KEYNOTE 01

Over New Horizon for One Korea together in Agricultural and Forest Meteorology

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Agricultural and forest ecosystems are evolving for best adapt to the rapidly changing natural and human environments in which climate change is superimposed on other stresses, thereby creating more new challenges. This paradigm is facing diverse challenges in science and technology for agricultural and forest meteorological services from farming to Earth Systems. Accordingly, agricultural meteorologists are being asked to address the interactions between human influences, ecological processes, and landscape dynamics that impact many diverse aspects of managing complex coupled human-nature systems, especially in the framework of sustainability science.

Agricultural sustainability is difficult to define and to measure. Along with biophysical indicators, a comparable set of economic and social indicators still needs to be developed. An important additional dimension is how to design monitoring and assessing systems to track the impacts of the management and the policy interventions, and to assess whether or not these are contributing towards sustainability. Key questions are related to system vulnerability, resilience, adaptation, feedback processing, cycling, non-linearities, and other complex behaviors, which should be addressed by employing trans-disciplinary framework to data collection and analysis in a holistic way (e.g., life cycle analysis, information theory, network science, big data, etc.). How to implement better agrometeorological research, education and services for agricultural and forest sustainability requires radical efforts to ongoing paradigm shift from classical mono-discipline to multi-discipline to inter-discipline to trans-discipline in particular by considering emerging new horizon for one Korea.

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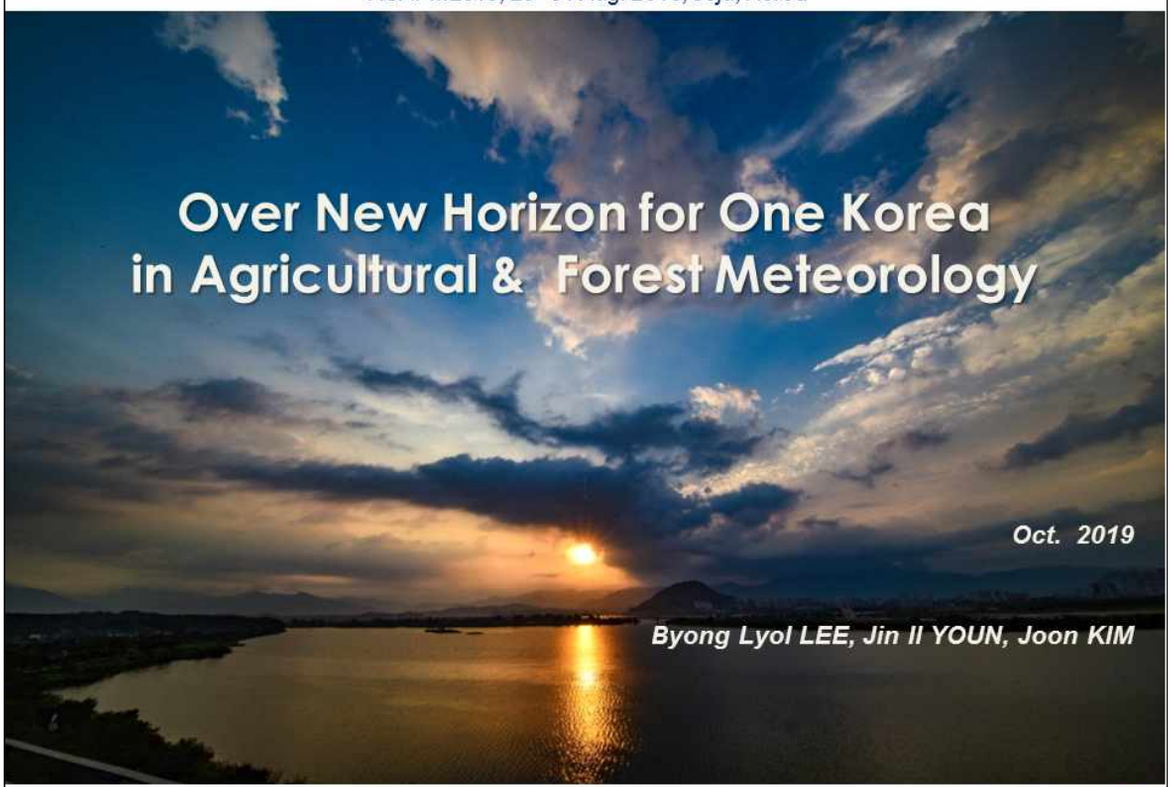
KSAFM2019, 29~31 Aug. 2019, Jeju, Korea



Photos by Jaiho OH

AgroEcosystem - Functions/Services

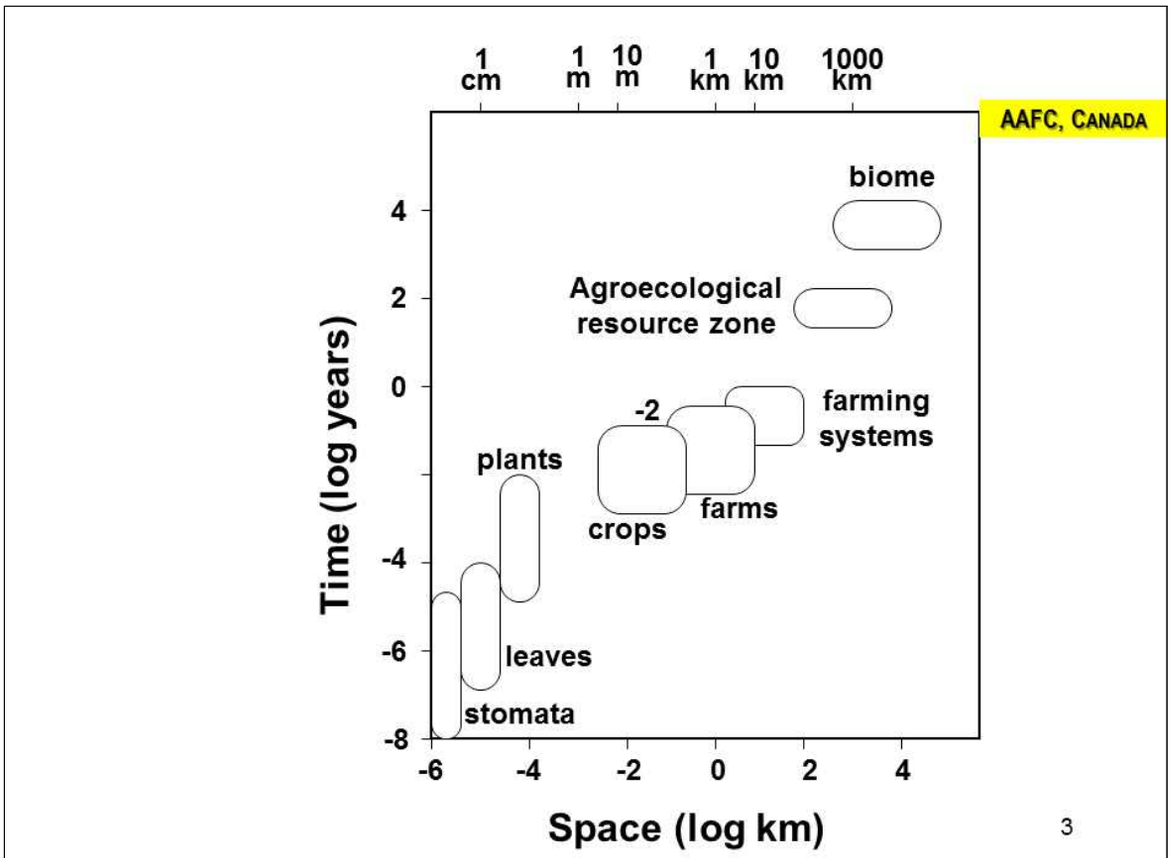
❖ **AgroEcosystem** ***(Elliott and Cole, 1989)***

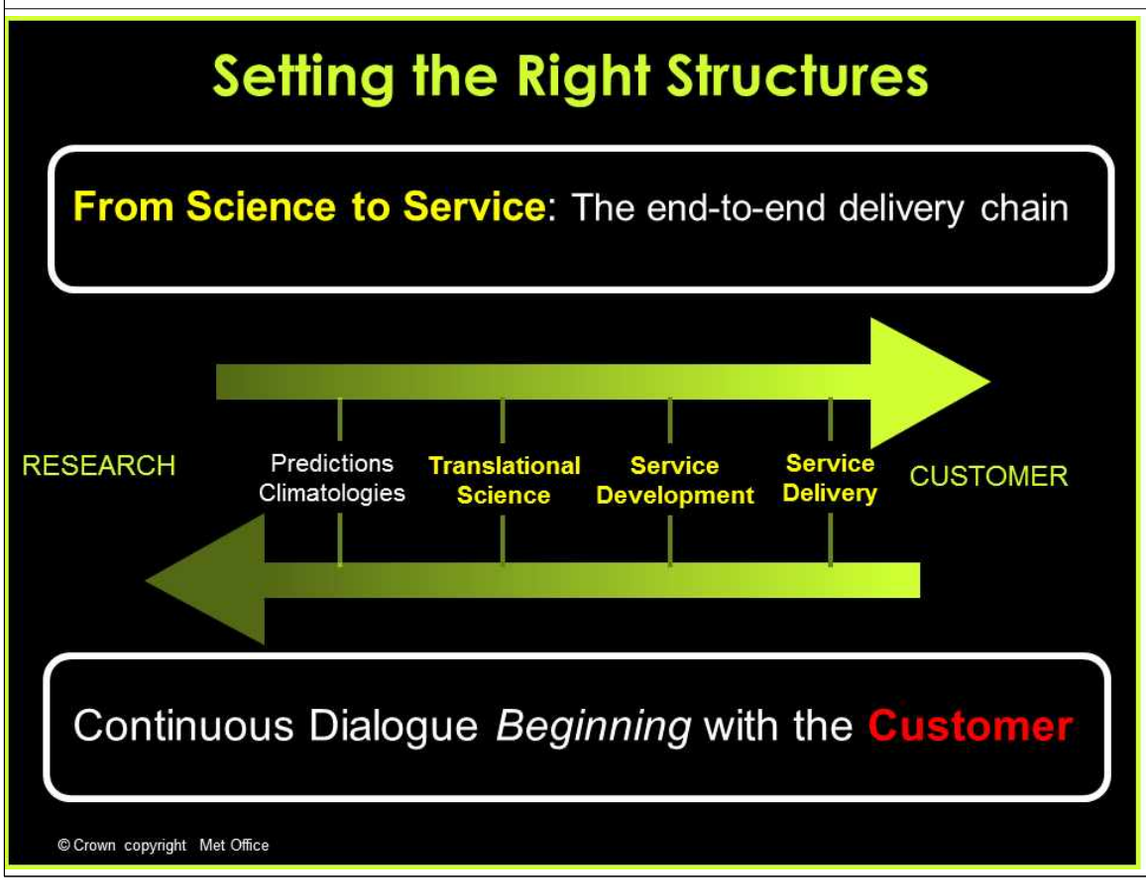
- an interactive group of **biotic and abiotic** components
- some of which are **under human control**
- that forms a **unified whole (ecosystem)**
- for the purpose of **producing food and fiber**

❖ **Agriculture & Forestry** can also provide **non-commodity** outputs, some of which **benefit the public** without compensating the farmer.

Non-commodity outputs (***public services***) by farms include both

- **ecological functions**
  (e.g. biodiversity, nutrient cycling, and carbon sequestration) and
- **cultural functions**
  (e.g. recreation, cultural heritage, and visual quality/amenity)


1 cm
1 m
10 m
1 km
10 km
1000 km
AAFC, CANADA
biome
Agroecological resource zone
farming systems
-2
plants
farms
crops
leaves
stomata
Time (log years)
Space (log km)
4
2
0
-4
-6
-8
-6
-4
-2
0
2
4
3


Setting the Right Structures
From Science to Service: The end-to-end delivery chain
RESEARCH
Predictions
Climatologies
Translational Science
Service Development
Service Delivery
CUSTOMER
Continuous Dialogue Beginning with the Customer
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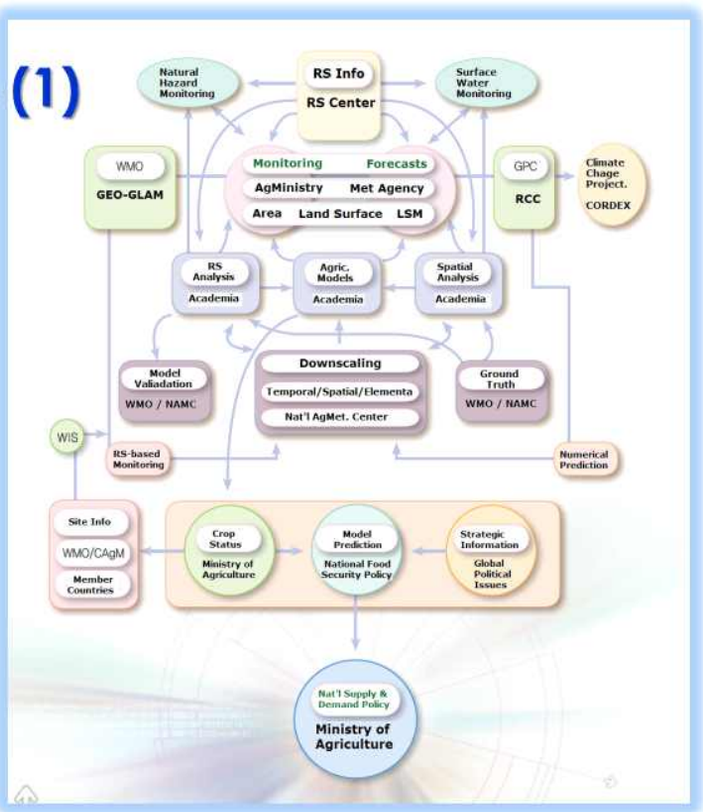
KEYNOTE 01

emerging Climate Services:
A revolution in the application of Climate Science

by Julia Slingo, Met Office, UK

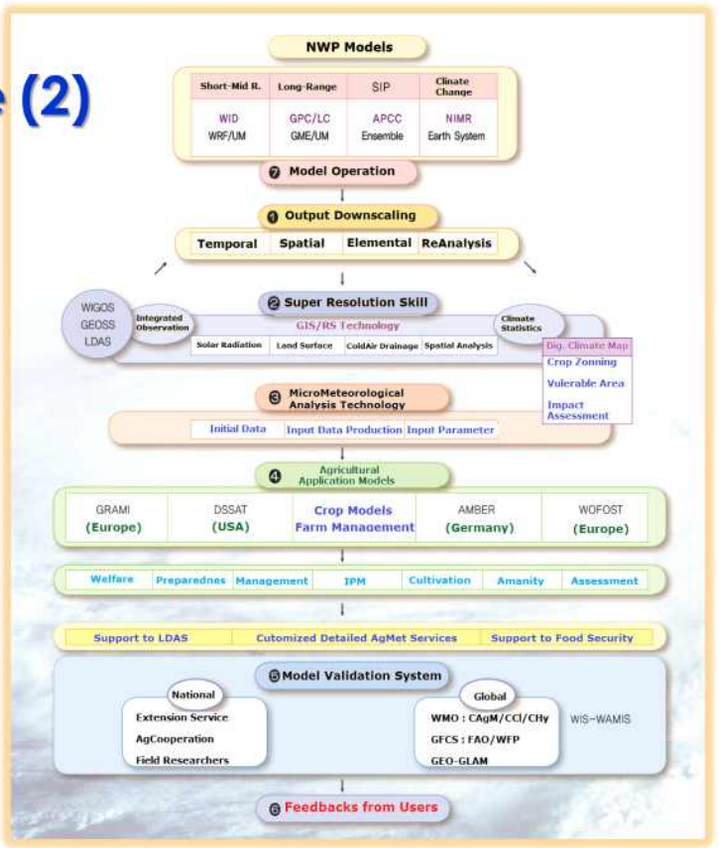
1) From mitigation to **mitigation** and **adaptation**
2) Climate change to **climate change** and **climate variability**
3) Global, century-scale scenarios to **regional predictions, days to decades** ahead
4) Global climate to characteristics of **hazardous weather** and **climate extremes**
5) From few to **many customers** – public, governments, business and industry
6) **Operational delivery** – from IPCC Assessment Reports to updated **monitoring, forecasts, products** and **services**

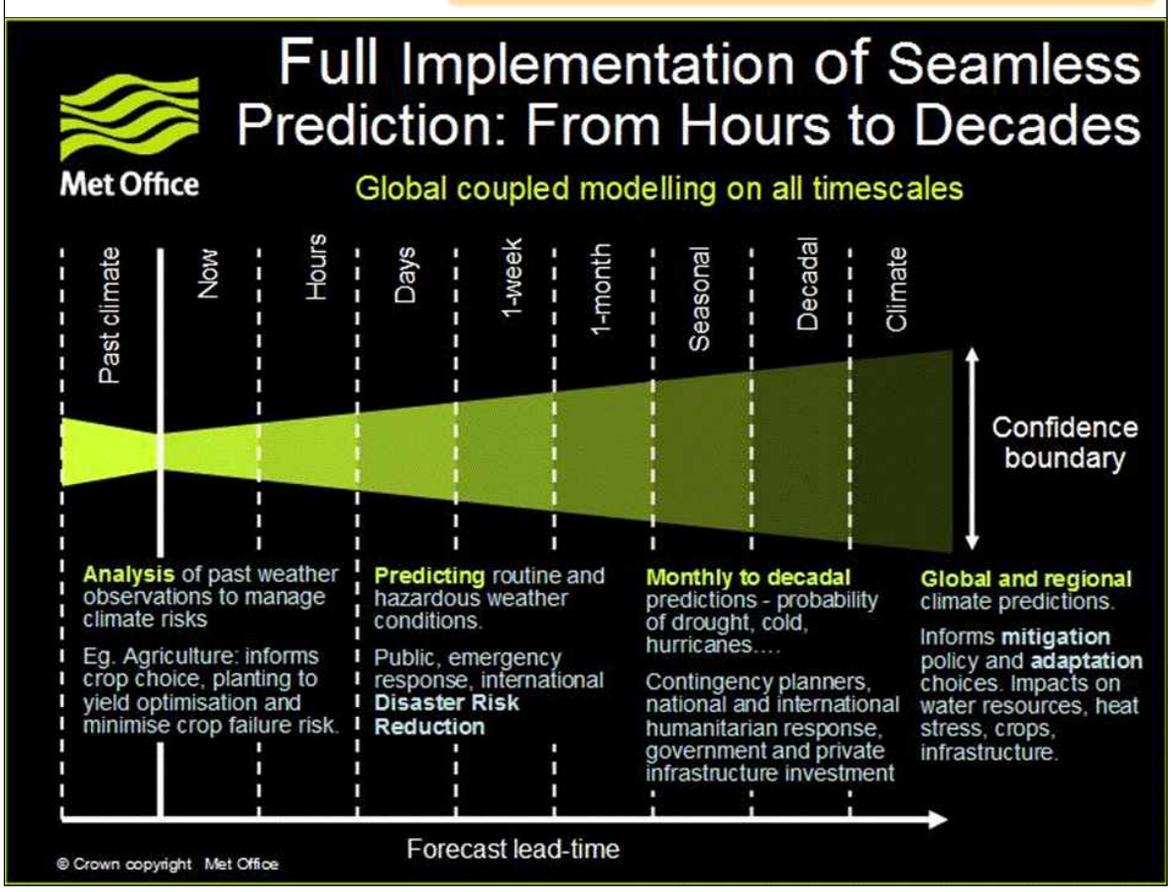
Climate Service (1)
(RS-based) Nowcasting Service Scheme (WIGOS,DRR)



Climate Service (2)

NWP-based (Long-range) Service Scheme (GFCS, S2S)





Earth System Science

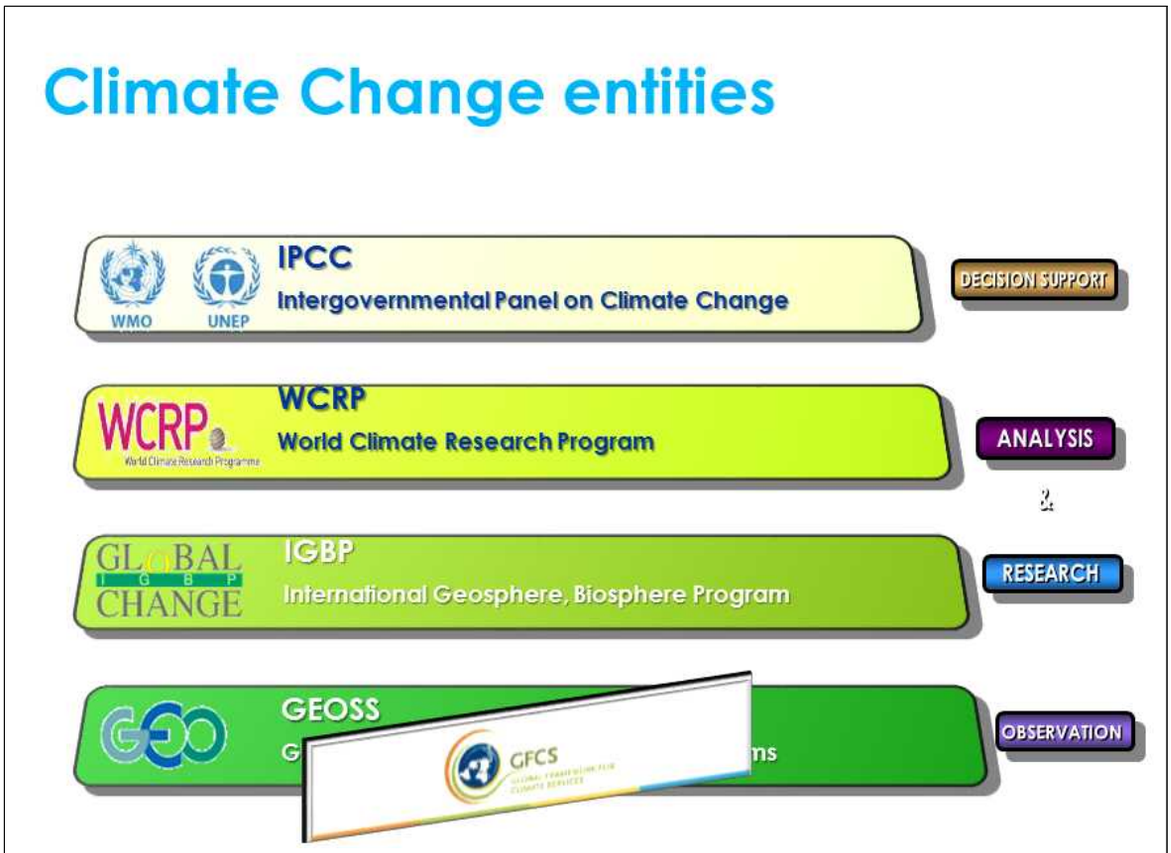
needs a holistic approach

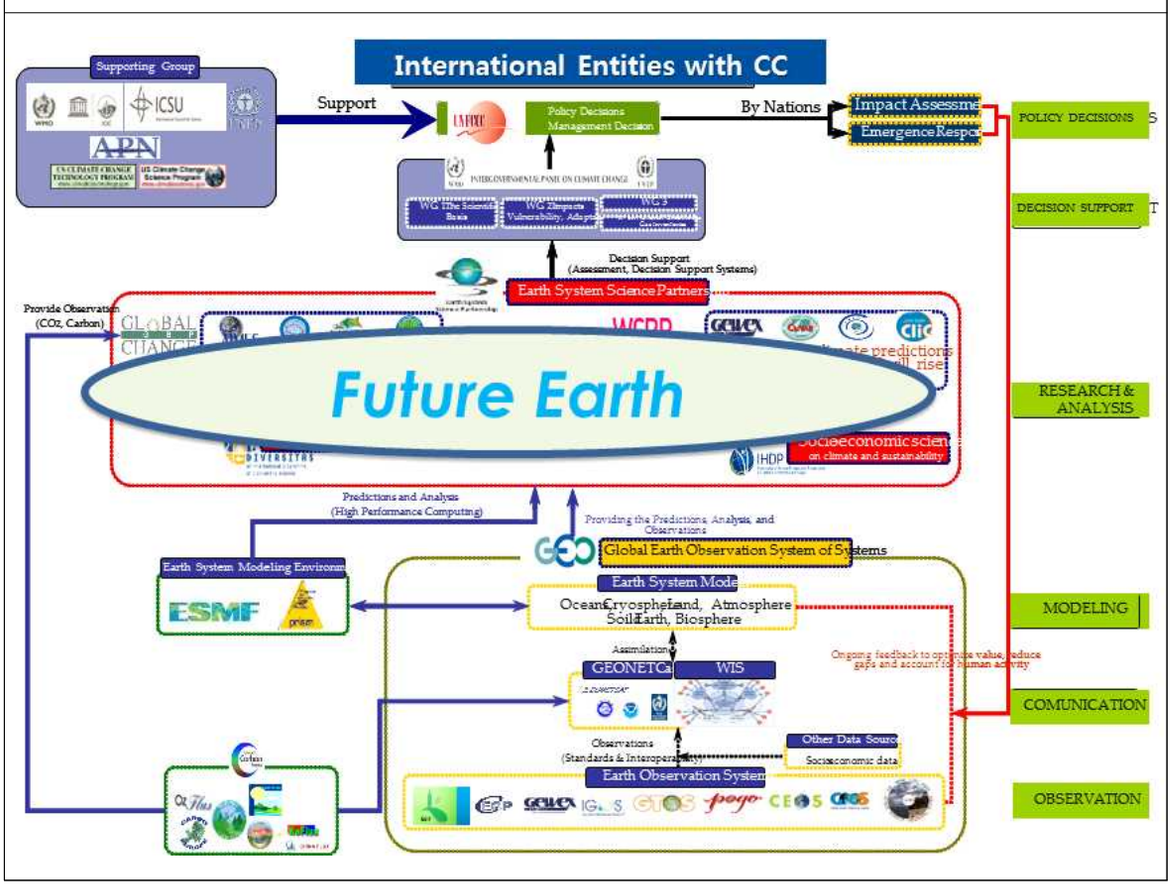
in order to put together the puzzle!

SUSTAINABLE DEVELOPMENT GOALS

- *Agricultural sustainability :* Concept is continuously evolving, *a comparable set of economic and social indicators* still needs
- *Additional dimension*

How to design *monitoring and assessing systems to track the impacts* of the management and the policy interventions, and How to assess whether these are *contributing towards or away from Sustainability.*


Climate Change entities
IPCC
Intergovernmental Panel on Climate Change
WMO
UNEP
DECISION SUPPORT
WCRP
World Climate Research Program
ANALYSIS
IGBP
International Geosphere, Biosphere Program
RESEARCH
GEOSS
GFCS
OBSERVATION


International Entities with CC
Supporting Group
ICSU
APN
Support
Policy Decisions
Management Decision
By Nations
Impact Assessme
Emergence Respo
POLICY DECISIONS
DECISION SUPPORT
Decision Support
(Assessment, Decision Support Systems)
Earth System Science Partners
Provide Observation
(CO2, Carbon)
Future Earth
RESEARCH &
ANALYSIS
Predictions and Analysis
(High Performance Computing)
Providing the Predictions, Analysis, and
Observations
Global Earth Observation System of Systems
Earth System Modeling Environm
ESMF
Earth System Mode
Ocean, Cryosphere, Land, Atmosphere
Soil, Earth, Biosphere
MODELING
Assimilation
GEONETCa
WIS
COMUNICATION
Observations
(Standards & Interoperability)
Other Data Sourc
Socioeconomic data
Earth Observation System
OBSERVATION

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Socio-economic Trends

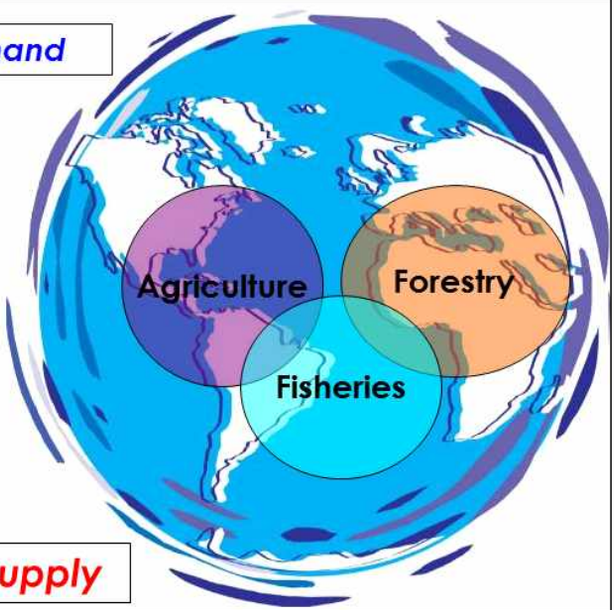
Population - Consumption - Urbanization - Migration - Economic growth - Political instability

Food - Feed - Fibre - Energy - Livelihood - Ecosystem Services

Increased demand

Policy makings for the optimal adaptation and mitigation is becoming more widespread, *but current implementation efforts in Agriculture sectors* are insufficient to avoid *increasingly negative social, environmental, and economic consequences.*

FAO Profile for Climate Change



Sustainable supply

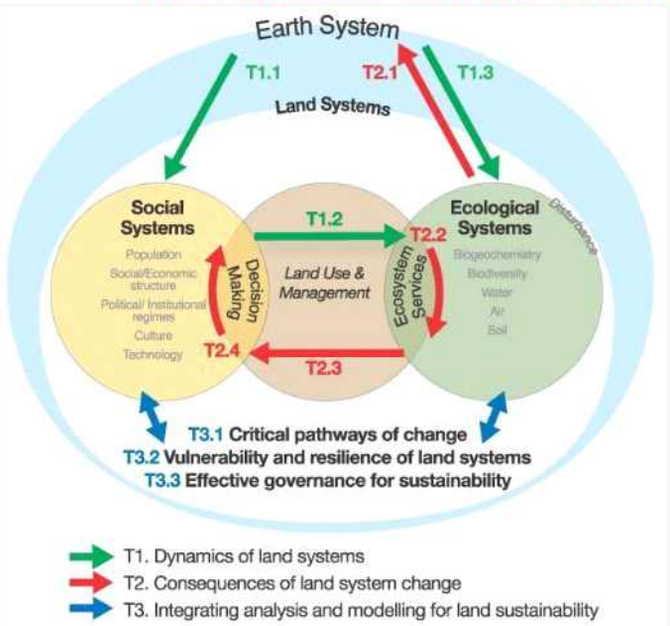
Soil - Land - Water - Biodiversity

Climate Change - Loss of Biodiversity - Land degradation - Water scarcity

Environmental Challenges

Land System Change (IGBP)

for Ecosystem Services & Earth System Functioning



- **This emerging application area is alternative futures analyses - the study of how complex coupled human/natural systems dynamically respond to varying management strategies and driving forces.**
- **This methodology is increasingly being used to inform decision makers *about the implications of policy alternatives related to land/water/GHG managements*, expressed in terms related to human valuations of the AgroEcosystem.**

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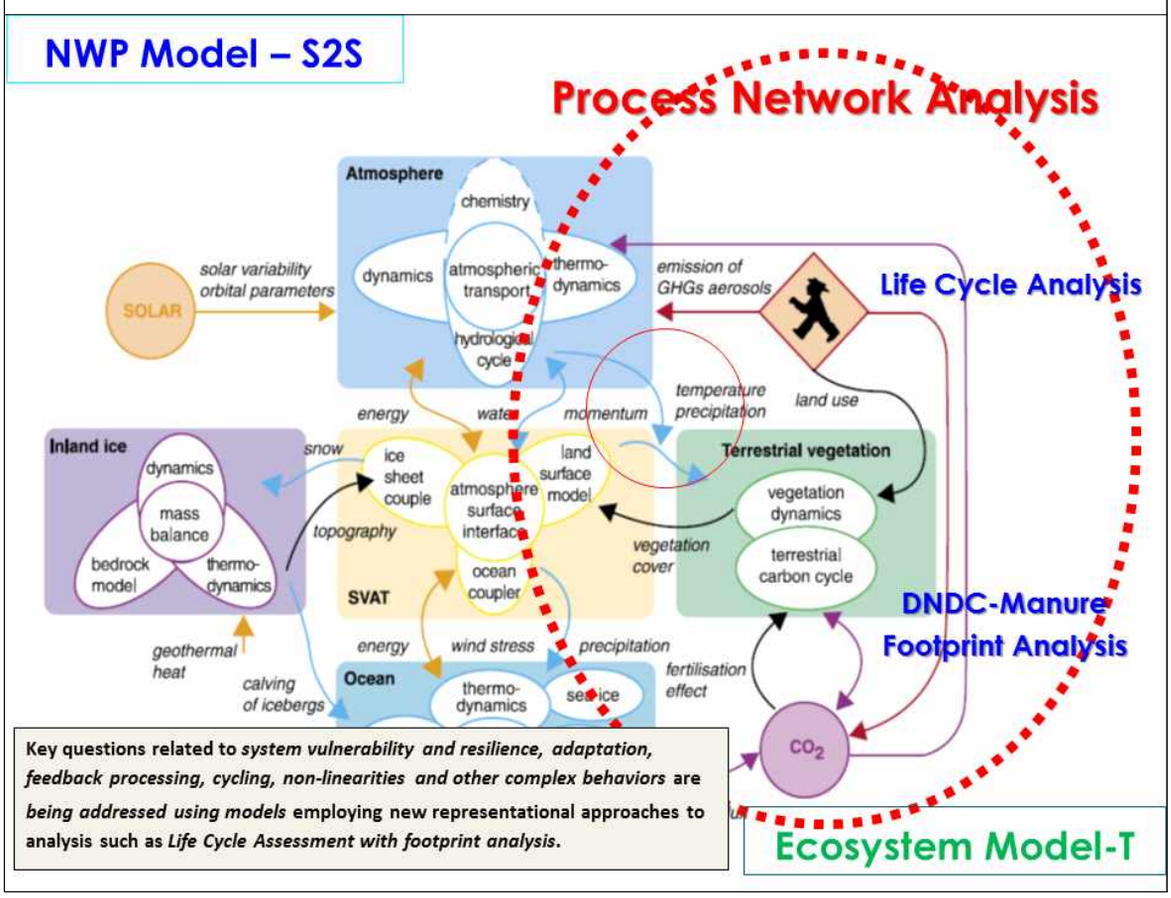
Global Challenges
in Climate Services for Sustainability Assessment

- **Identification of ecosystem/climate system interactions**
  Climate change : ecosystem evolution over decades
  Climate variability : agroecosystem changes with feedbacks

- **Framework development for Sustainability Assessment**
  Concurrent assessment : mitigation/adaptation policy
  Sustainability indicators : assessment criteria/metrics
  Assessment tools : LCA framework with foot print analysis

- **Implication of human dimensions in sustainability assessments**
  Wide user engagements in Climate Service development
  Implication of Socio-economic-policy aspects



Process Network

(Ruddell & Kumar 2009; Kumar & Ruddell 2011)

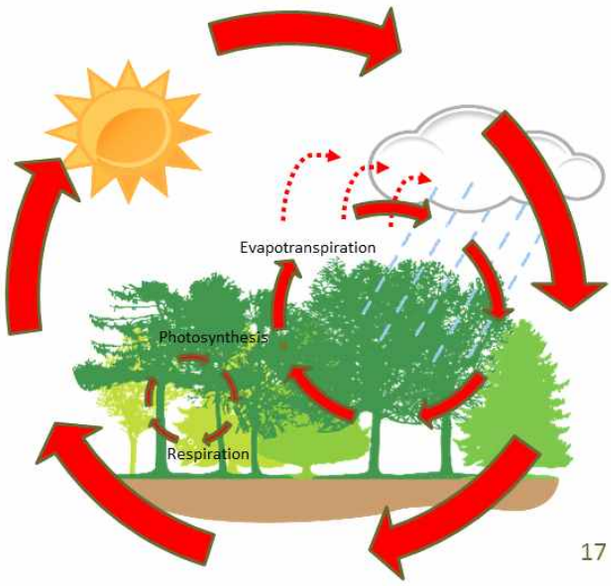
A network of feedback loops & direction of flow of matter, energy & information between the different variables.

Information Flow Statistics using

- Flux time series
- Information theory

Describing :

- Feedback loops
- Couplings
  - direction, type
  - magnitude
  - time lags



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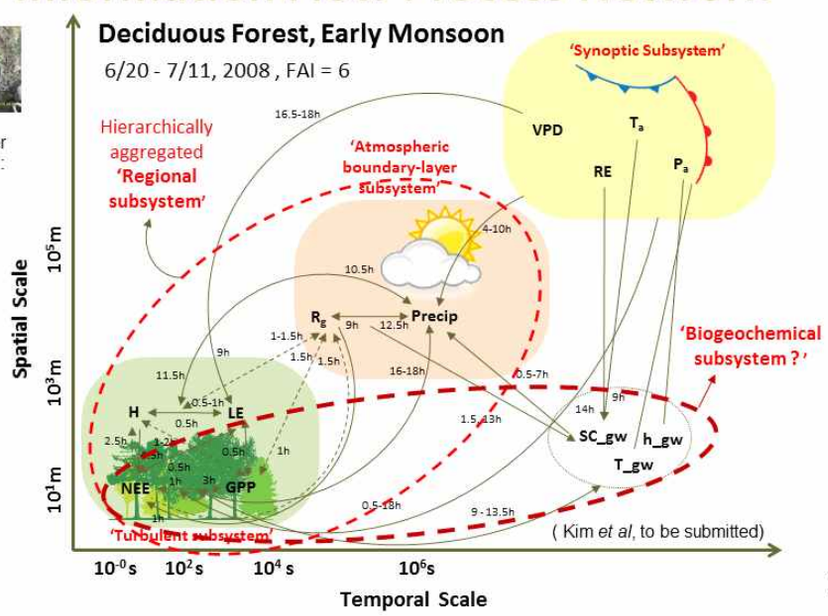
Information Flow Process Network

Groundwater data added :
SC_gw
h_gw
T_gw



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Technological Challenges

High Resolution Data/Inforamtion in
Space
Time
Elements

- Diverse challenges in developing downscaling technologies for in-situ, monitoring, RS, predictions over the world have been made to meet the user requirements for higher resolutions in time, space and element in the disciplines of Applied Meteorology.

GridMET (NUIST, **China**) : Xinfa QIU
Real-time Downscaling : Grid-RD (PKNU, **Korea**), Jaiho OH
Digital Climate Map (SNU/NCAM, **Korea**), Byong LEE
Uncoupled Surface Model (Nanowx， USA） Matt HAUGLAND
Synthetic Observations (EC, **Canada**) (TBD)
GPCC-Generator (USDA-ARS， **USA**） John ZHANG
etc.

ICT resource sharing system

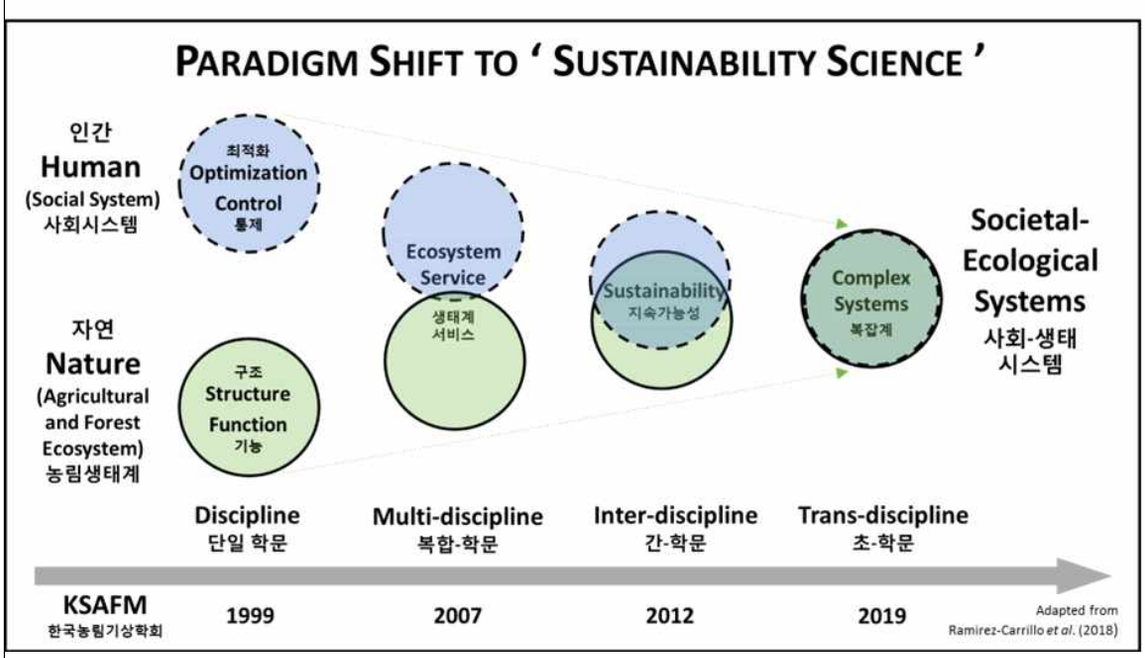
WAMIS II (DCPC)

* ICT : Information, Communication Technology

Potential Solution

- It has been under discussion among diverse disciplines to **establish** ***Operational Framework for AgroEcosystem Sustainability Assessment*** to support Policy Decision Making for better AgroEcosystem Performance under present and future Climate Change at diverse spatial scales
- through ***routine evaluation on cross-cutting implementation practices for mitigation and adaptation strategies***, being based on long-range forecasts (Sub-seasonal to Seasonal Weather/Climate predictions) along ***with the incorporation of socio-/economic aspects*** of societies at diverse spatial scales. (i.e. farm/catchment/county/province/state/regional and global scale)

Evolution of Disciplines



Beyond Classical AgroMeteorology

❖ ***Applied Meteorology : Current & Future Scopes***

*A Meteorological Science - **Service/Application oriented***

Agricultural & Forestry Meteorology : including **Livestock, Fishery**

BioMeteorology : **Health** – **human**/animal/plant, **Phenology**,, etc.

Hydrology
Climatology
Marine/Ocean Meteorology,
Aviation Meteorology
Radar/Satellite Meteorology,
Air pollution Meteorology, etc.

❖ **Future Applied Meteorology** should cover …

emerging **Climate Service Science**

Rural/Urban Meteorology : resilience, amenity, environmental quality, hazards, health, ..

Ecological Meteorology : Ecosystem health, Bio-diversity, interactions with Atmosphere, long-term evolution under climate change and variability

New Horizon

What we are aiming at?

■ ***One Korea : global leader by capacity developments (*human) in economy, democracy, culture, humanitarian, nature, etc.***

through

Science = R&D : Searching for what we do not know

Visioneering of future Science/Society

Recognizing

Ecosystem/Environment – Nest of Nature :

Human beings are **a Part of Ecosystem**

We are **just Guardian, not Manager** : Lives, Niche, Health, Resilience, Diversity

Weather/Climate/Water : *unlimited/undepleted* ***Natural Resources***

Hazard or Resource is up to Us ! - **No hazard** in Nature, just **a part of Nature**!

-> Applied Meteorology : Promising way of utilizing Weather/Climate/Water as Natural Resources (Agriculture, Energy, Materials,.)

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