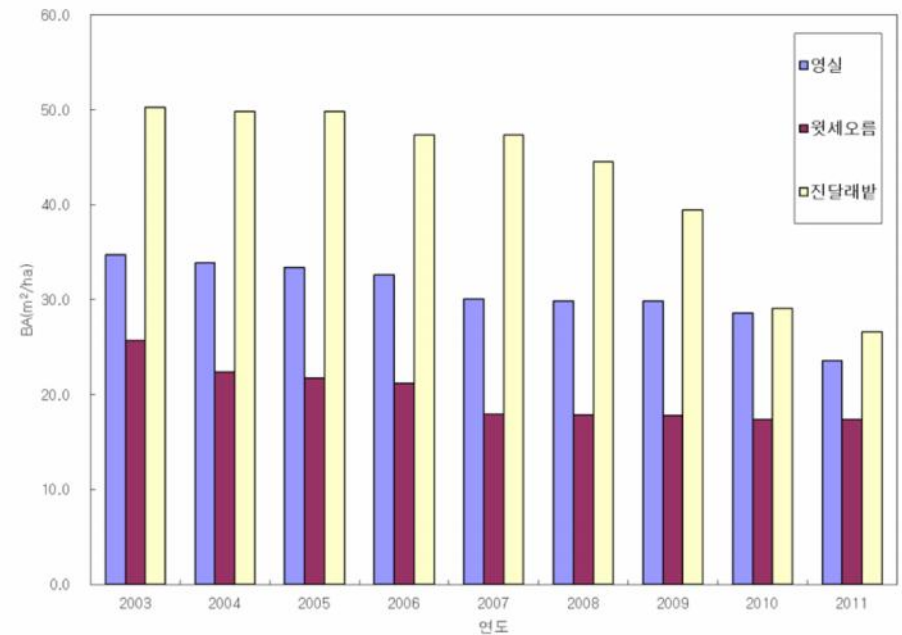
- 3~6 °C increase in annual mean temperature under IPCC RCP 8.5 climate change scenario.
- Vegetation zones are likely to shift, especially in high mountain areas

Natural Disasters



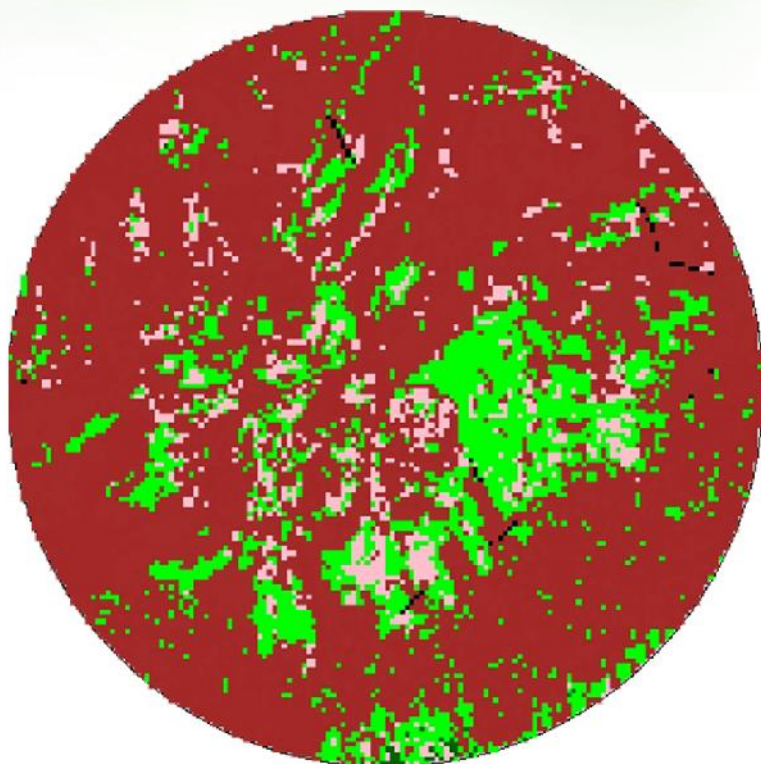
- The frequency and magnitude of natural disasters such as landslide and forest fire due to extreme weather events are increasing in Korea.
- The impact of natural disasters may be bigger when extreme weather events strike vulnerable areas.

High Mountain Tree Species

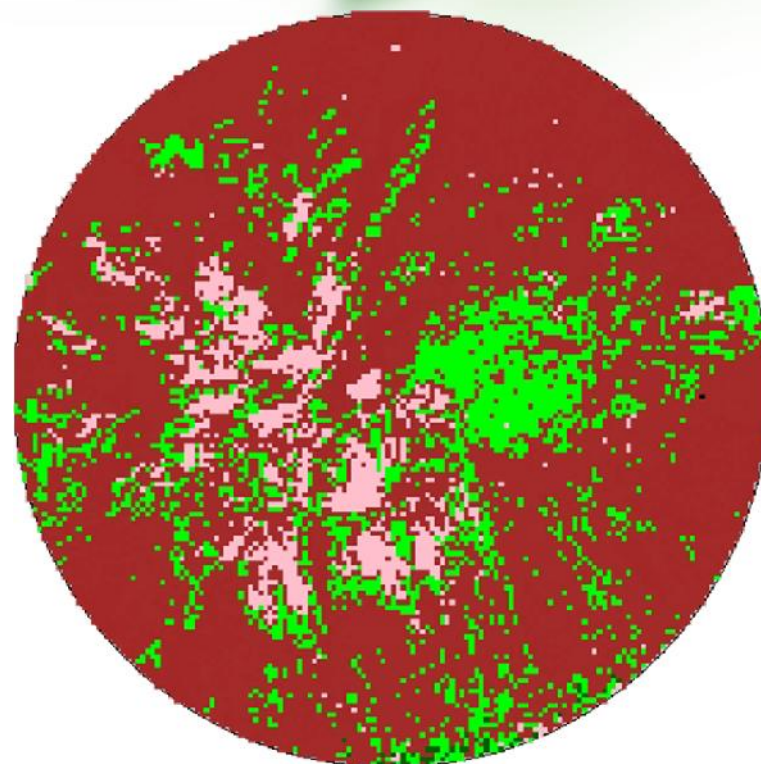


- Dieback of Korean fir (*Abies koreana*) on Mt. Hallsan (1,950m asl.) in Jeju island

High Mountain Tree Species



1975

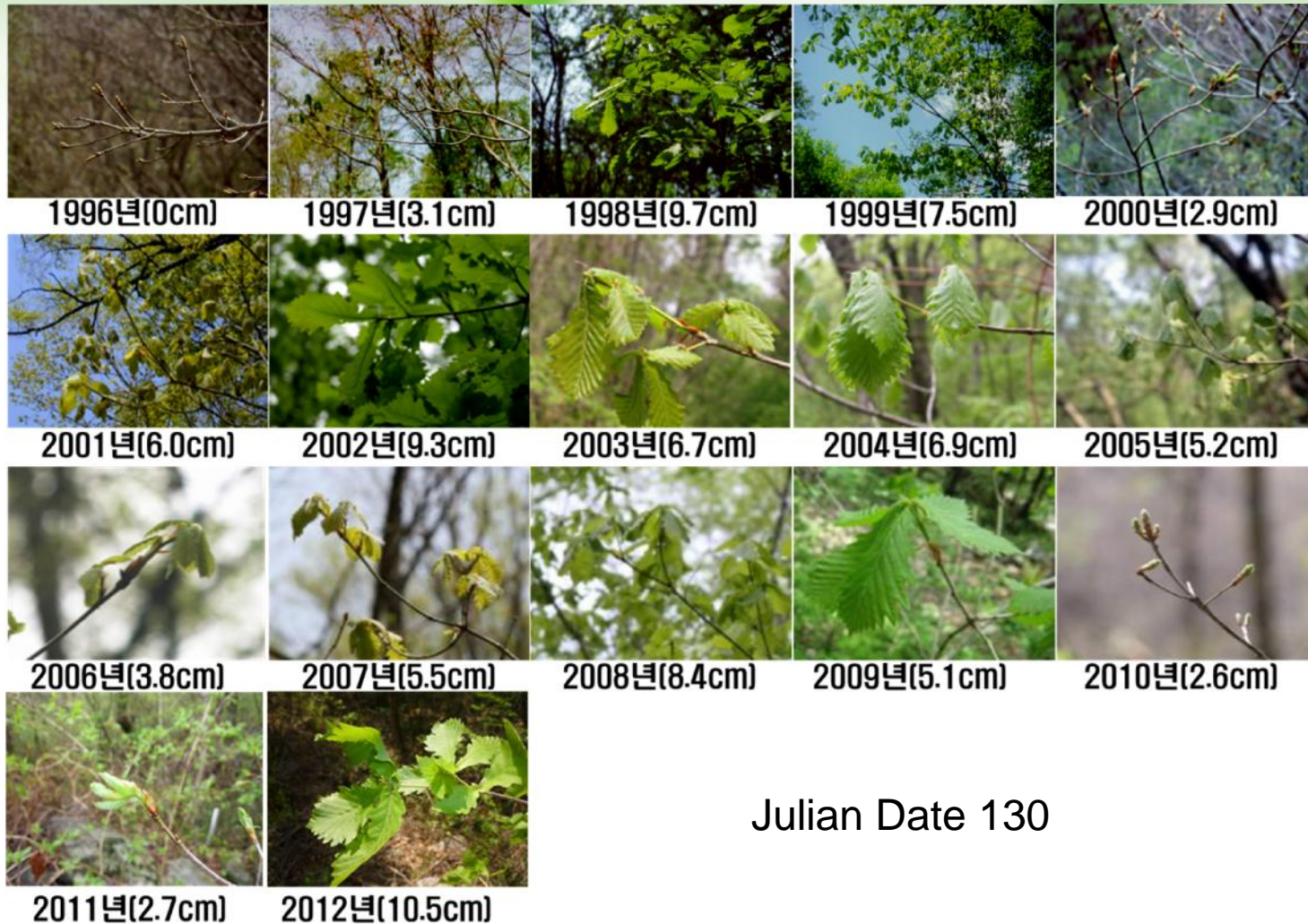


2002

- Korean fir(green) decline and grassland increase(pink) around the peak of Mt. Hallasan in Jeju island



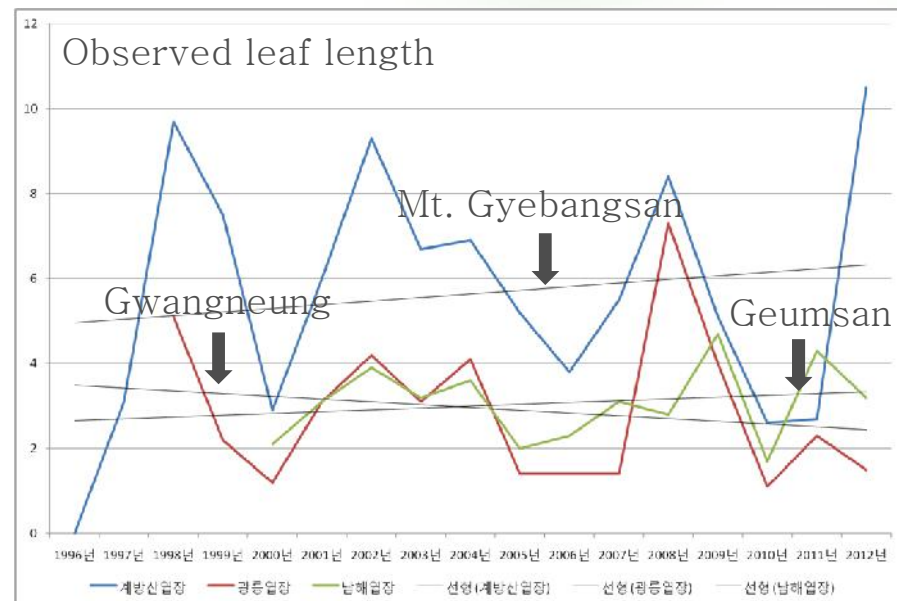
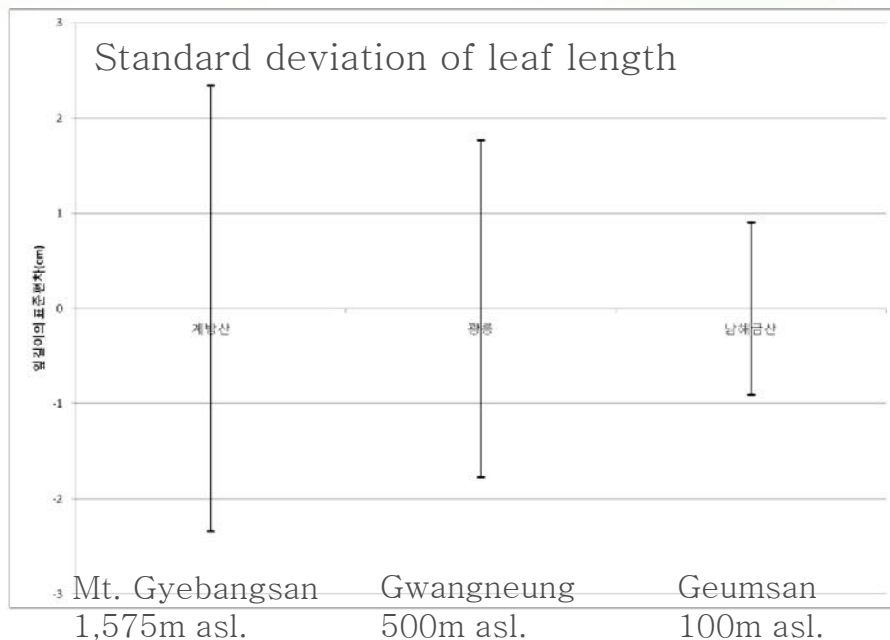
Phenology – Leaf Growth



Julian Date 130

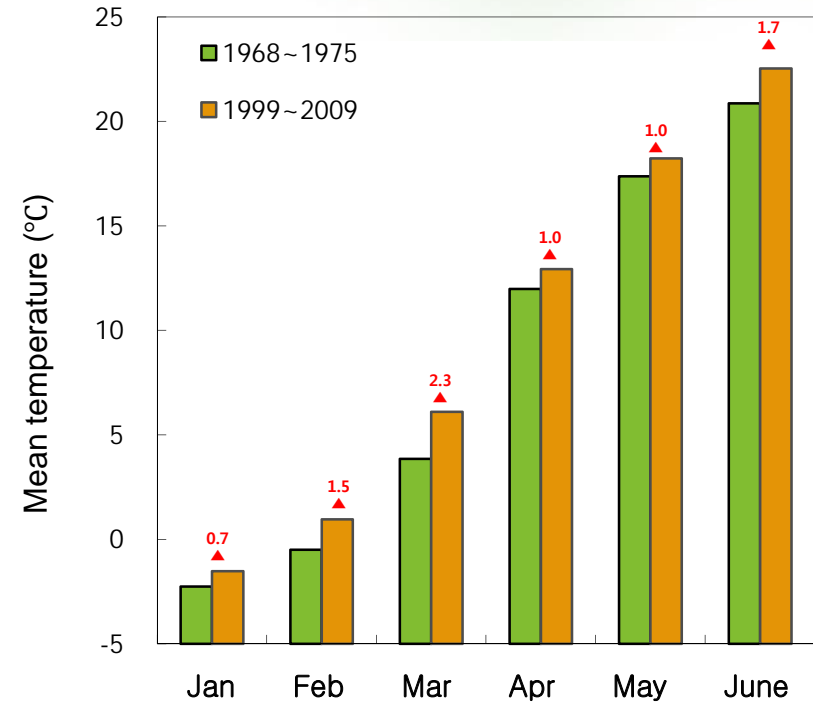
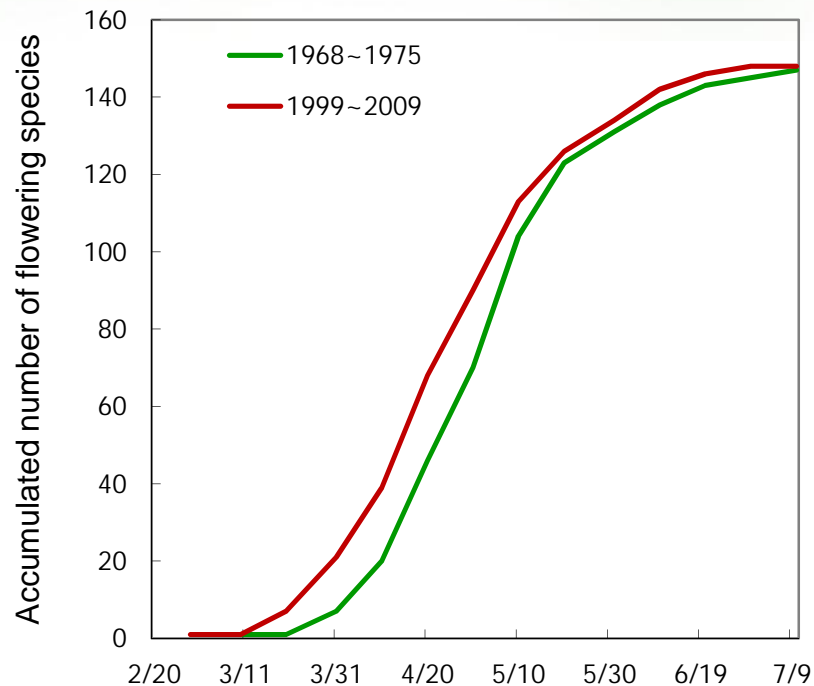
- Leaf length of *Quercus mongolica* on Mt. Gyebangsan (1,575m asl.) in Gangwon-do

Phenology – Leaf



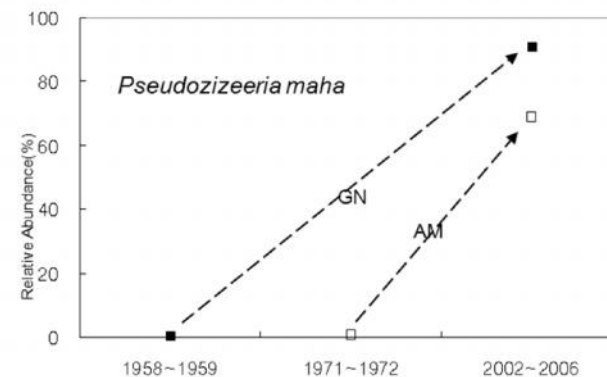
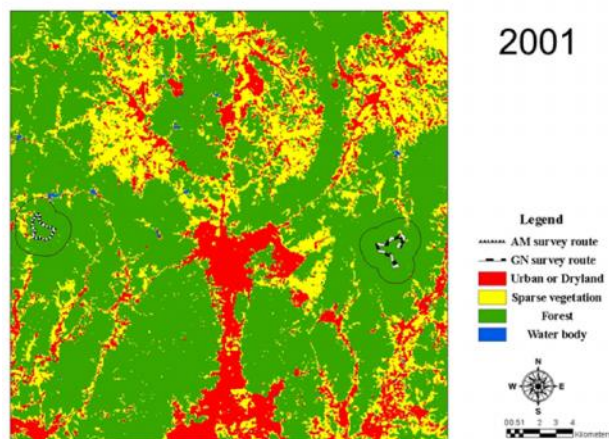
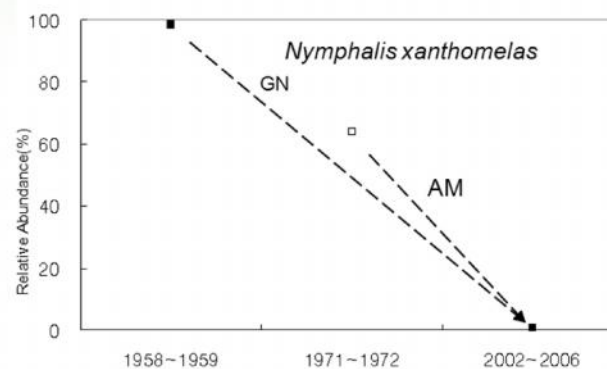
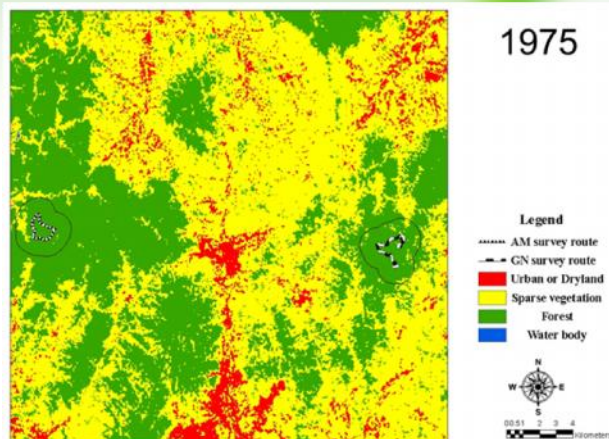
- Leaf length of *Quercus mongolica* on Mt. Gyeongsan (1,575m asl.) in Gangwon-do

Phenology – Flowering



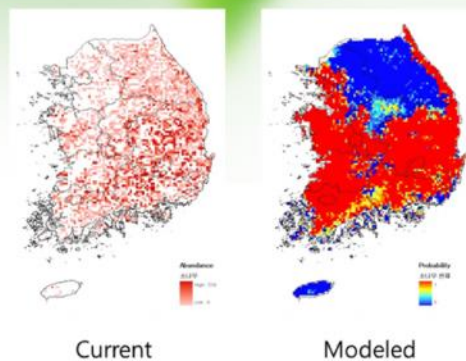
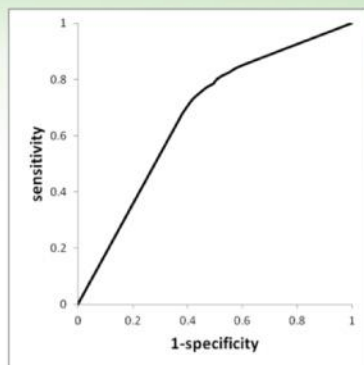
- Increased mean temperature in Spring has advanced the time of flowering by about 8 days in Hongneung forest in Seoul.

Butterfly Population



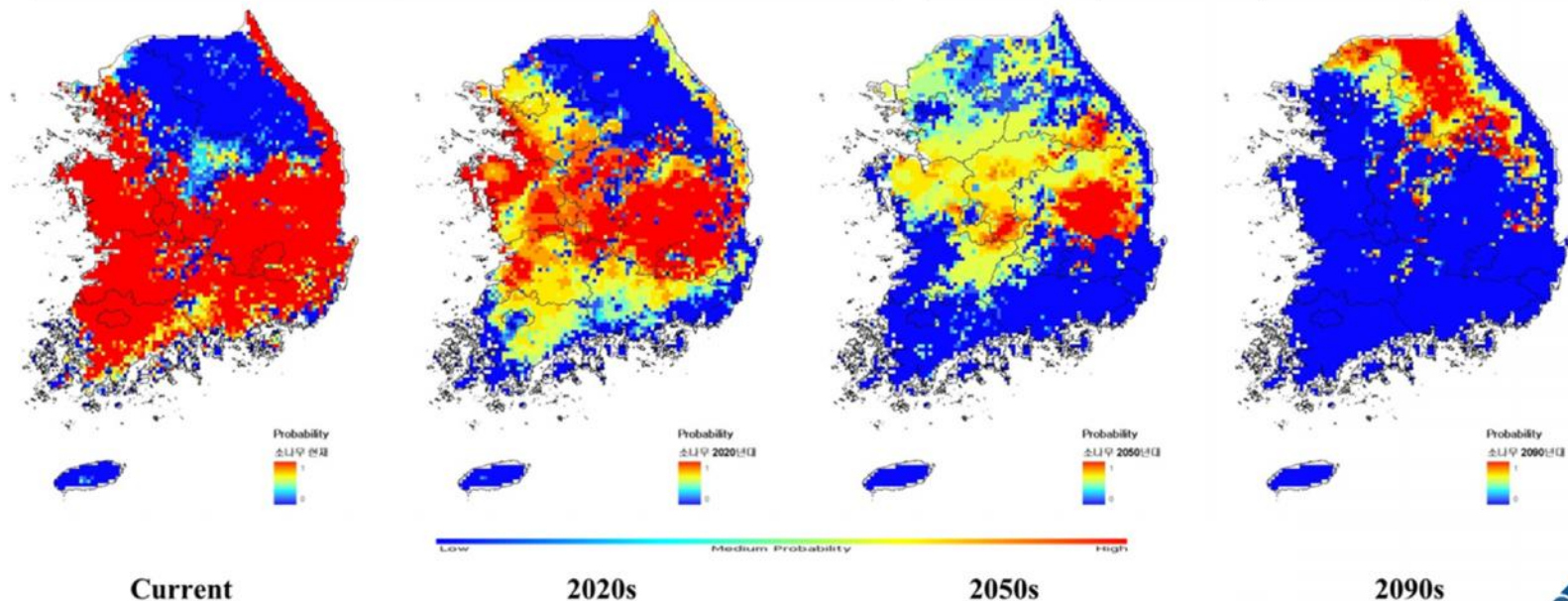
- Land use pattern and increased temperature affected the population size of butterfly species.

Distribution of Tree Species



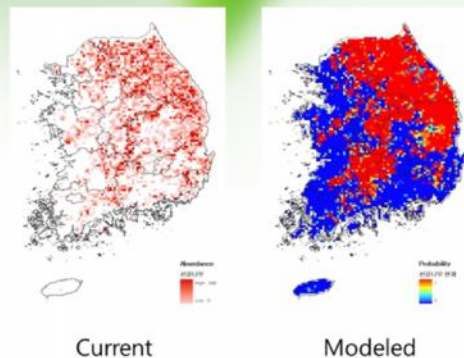
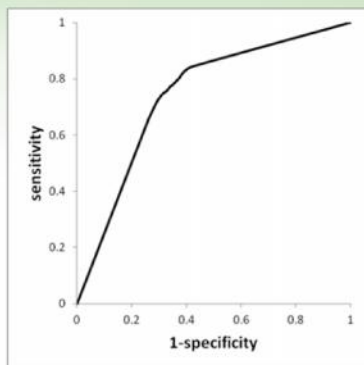
prevalence	global diagnostic power	correct classification rate	sensitivity	specificity	omission error	1-specificity= commission error	AUC
0.392	0.608	0.614	0.787	0.503	0.213	0.497	0.67

	potential threats from climate changes	Potential responses	Probability based on AUC of modeled results
<i>Pinus densiflora</i>	Increased temperature and altered precipitation pattern may lead to reduced soil water availability on dry sites in the growing season.	Habitat suitability may substantially decreased. Increased threats from insects, diseases Increased competition with shade tolerant species	Intermediate



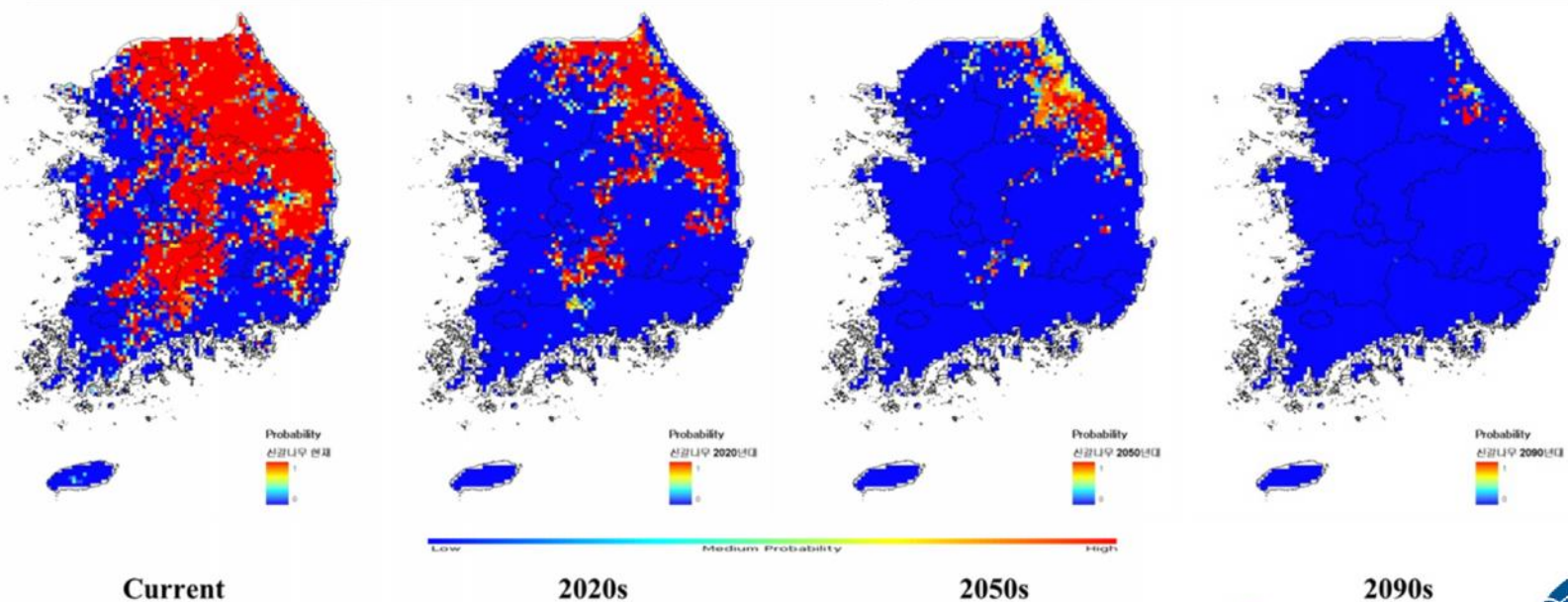
Modeled distribution change of *Pinus densiflora*

Distribution of Tree Species



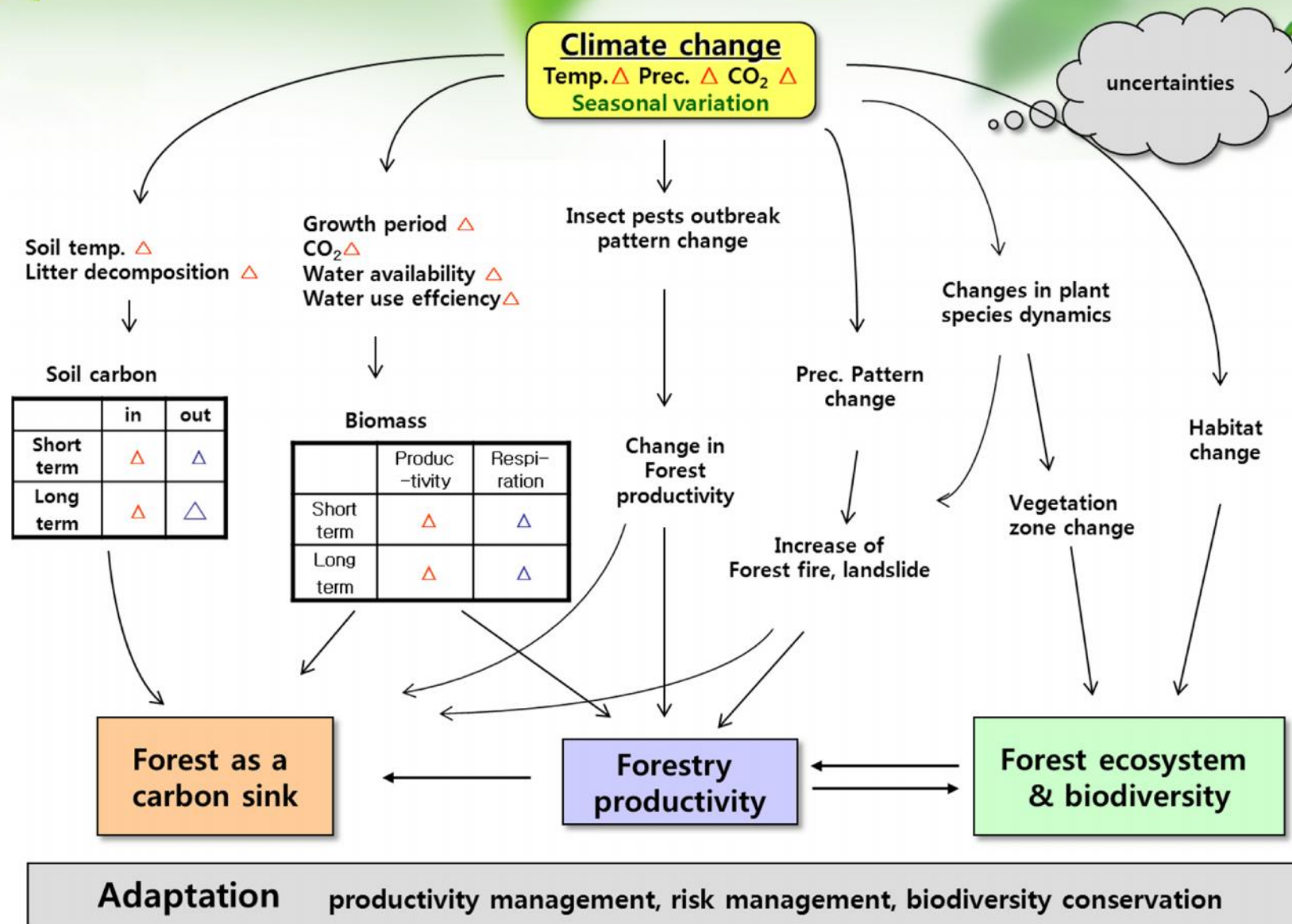
	potential threats from climate changes	Potential responses	Probability based on AUC of modeled results
<i>Quercus mongolica</i>	Increased temperature and altered precipitation pattern may lead to reduced soil water availability on dry sites in the growing season.	Habitat suitability may substantially decreased. Increased threats from insects, diseases Increased competition with increasing stand density	Intermediate

prevalence	global diagnostic power	correct classification rate	sensitivity	specificity	omission error	1-specificity= commission error	AUC
0.476	0.524	0.714	0.770	0.662	0.230	0.338	0.74



Modeled distribution change of *Quercus mongolica*

Expected Effects of Climate Change





Climate Change Adaptation





Mountain Forest Monitoring



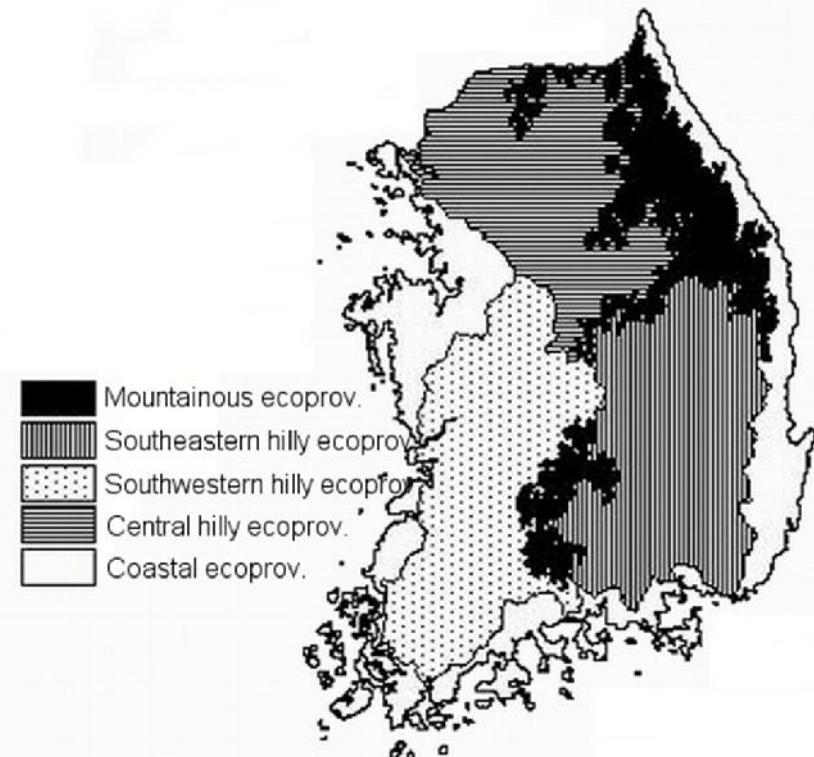
Forest Monitoring under a Changing Climate

- The geographical complexity of very rugged and elevated terrain and temperate climate condition seem to be the major driving forces to give Korea high biodiversity status, generating large spatial heterogeneity.
- Spatial heterogeneity of physical and biological features composing the forest is a key to understand the structure, function, and process of forest ecosystem at various spatial scales in Korea.
- It is necessary to monitor forest information from national forest inventory to changes in species composition by environmental changes.
- Integrated monitoring and risk management system to expand the scientific understanding of climate change impacts on mountain ecosystem, to assess the vulnerability to climate change, and to warn against natural disasters linked to climate change.

Ecosystem Classification

The criteria of ecoprovince classification were ecosystem connectivity and cultural homogeneity. Connectivity, the spatial distribution of similar ecosystems, affects not only the way in which natural disturbances affect ecosystems (Turner *et al.* 1994) but also how well members of many populations and genes of some species are distributed over time (Crow and Gustafson 1997).

The ecoprovince is a useful unit to express the distributions of animals.

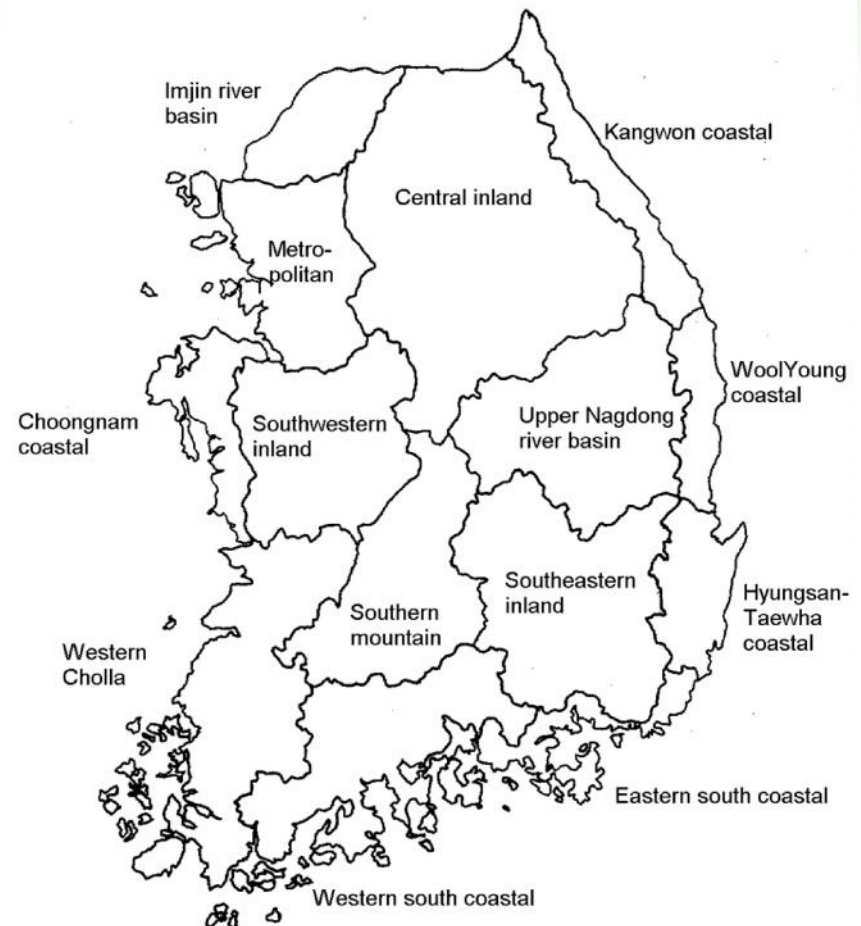


Ecoprovinces of South Korea

Ecosystem Classification

Ecoregions were classified by cluster analysis. The variables used in the analysis were latitude, longitude, seasonal mean temperature, and seasonal precipitation.

The ecoregion is a useful unit to express climate regime as well as the distributions of mushroom and the frequency and scale of forest fire. Some ecoregions have several problems for biodiversity conservation and some have high biodiversity potentials.

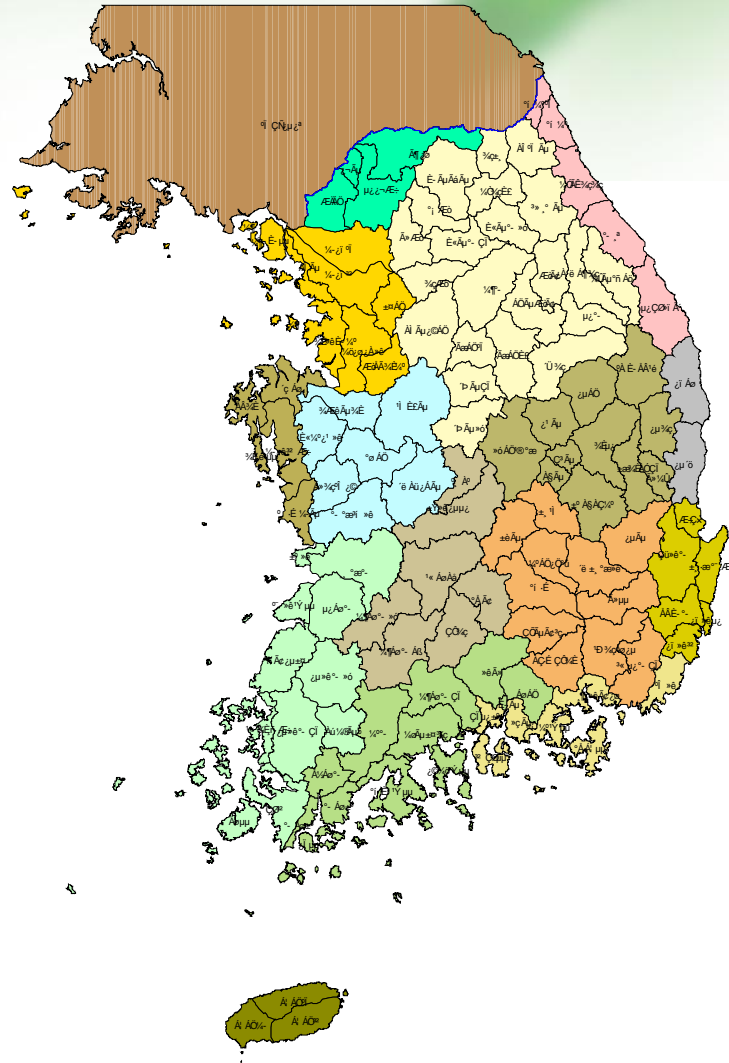


Ecoregions of South Korea

Ecosystem Classification

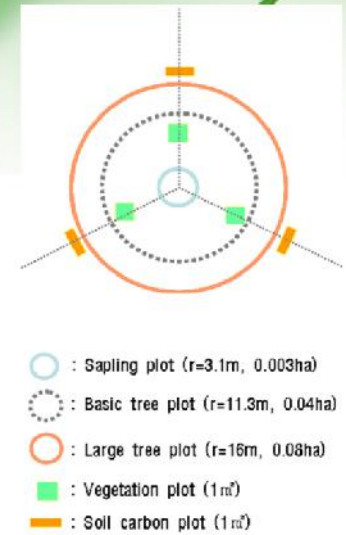
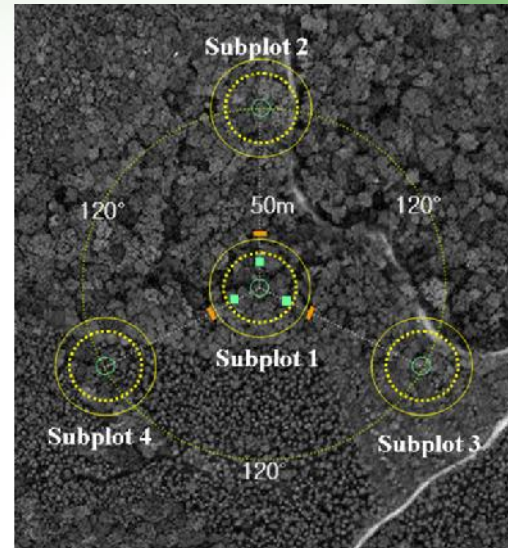
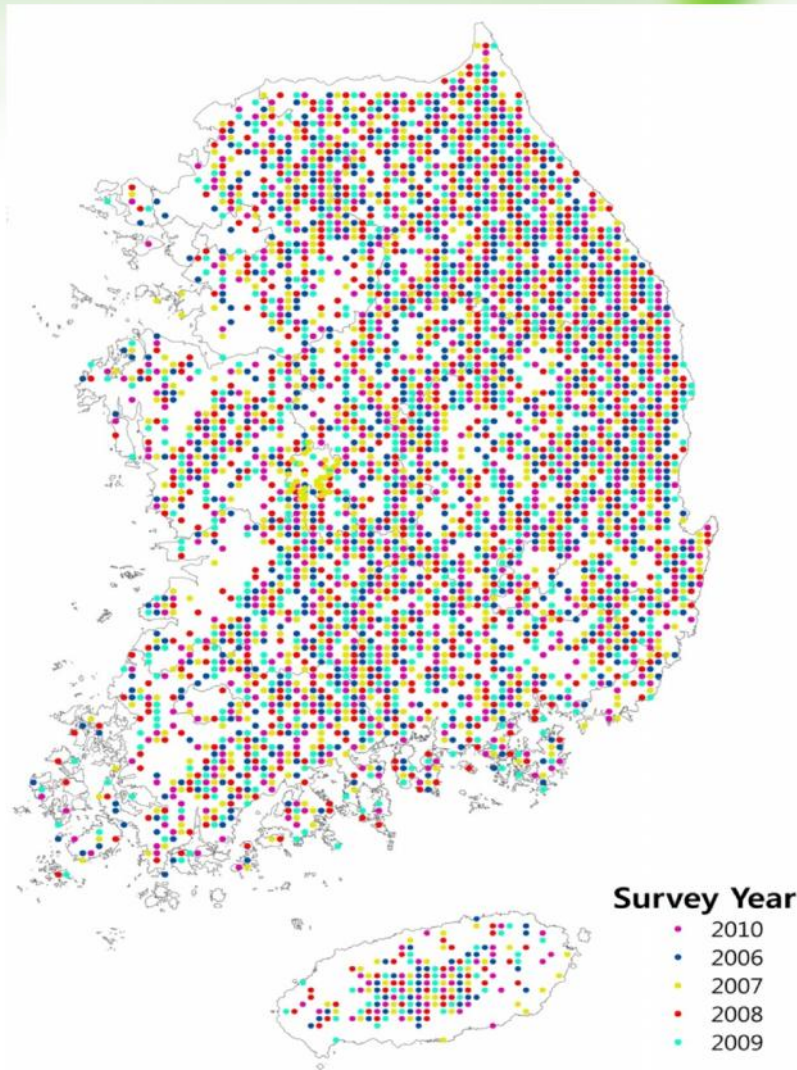
Ecodistricts were divided with the criteria of similar landscape association in the systems of watershed.

The ecodistrict is a useful unit to analyze the distribution of endemic fish species and to assess environmental impacts on freshwater ecosystems.



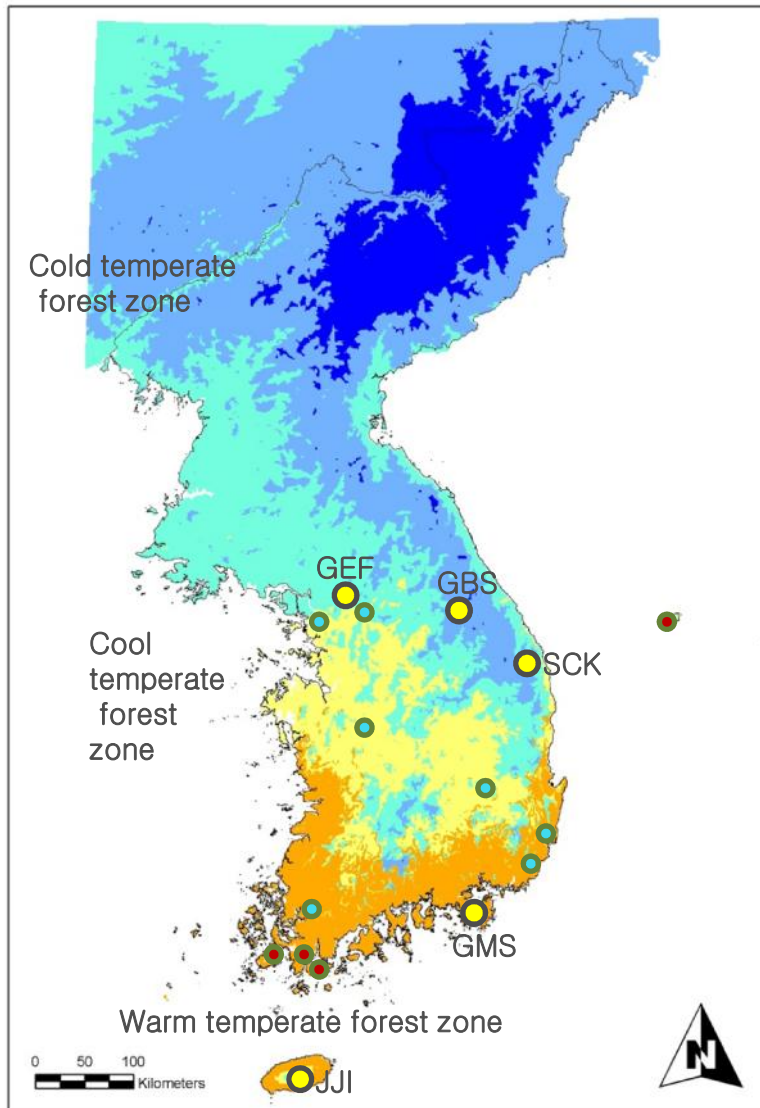
Ecodistricts of South Korea

National Forest Inventory (NFI)



- ✓ 4,000 permanent sample plots have been systematically distributed all over the forests.
- ✓ The plots have divided into five groups. Each group consists of 20% of the plots and is measured every year.
- ✓ Long-term high quality NFI data is expected to play important role in assessing the range shifts of plant species.

Long-Term Ecosystem Monitoring



✓ KFRILTER sites

1. Mt. Gyebangsan Forest (GBS)
 - Deciduous broad-leaved and conifer
 2. Gwangneung Exp. Forest (GEF)
 - Main site
 - Deciduous broad-leaved
 3. Mt. Geumsan Forest (GMS)
 - Deciduous & evergreen broad-leaved
 4. Samchuk Forest (SCK)
 - Restoring area after big forest fire
 5. Jeju-do island (JJI)
 - from warm temperate to cold
 - Deciduous & evergreen broad-leaved, conifer
- Forests around major cities
● Islands and warm temperate natural forests



Long Term Ecosystem Monitoring

✓ KFRI's monitoring system

Conventional

- Long-Term monitoring on major forest pests and disease from 1968
- National Forest Inventory from 1972
- Hydrological monitoring in the forested catchment from 1979
- Air pollution, soil acidification and response of forest ecosystem from 1991
- Long-Term Ecological Research from 1994

Recently Added

- Forest Health and Vitality
- Influence of climate change on forest ecosystems including hydrological cycle and forest pests
- Estimation of frequency and intensity of forest disasters by climate change
- Soil erosion and sediment yield in the forested catchment
- Weather station network in the mountain to study forest disasters
- Changes in species composition of ants and butterfly by air temperature increase

It is also recommended to monitor symbiotic relationships, traditional knowledge and valuation trends.



Traditional Forest-related Knowledge



✓ TFK for sustainable forest management under a Changing Climate

- The increasing emphasis are being placed on integrated forest management system which integrates ecological, social, cultural, spiritual, and economic sustainability.
- Collaboration among government agencies, forest managers, local and indigenous communities, and the scientific community is required to meet diverse criteria for maintaining ecosystem services.
- There is a growing need for decision-makers and managers to consider all relevant knowledge about forest ecosystems and the impact of forest management options in the development of forest policies and operational practices.
- It is needed to increase the understanding of inter-relationships between traditional and formal (scientific) forest-related knowledge and catalyze potential synergistic applications to strengthen capacity for climate change.

Korean people's life adapting to nature

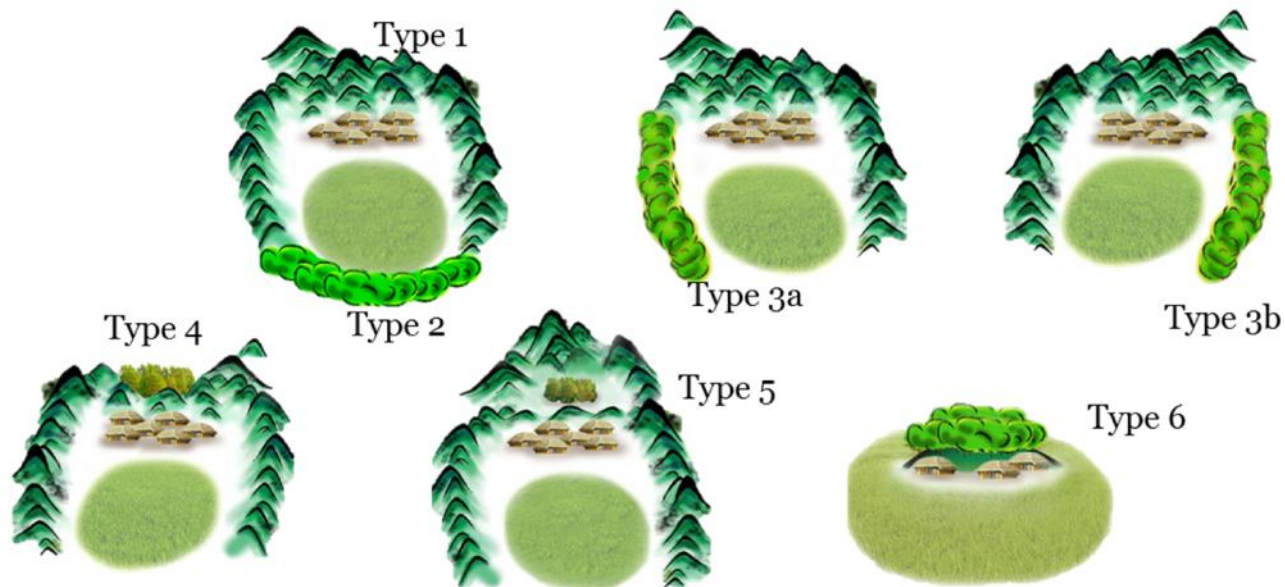


- Coexistence and Harmony
- Respect for Life
- Equal Values on Human and Nature / Harmony with Forest
- Sense of Nature and Human becoming One

Maeulsoop : Korean Traditional Village Grove

The Maeulsoop is a complementary system linking nature and culture in the mountainous landscape in Korea

✓ Diverse Types of Maeulsoop



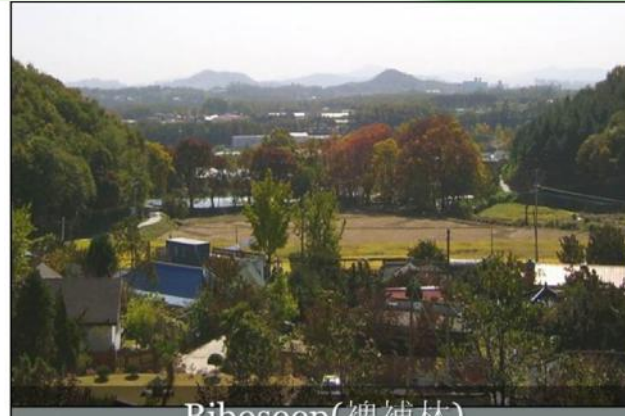
<Lee et al., 2007>

Maeulsoops in Korea were established based on the PUNGSU theory on typical topography and traditional religious beliefs.

Diverse Types of Maeulsoops



Sacred Forest(神林)



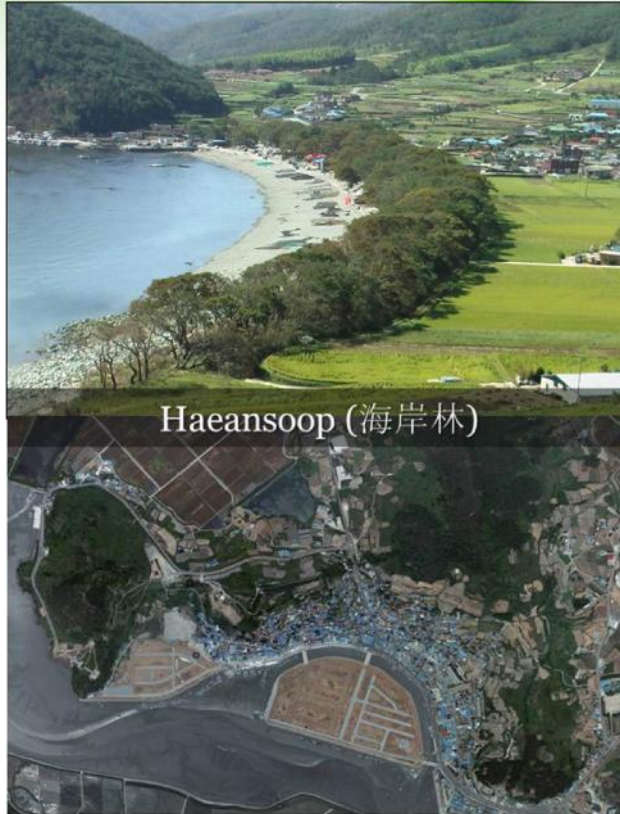
Bibosoop(裨補林)



Some of the Maeulsoops were established and preserved for local sociocultural and religious purposes.

Maeulsoops are closely related to ameliorating climate conditions and preventing natural disasters.

Diverse Types of Maeulsoops



Traditionally Korean people thought highly of coexistence and Harmony and place equal values on human and nature.

Traditional Forest -related Knowledges(TFK) and the wisdom of ancestors are will help us adapt to climate change.

Establishment of Asian Center for TFK

- ✓ The three East Asian countries - China, Japan, and Korea - have been hosting the international conferences on Traditional Forest-related Knowledge since 2008, and the 4th conference was held on Jeju in the year of 2011.
- ✓ Until now, total **10 countries and about 170 individuals** had participated in the scientific meeting.
- ✓ We need to establish the Asian networks
 - Sharing the information of TFK
 - Supporting new paradigm for Asian countries.
 - Enhancement of collaborative research on TFK





Mountain Forest Protected Areas

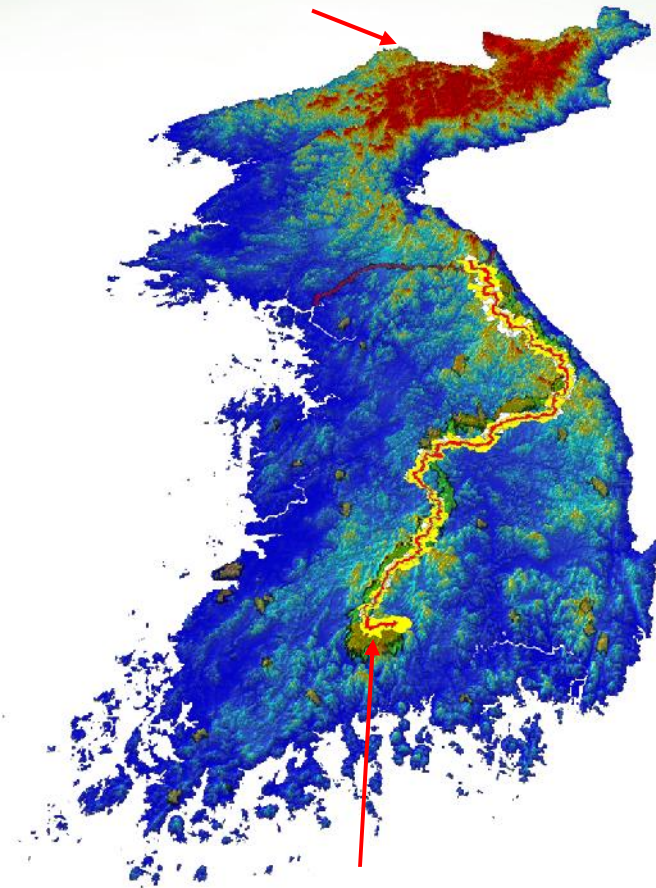


Protected Areas under a Changing Climate

- maintain watersheds and water retention in soil
- limit incursion into fire-prone areas
- help maintain traditional management systems
- limit land-use transformation
- reduce other pressures such as poaching, grazing, logging or harvesting within their boundaries
- help reduce the impacts from extreme climatic events, such as storms, floods,
- help mitigate the effects of climate change by the capture and storage of CO₂ from the atmosphere

Baekdudaegan Mountain System

Mt. Baekdusan



Mt. Jirisan

✓ Korean People and Baekdudaegan

- Traditional concept connecting geography and geomancy : Philosophy on the geography viewing the land as a living entity
- Mountain ranges forming the backbone of Korean peninsula extending from Mt. Baekdusan all the way down to Mt. Jirisan : total length of 1,400Km (684km in South Korea)
- Treasure house of biodiversity serving as an ecosystem corridor in Korean peninsula
- The essence of the Korean natural landscape designated as a protected area in 2006
- Source of energy for Korean people

Baekdudaegan Mountain System

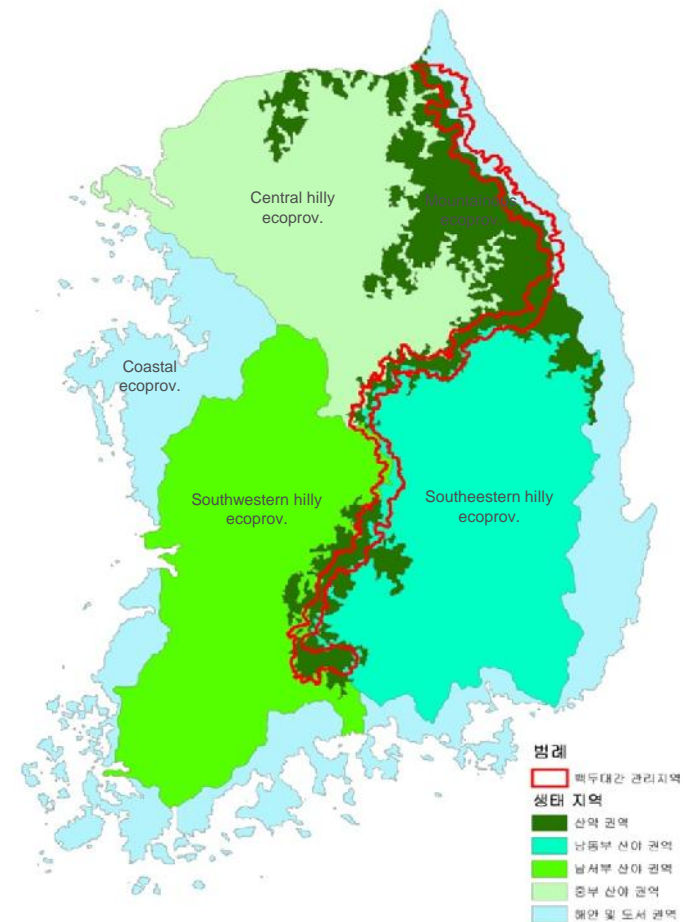


Traditional Geographic Classification System

- One mountain system : Baekdudaegan Mountain System
- One primary chain of mountain called Jeong-gan : Jangbaek jeong-gan
- Thirteen secondary chains of mountains called Jeong-maek : Nangnam Jeong-maek, Chungbuk Jeong-maek, Cheongnam Jeong-maek, etc.

Baekdudaegan Mountains Reserve

- Total area : 263,427 ha
 - Core zone : 169,950ha (65%)
 - Buffer zone : 93,477ha (35%)
- 6 provinces, 32 cities or counties and 108 districts or regions
- The designation area accounts for 2.7% of the total territorial land and 4% of the total forest cover
- KFS is examining the value of Baekdudaegan mountain system as World Heritage Site.



Biodiversity of Baekdudaegan



*Hanabusaya
asiatica*



*Naemorhedus
goralcaudatus*



*Megalerabthis
saniculifolia*



Epilobium angustifolium



*Thymus
quinquecostatus*

- ✓ Flora : 5 class 126 family 541 genus 1,248 species
3 subspecies 204 variety 22 forma
- ✓ Fauna : 564 species
- ✓ Crucial Habitat for Endangered Species



*Felisbengalensis
euphilura*



*Bonasa
bonasia*



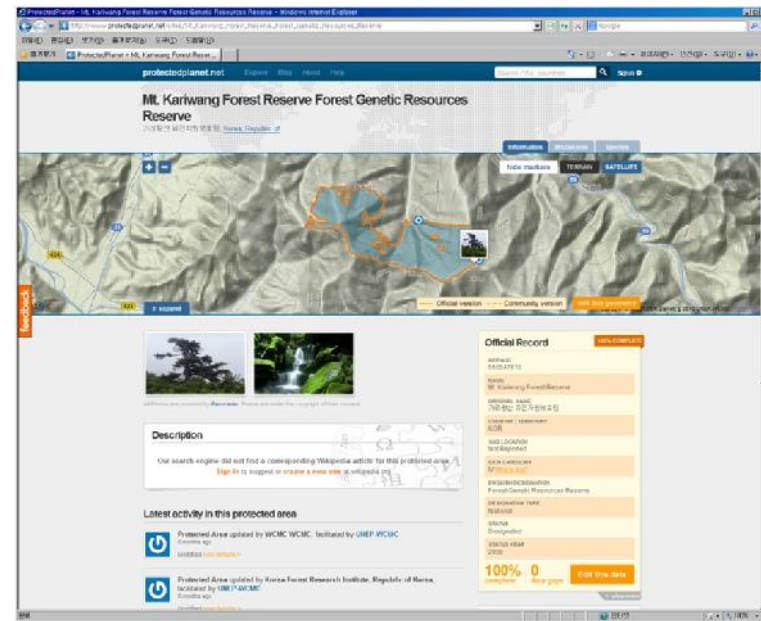
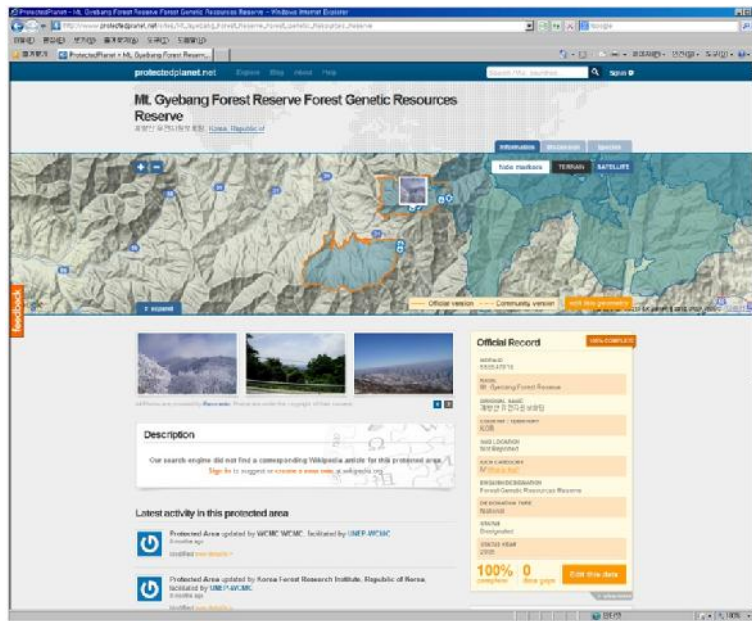
*Susscrofa
coreanus*

Forest Genetic Resources Reserves



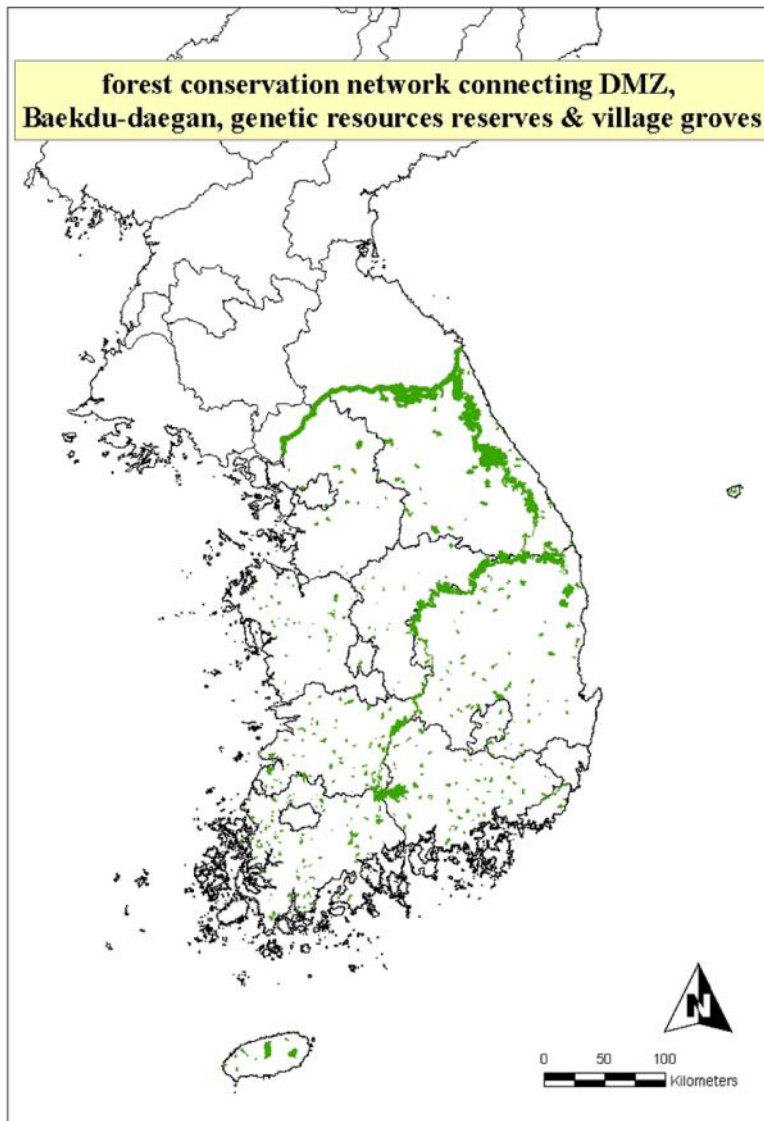
Status of Mountain Forest Protected Areas in Korea

	Total		Natural Forest		High Mountain Forests		Rare Forest Landscape		Rare Plants		Economic Plants		Mountain Wetlands		Ecological Function	
	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
Total	462	126,868	70	9,219	3	306	63	39,853	121	39,223	38	8,803	109	1,362	58	28,102
Local Gov.	83	5602	41	2,681	0	0	25	249	7	2310	4	35	2	196	4	131
KFS	379	121,266	29	6,538	3	306	38	39,604	114	36,913	34	8,768	107	1,166	54	27,971



Forest Genetic Resources Reserves registered to WDPA

Protected Area Network



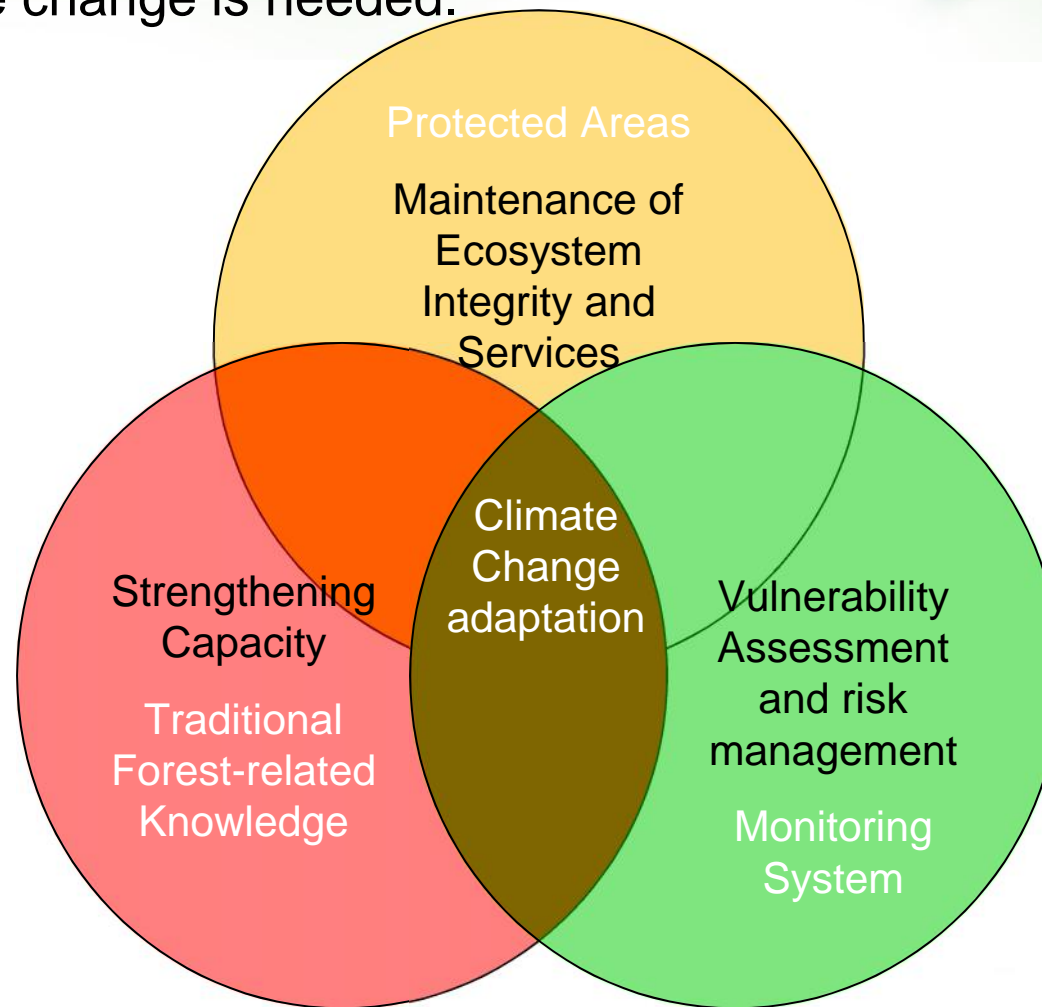
Protected area network linking diverse types of protected areas will help conserve valuable ecological and economic resources maintaining biodiversity and ecosystem services



Suggestions



Integrated approach enhancing the human and ecosystem resilience to climate change is needed.





Thank you for your attention!

Mt. Hallasan