6th APBON Web seminar
15:00-17:00 (GMT+9:00)
25 February 2021
Cisco Webex Meeting

Ecological observation of the declining Korean fir forest on the higher altitude area of Mt. Hallasan National Park, Jeju Island, Korea, under changing climate aided by the ICT (information and communications technology)

Eun-Shik Kim, PhD
Professor Emeritus, Kookmin University, Seoul, Korea
President, International Association for Ecology (INTECOL)
An immediate past Co-Chair of APBON

The first ASIAHORCs Joint Symposium & the initiation of APBON in July 2009

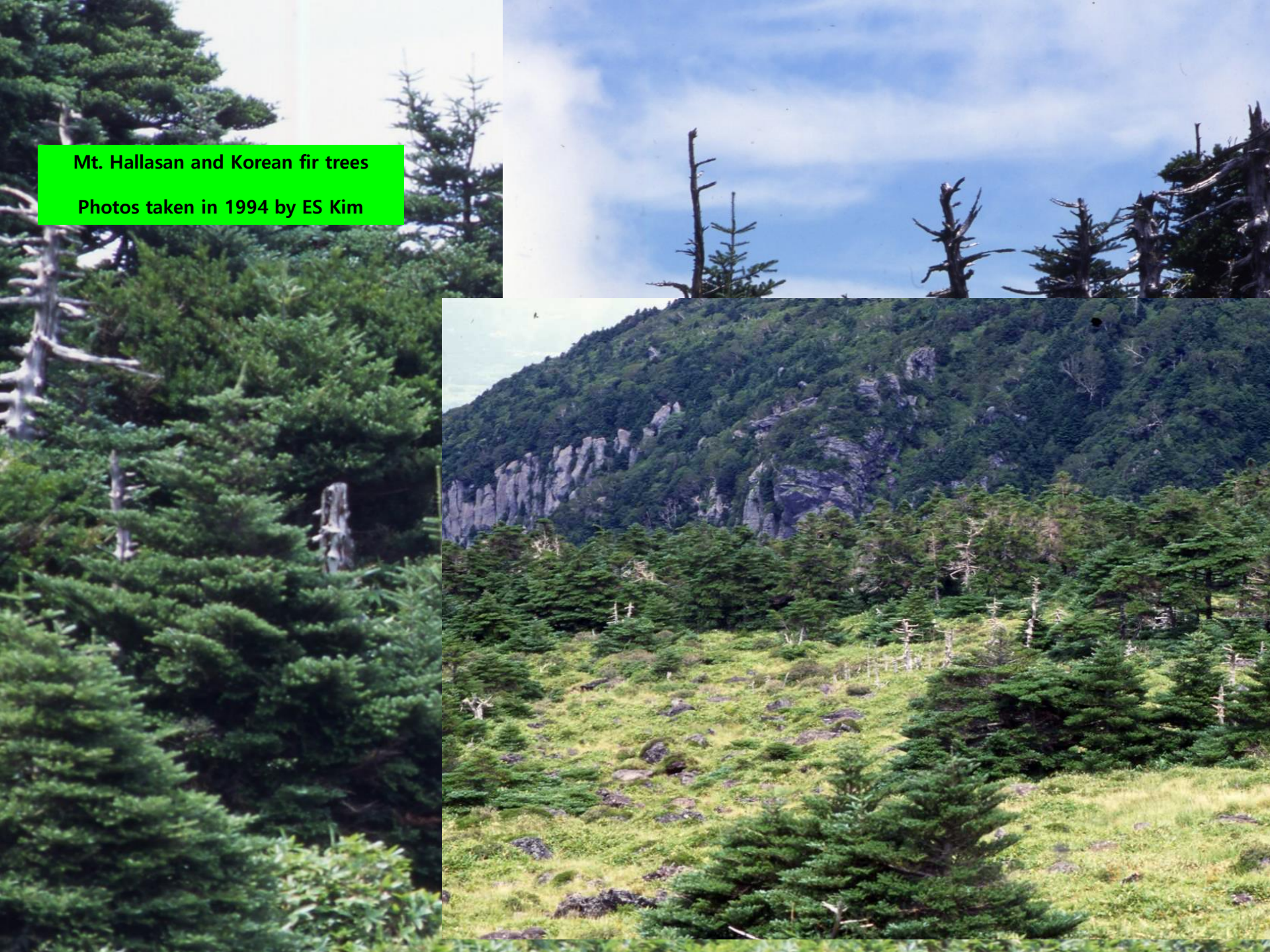

Profs. H. Matsuda & T. Yahara
at a field trip in Nagoya, Aichi, Japan, July 2009

Discussion of a regional biodiversity observation network
& APBON in July 2009

Sequence of Presentation-1

- **Declining forests of Korea Fir (*Abies koreana*) on the higher altitude area of Mt. Hallasan, Jeju Island, Korea**
- **A real-time ecological observation platform to monitor the changes of a forest ecosystem aided by the ICT (Information and Communication Technology)**
- **Challenges and opportunities in observation of biodiversity, ecosystems, and ecological sustainability**


A photo ⓒ The Jeju World Natural Heritage Center
Columnar Joint
UNESCO's Triple Crown
Biosphere Reserve
World Natural Heritage
Global Geopark
Jeju Island in the Past
The Island of Stones, Wind, and Women


Mt. Hallasan and Korean fir trees
Photos taken in 1994 by ES Kim


Korean fir trees declining on Mt. Hallasan, Jeju Island blown by strong winds
Photo taken in 2013 by ES Kim

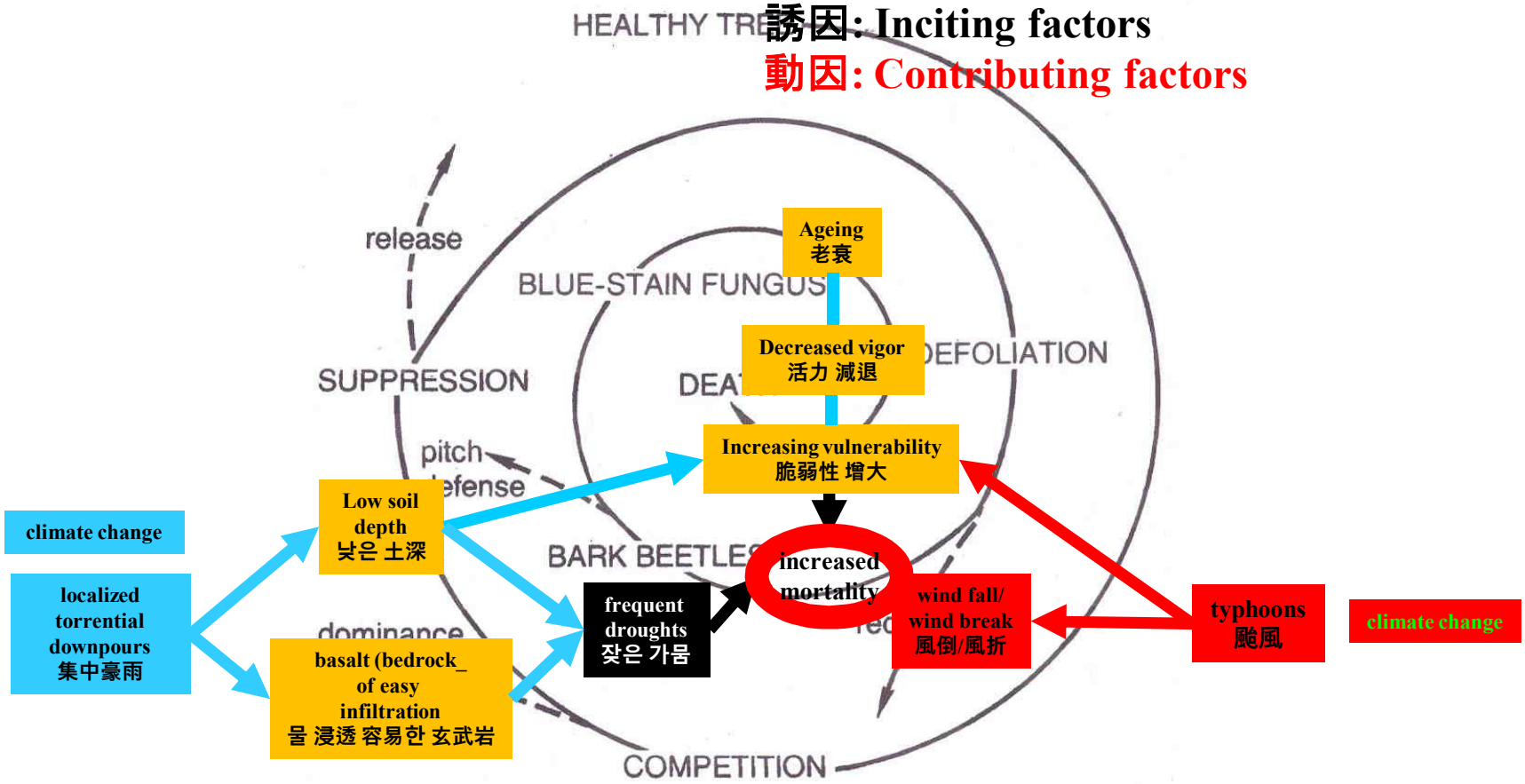

Korean fir trees declining on Mt. Hallasan, Jeju Island blown by strong winds
A photo taken in 2013 by ES Kim
Photo: Eun-Shik Kim


The population of dwarf bamboo (*Sasa quelpaertensis*)
outcompeting & covering the shrub layer
in the Korean fir forest
on Mt. Hallasan, Jeju Island, Korea

A photo taken in 2013 by ES Kim

Further understandings are needed on the decline mechanism of the old Korean fir trees under the changing climate regimes

素因: Predisposing factors
誘因: Inciting factors
動因: Contributing factors

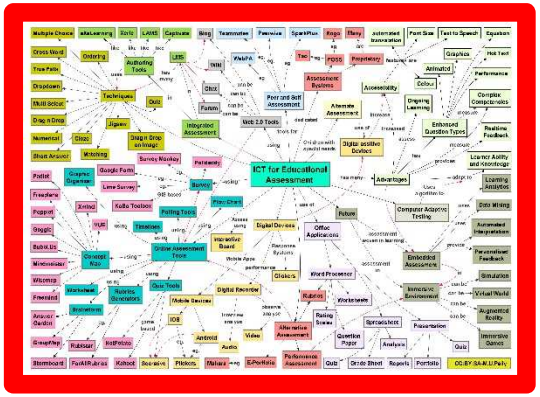


Sequence of Presentation-2

- Declining forests of Korea Fir (*Abies koreana*) on the higher altitude area of Mt. Hallasan, Jeju Island, Korea
- **A real-time ecological observation platform to monitor the changes of a forest ecosystem aided by the ICT (Information and Communication Technology)**
- **Challenges and opportunities in observation of biodiversity, ecosystems, and ecological sustainability**

ICT: information and communications technology

(wikipedia)



an extensional term for

information technology (IT) that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage and audiovisual, that enable users to access, store, transmit, and manipulate information

Ecological parameters to consider for sound ecological integration

Ecosystems and habitats	Biota and ecosystem components	Ecosystem services	Ecological fields	Ecological impacts on society
✓ Oceans ✓ Tidal flats and coasts ✓ Rivers & streams ✓ Lakes and marshes ✓ Forests ✓ Grasslands ✓ Deserts ✓ Alpine mountains ✓ Tundra ✓ Agro-ecosystems ✓ Urban environments ✓ Industrial environments ✓ …	➢ Biotic Components - Plants - Animals - Microbes ➢ Abiotic Environment - Soil - Atmosphere - Hydrosphere	❖ Water quality ❖ Food production ❖ Climate regulation ❖ Recreation ❖ Flood prevention ❖ Land protection ❖ Eco-engineering ❖ Air quality	✓ Biogeography ✓ Population dynamics ✓ Element cycling ✓ Plant-animal interactions ✓ Plant-microbe interactions ✓ Species diversity ✓ Functional diversity ✓ Global change ✓ Trophic interactions ✓ Energy flow ✓ Primary production ✓ Decomposition ✓ Development and succession ✓ Habitat fragmentation ✓ Invasions ✓ Ecophysiology ✓ Theory and modeling ✓ Molecular ecology ✓ Ecotoxicology	❑ Decision making ❑ Education ❑ Policy development ❑ Ethics ❑ NGO activity ❑ EIA
landscape elements	**biodiversity**	**ecosystem functions**	**ecological science**	**ecological sustainability**

LTER (Long-Term Ecological Research) Network

IoT based monitoring network with diverse ecological/weather sensors

Sensor Node #1
(Soil Moisture, Sap flow, Tree diameter, Tilt)

Soil moisture sensor

Gateway/Solar panel/Battery

Solar panel/Battery
(Supply power to Node #2)

Senso Node #3
(Soil Moisture, Sap flow, Tree diameter, Tilt)

Battery Box
(Supply power to Node #1, #3)

Sap flow

Tree diameter

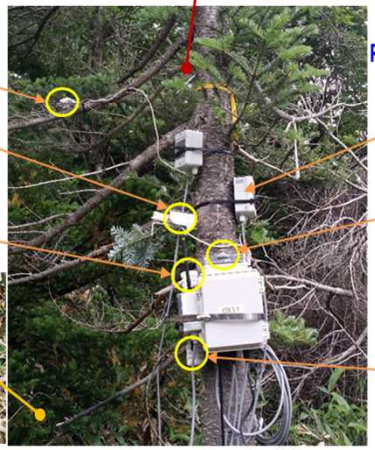
Temperature/ Humidity

Rain Guage

Tilt

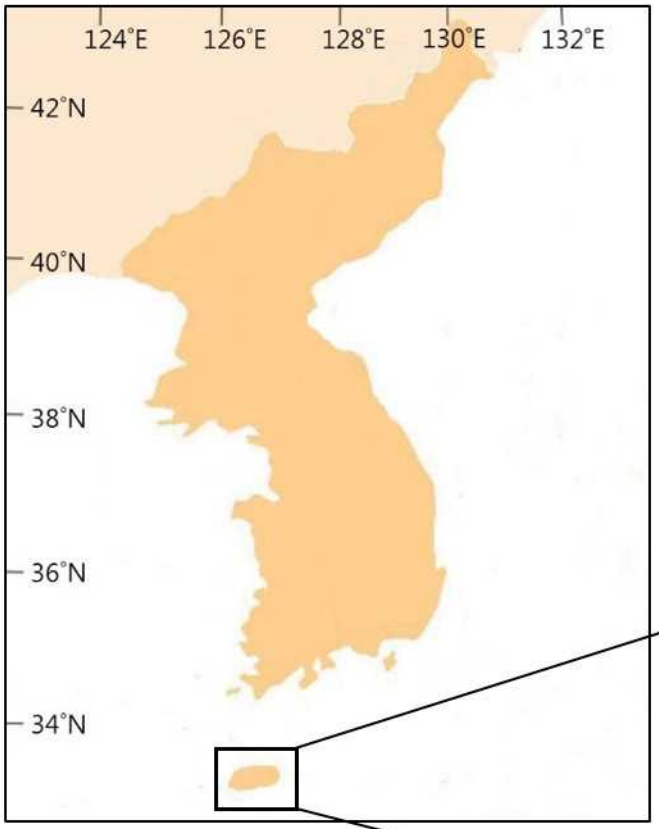
Illumination

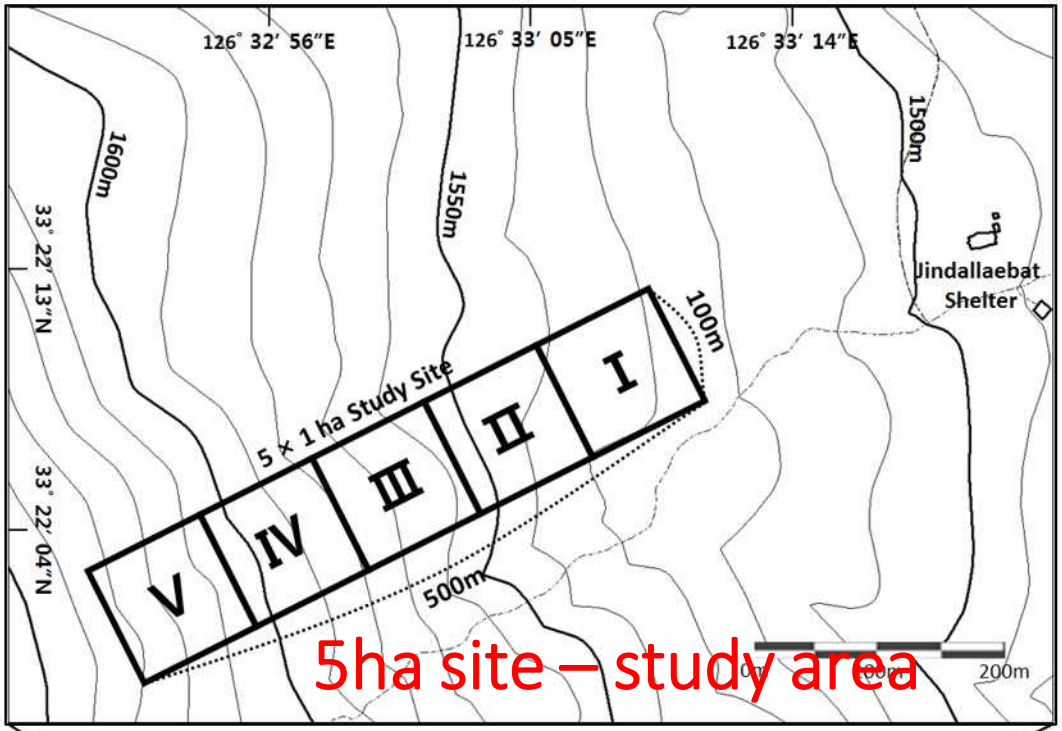
CO_2



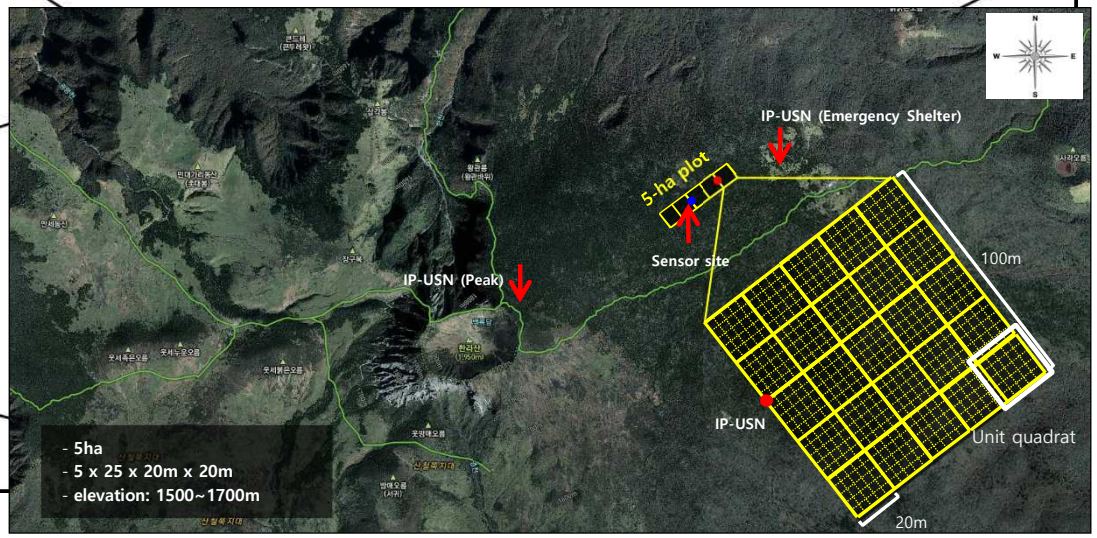
Multi-layer Soil Moisture & Temp.

Sensor Node #2
(Multi-layer Soil Moisture&Temp., Temp./Humidity, CO_2, Illumination, Sap flow, Tree diameter, Tilt)

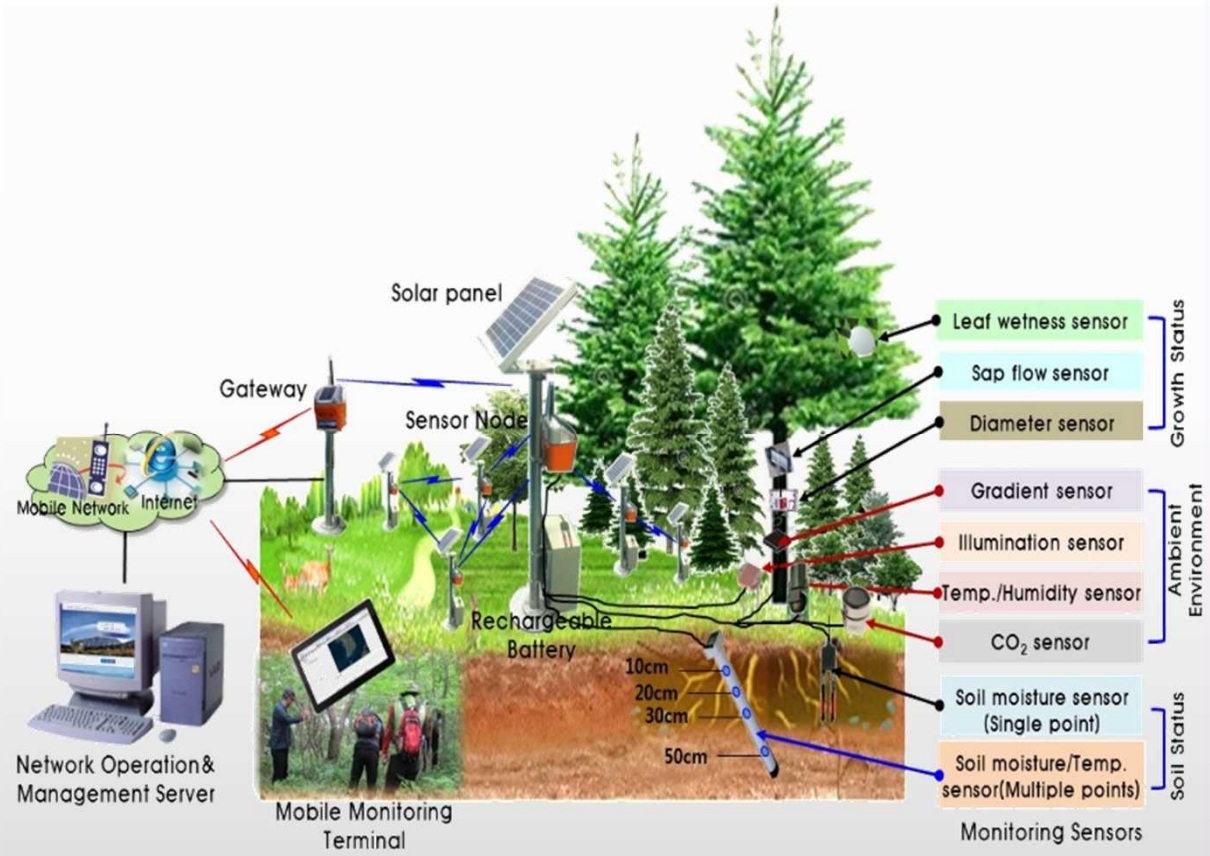




5ha site – study area



Real-time ecological monitoring system and the sensor network (wireless, solar powered)



Examplar questions to address

- the time when the radial growth initiated for the season;
- the time when the radial growth ceased for the season;
- the length of days for the radial growth for the season;
- the factors that are related to the initiation of radial increment for the season;
- the factors that are related to the fluctuation of radial increment for the season; and
- the factors that are related to the cessation of radial increment for the season.

- <u>The relationships among the factors at the forest site</u>

10 minutes interval

WIRELESS and REALTIME

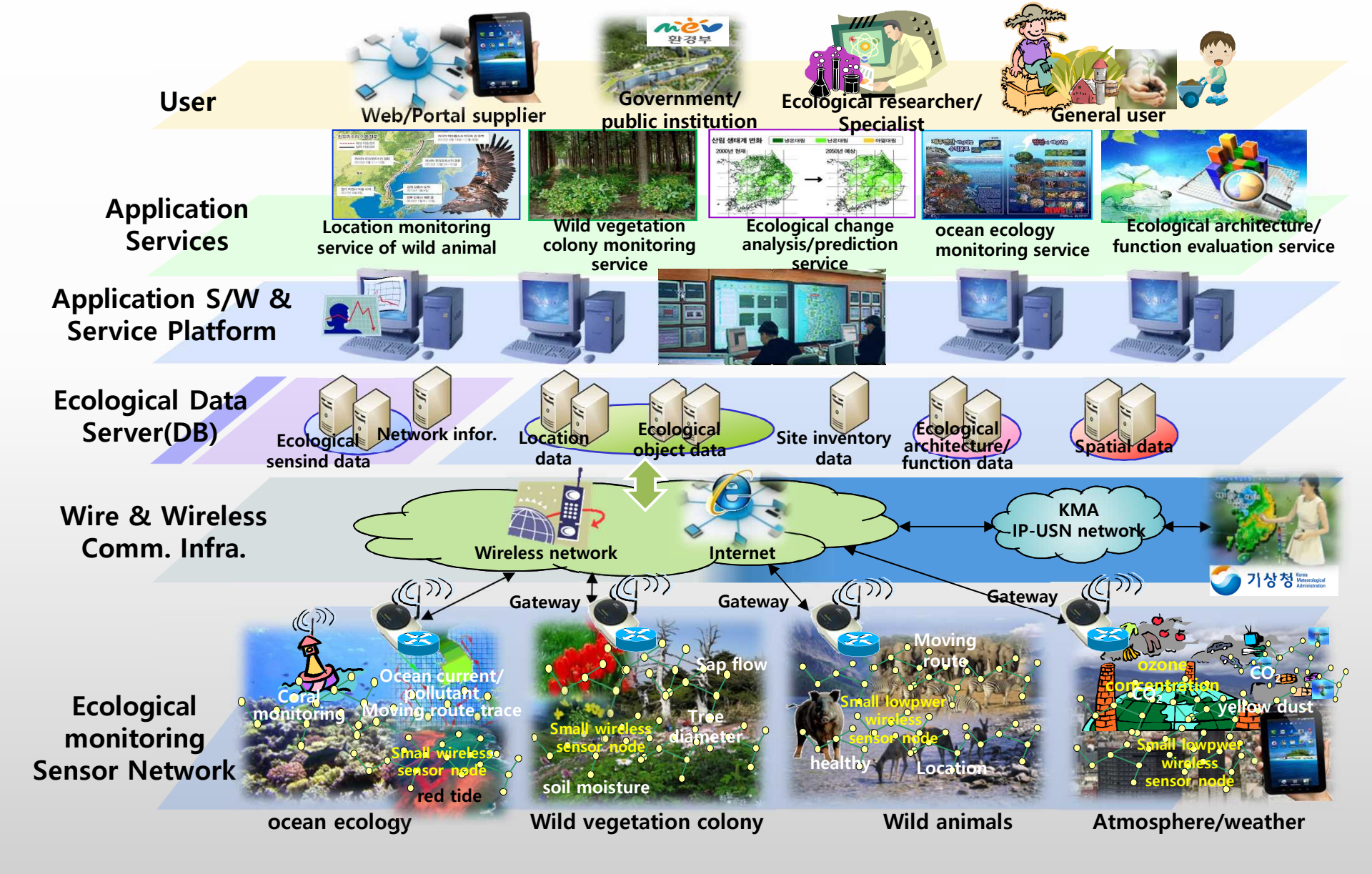
sensors' data transferred to main server

using solar energy without other power supply from outside

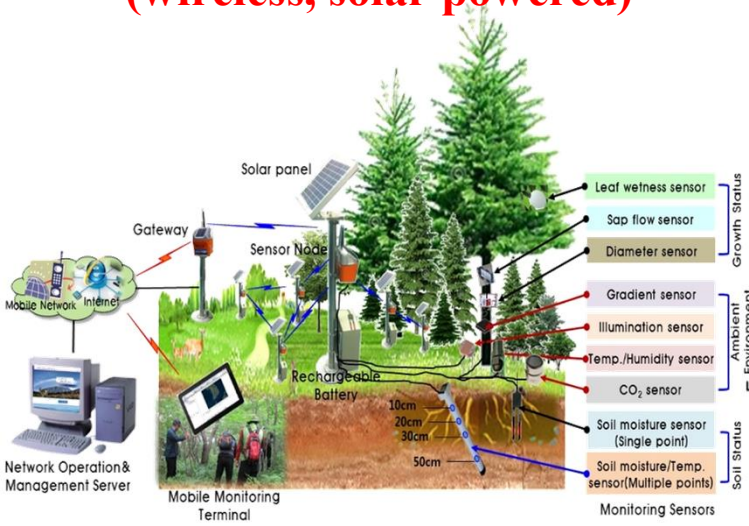
A Real-time Monitoring System for the Data from the Sensors

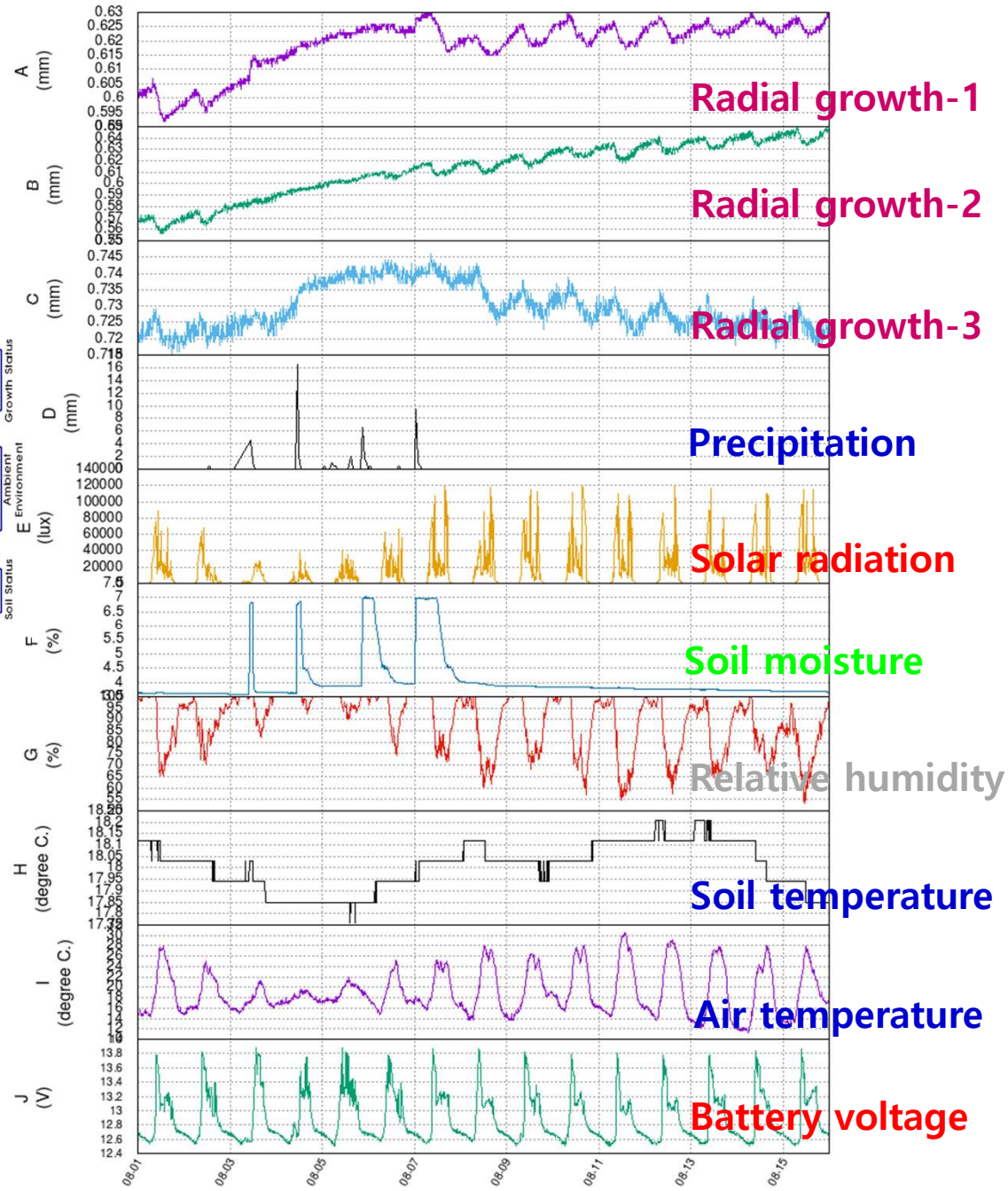
Mobile App. Service: able to check from all over the world

Conceptual Image of the Platform



Real-time Monitoring System and the Sensor Network (wireless, solar powered)





Questions to Address

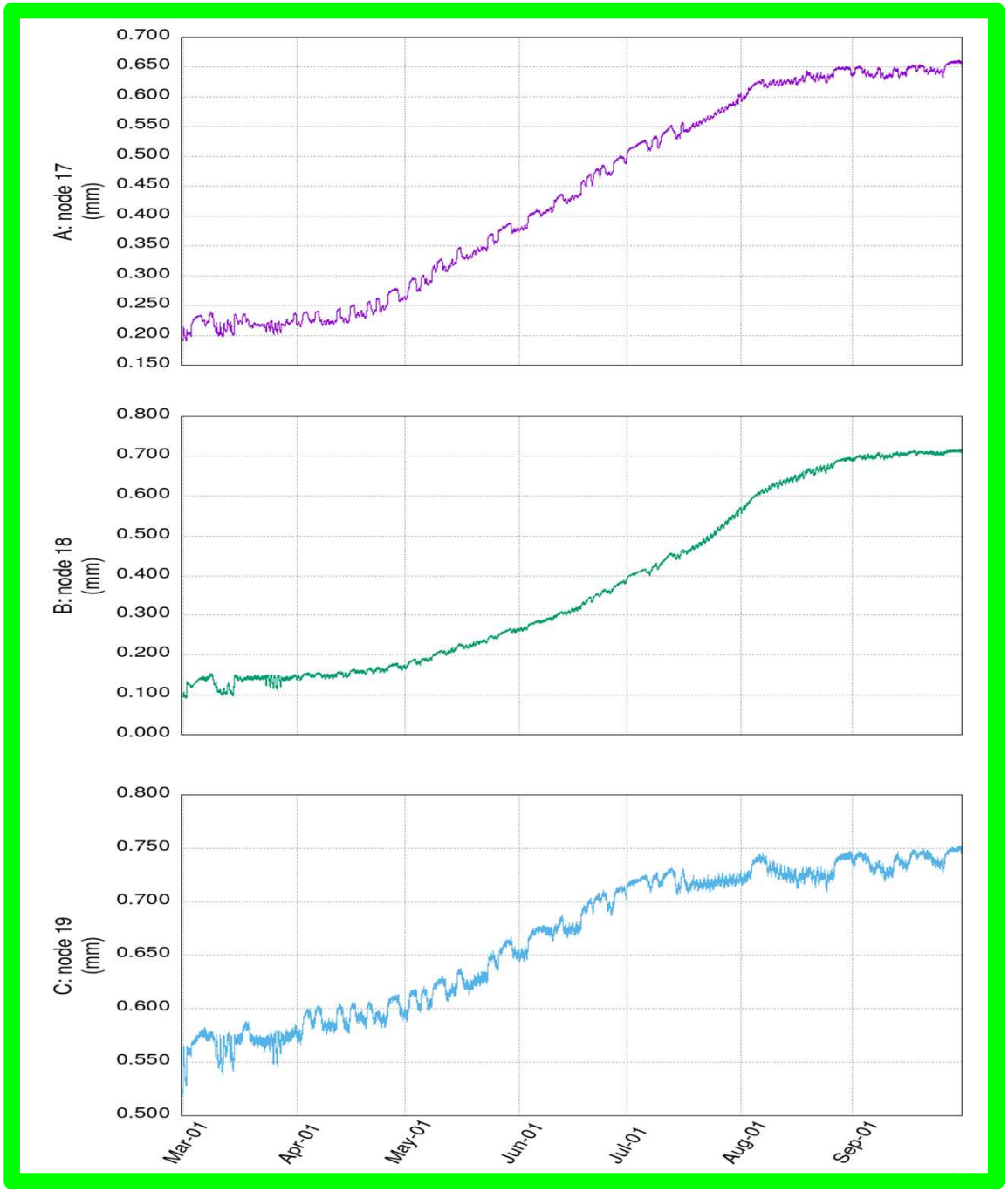
- the time when the radial growth initiated for the season;
- the time when the radial growth ceased for the season;
- the length of days for the radial growth for the season;
- the factors that are related to the initiation of radial increment for the season;
- the factors that are related to the fluctuation of radial increment for the season; and
- the factors that are related to the cessation of radial increment for the season.

- **The relationships among the factors at the forest site**

radial increment change during a growing season in 2016

data sensed and by 10 minutes interval

For Korean fir trees



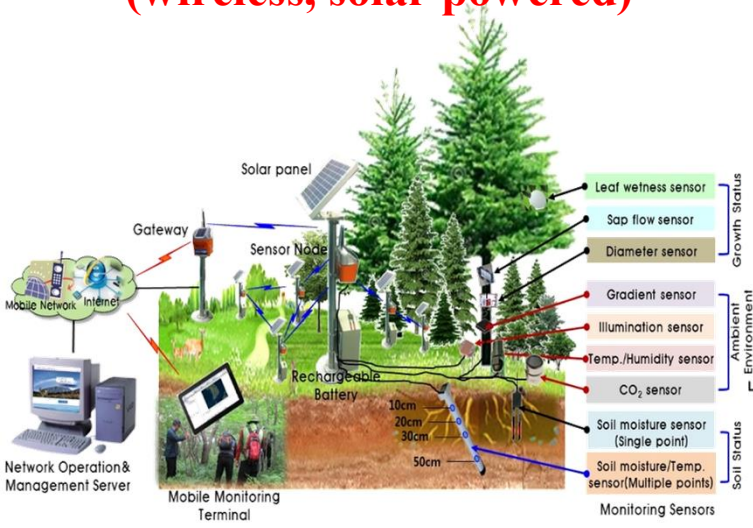
Statistical Correlation Analysis

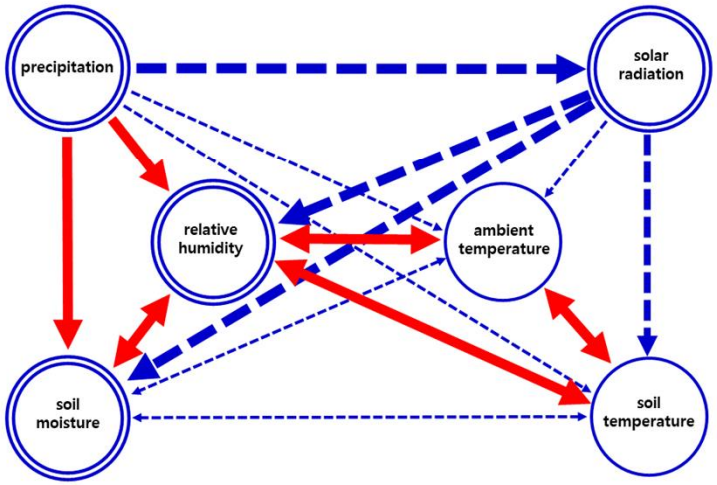
among the factors affecting the radial growth of trees

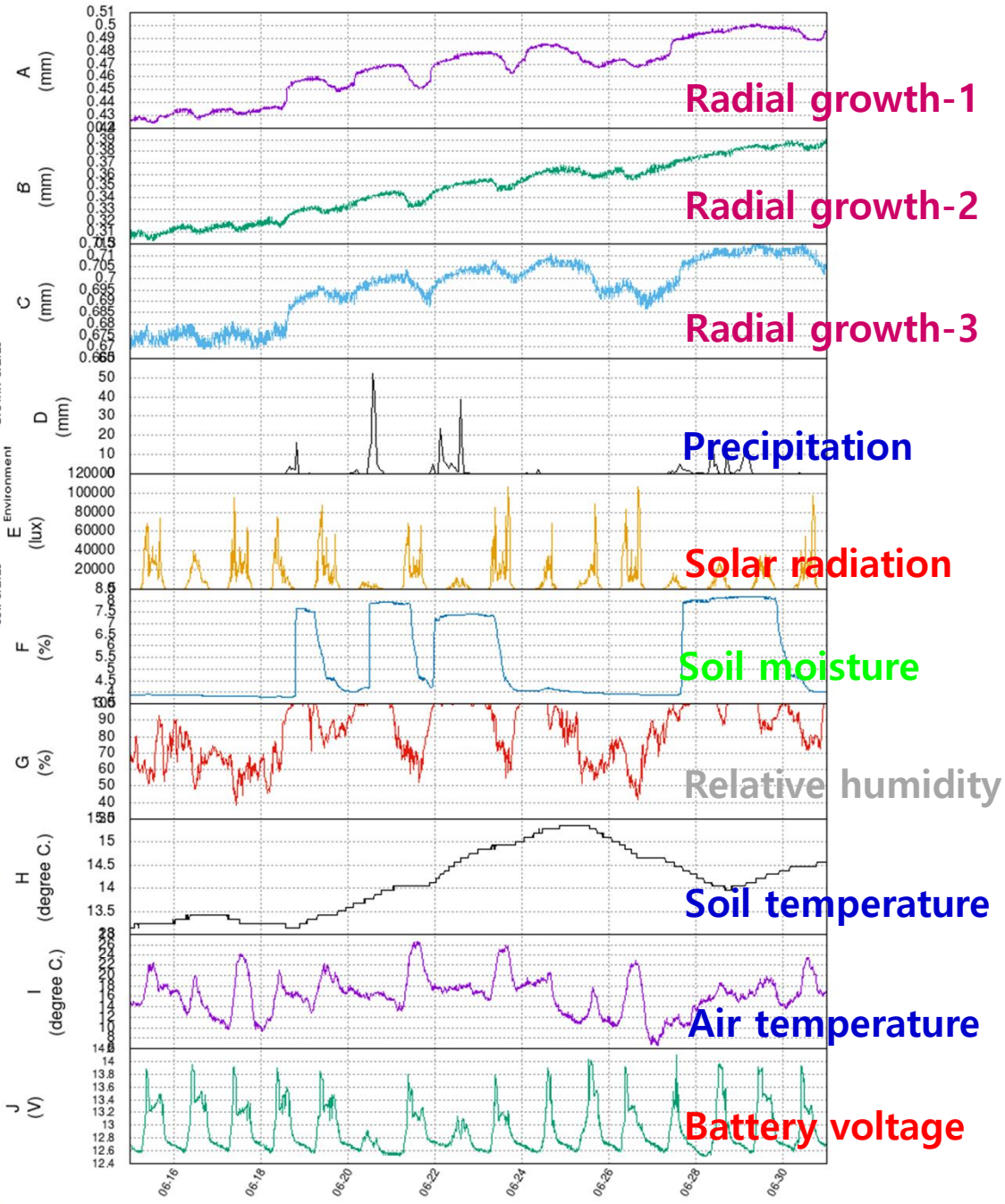
Table 1 Correlation coefficients and the levels of significances among the environmental factors

	Mean daily soil temp. at depth of 20 cm	Mean daily soil temp. at depth of 30 cm	Mean daily soil temp. at depth of 50 cm	Mean daily ambient temp.	Mean daily relative humidity	Mean daily solar radiation	Mean daily soil moist. Content at depth of 20 cm	Mean daily soil moist. Content at depth of 30 cm	Mean daily soil moist. Content at depth of 50 cm
Daily precipitation	−0.170	−0.148	−0.158	−0.144	0.363	−0.490	0.809	0.701	0.488
	$P = 0.05$	$P = 0.08$	$P = 0.06$	$P = 0.09$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$
Mean daily soil temp. at depth of 20 cm		0.976	0.941	0.961	0.456	−0.216	0.055	0.019	−0.158
		$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P = 0.01$	$P = 0.52$	$P = 0.83$	$P = 0.06$
Mean daily soil temp. at depth of 30 cm			0.989	0.907	0.506	−0.285	0.061	0.029	−0.180
			$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P = 0.001$	$P = 0.47$	$P = 0.73$	$P = 0.03$
Mean daily soil temp. at depth of 50 cm				0.863	0.503	−0.277	0.038	0.0098	−0.209
				$P < 0.0001$	$P < 0.0001$	$P = 0.001$	$P = 0.66$	$P = 0.91$	$P = 0.01$
Mean daily ambient temperature					0.377	−0.153	0.053	0.014	−0.174
					$P < 0.0001$	$P = 0.07$	$P = 0.53$	$P = 0.87$	$P = 0.04$
Mean daily relative humidity						−0.763	0.475	0.491	0.407
						$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$
Mean daily solar radiation							−0.545	−0.511	−0.387
							$P < 0.0001$	$P < 0.0001$	$P < 0.0001$
Mean daily soil moist. Content at depth of 20 cm								0.942	0.707
								$P < 0.0001$	$P < 0.0001$
Mean daily soil moist. Content at depth of 30 cm									0.758
									$P < 0.0001$

Real-time Monitoring System and the Sensor Network (wireless, solar powered)

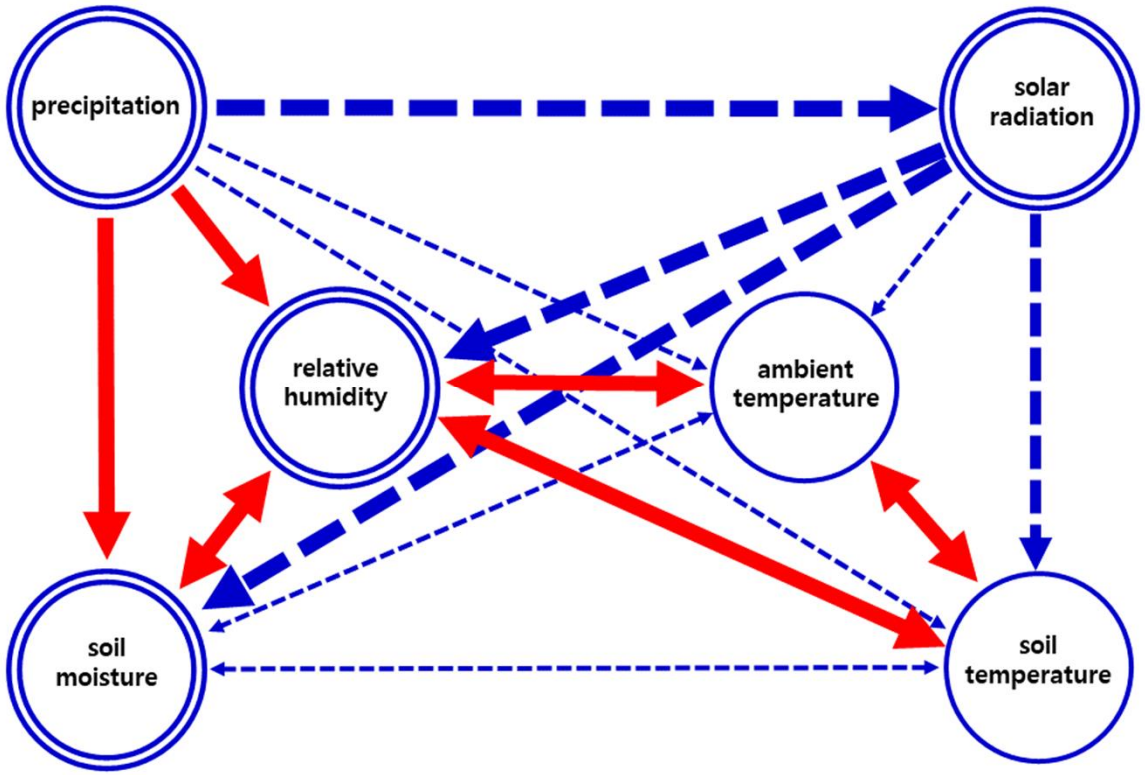






OUTCOME-1

Diagram showing the interrelationships among the environmental factors that affect the radial growth of trees at the study site, Jeju, Korea.



circles with double lines indicate abruptly fluctuating environmental factors; circles with single line indicate gradually changing environmental factors;

solid lines (in red) indicate positive effects; dashed lines (in blue) indicate negative effects;

thick lines indicate major and/or direct effects; thin lines indicate minor and/or indirect effects;

arrows show the directions of the affecting natures between the factors.

Real-time Monitoring System and the Sensor Network (wireless, solar powered)

OUTCOME-2

papers published:

Precision monitoring of radial growth of trees and micro-climate at a Korean Fir (*Abies koreana* Wilson) forest at 10 minutes interval in 2016 on Mt. Hallasan National Park, Jeju Island, Korea

https://jecoenv.biomedcentral.com/articles/10.1186/s41610-019-0117-4

Research | Open Access | Published: 28 May 2019

Precision monitoring of radial growth of trees and micro-climate at a Korean Fir (*Abies koreana* Wilson) forest at 10 minutes interval in 2016 on Mt. Hallasan National Park, Jeju Island, Korea

Eun-Shik Kim, Hong-Bum Cho, Daeyoung Heo, Nae-Soo Kim, Young-Sun Kim, Kyeseon Lee, Sung-Hoon Lee & Jaehong Ryu

Journal of Ecology and Environment **43**, Article number: 23 (2019) | Cite this article

809 Accesses | Metrics

Abstract

To understand the dynamics of radial growth of trees and micro-climate at a site of Korean fir (*Abies koreana* Wilson) forest on high-altitude area of Mt. Hallasan National Park, Jeju Island, Korea, high precision dendrometers were installed on the stems of Korean fir trees, and the sensors for measuring micro-climate of the forest at 10 minutes interval were also installed at the forest. Data from the sensors were sent to nodes, collected to a gateway wireless, and transmitted to a data server using mobile phone communication system. By analyzing the radial growth data for the trees during the growing season in 2016, we can estimate that the radial growth of Korean fir trees initiated in late April to early May and ceased in late August

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Sections Figures References

Abstract
Background
Methods
Results and discussion
Conclusions
Abbreviations
References
Acknowledgements
Author information
Ethics declarations
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About this article

OUTCOME-2

papers published:

Journal of Marine and Island Cultures (2016) 5, 68–78

Journal of Marine and Island Cultures

www.sciencedirect.com

Disturbed regeneration of saplings of Korean fir (*Abies koreana* Wilson), an endemic tree species, in Hallasan National Park, a UNESCO Biosphere Reserve, Jeju Island, Korea

Eun-Shik Kim [a,*], Choong Hyeon Oh [b], Hong Chul Park [c,1], So-Hee Lee [d], Junghwan Choi [d], Sung-Hoon Lee [e], Hong-Bum Cho [e], Wontaek Lim [d], Hyojung Kim [d], Young-Kyun Yoon [f]

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KEYWORDS

Decline;
Dwarf bamboo (*Sasa quelpaertensis* Nakai);
Frequency distribution;
JEJU Island;
Korean fir (*Abies koreana* Wilson);
Mt. Hallasan;
Regeneration;
Saplings;
Seedlings;
Siberian roe deer (*Capreolus pygargus* Pallas);
Stand dynamics;
Ungulate browsing

Abstract Limited knowledge is available on the regeneration of Korean fir (*Abies koreana* Wilson), an endemic plant species, growing on the upper part of Mt. Hallasan, a volcanic mountain, located in the central part of Jeju Island, Korea. A forest stand with the size of 1 ha dominated by Korean fir trees was established and all the trees with DBH 2 cm or larger were mapped and surveyed. Initial analysis indicated that the numbers of saplings with their DBHs between 2 cm and 10 cm were very small and that there was a big gap in the frequency of the number of saplings regenerated from the forest stand. It seems clear that the regeneration of the Korean fir trees was disturbed for longer than the last two decades, potentially by the browsing of the seedlings by ungulate including Siberian roe deer and by the physical hindrance of the dwarf bamboo to the development of the saplings of the Korean fir. Urgent measures and extensive studies are needed to promote the natural regeneration of the tree species on the dynamics of the forest regeneration and the mechanism of forest development of the forests on the Mt. Hallasan, Jeju Island, Korea.

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papers published:

Kim et al. Journal of Ecology and Environment (2017) 41:22
DOI 10.1186/s41610-017-0037-0

Journal of Ecology and Environment

RESEARCH Open Access

Disturbance in seedling development of Korean fir (*Abies koreana* Wilson) tree species on higher altitude forests of Mt. Hallasan National Park, the central part of Jeju Island, Korea

Eun-Shik Kim[1*], Jong-Won Lee[2], Im-Joon Choi[1], Wontaek Lim[2], Junghwan Choi[2], Choong Hyeon Oh[3], Sung-Hoon Lee[4] and Young-Sun Kim[1]

Abstract

Background: Natural regeneration of seedlings as well as saplings of Korean fir has been significantly impacted by the browsing from the early stages of their development, potentially, by roe deer for the last two to three decades at the study site since late 1980s. This study was carried out to investigate current status of the disturbance in the seedling development of Korean fir (*Abies koreana*) on Mt. Hallasan, Jeju Island, Korea.

Methods: Field survey was carried out during June and August in 2016 to measure the characteristics of study site and understory vegetation by applying systematic sampling to 125 plots of 5 m × 5 m quadrat located on eastern slope of the mountain. Correlation and regression analyses were applied to the variables quantified from the data sets using the SAS software.

Results: No saplings with their diameters at breast heights smaller than 5.0 cm were found at the study site indicating the serious disturbance in the natural regeneration of Korean fir at the study site. No seedlings with their heights taller than 36.0 cm were found at the study site indicating even more serious disturbance during earlier stage of the natural regeneration of Korean fir at the study site. A total of 616 individuals of the seedlings of Korean fir were found at 54 out of 125 sampling plots. One hundred thirty-eight seedlings (22.4%) out of 616 individual seedlings have the vestiges for being grazed, potentially, by roe deer.

Conclusions: Due considerations should be given to the effects of browsing of the seedlings by roe deer to promote the natural regeneration of Korean fir, ultimately to restore Korean fir. It is needed for the managers of the forest to install fences around the forest area. Exclosure experiments as well as enclosure experiments of different densities of browsing should be carried out. In addition, treatment with different densities of Jeju dwarf bamboo should also be included in the experiment on Mt. Hallasan National Park, Jeju Island, Korea.

Keywords: Browsing, Disturbance, Korean fir, Regeneration, Seedling development, Roe deer

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[1]Department of Forestry, Environment, and Systems, Kookmin University, Seoul 02707, Republic of Korea
Full list of author information is available at the end of the article

OUTCOME-3

Understanding on the disturbed regeneration of Korean fir saplings & seedlings

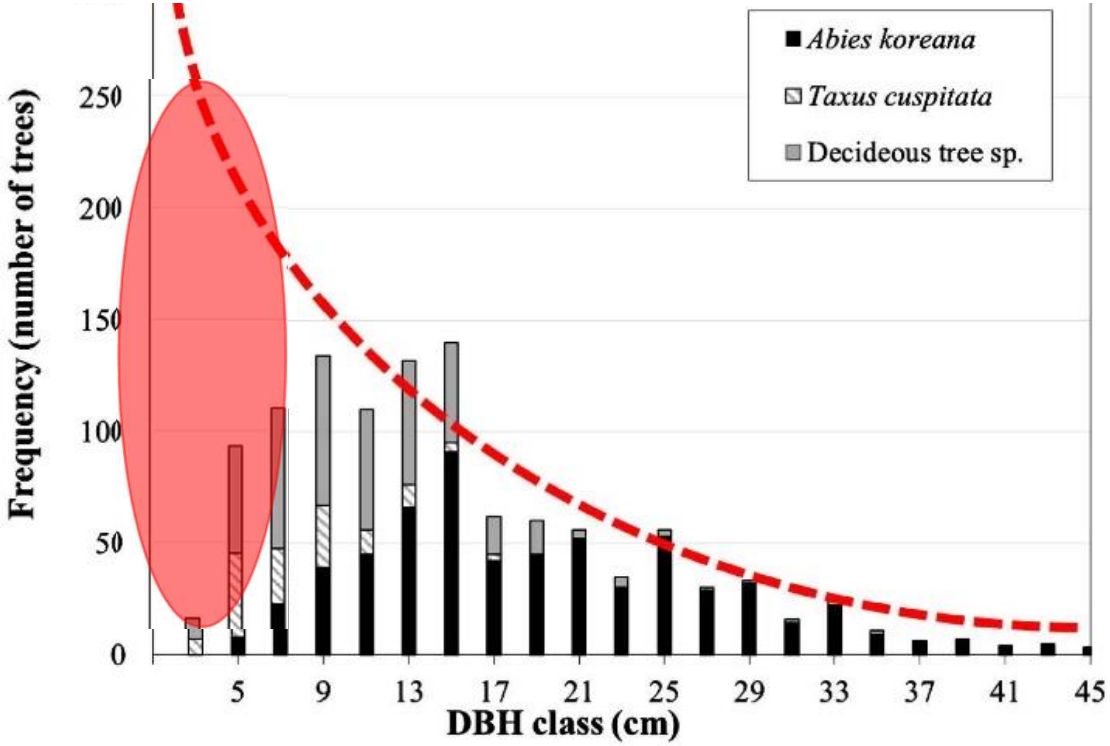
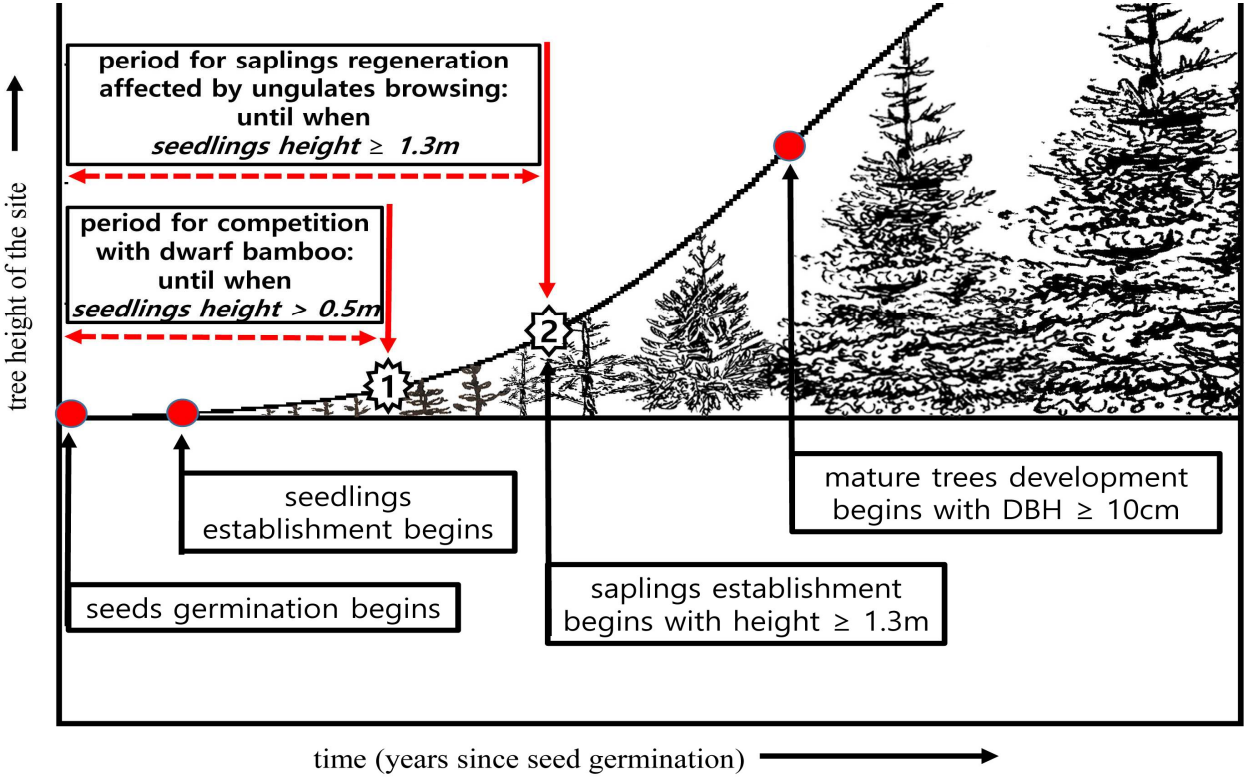


Fig. 3 A cumulative frequency distribution for the number of trees for Korean fir, Japanese yew and other deciduous hardwood species combined by DBH class at the study site near Jindallaebat Shelter area on Mt. Hallasan, Jeju Island, Korea. In order to suggest a hypothetical frequency distribution of trees at a multi-layered natural forest without major disturbances, an imaginary reverse-J shaped curve (dotted negative exponential curve) was superimposed.

Understanding on the disturbed regeneration of Korean fir saplings & seedlings

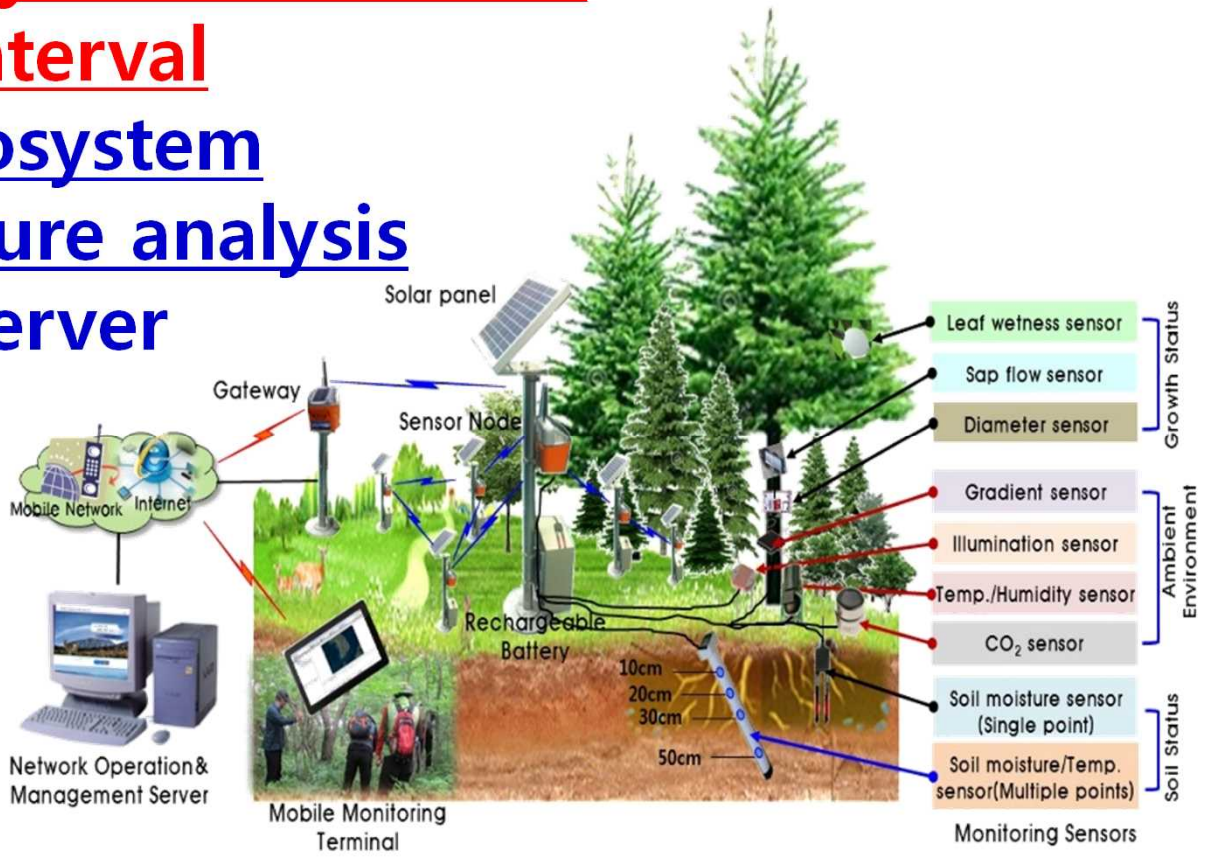


A schematic diagram showing the stand dynamics of the Korean fir trees

Two important time periods for the successful regeneration of Korean fir trees on Mt. Hallasan from the seed germination on the ground at the site to the maturing stages at the forest stand

OUTCOME-4

real-time data on radial growth of trees
and the environmental change
including climate data
for the last few years since 2015
at 10 minutes interval
at the forest ecosystem
available for future analysis
in a computer server

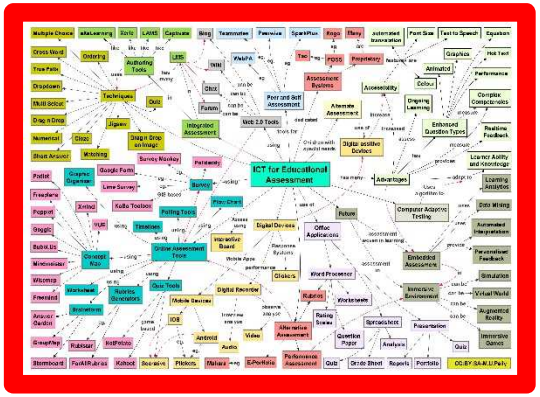


OUTCOME-5

The monitoring system was agreed to be further managed by the National Park Research Institute of Korea for continuous monitoring in the future

ICT: information and communications technology

(wikipedia)



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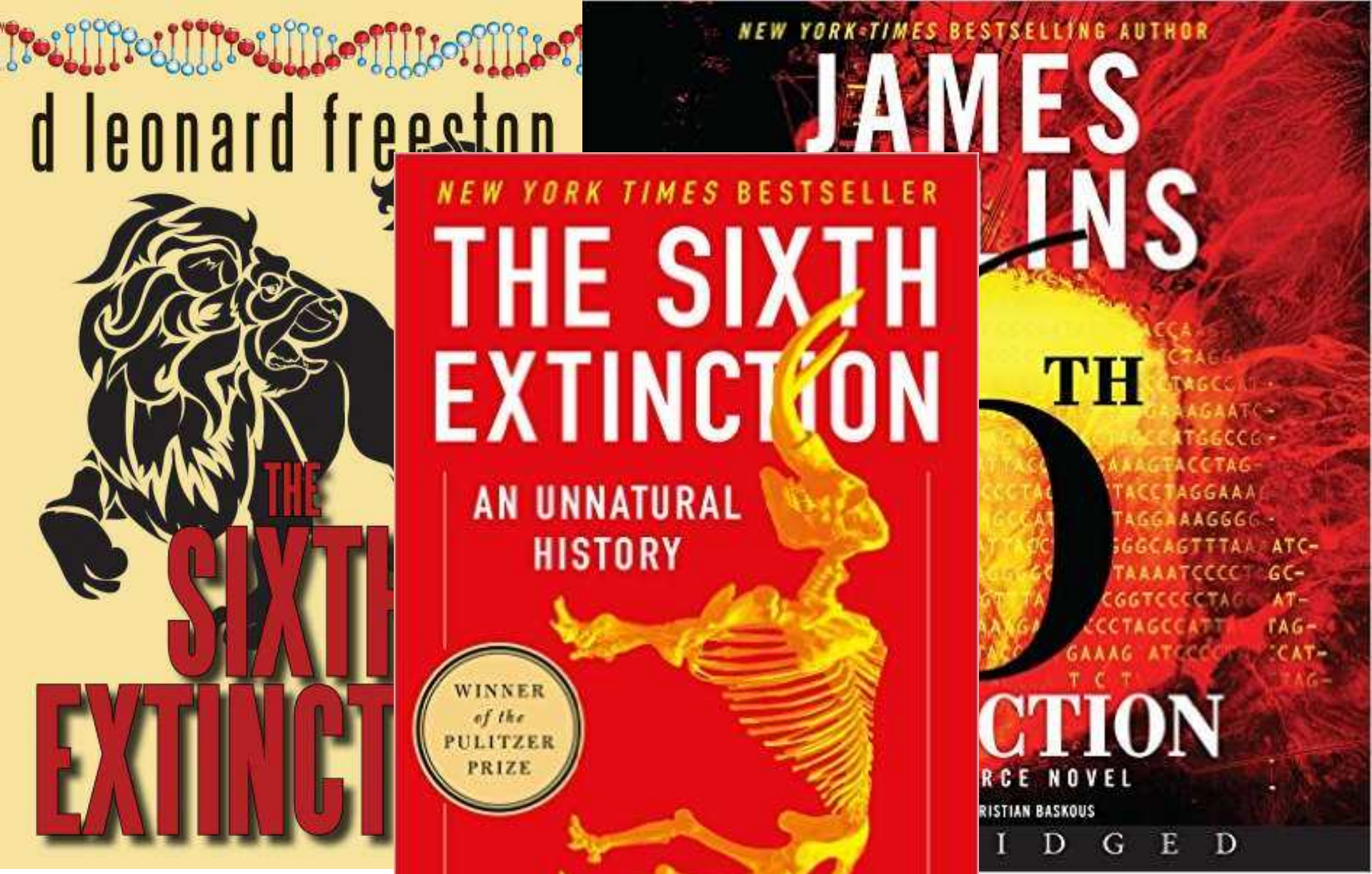
information technology (IT) that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage and audiovisual, that enable users to access, store, transmit, and manipulate information

Sequence of Presentation-3

- Declining forests of Korea Fir (*Abies koreana*) on the higher altitude area of Mt. Hallasan, Jeju Island, Korea
- A real-time ecological observation platform to monitor the changes of a forest ecosystem aided by the ICT (Information and Communication Technology)
- **Challenges and opportunities in observation of biodiversity, ecosystems, and ecological sustainability**

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015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Millennium Ecosystem Assessment Findings

www.millenniumassessment.org | Strengthening Capacity to Manage Ecosystems Sustainably for Human Well-Being

Millennium Ecosystem Assessment

MA Findings - Outline

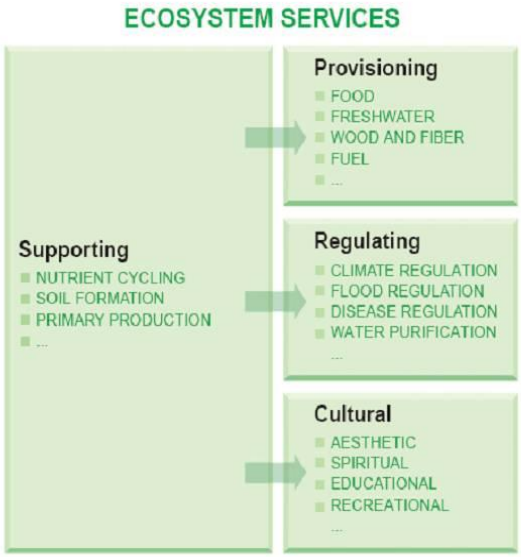
1. **Ecosystem Changes in Last 50 Years**
2. **Gains and Losses from Ecosystem Change**

   Three major problems will decrease long-term benefits
   - Degradation of Ecosystem Services
   - Increased Likelihood of Nonlinear Changes
   - Exacerbation of Poverty for Some People
3. **Ecosystem Prospects for Next 50 Years**
4. **Reversing Ecosystem Degradation**

Millennium Ecosystem Assessment

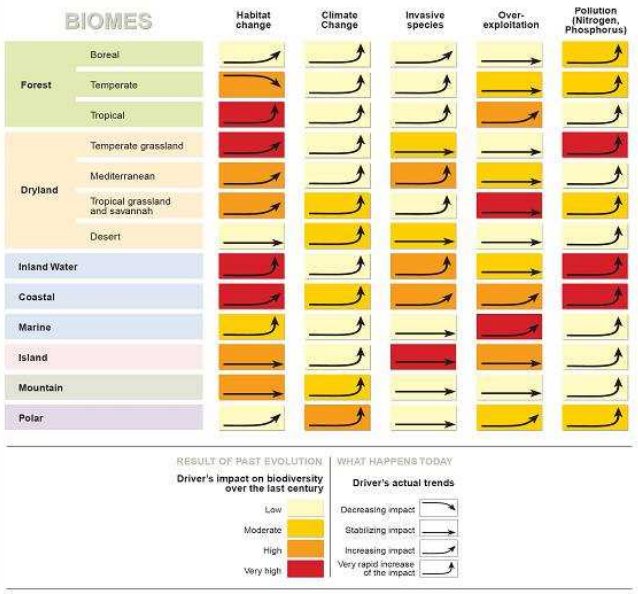
Focus: Ecosystem Services

The benefits people obtain from ecosystem



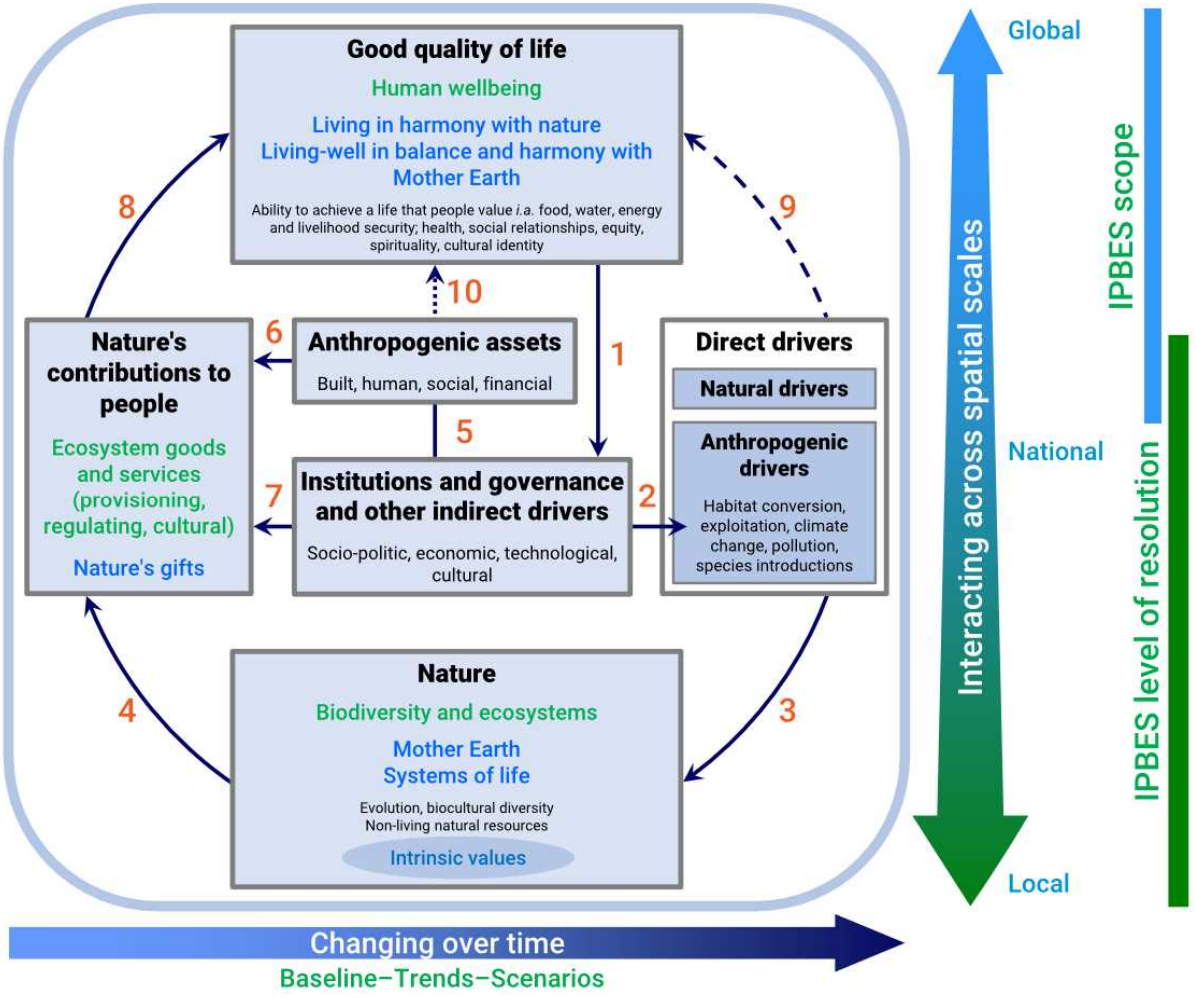
Millennium Ecosystem Assessment

Direct drivers growing in intensity



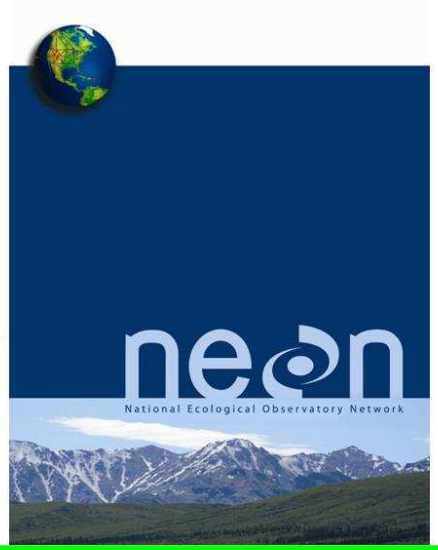
Most direct drivers of degradation in ecosystem services remain constant or are growing in intensity in most ecosystems

IPBES and its Conceptual Framework



US NEON Science Strategy

Enabling Continental Scale Ecological Forecasting



Source : US NEON Inc.

US NEON Science Strategy

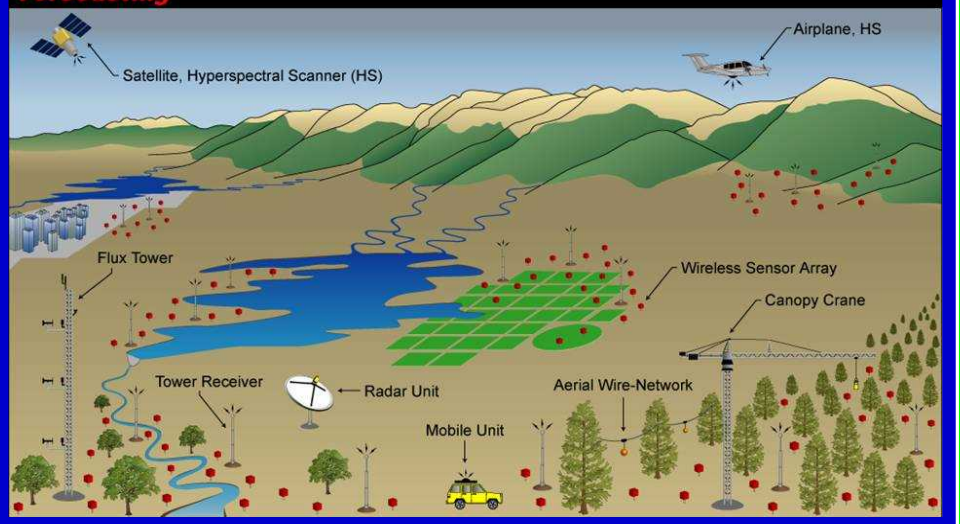
Enabling Continental Scale Ecological Forecasting

Source : US NEON Inc.

Enabling Continental Scale Ecological Forecasting

NEON Infrastructure Overview

Source : US NEON Inc.



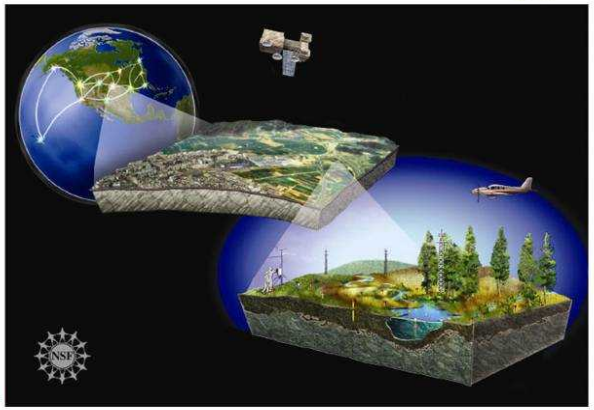
US NEON Science Strategy

LUAP

AOP

FIU

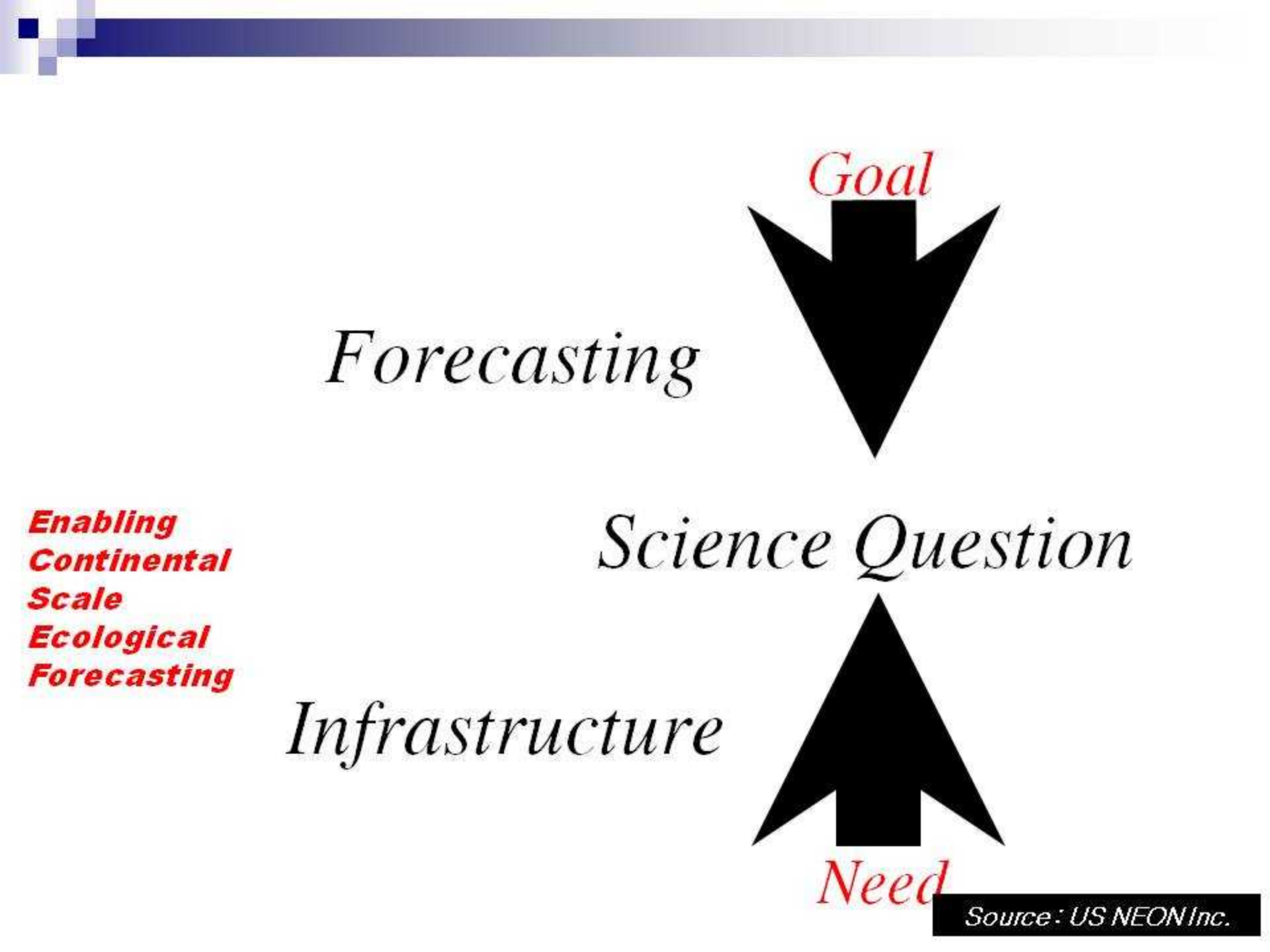
FSU



Ecological Forecast Models

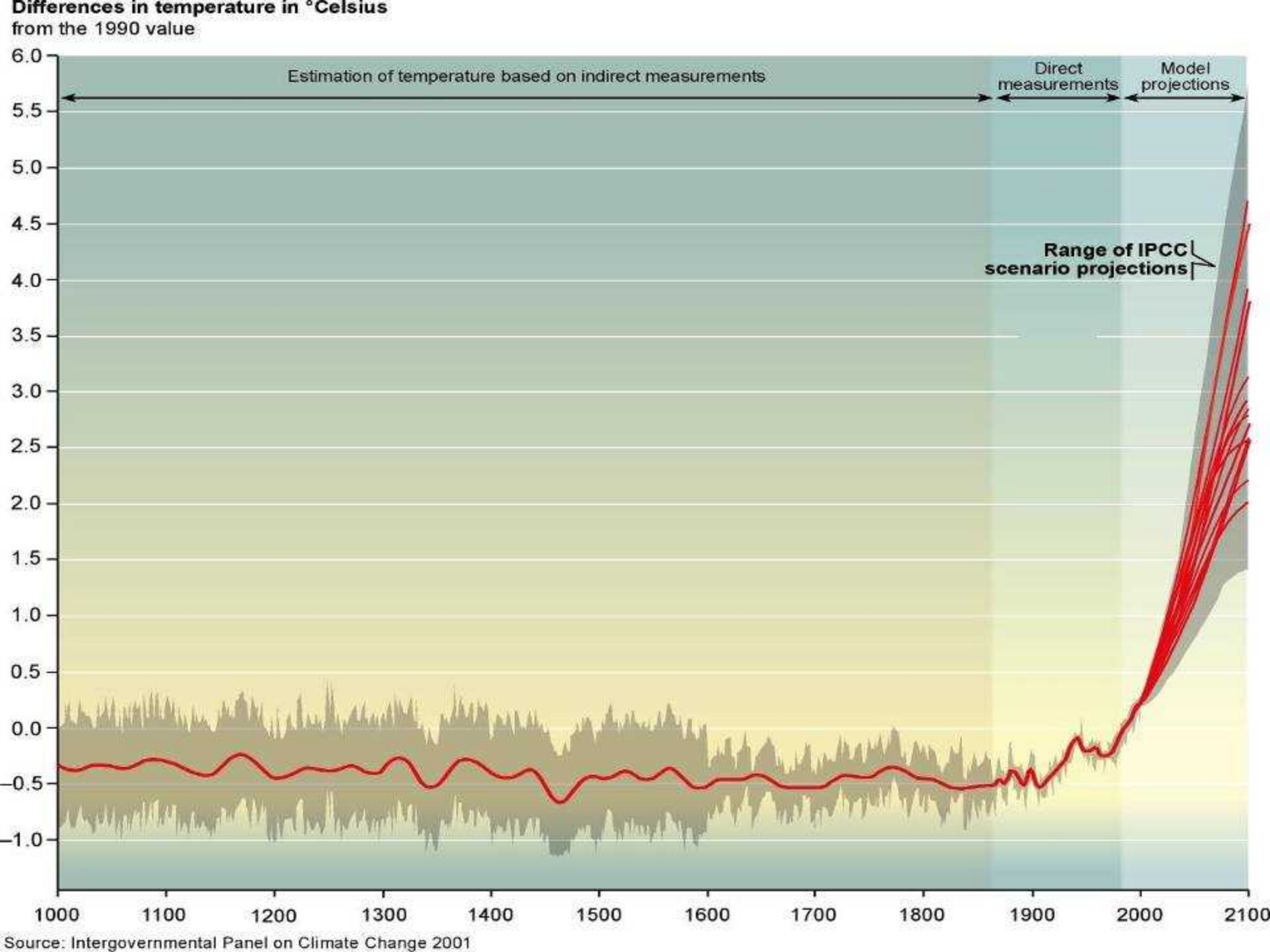
Enabling Continental Scale Ecological Forecasting

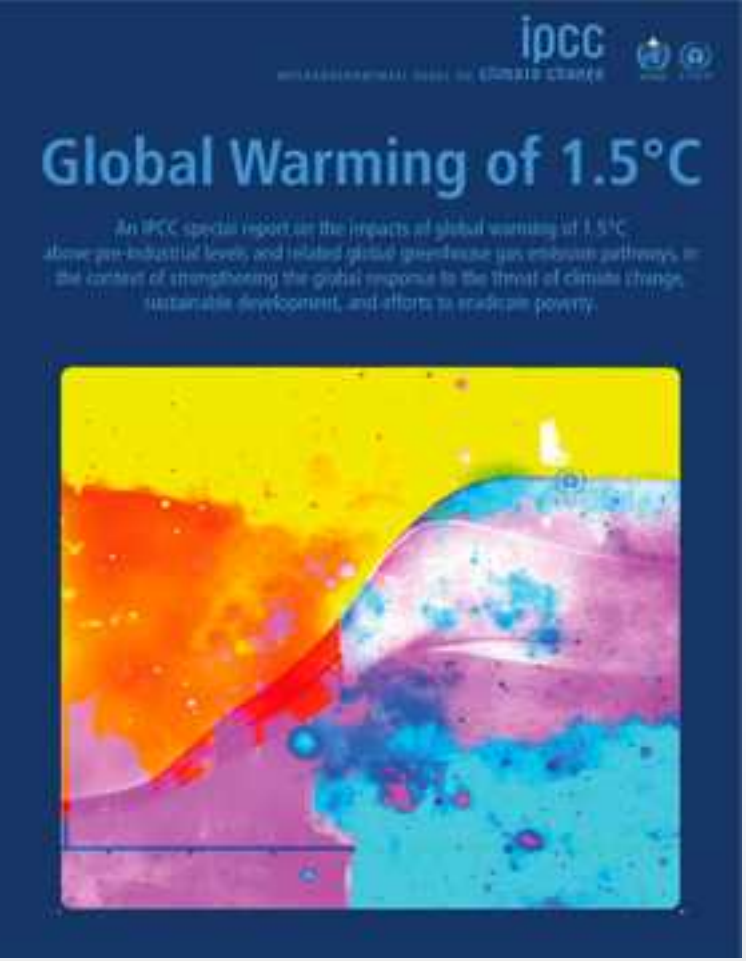
Source : US NEON Inc.



Enabling Continental Scale Ecological Forecasting

Source : US NEON Inc.

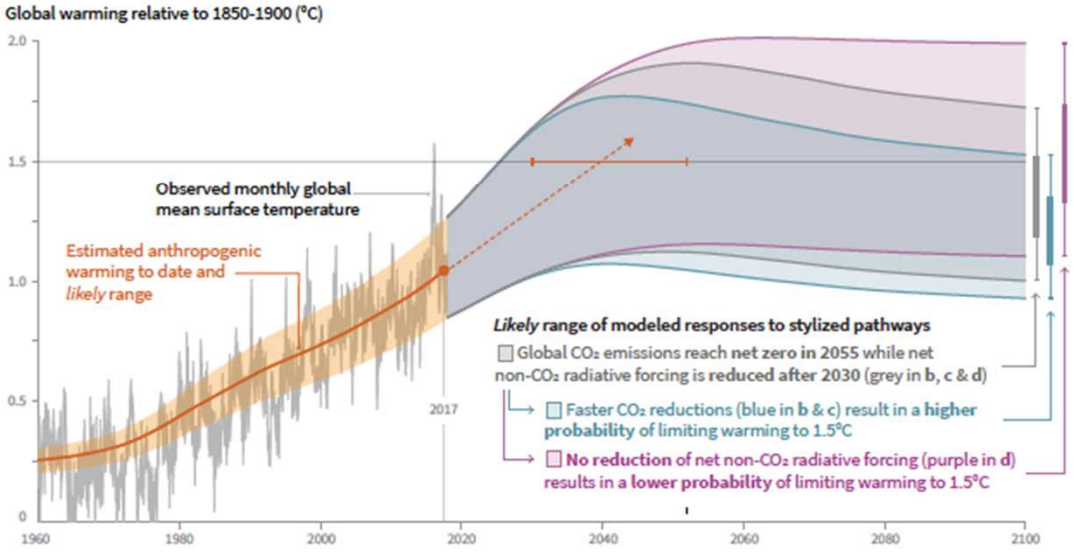

Differences in temperature in °Celsius
from the 1990 value
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
Estimation of temperature based on indirect measurements
Direct measurements
Model projections
Range of IPCC scenario projections
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
Source: Intergovernmental Panel on Climate Change 2001



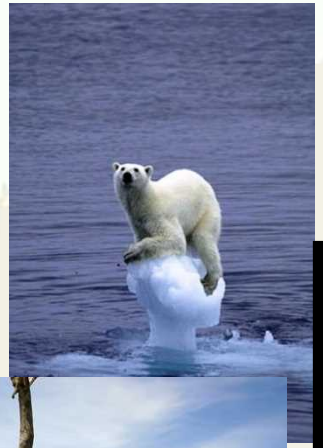
IPCC says limiting global warming to 1.5 °C will require drastic action

Cumulative emissions of CO_2 and future non-CO_2 radiative forcing determine the probability of limiting warming to 1.5°C

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways

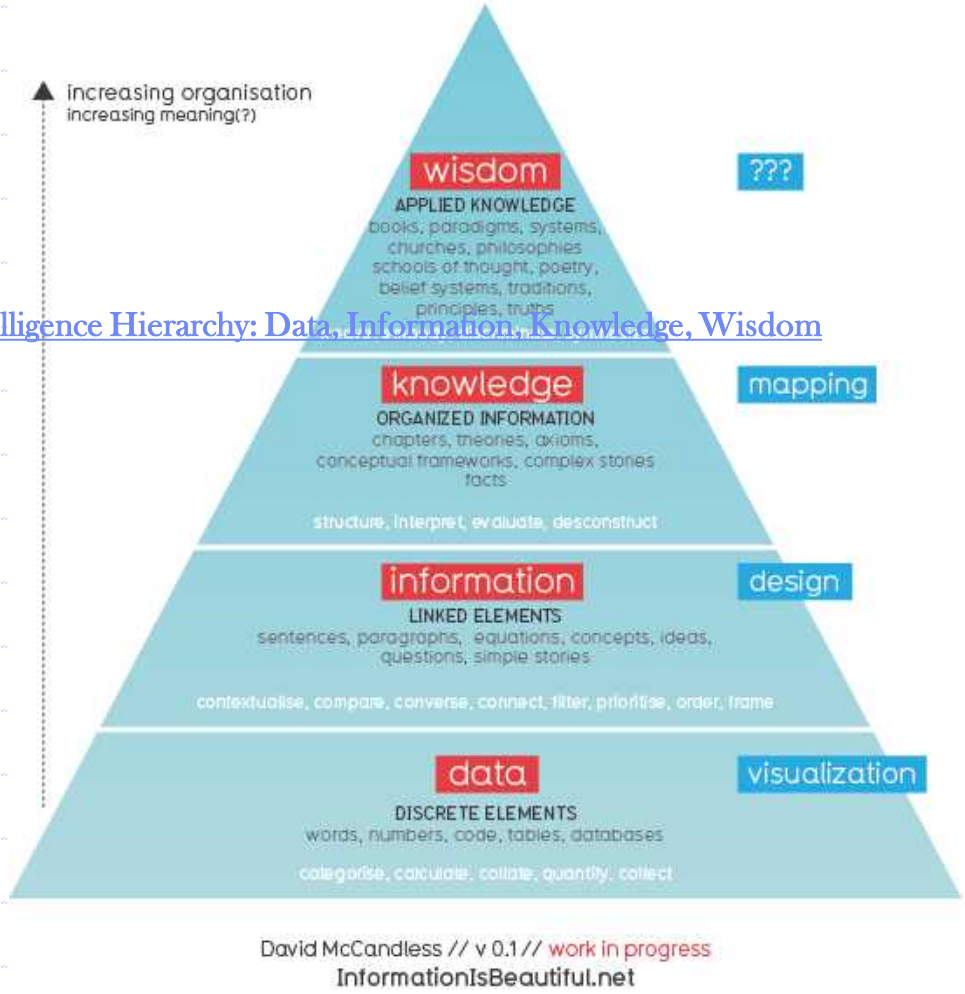


Disasters Human Species Faces



COVID-19

Challenge: Bottom Up Scheme of Intelligence Hierarchy: Data -> Information -> Knowledge -> Wisdom



- Intelligence Hierarchy: Data, Information, Knowledge, Wisdom

•**http://www.ritholtz.com/blog/2010/12/hierarchy-of-visual-knowledge/**

Photo: Eun-Shik Kim

Identifying and sharing the vision and strategies

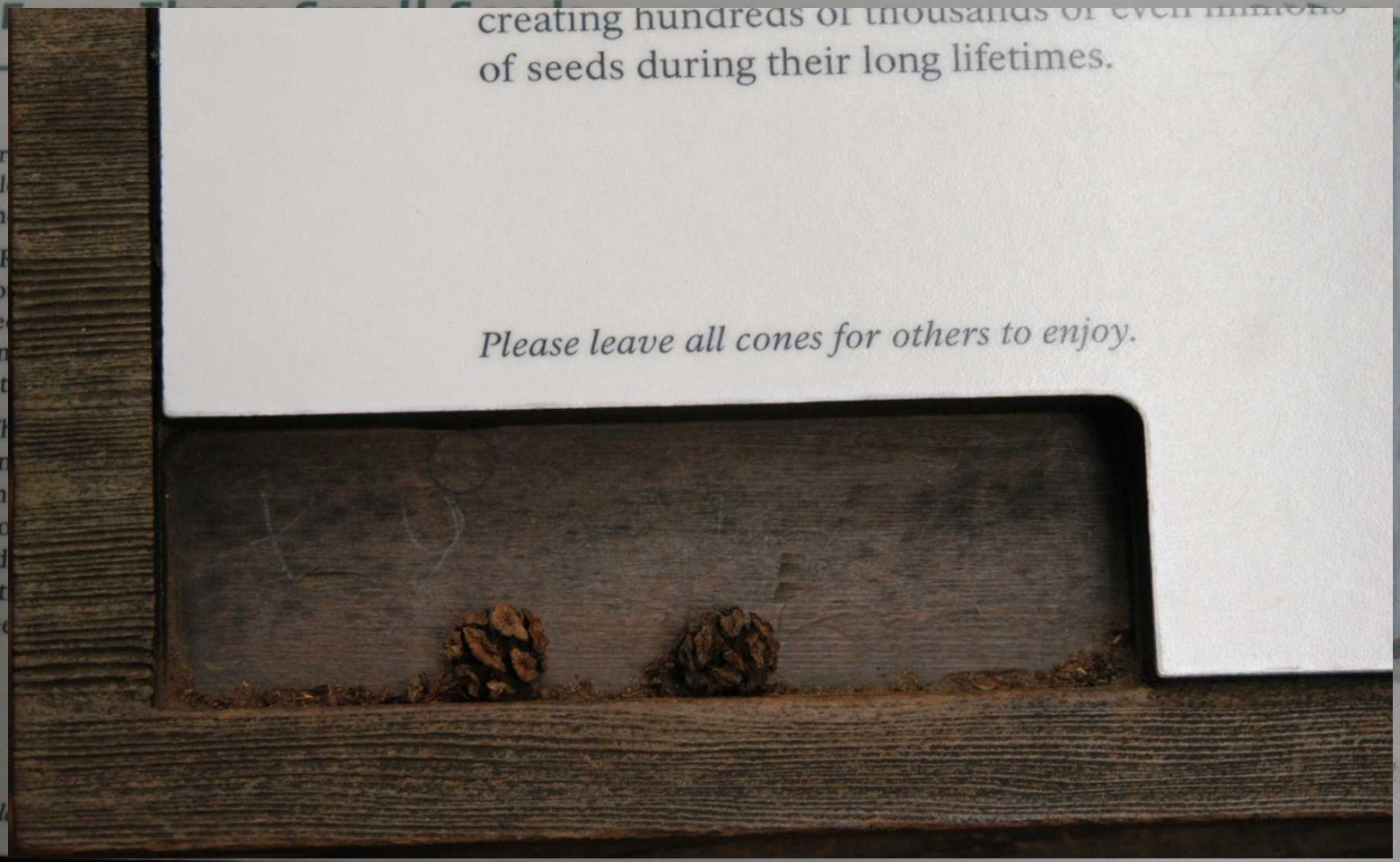
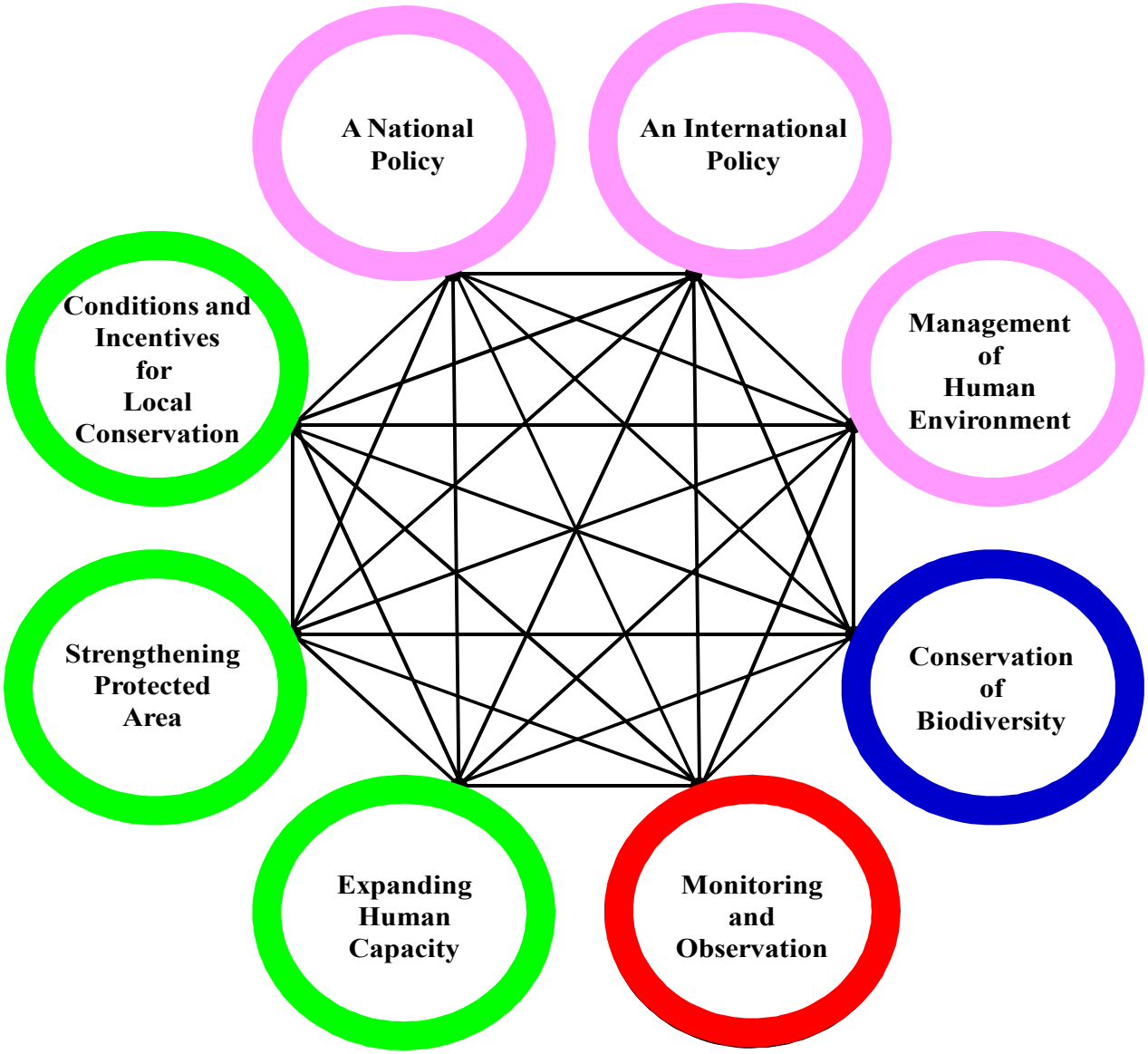


Photo: Eun-Shik Kim



Eight strategy areas for catalyzing action for the conservation of biodiversity

(ES Kim, 2012)

Sequence of Presentation-0

- **Declining forests of Korea Fir (*Abies koreana*) on the higher altitude area of Mt. Hallasan, Jeju Island, Korea**
- **A real-time ecological observation platform to monitor the changes of a forest ecosystem aided by the ICT (Information and Communication Technology)**
- **Challenges and opportunities in observation of biodiversity, ecosystems, and ecological sustainability**

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- Jeju Special Self-Governing Province
- Biodiversity Center of Japan
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- NRF (National Research Foundation) of Korea, formerly KOSEF (Korea Science and Engineering Foundation)
- US National Science Foundation
- ECO-COPs & Friends
- Kookmin University


Thank you, all!

Short CV of Eun-Shik Kim

Eun-Shik Kim is currently a Professor Emeritus at Kookmin University, Seoul, Korea and is serving the International Association for Ecology (INTECOL) as President.

He earned his undergraduate and M.S. degrees in forest science from Seoul National University, Korea and M.S., M.Phil., and Ph.D. degrees on Forestry and Environmental Studies from Yale University, USA. He worked for the National Institute of Forest Science and the National Institute of Environmental Research before he moved to Kookmin University in 1991.

For more than the last two decades, he has been working with the International Long-Term Ecological Research (ILTER) Network at global as well local level and served the East Asia-Pacific Regional Network of ILTER (ILTER-EAP) as the Chair. In addition, he contributed to the Asia-Pacific Biodiversity Observation Network (APBON) as a co-chair. He also served the Ecological Society of Korea (ESK) and the East Asian Federation of Ecological Societies (EAFES) as President.

In addition to his efforts in networking research and people, his research theme covers the changes of biodiversity and ecosystem function under changing climate and environment. Domestically, he is interested in establishing ecosystem observation platforms in Korea.

6th APBON Web seminar
15:00-17:00 (GMT+9:00)
25 February 2021
Cisco Webex Meeting

Ecological observation of the declining Korean fir forest on the higher altitude area of Mt. Hallasan National Park, Jeju Island, Korea, under changing climate aided by the ICT (information and communications technology)

Eun-Shik Kim, PhD
Professor Emeritus, Kookmin University, Seoul, Korea
President, International Association for Ecology (INTECOL)
An immediate past Co-Chair of APBON