Climate Change Impacts on Forest Ecosystems in Korea, and Needs of Proactive Adaptation Measures

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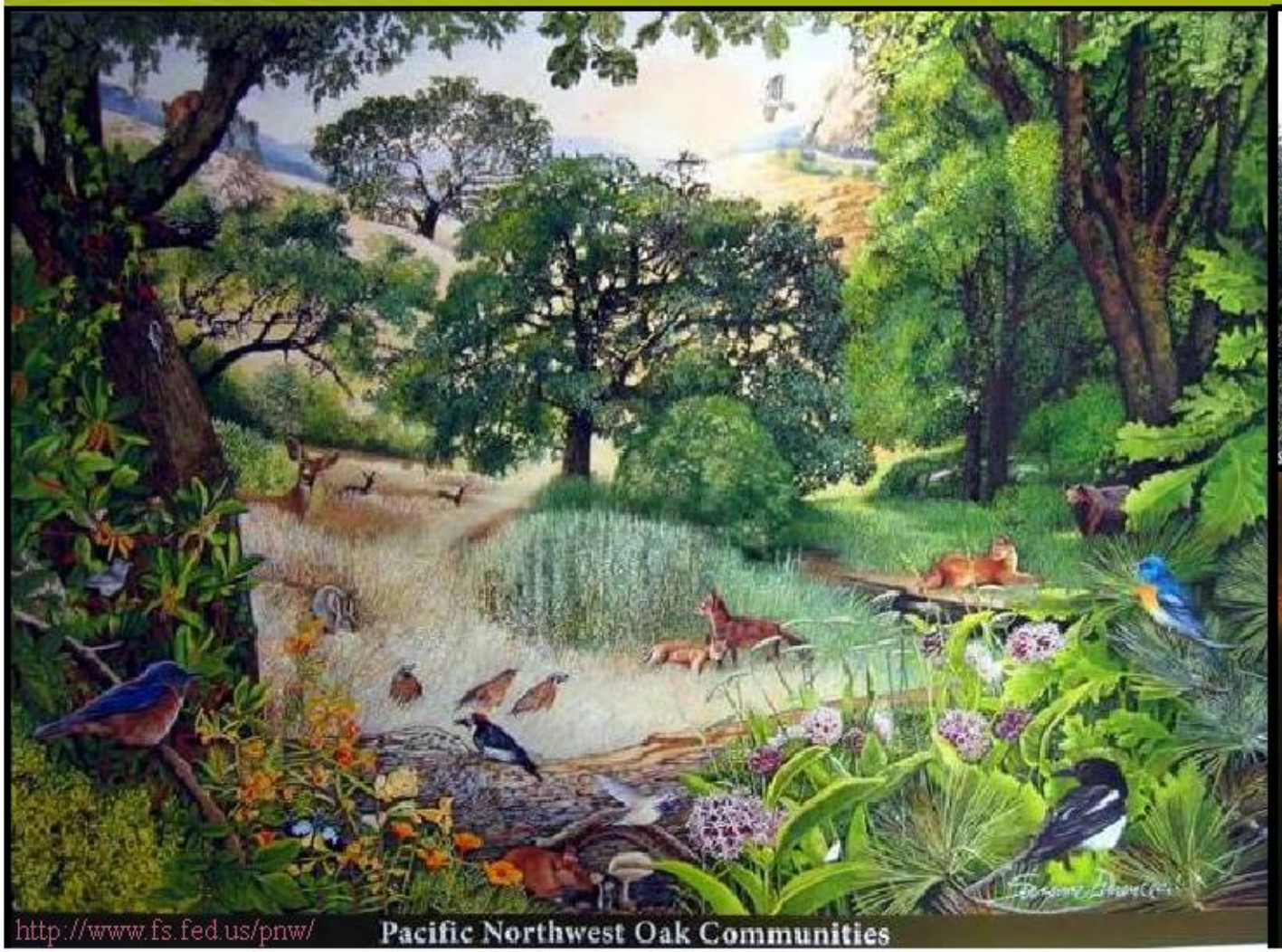


Contents

Introduction

- Forest and FBD changes in Korea
- Threatening factors to FBD
- Climate change as an emerging threatening factor

Climate Change Impacts on Korean Forests

- Biodiversity changes: phenology, vegetation shifts
- Disasters and forest pests and insects
- Forest productivity and so on

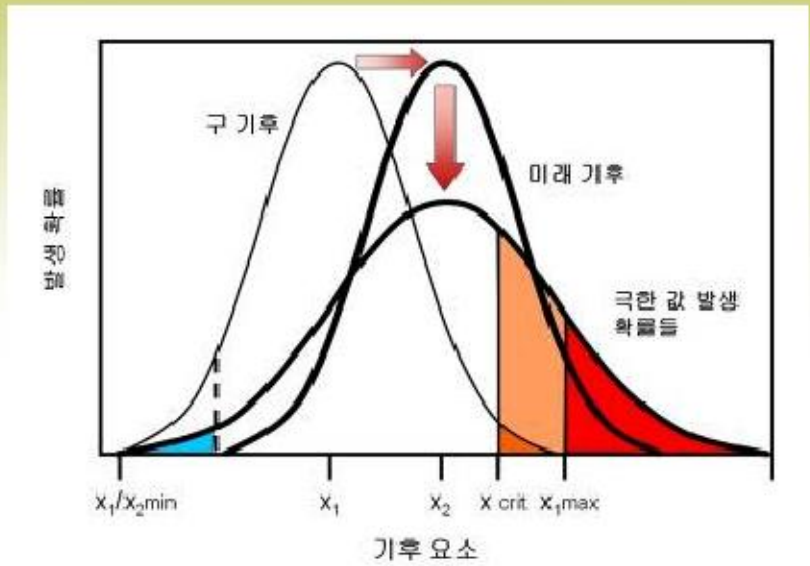
Adaptation Measures to Climate Change

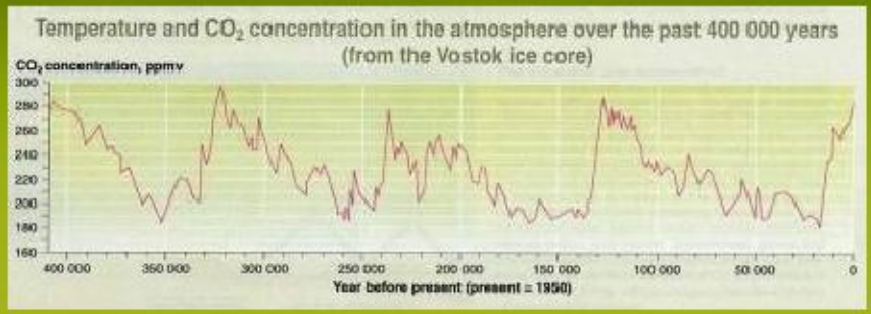
- Restoration of vulnerable area
- Networking of natural ecosystems

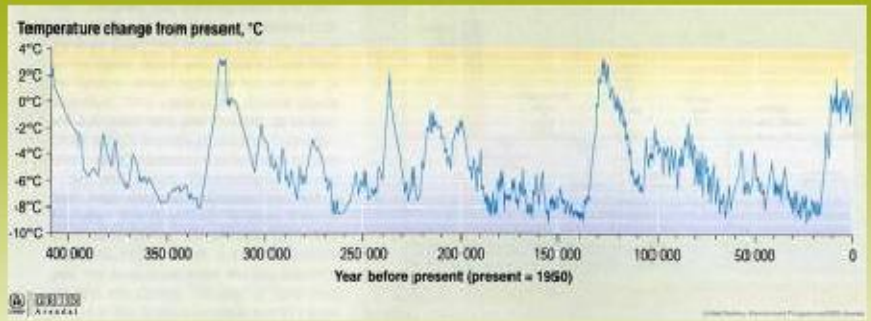
Climate Change

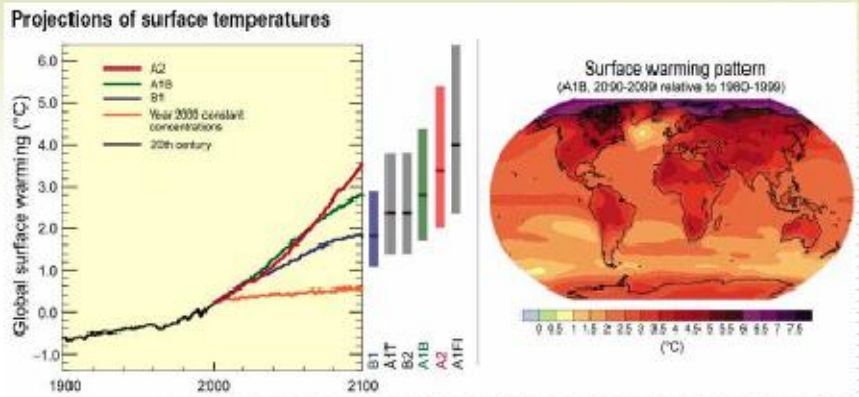
- Global warming and GHG
- Natural vs. Anthroposenic
- Air temp & precipitation changes
  + Atmospheric C02 concentration
  + Other pollutants

Seasonal pattern change,
Abnormal extreme events



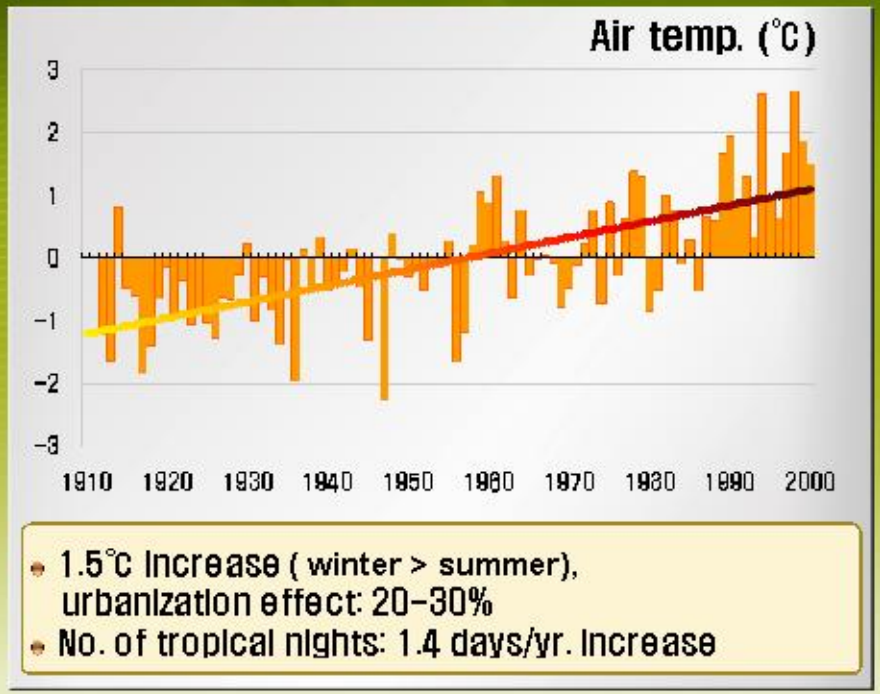




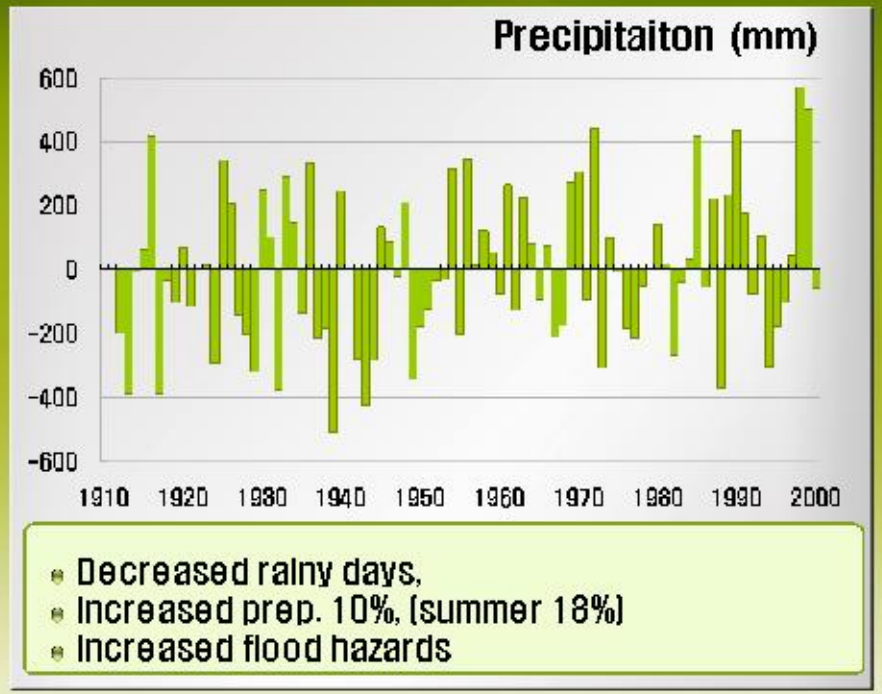


IPCC, 2007

Climate Change in Korea (1912~2005)



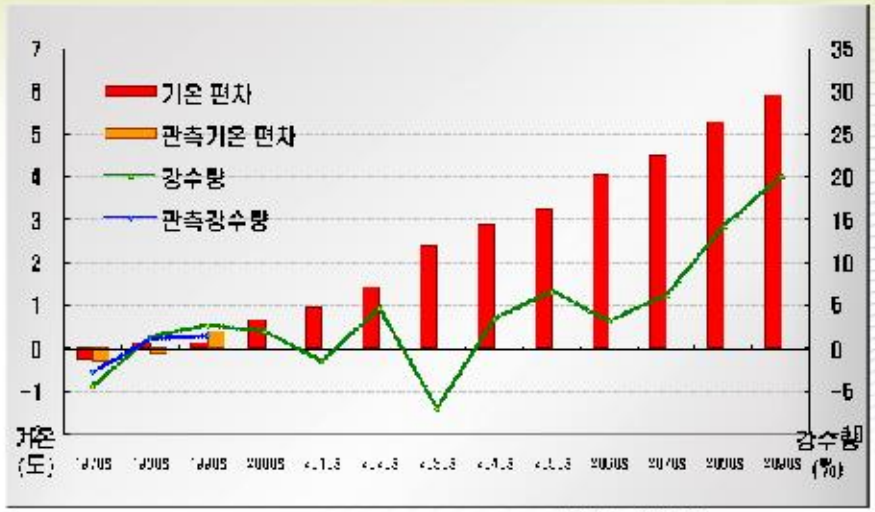
- 1.5℃ increase (winter > summer), urbanization effect: 20-30%
- No. of tropical nights: 1.4 days/yr. increase



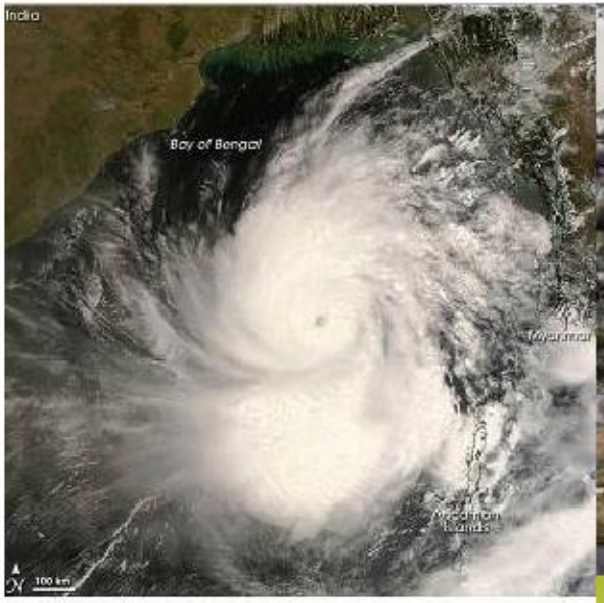
- Decreased rainy days,
- Increased prep. 10%, (summer 18%)
- Increased flood hazards

Future senarios

- Temp. increase up to 1.1-6.4℃
  winter > summer
- Precipitation increase
  winter < summer



KMA, 2004



Cyclone in Myanmar, 2008.5.

Cyclone Nargis Floods Myanmar (Burma)

April 15, 2008

May 5, 2008

earthobservatory.nasa.gov/Newsroom

Hurricane Katrina, 2005.8.

Drought

Dust wind

Figure 1.1. *Areal extent of Chacaltaya Glacier, Bolivia, from 1940 to 2005. By 2005, the glacier had separated into three distinct small bodies. The position of the ski hut, which did not exist in 1940, is indicated with a red cross. The ski lift, which had a length of about 600 m in 1940 and about 680 m in 1996, was normally installed during the summer months (precipitation season in the tropics) and covered a major portion of the glacier, as indicated with a continuous line. The original location of the ski lift in 1940 is indicated with a segmented line in subsequent epochs. After 2004, skiing was no longer possible. Photo credits: Francou and Vincent (2006) and Jordan (1991).*

Ice sheet decrease

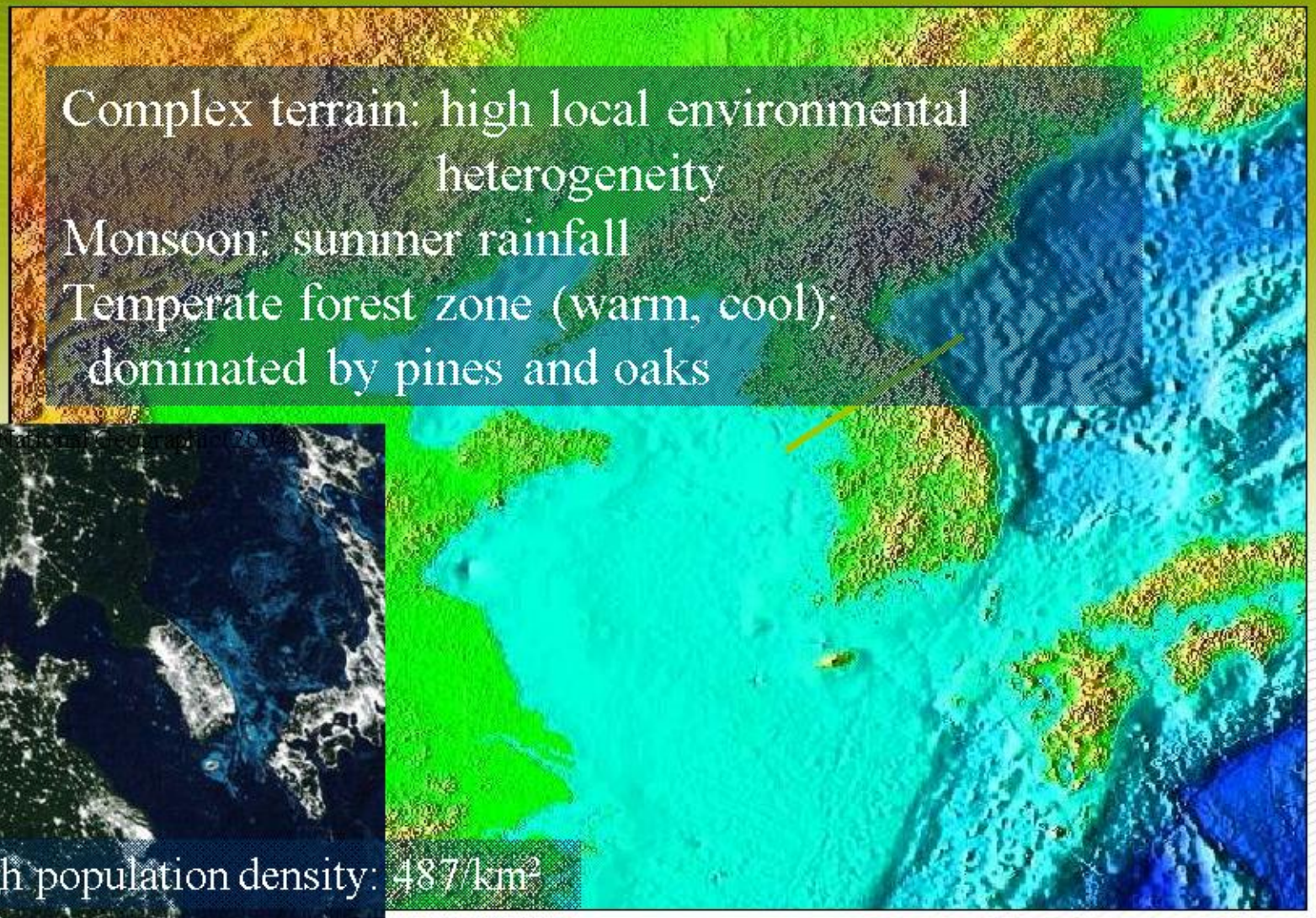
Fire

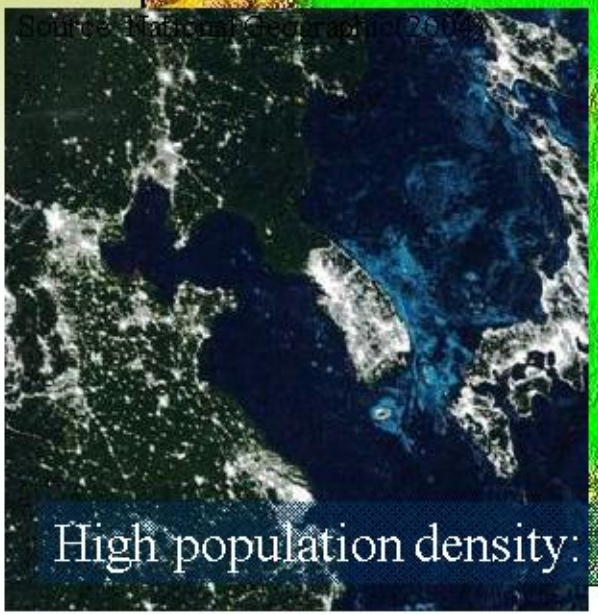
Sea level rise

Ocean acidification

and so on

Ecological Characteristics of Korea





Influencing disturbances on forest biodiversity in Korea

1. Short-term natural disturbances

a. forest fire
b. landslide
c. outbreaks of pest and insects

2. Global environmental changes

a. air/water pollution: acid rain, dust storm, and so on
b. global warming

3. Human activities

a. forest conversion, road construction, forest fragmentation
b. forestry activity: cutting, planting, silvicultural practices
c. selective collection of forest byproducts

Changes of Forest Cover and Major Disturbances

until 1960s

- Denuded forest area
  (Stock volume : 10m^3/ha)
- Over-exploitation by human for timber, fuels and foods
- Soil erosion was severe

1970s – 1980s

- Recovered by reforestation
- Pine forests dominated (young age)
- Outbreaks of pine insects
- Habitat destruction and pollution

1990s - present

- Oaks and Pine forests dominated (ages 20-40s, mostly)
- Climate-related natural disasters, IAS
- Reduced human interactions
- Selective exploitation of forest products

Forest biodiversity has been recovered !!
While those in other ecosystems were degraded

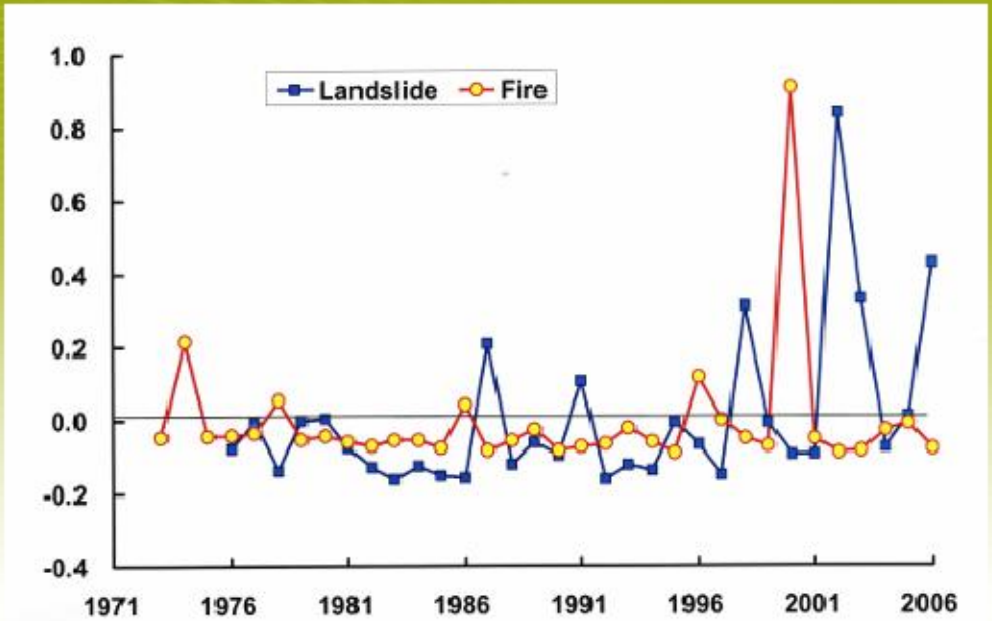
Even though some species of higher trophic level (tigers, wolves and so on) extinct already (about 30years ago),
recently, governmental reports and so many news say that forest dwelling species have been increased, and we encounter them frequently!!!

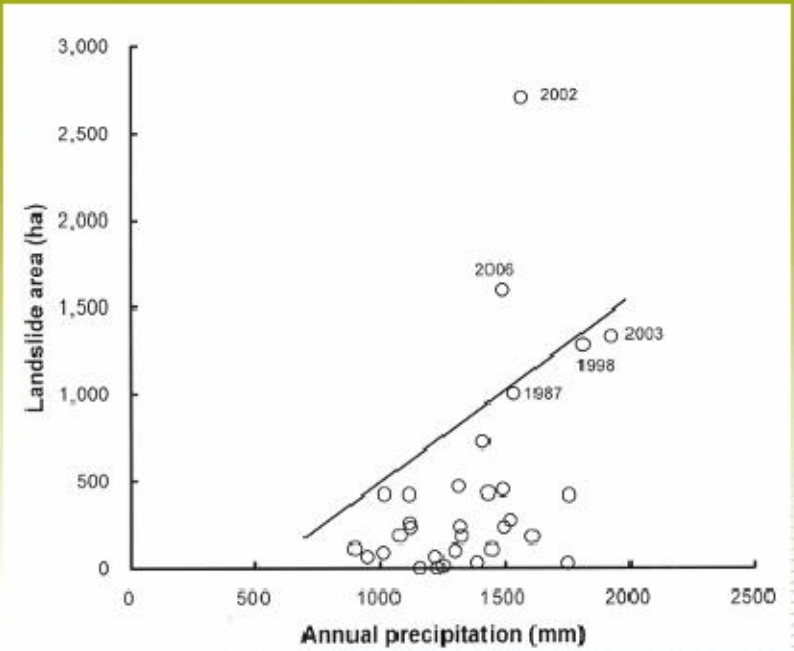
How Korean forest biodiversity could have been recovered?

- Success of the powerful "Forest Rehabilitation Project" in 1970s leaded by government
- Poverty elimination and changes in fuel sources from biofuels to other sources
- Effective establishment and management of various Forest PAs
- Paradigm shift in forest management: SFM

….

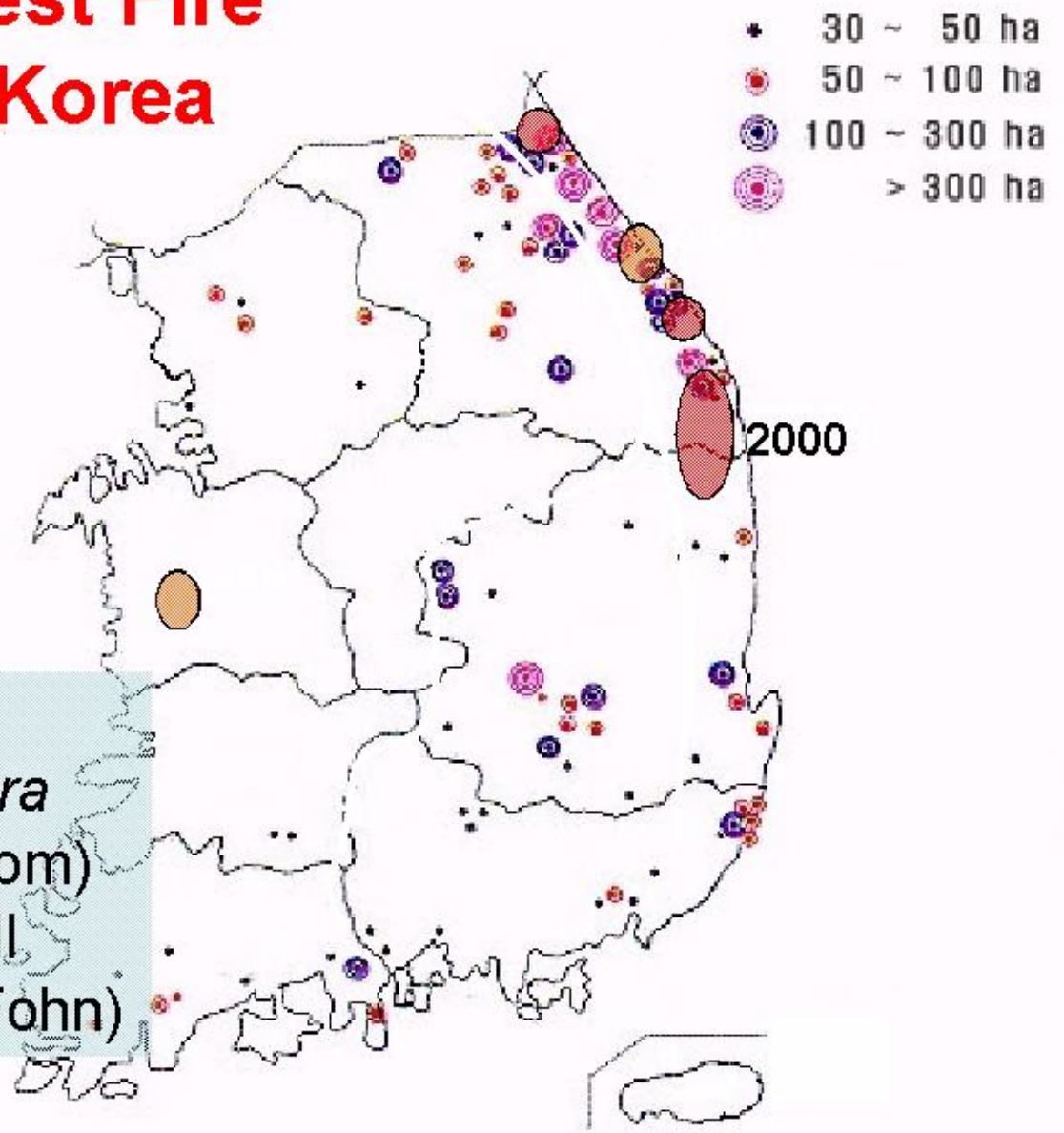
Recent Increase of Forest Disasters by Extreme Climatic Events





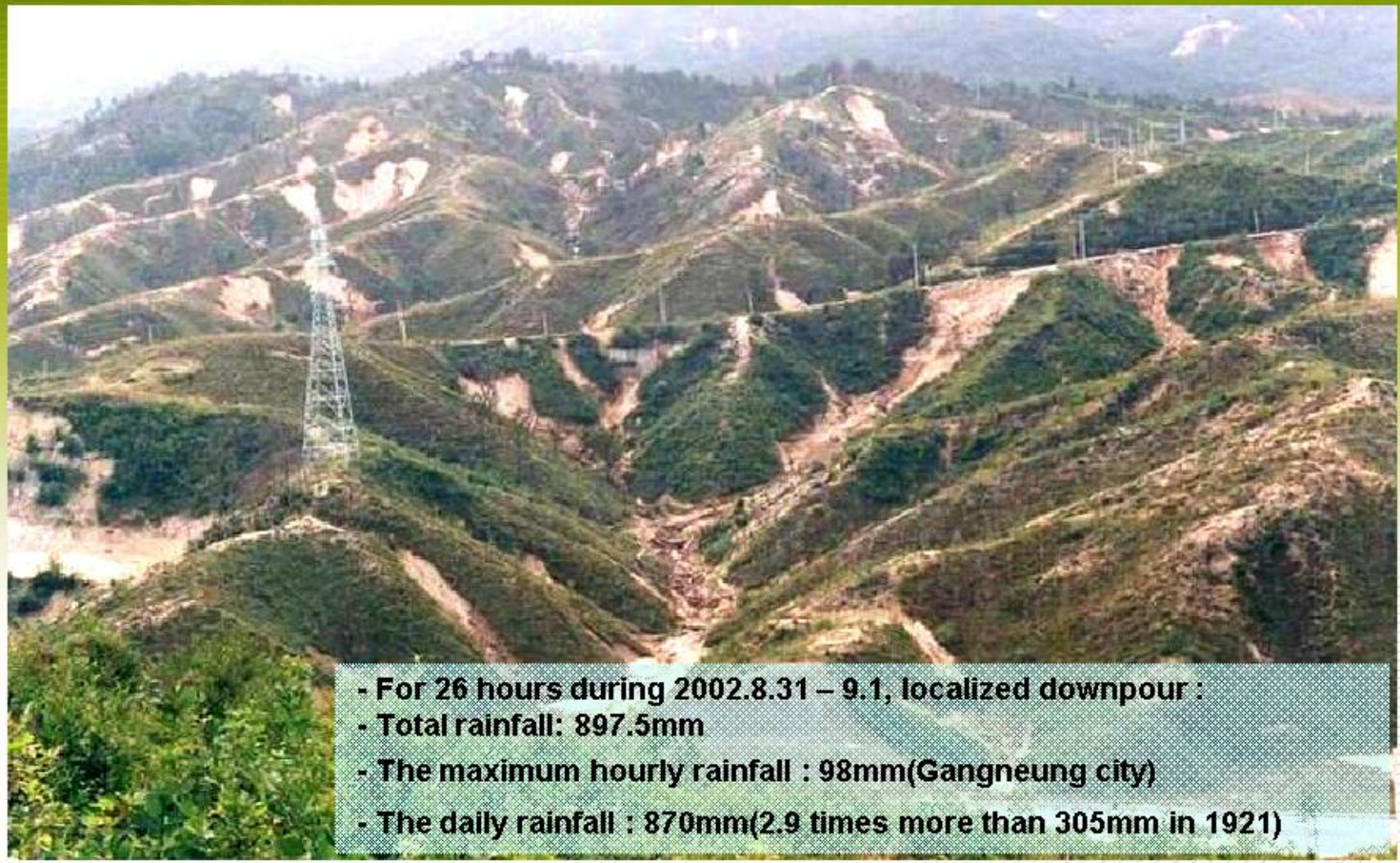
- Abnormal climatic events: global warming?
- Increased damages of forest resources

Forest Fire in Korea



East-coastal ecoregion
- Forest type: *P. densiflora* (produce pine mushroom)
- In spring: lowest rainfall and strong dry wind (Fohn)

Post-Wildfire Landslide Hazards



Destroyed the same area in 2002 damaged by fire in 2000

In summary, in Korea

FBD Conservation Activities were Successful

- Forest rehabilitation and restoration
- Conservation by various types Forest PA: complement each other
- Sustainable forest management: various ecosystem services

Threatening Factors to Biodiversity are Changing

- Far past: overexploitation, denudation of forests
- Before 1990: land-use change, habitat destruction and fragmentation, pollution
- Recent and future: global warming, selective exploitation and reduced human-nature interaction

Ecosystem Services: Forest/Mountains

1. Biodiversity

2. Fresh Water

3. Protection

4. Resource Extraction

5. Carbon storage

6. Tourism

Global Warming Effects on Forest Ecosystem

- Timing of biological events (Phenology)
- Species distribution ranges
- Frequency and intensity of outbreaks of pests and diseases
- Forest disasters: fire and landslide
- Structure and function of ecosystem

Forests stores lots of carbon and interact with atmosphere

- Stores 80% of C in terrestrial ecosystem and 40% of soil C

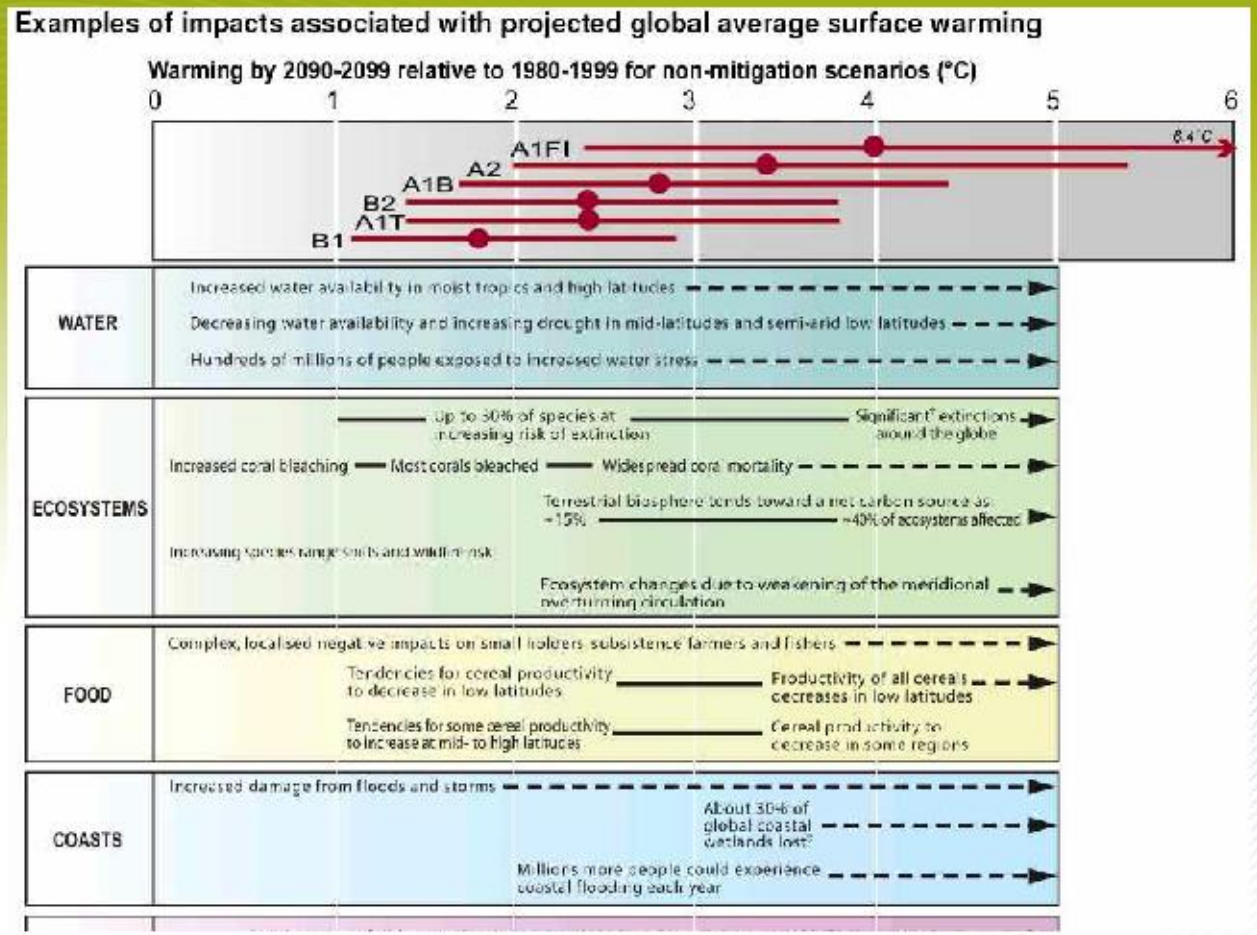
Trees has long life-span

- Cumulative risks of extreme climatic events

Climate Change Adaptation is Urgent!!

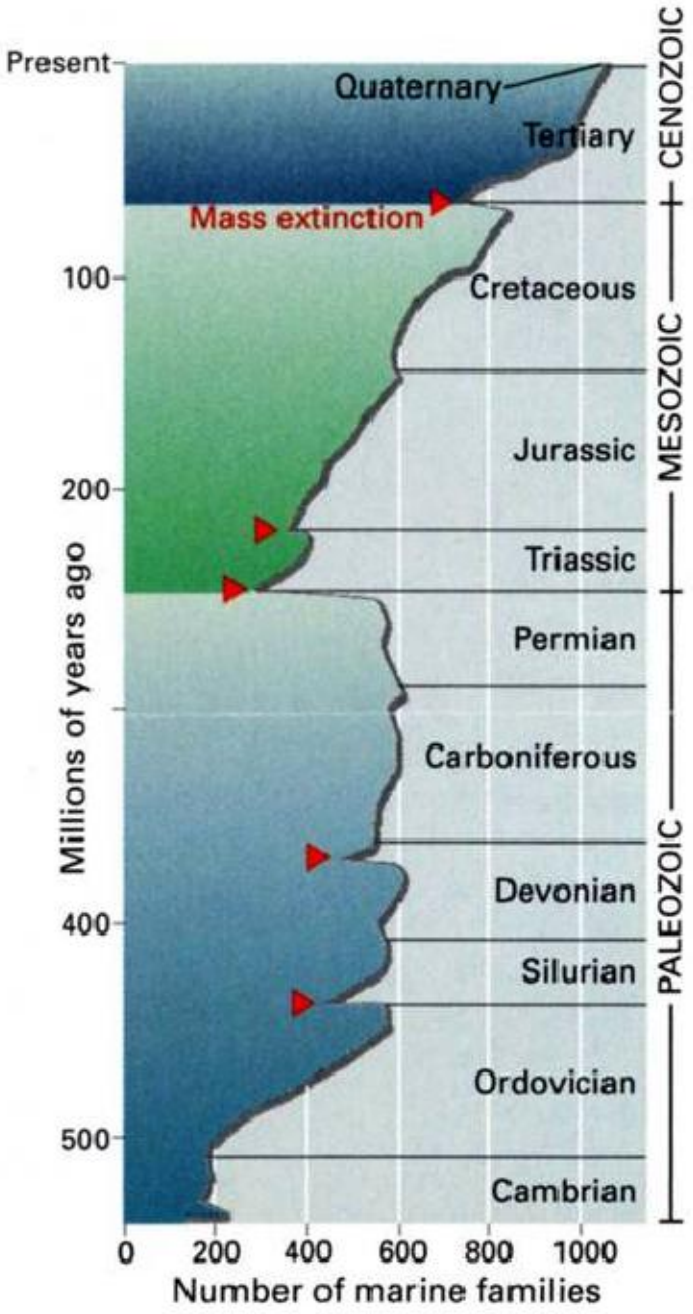
기후변화의 영향

1 million species will be endangered in 2100 (CBD, 2007)
In 50 years, 15-37% of species will be endangered by single factor of climate change (more than 1/4 of mammals, 1/3 of amphibians, 1/10 of birds)



IPCC, 2007

Golden frog, Panama



after Erwin et al.(1987)

Rapid extinction, Slow recoveries

An estimated 99% of all sp. that ever lived are extinct.

Recovery took millions of years.

Are we in the another wave of sixth extinction?

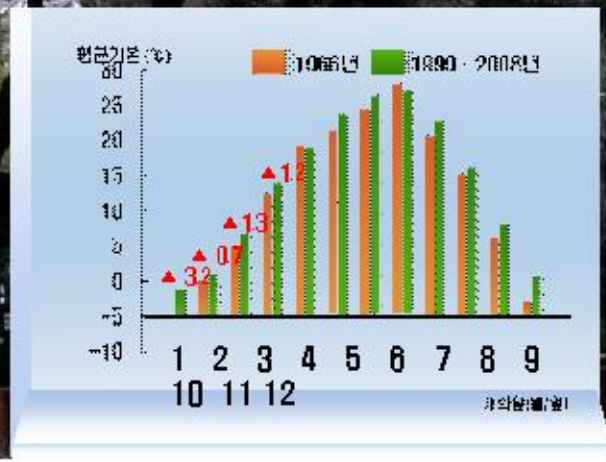
In Tertiary era, species increasing rate > extinction rate. However, recently extinction rate has rapidly increased by anthropogenic causes including popn. Increase, deforestation, industrialisation, pollution, overhunting and so on.

Endanged sp. : mammals 24%,
birds 12%

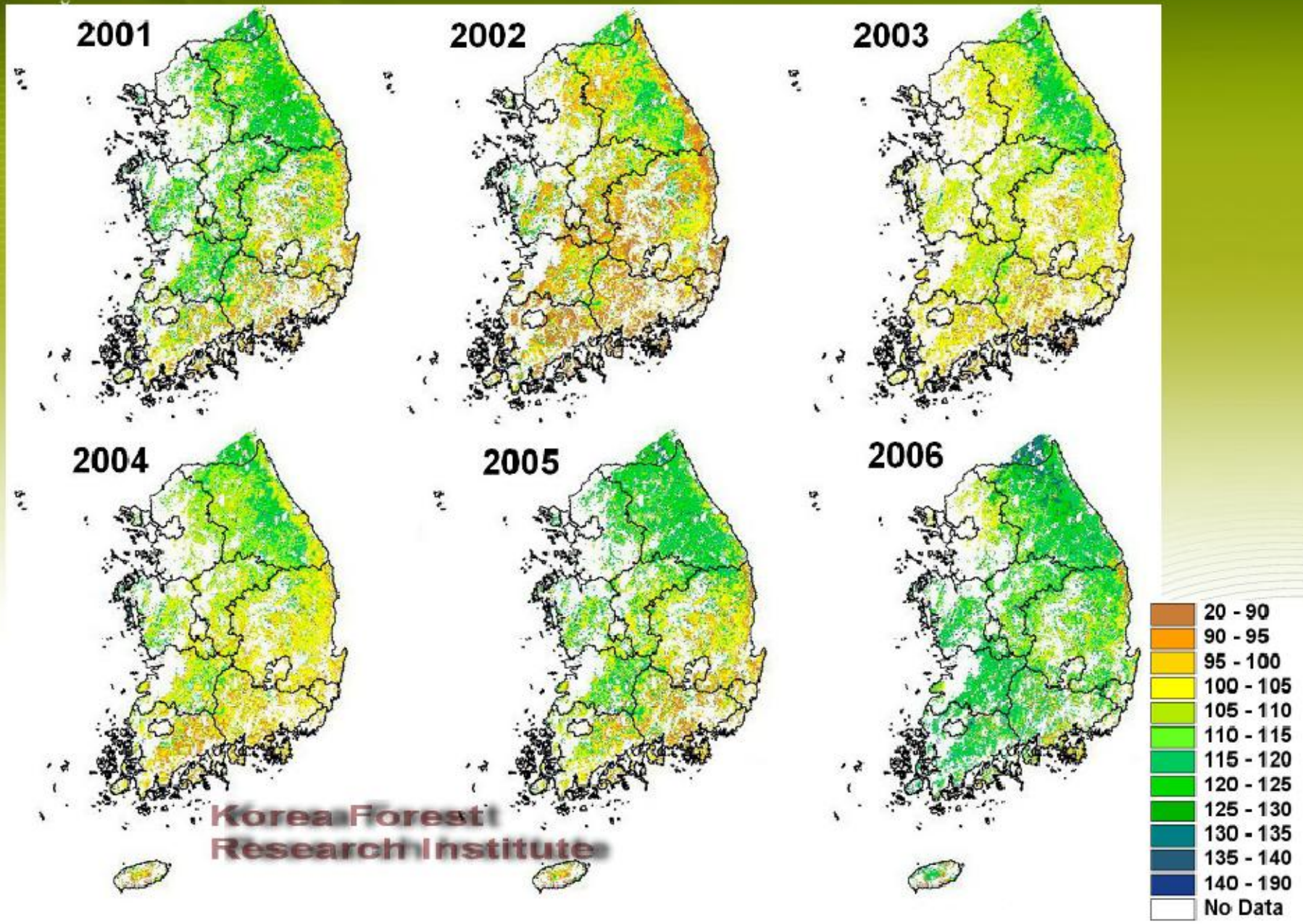
Extinct sp.: mammals 87, birds 131
(CBD, 2001)

Phenology

- changes in the timing of seasonal activities include leaf burst, flowering, emergence of frogs and insects, breeding of birds, and so on.
- Leafing time
- Flowering time



Maps of leafing date changes



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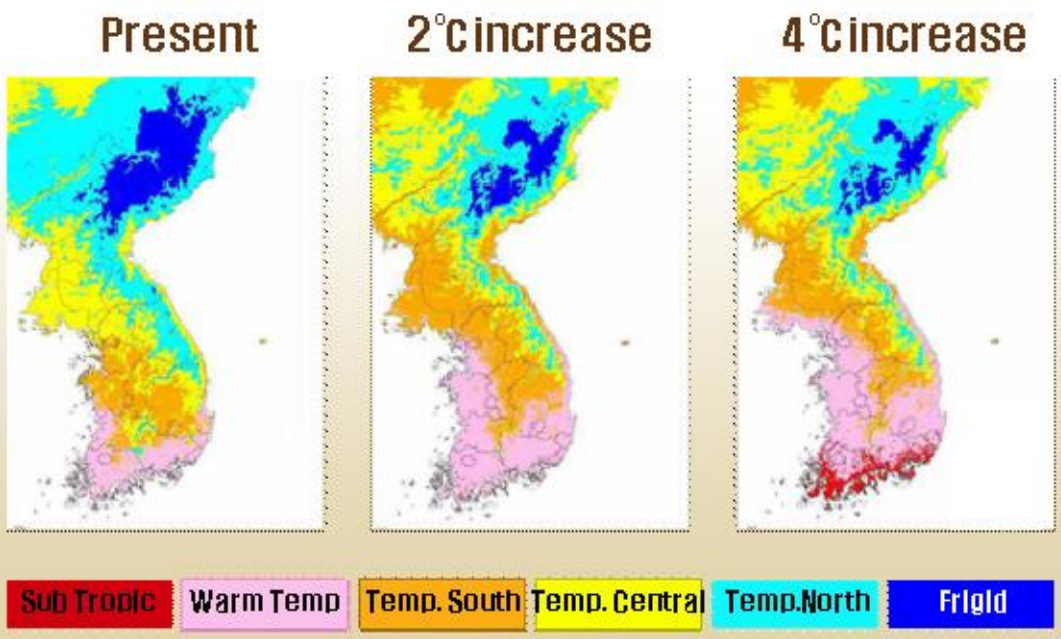
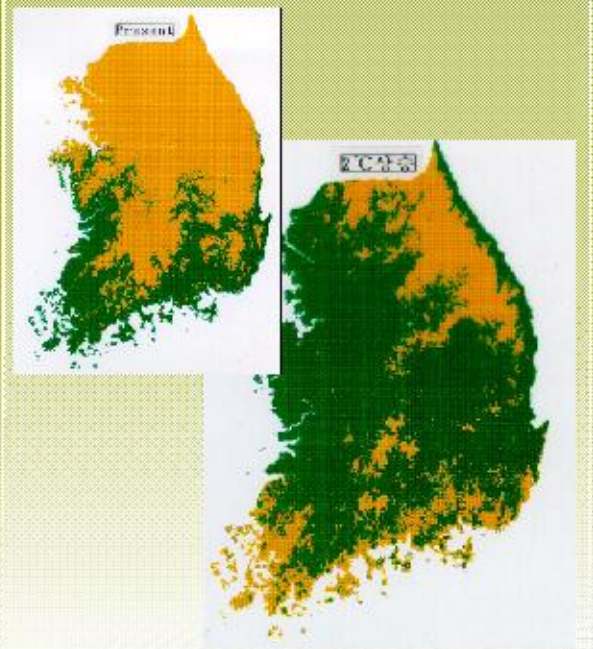
Vegetation Zone Shift



- Fast change of environments
  - gap with historic tree species movement
- Other problems
  - habitat fragmentation: urban, roads, agricultural fields
  - pollutions

Potential Distribution Zone of *Camellia japonica*

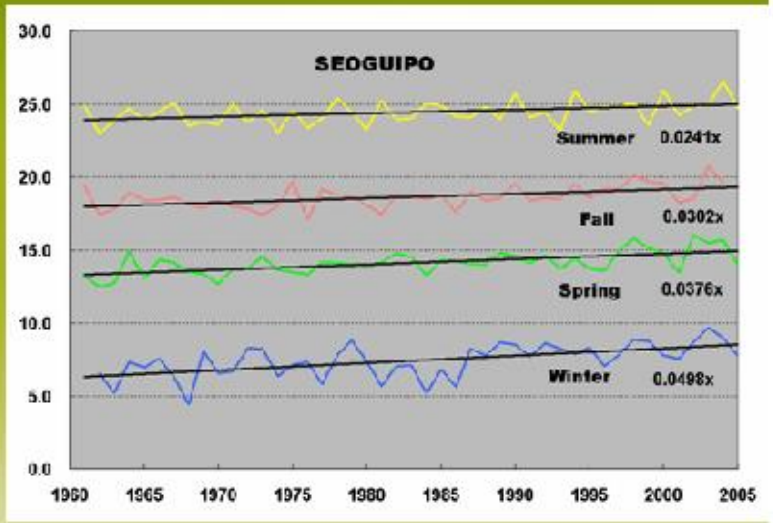


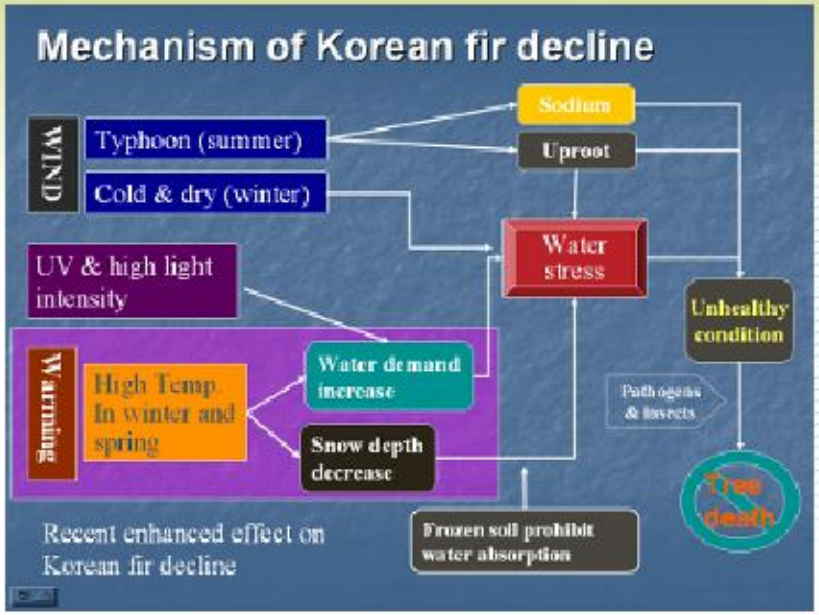
- Mountain island
  - biodiversity loss
- Distribution range shift
  - suitable planting sp. change

Alpine vegetation is one of the most vulnerable biota to climate change

Vulnerable ecosystem: alpine/subalpine forest

- **Korean fir in Mt. Halla**
  - recent dieback and decline is caused by warming in winter season

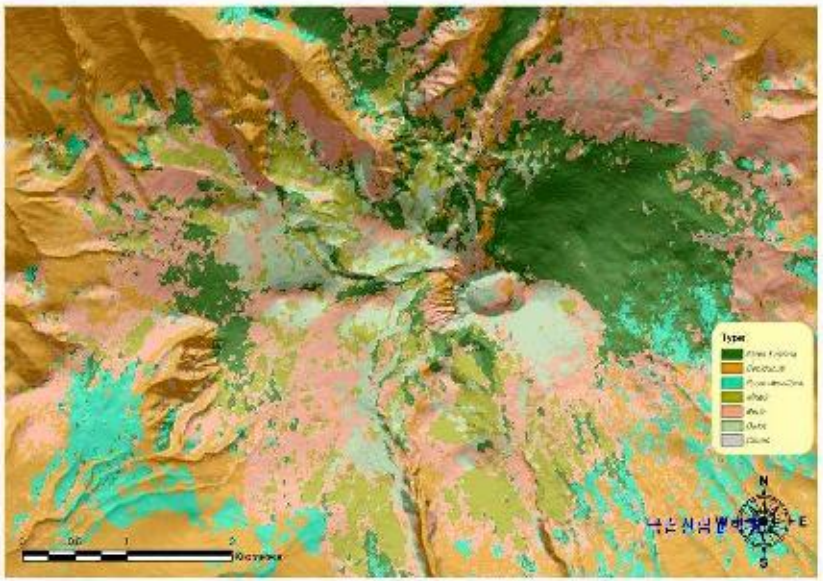


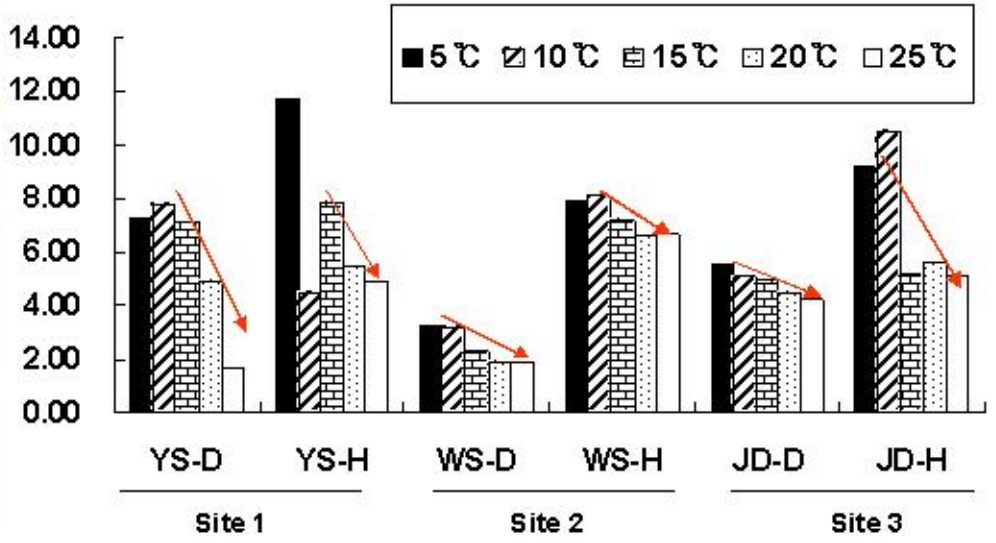


Korean fir (*Abies koreana*)

- Endemic in Korea
- 4 types (forma) by cone colors
- Valuable for ornamental use
- Genetically diversified from *A.nephrolepis*
- Distributed at high mountains in S.Korea including Mts. Halla, Jiri, Dukyu, Gaya
- 1,400-1,900m a.s.l in Mt. Halla

High temp. in winter is stressful, physiologically. Mortality was increased by winter warming

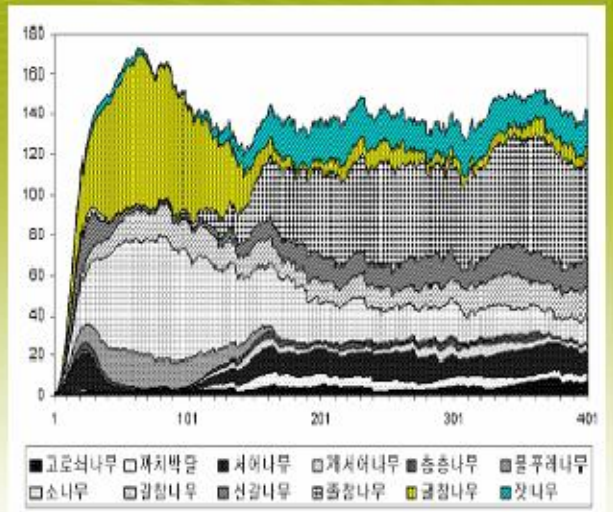


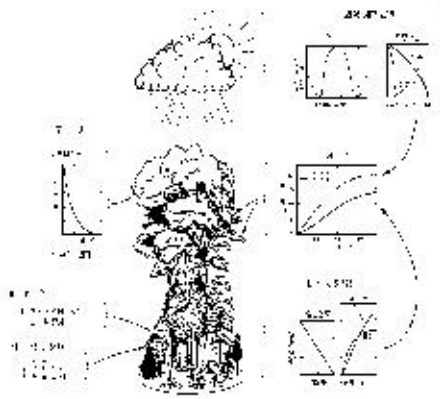


Forest Community and Productivity Change

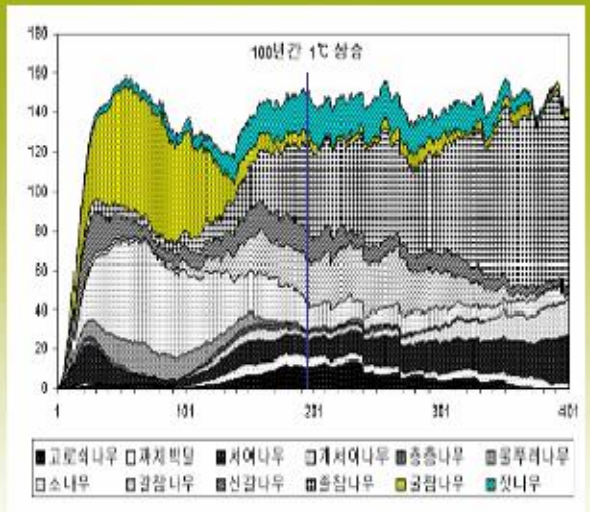
Simulation for Central Temperate Forest Zone

Present climate



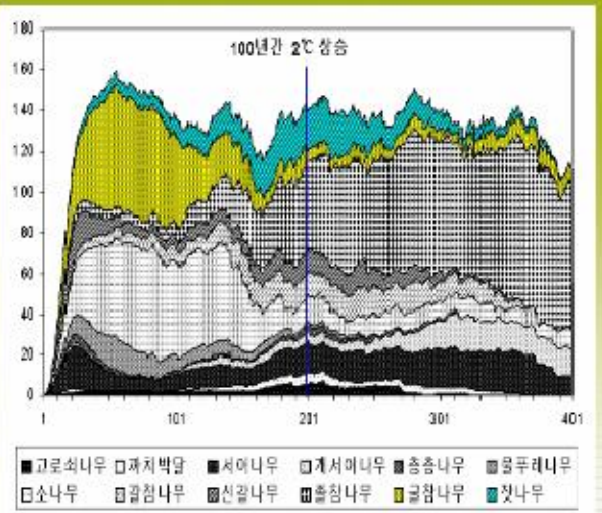


1℃ increase



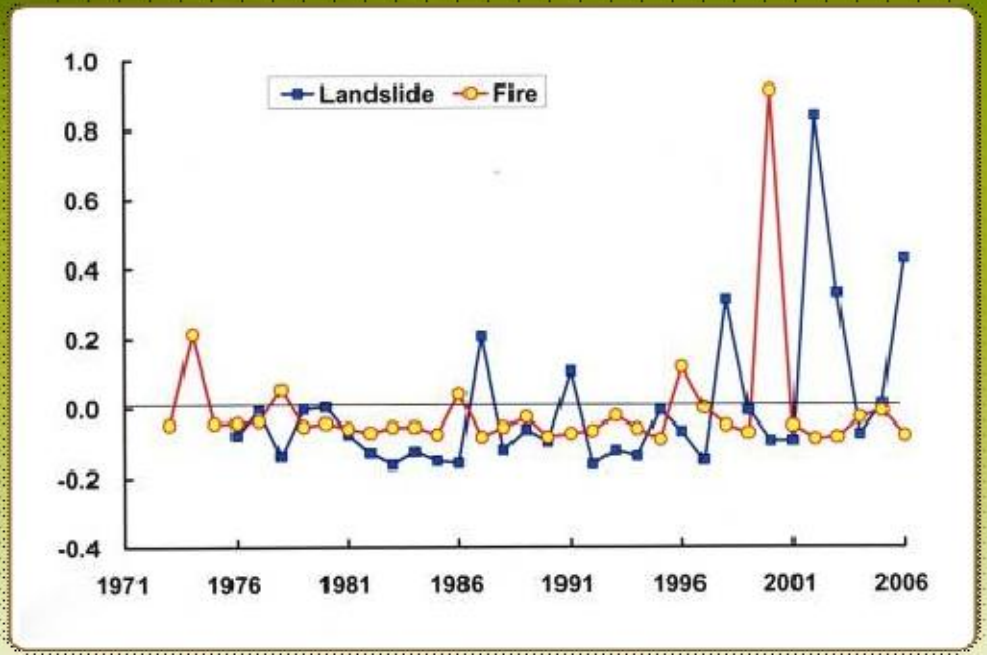
- Increse: *Q.serrata, Carpinus* sp.
- Decrease: *P.koraiensis, Q.mongolica*
- Productivy maintained

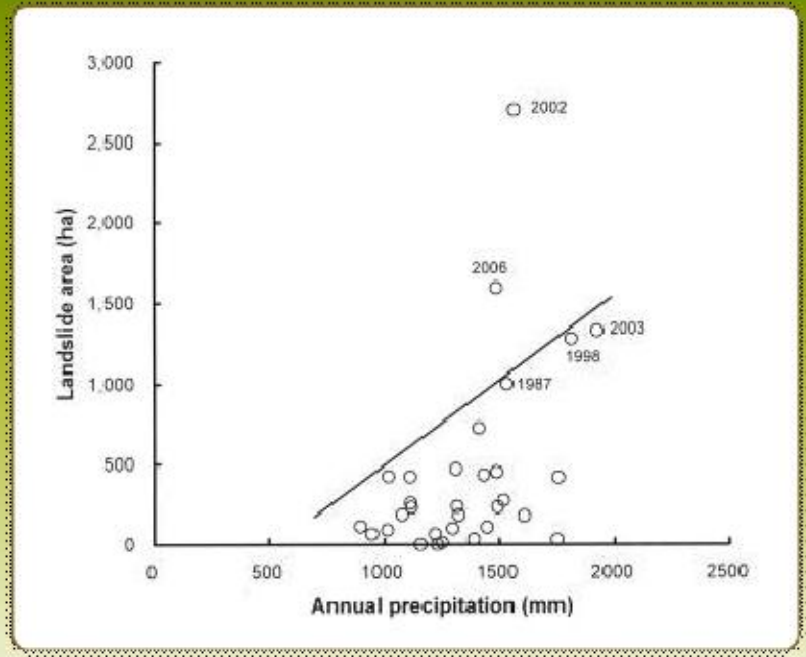
2℃ increase



- Increse: *Q.serrata, Carpinus* sp.
- Decrease: *P.koraiensis, Q.mongolica*
- Productivy declined

Forest Disasters: Fire, Landslide





- Extreme events will be increased
- Amplified effects among disasters
- Relationship with vegetation change

(Pine forest distribution, forest fuel)

Insects, Pests and Disease

Increased number of generations

Jour. Korean For. Soc. 91(2) : 149 - 155. 2002
韓國林學會誌 91(2) : 149 - 155. 2002

Increase in the Number of Generations in *Dendrolimus spectabilis* (Butler) (Lepidoptera : Lasiocampidae) in Korea[1]

Tae-Sung Kwon[2*], Young-kyu Park[3], Ki-Seok Oh[3], Young-Dae Kwon[3], Sang-Chul Shin[3], Chul-Su Kim[2], Ji-Du Park[1] and Hai-Poong Lee[2]

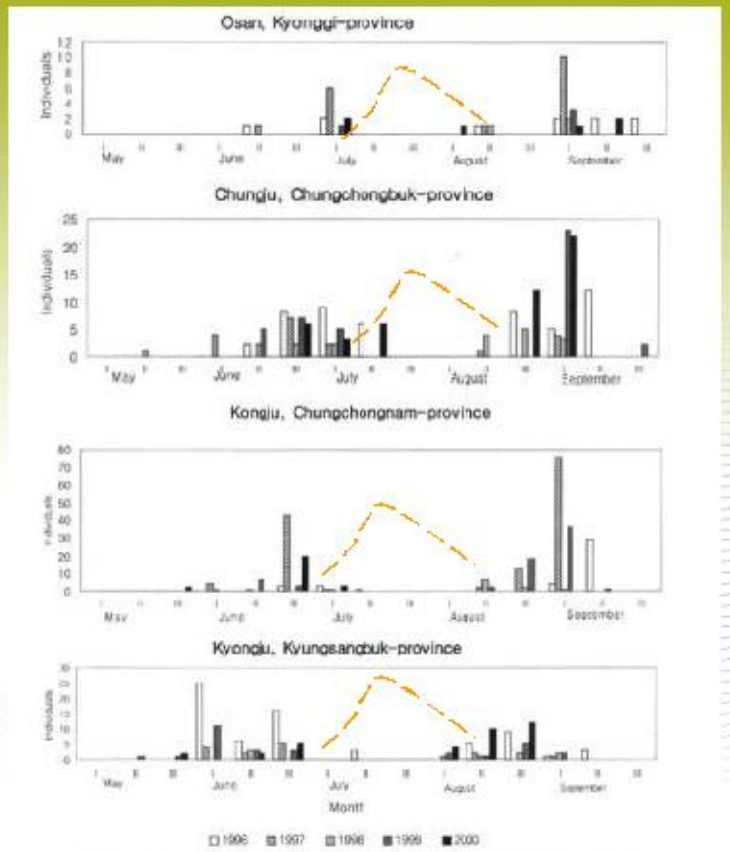


Figure 1. Emergence of adults of *Dendrolimus spectabilis* from 1996 to 2000 in Korea.

Outbreaks :

Other alien pests and disease

oak wilt disease, pine nematode and so on

What we can do to respond the climate change?

1. 온실가스 저감(Mitigation)
2. 기후변화 적응(Adaptation)
3. 피해를 받아들임(Suffering)

Whitch forest sectors are vulnerable in Korea?

- Heavy Rainfall in summer
- Occational extreme climate: eg. drought
- Raipid increase of Temp. and CO2

+

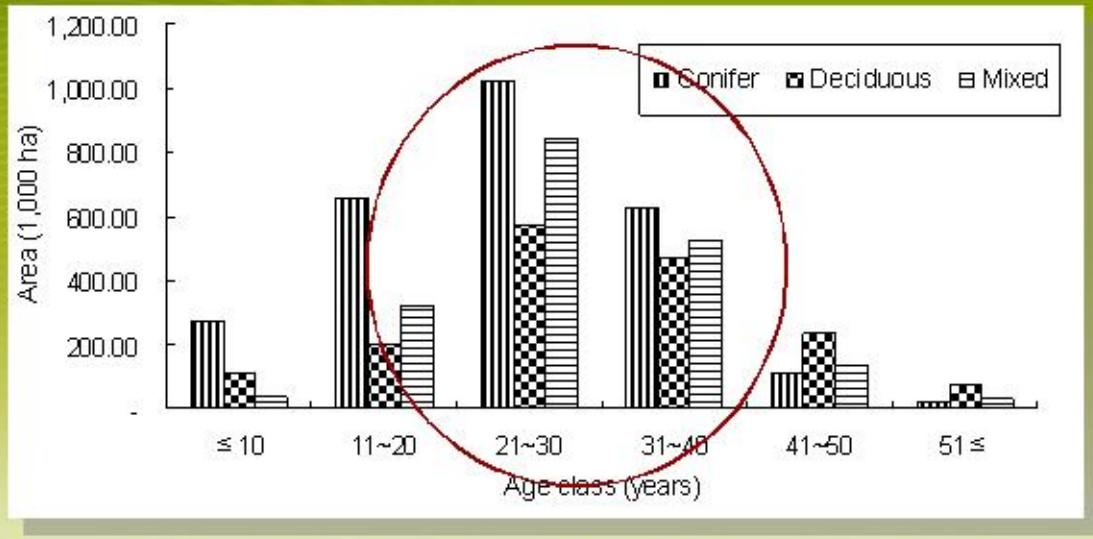
- Topographically steep
- Concentrated age class
- Unsuitable species to future climatge
- Thick forest stand: increased fuels, increased water demand
- Fragmented landscape
- Possibly increase of invasive alien species

→

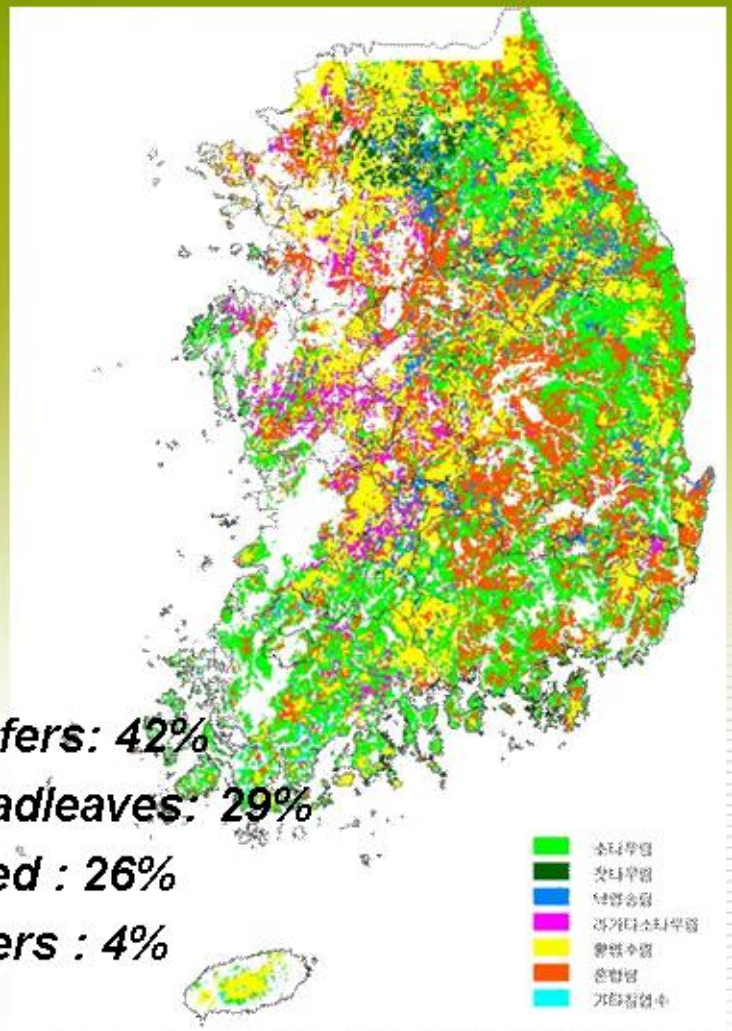
Vulerable area

- **Forest disasters**
  - Landslide
  - Forest fire
- **Forest health**
  - pests and disease
  - decline
- **Biodiversity loss**
- **Other ecosystem services change**

Forest Types and Age Distribution



- Most of the forests are 20 to 40
- Old-growth or virgin forests are rare



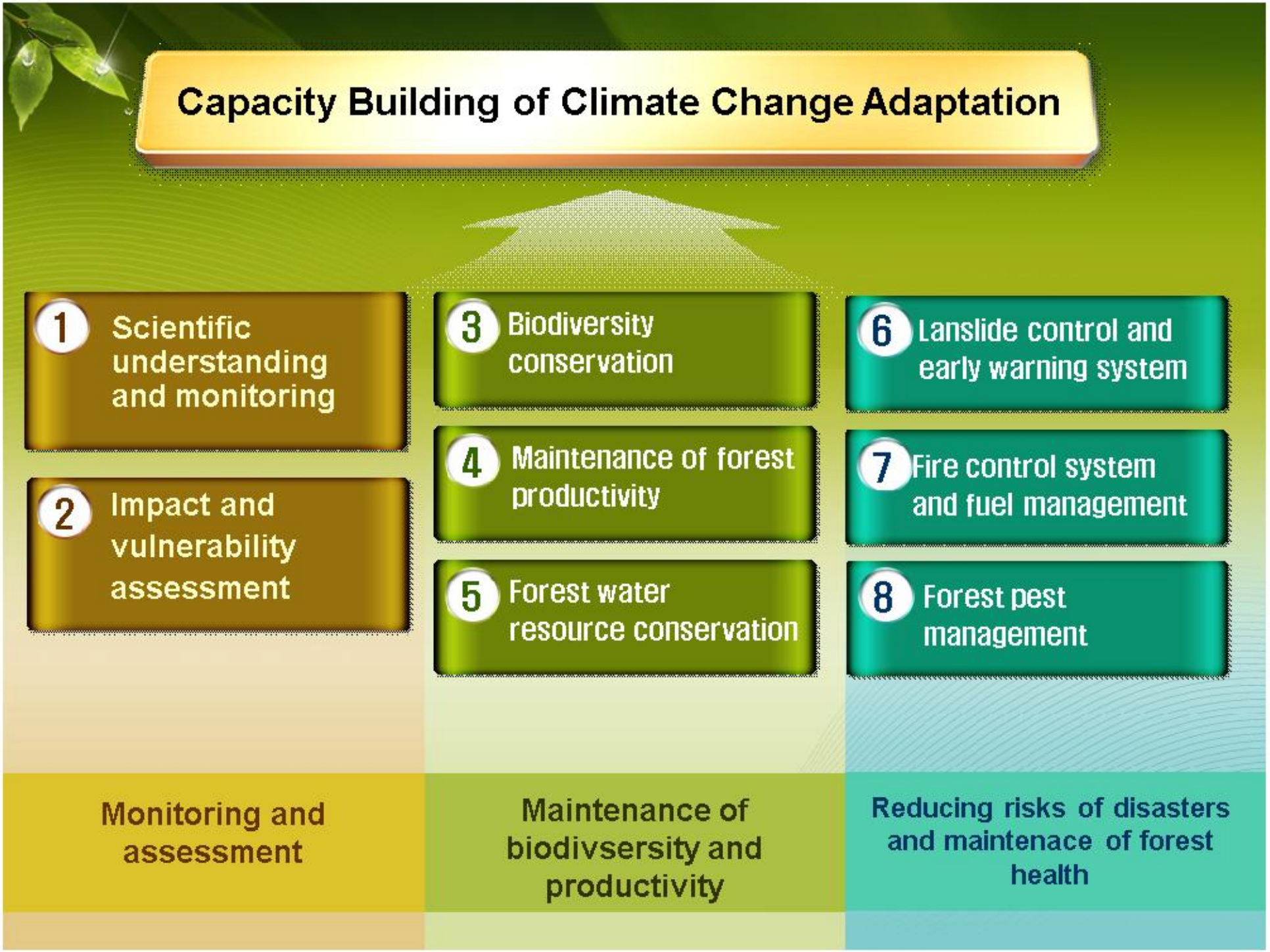
Confers: 42%

Broadleaves: 29%

Mixed : 26%

Others : 4%

Capacity Building of Climate Change Adaptation



Climate change adaptation measures

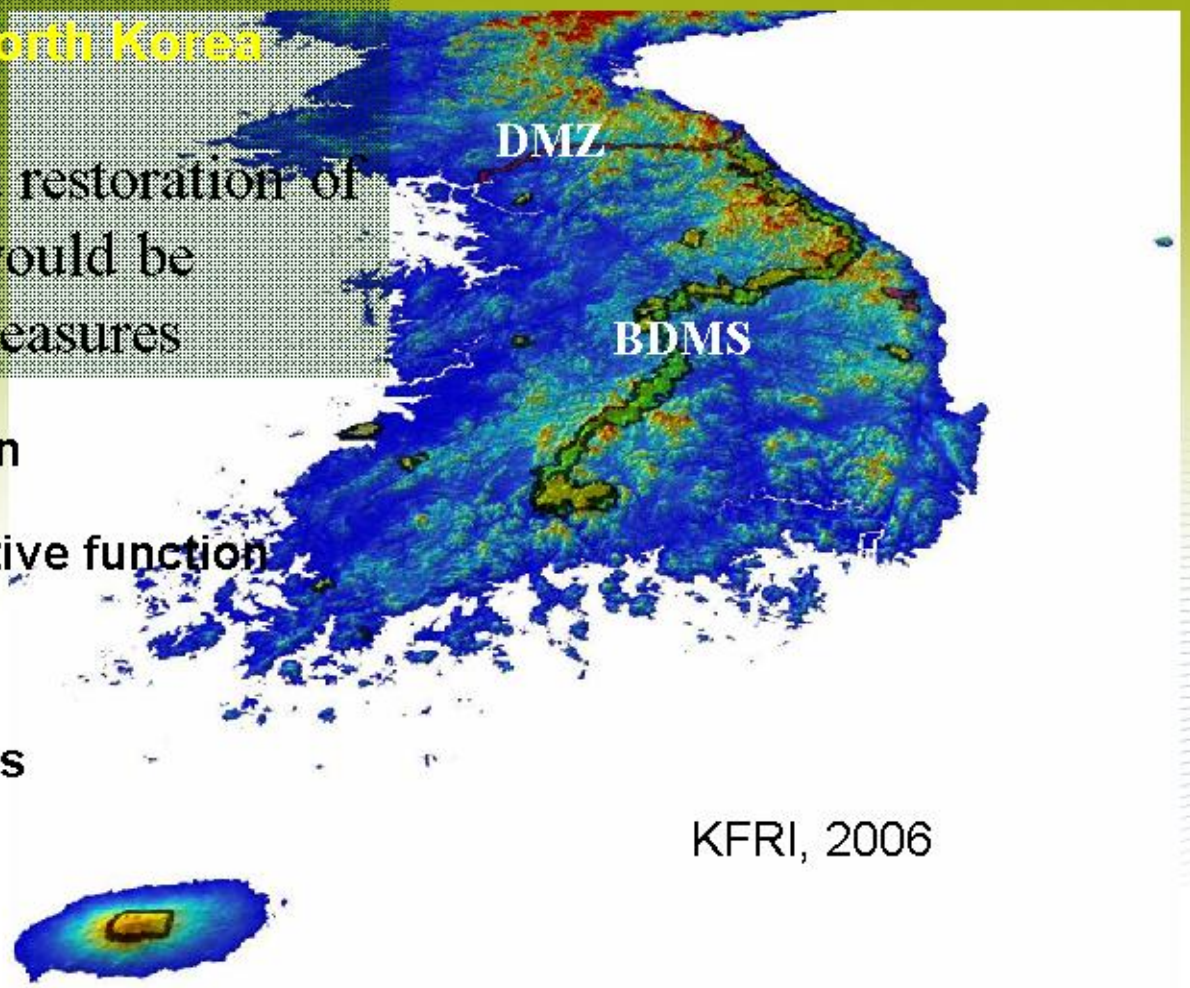
proactive

- Forest biodiversity conservation
  - inter-linkage of ecosystems, PA, restoration
  - in/ex situ conservation of vulnerable genes, species and communities
- Prevention, early warning and suppression system of forest disasters
- Control and quarantine system of forest insects and plant pathogens
- Forest management: diversification of age class and species
- Thinning for forest health and water conservation
- Maintaining forest productivity by silvicultural methods and soil conservation

Synergistic adaptation measure

- **Baekdudaegan Mountains System (BDMS)**
- **DMZ/CCZ area**
- **Degraded forests in North Korea**

Networking of PAs and restoration of degraded ecosystems would be important adaptation measures



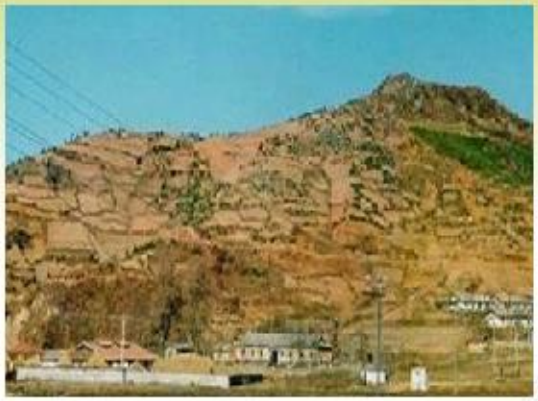
- **Biodiversity Conservation**
- **Forest health and protective function**
- **GHG mitigation**
- **Other ecosystem services**
  - tourism, fresh water

KFRI, 2006

Quarry (mining field)

Forest road

Paddy field



North Korean Forest

Forests in coastal area and sand dune

Thak you!!