The background image shows a wide river basin under a blue sky with scattered clouds. In the distance, a long dam with multiple blue-roofed sections spans across the river. In the foreground and middle ground, several small, rectangular islands or floating structures are situated in the water. These islands are densely planted with banana trees and other tropical vegetation. A small blue boat is visible on the right side of the river. The overall scene depicts a water management or agricultural project in a tropical region.

Orientation Seminar on Climate Change Adaptation
in the Pilot Case of Solo River Basin
Introduction of IFI Platform and Climate Change

**Strengthening Resilience
and Enabling Sustainable Development
under Climate Change**

Toshio Koike

Director, International Centre for Water Hazard and Risk Management (ICHARM)

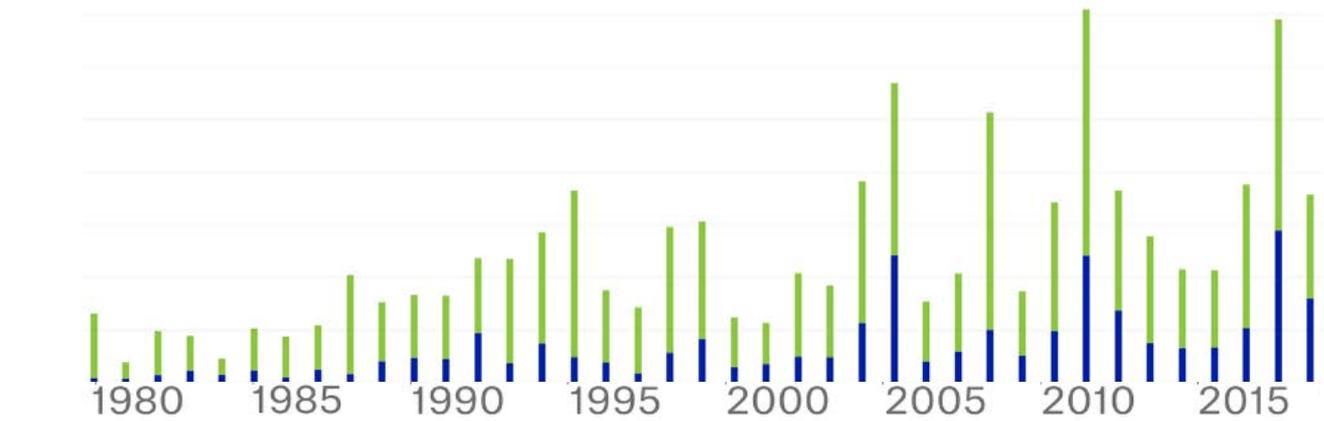
Professor Emeritus, the University of Tokyo

Council Member, Science Council of Japan (SCJ), Cabinet Office of Japan

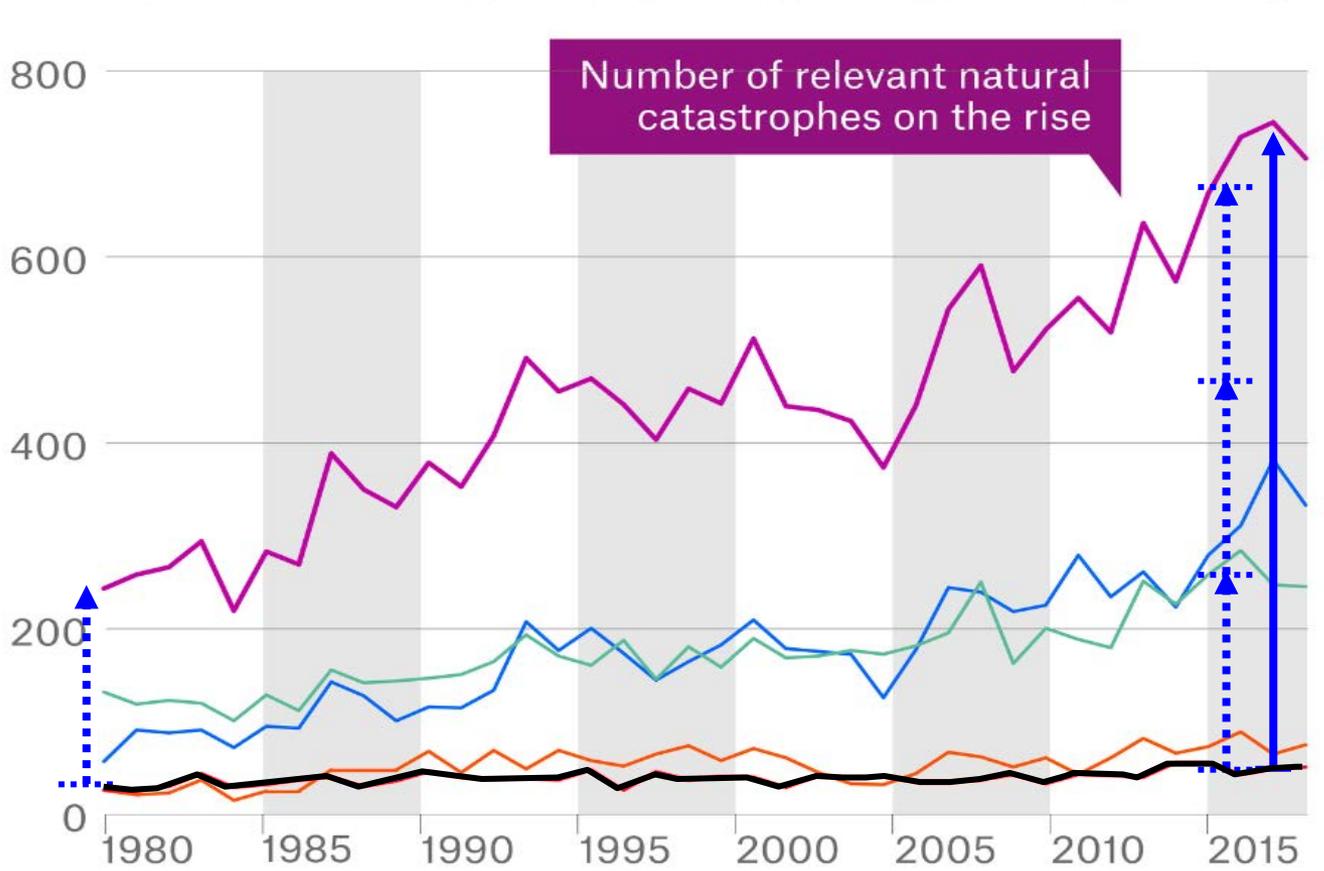
Chair, Japan National Committee on Earth Observation, MEXT

Chair, River Council of Japan, MLIT

Overall Losses for Natural Loss Events Worldwide 1980-2018

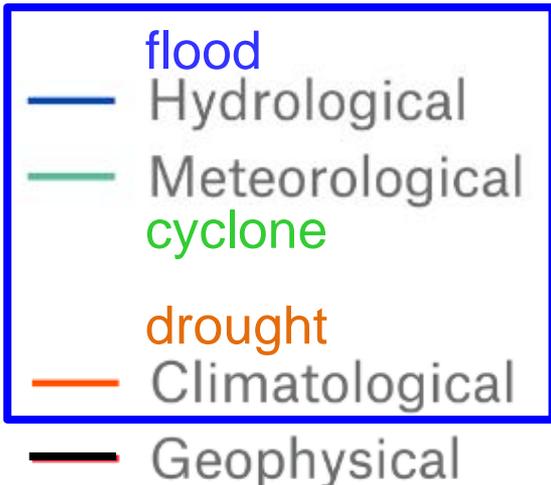


Source:
Munich Re NatCatSERVICE

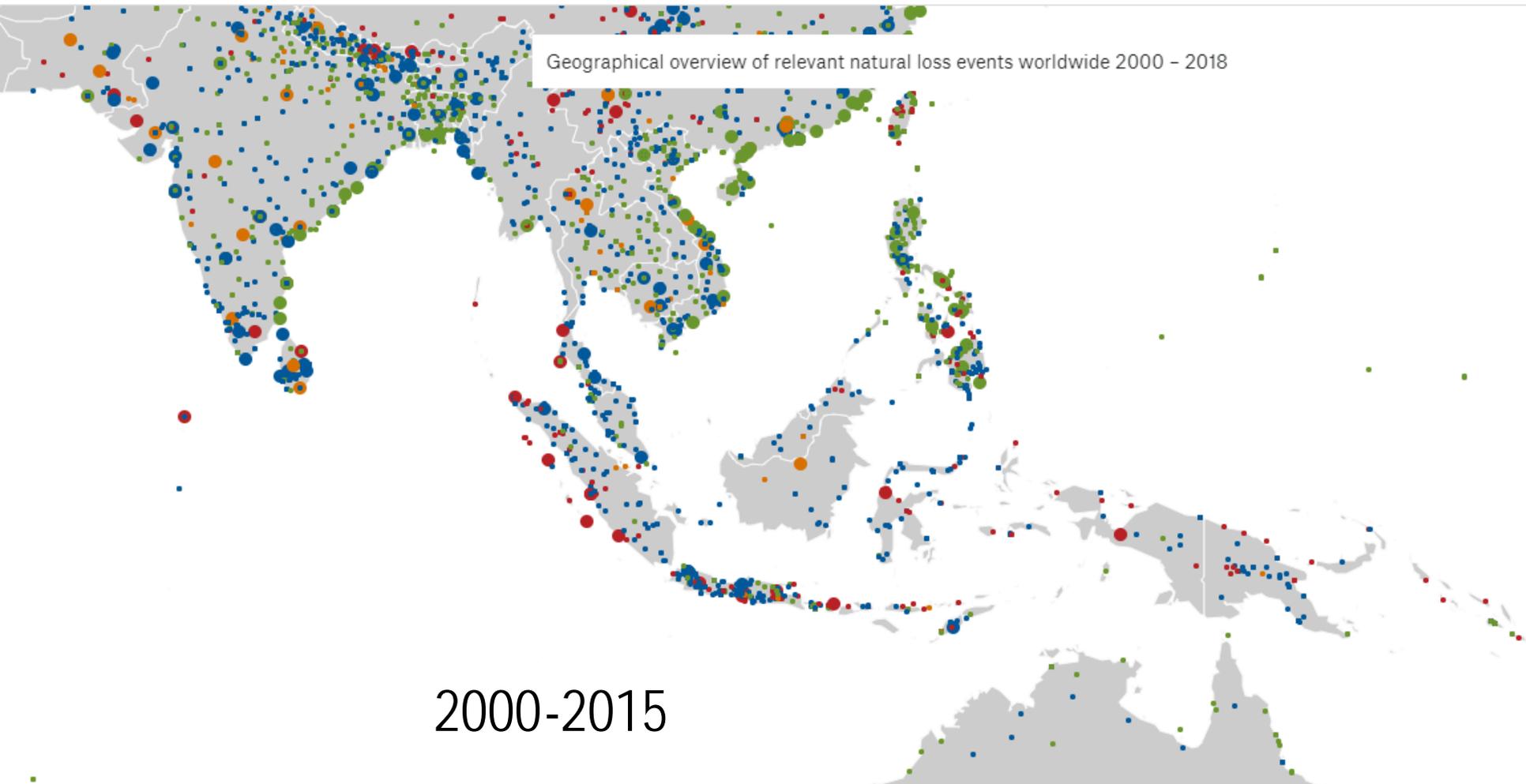


Number of Events
Worldwide
1980-2018

Water-related Disasters



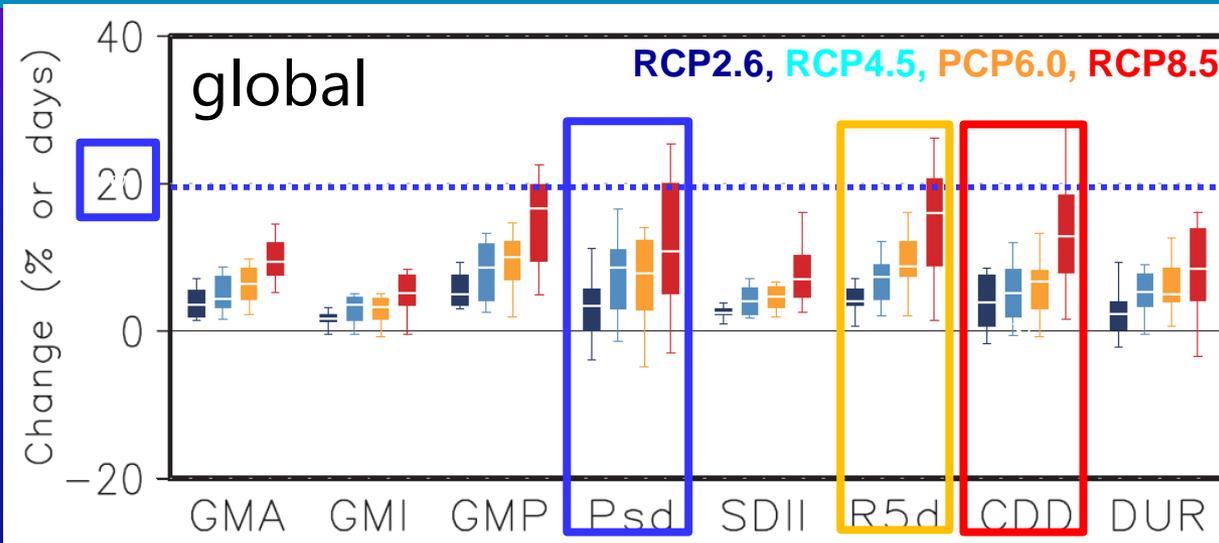
Geographical Overview of Water-related Disasters



- Meteorological events
- Hydrological events
- Climatological events

Monsoon

IPCC/AR5 (2014)



CDD: consecutive dry days

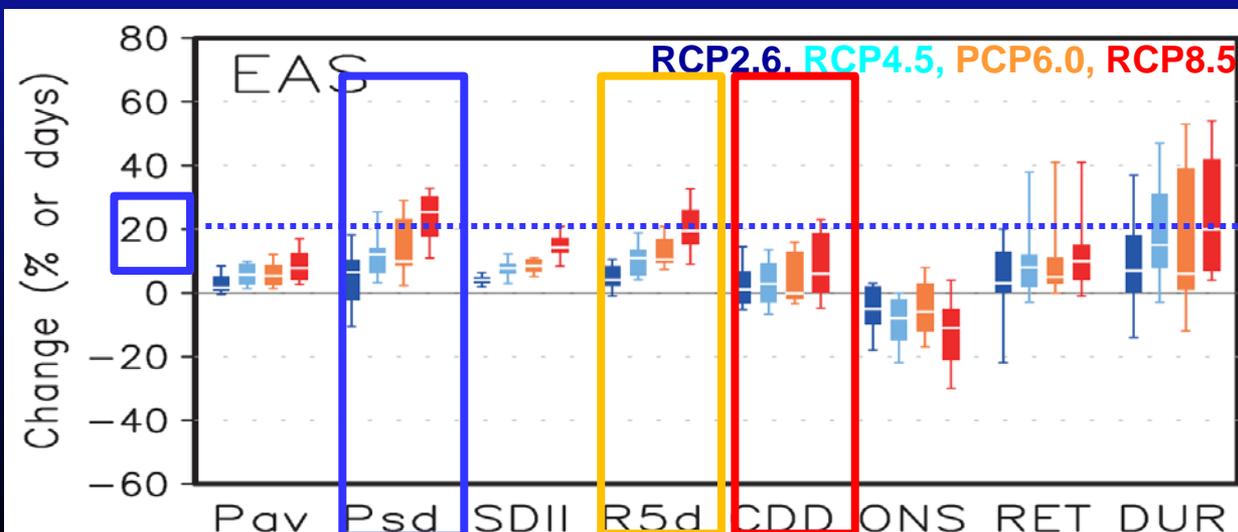
→ **Not Big Change of Droughts**

Psd: standard deviation of inter-annual variability in seasonal average precipitation

→ **Wet-Dry Contrast (water storage)**

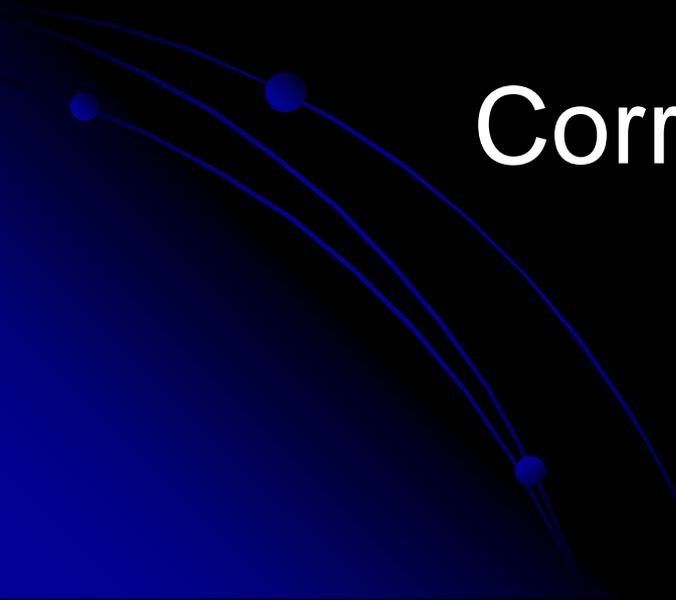
R5d: seasonal maximum 5-day precipitation total

→ **Large Flood (flood early warning)**



As **the climate system** changes,
heavy rainfall events increase.

Correct or Incorrect?



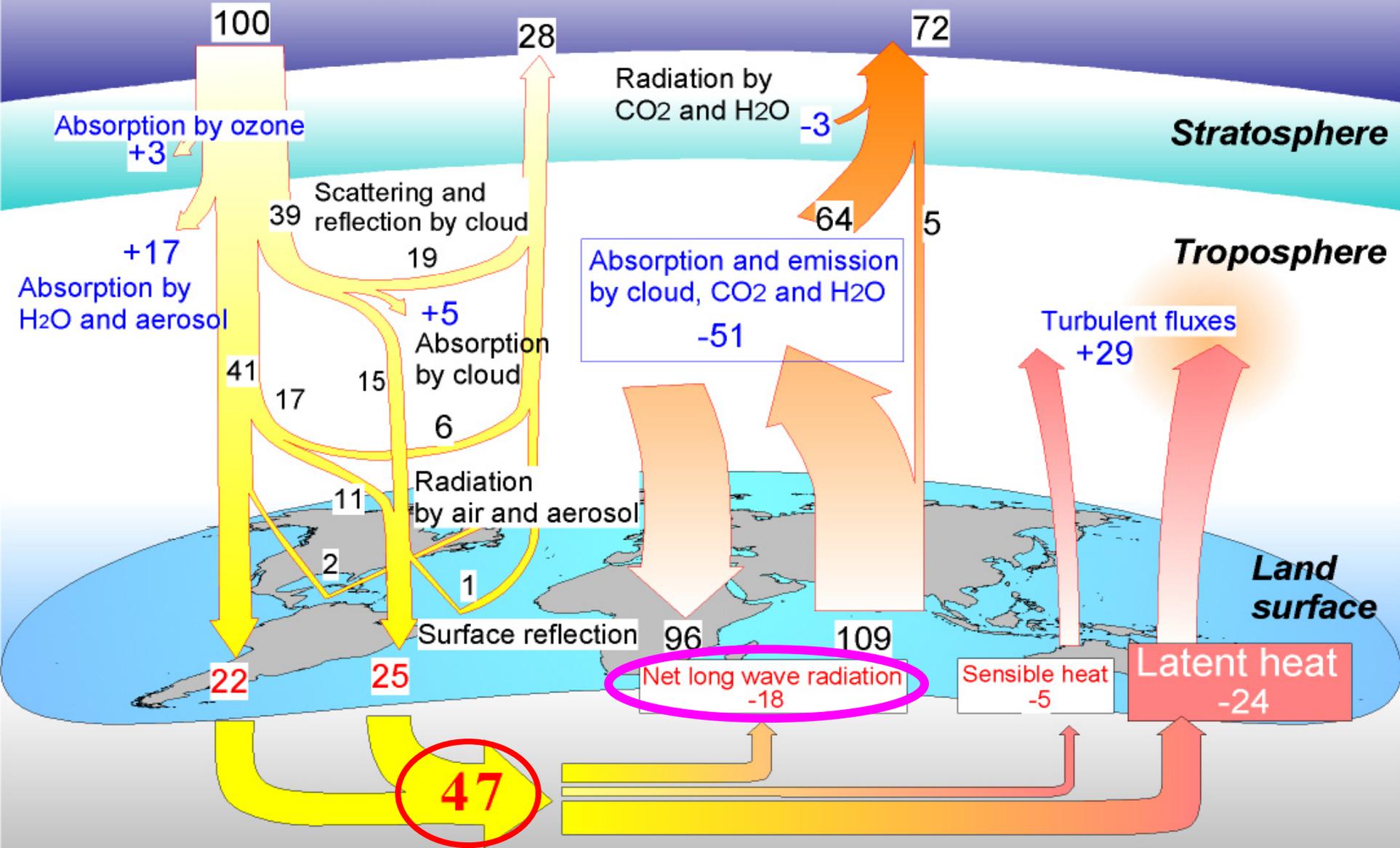
Global Energy and Water Cycle

Space

Stratosphere

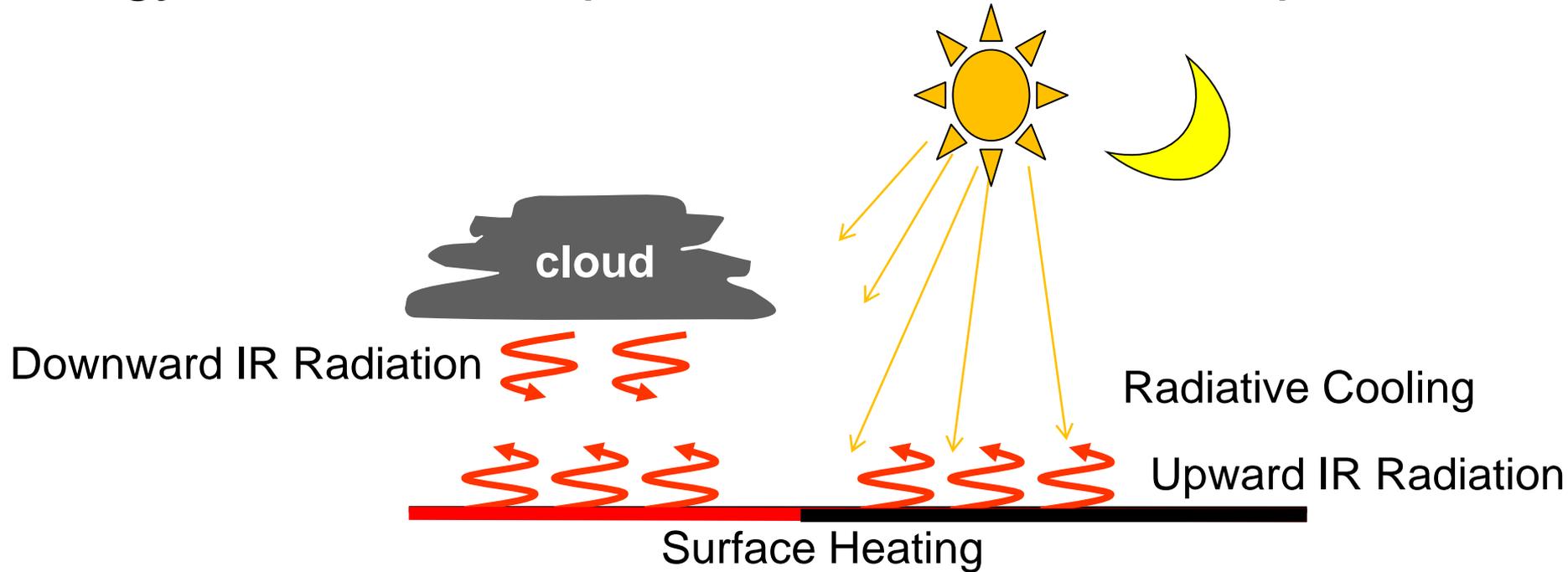
Troposphere

Land surface



Radiation

Stefan-Boltzmann Law: *Material emits radiative energy with the fourth power of the surface temperature.*



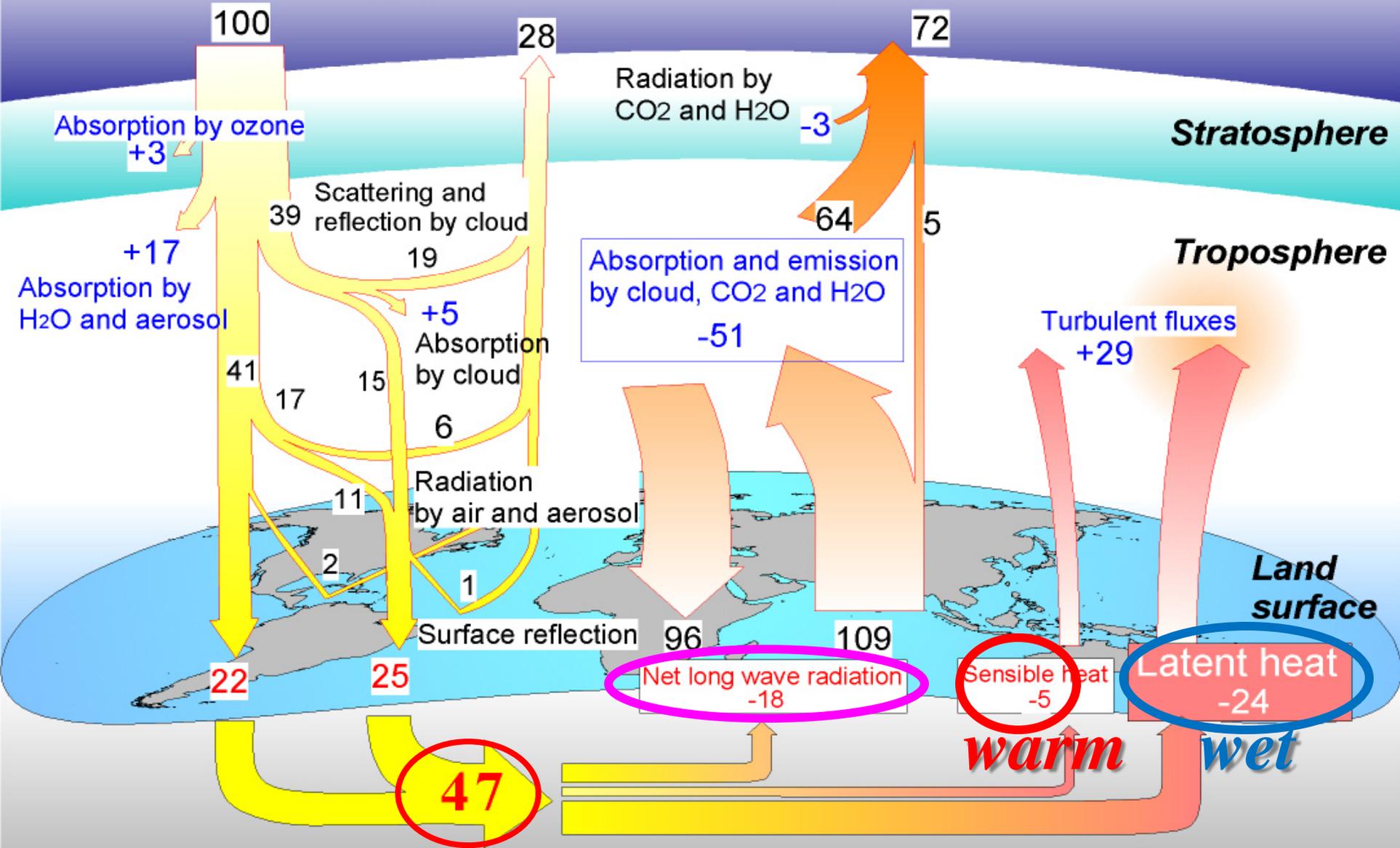
Global Energy and Water Cycle

Space

Stratosphere

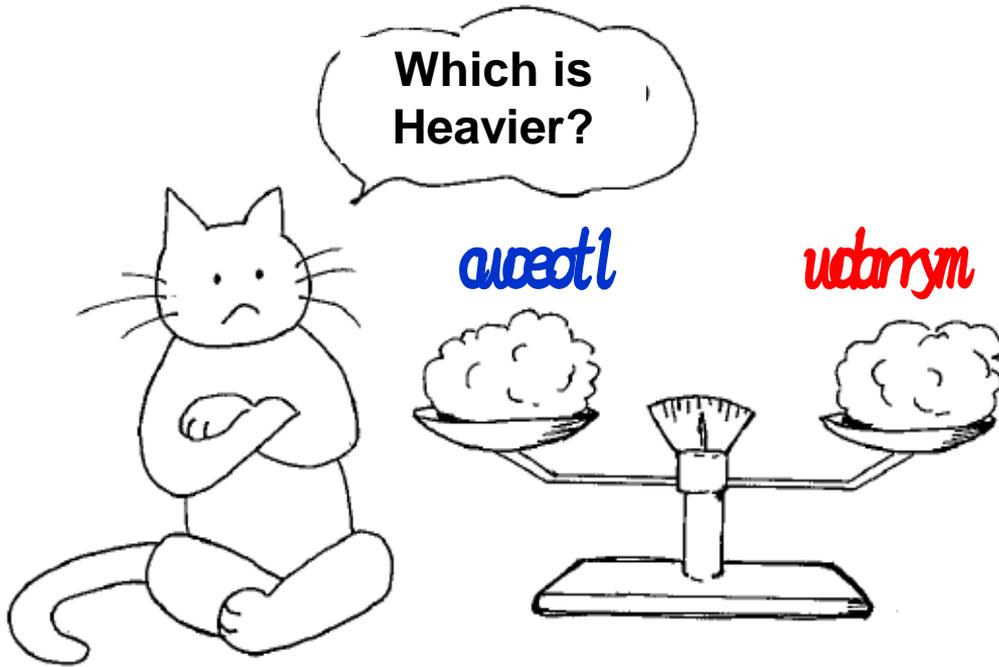
Troposphere

Land surface



Variability of Climate and Water Cycle: Unique Roles of Water

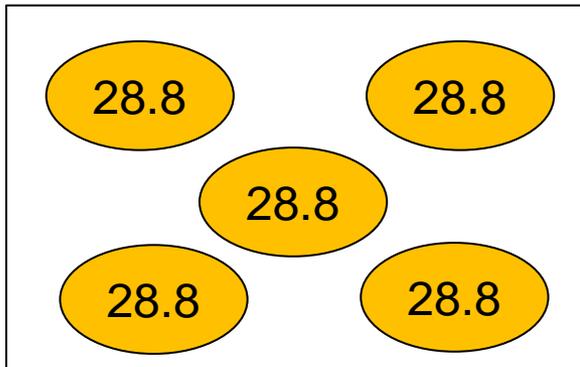
Warm Air - Cool Air and Dry Air - Wet Air



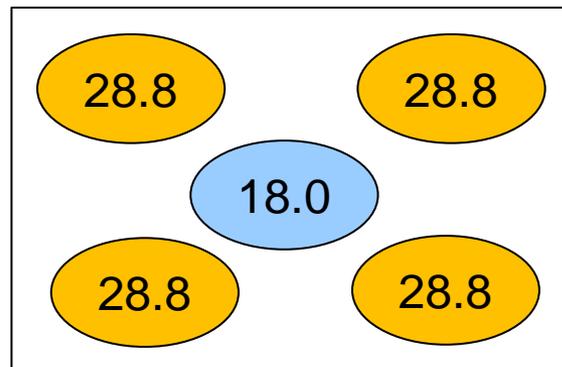
Regardless of kinds of gases, a same number of molecules is included in a certain volume of gas under a certain temperature and pressure.

Dry air consists of nitrogen (MW=28) and oxygen (MW=16).

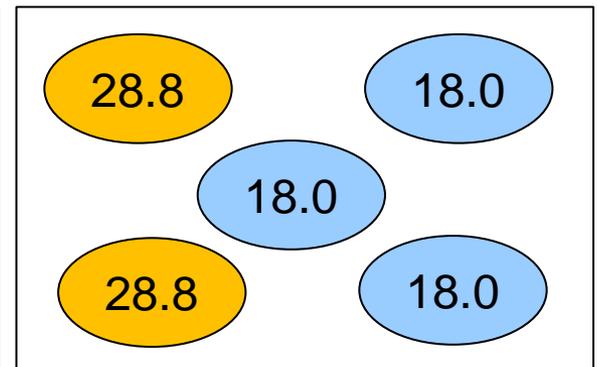
The ratio is 4 to 1. Average MW=28.8
In wet air, a certain number of molecules of nitrogen and oxygen are replaced with the same number of water molecules of water (MW=18)



perfectly dry air



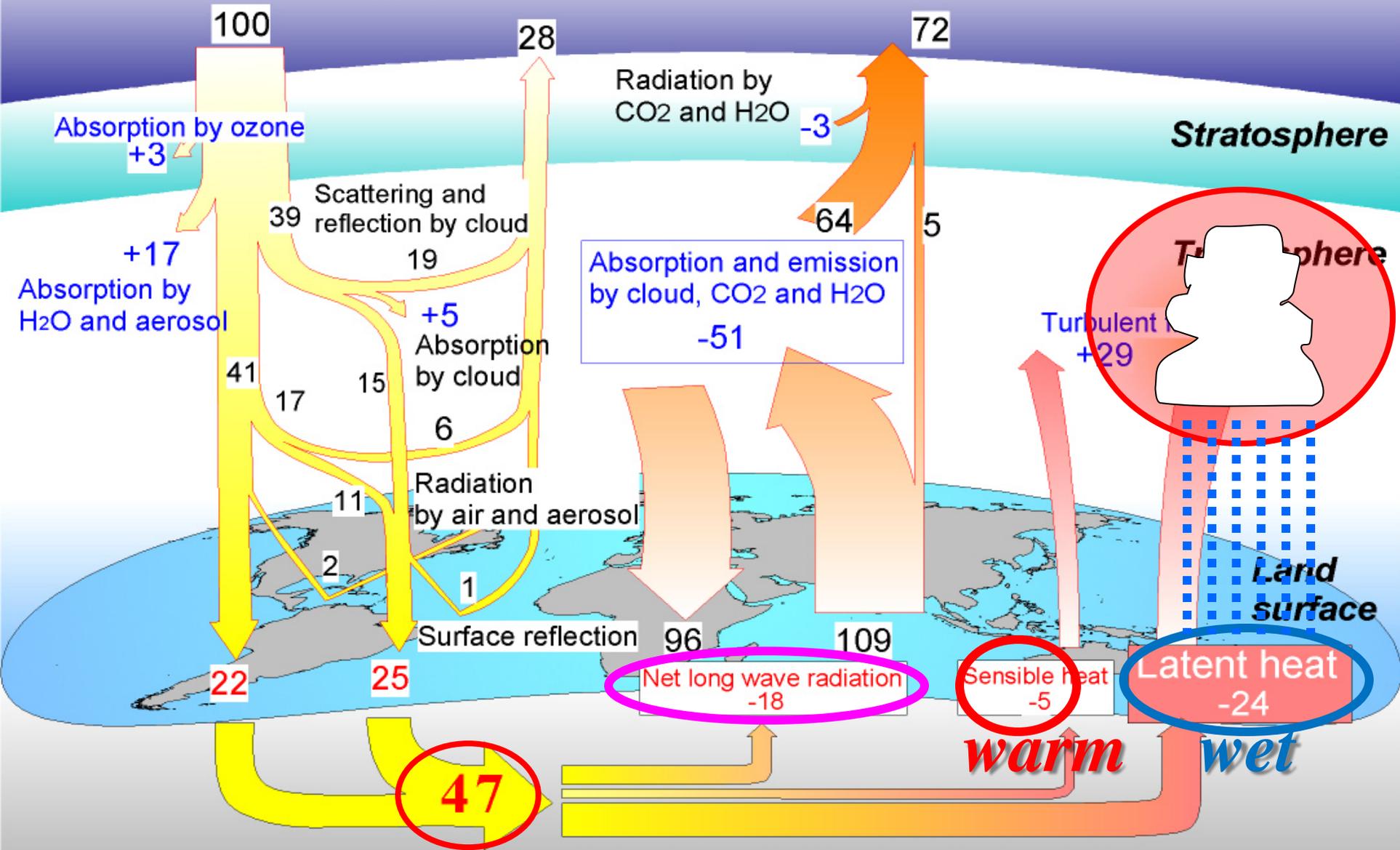
a little bit wet air



very wet air

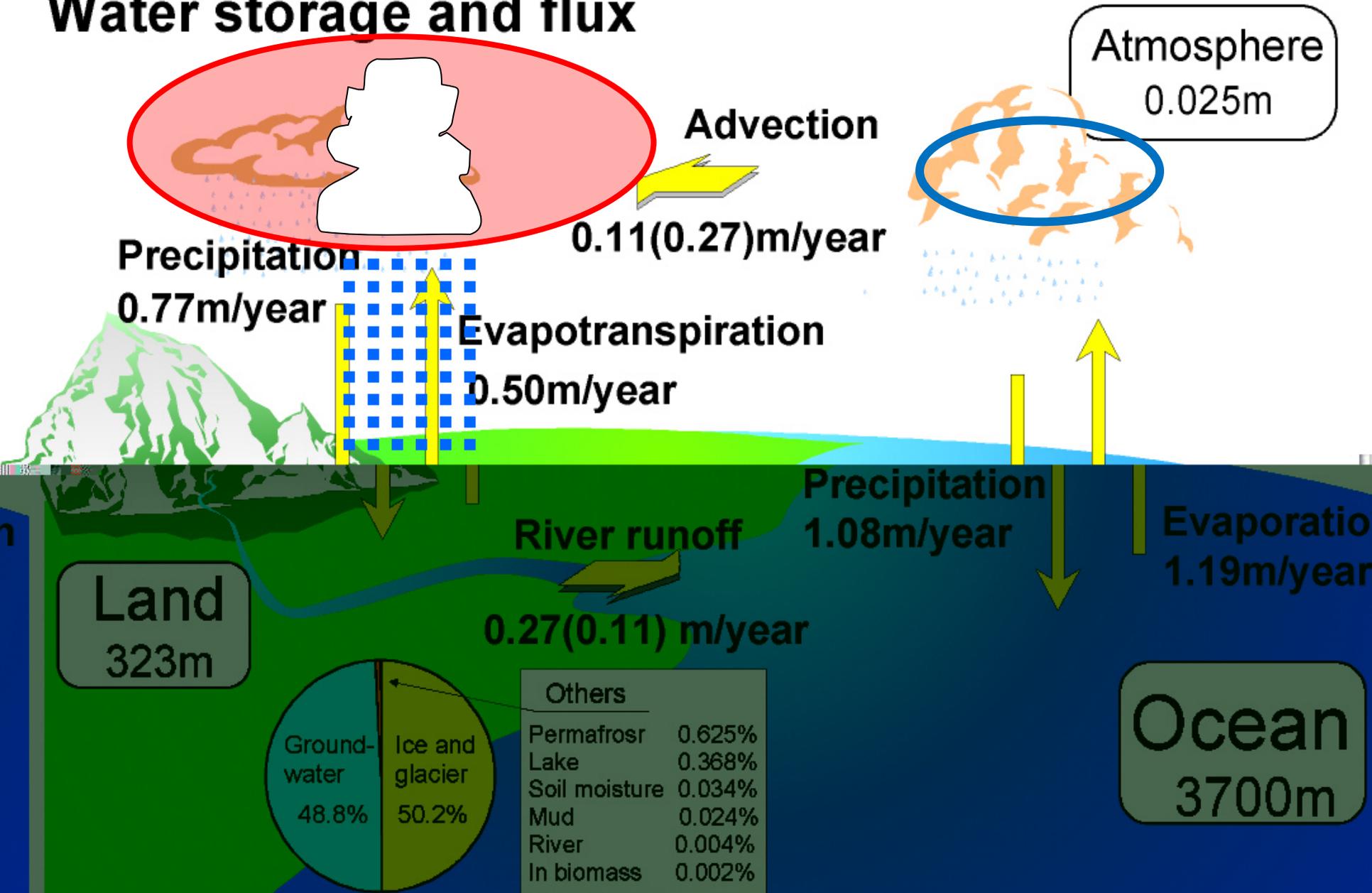
Variability of Climate and Water Cycle: Unique Roles of Global Energy and Water Cycle

Space



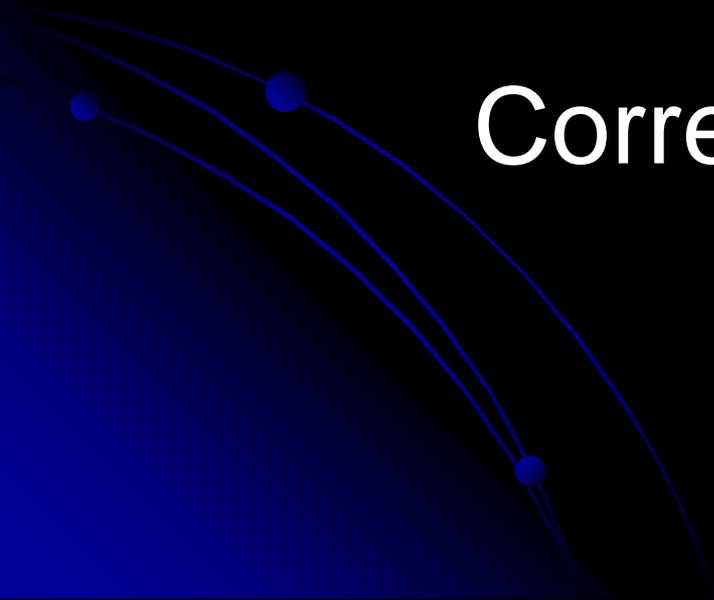
Variability of Climate and Water Cycle: Unique Roles of Water

Water storage and flux



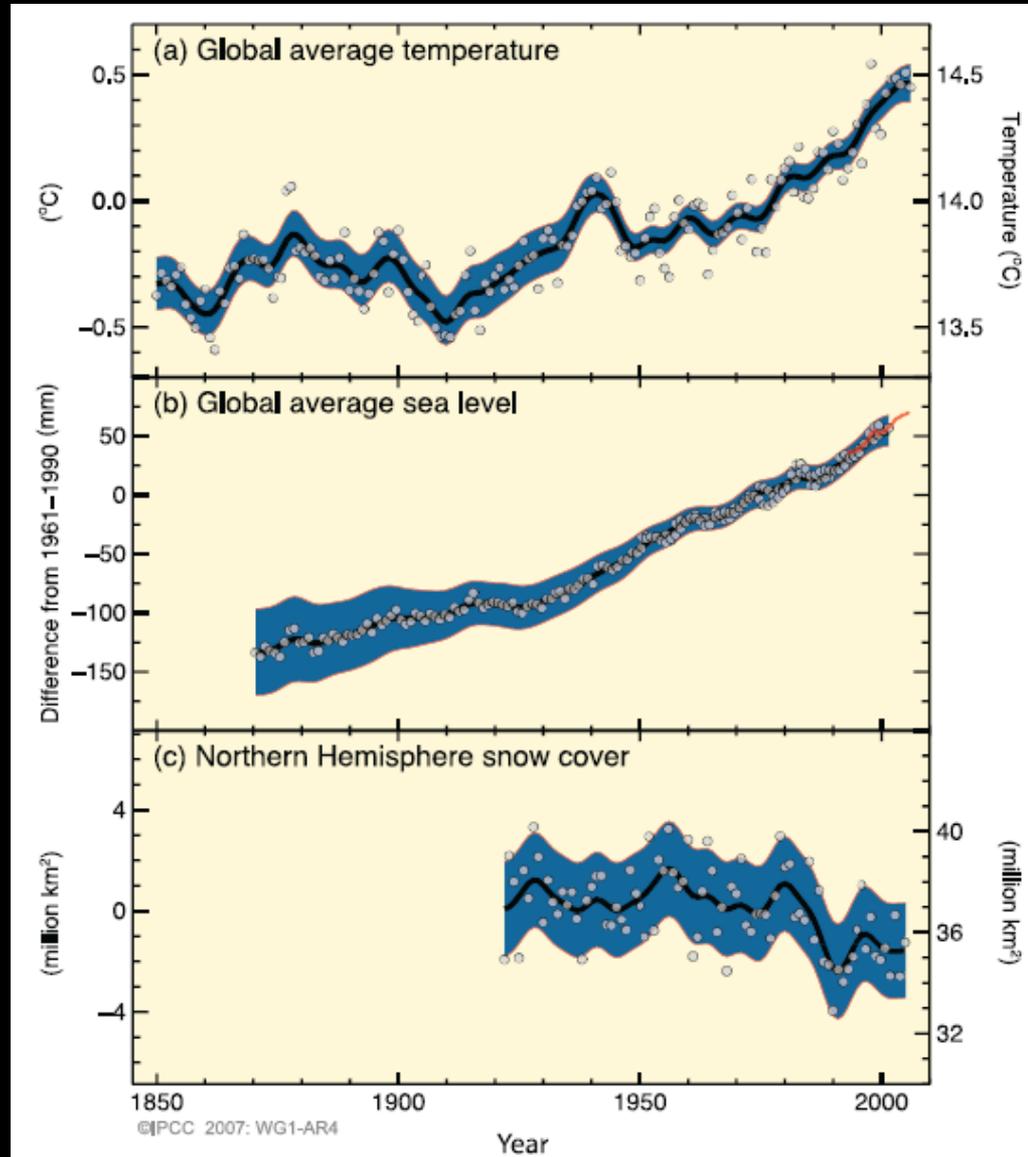
As the climate system changes, heavy rainfall events increase.

Correct or Incorrect?



Is the climate changing?

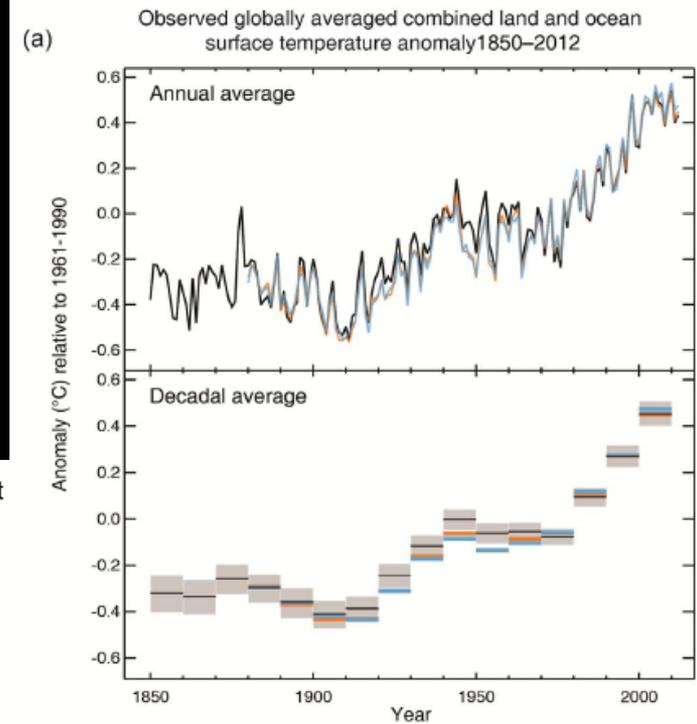
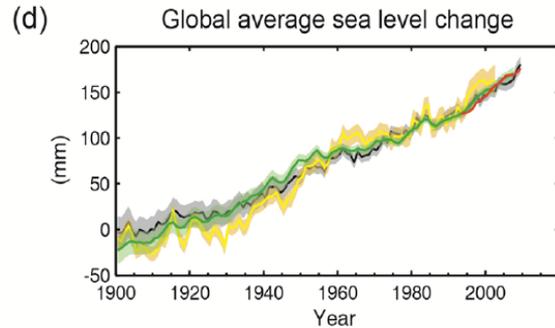
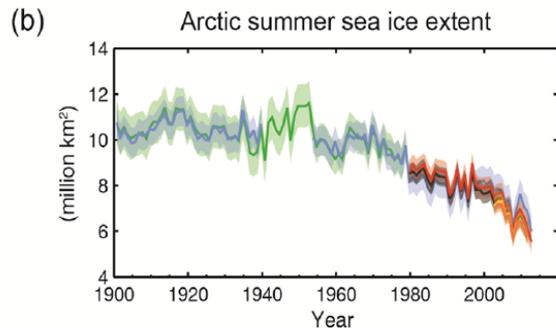
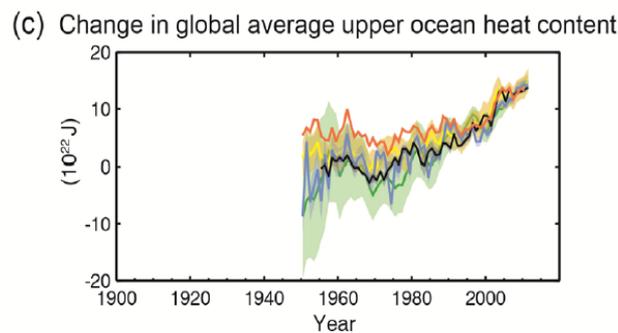
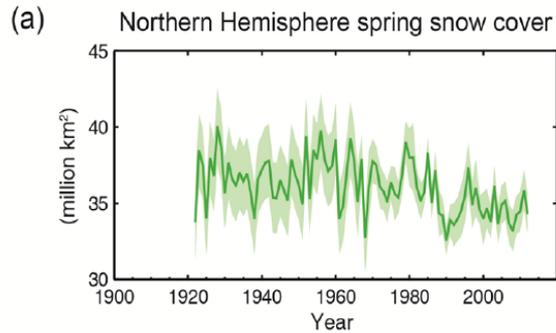
Warming of the climate system is unequivocal.
IPCC/AR4 (2007)



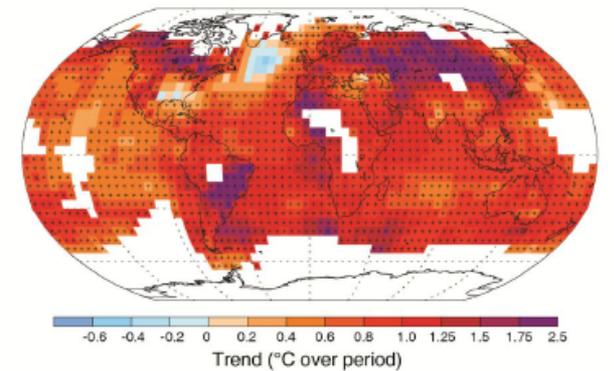
Is the climate changing?

Warming of the climate system is unequivocal.

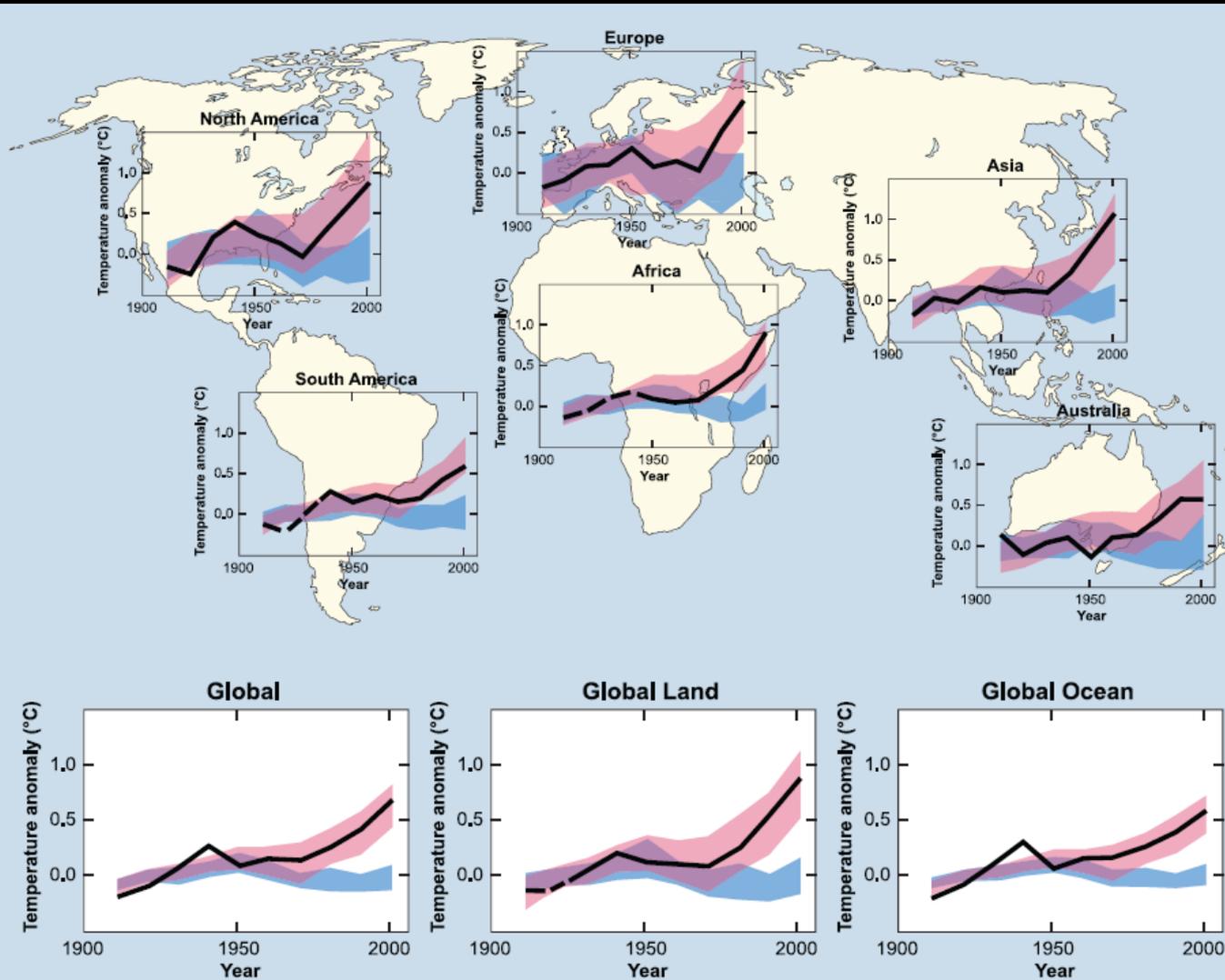
IPCC/AR5 (2013)



(b) Observed change in average surface temperature 1901–2012



What does change the climate?

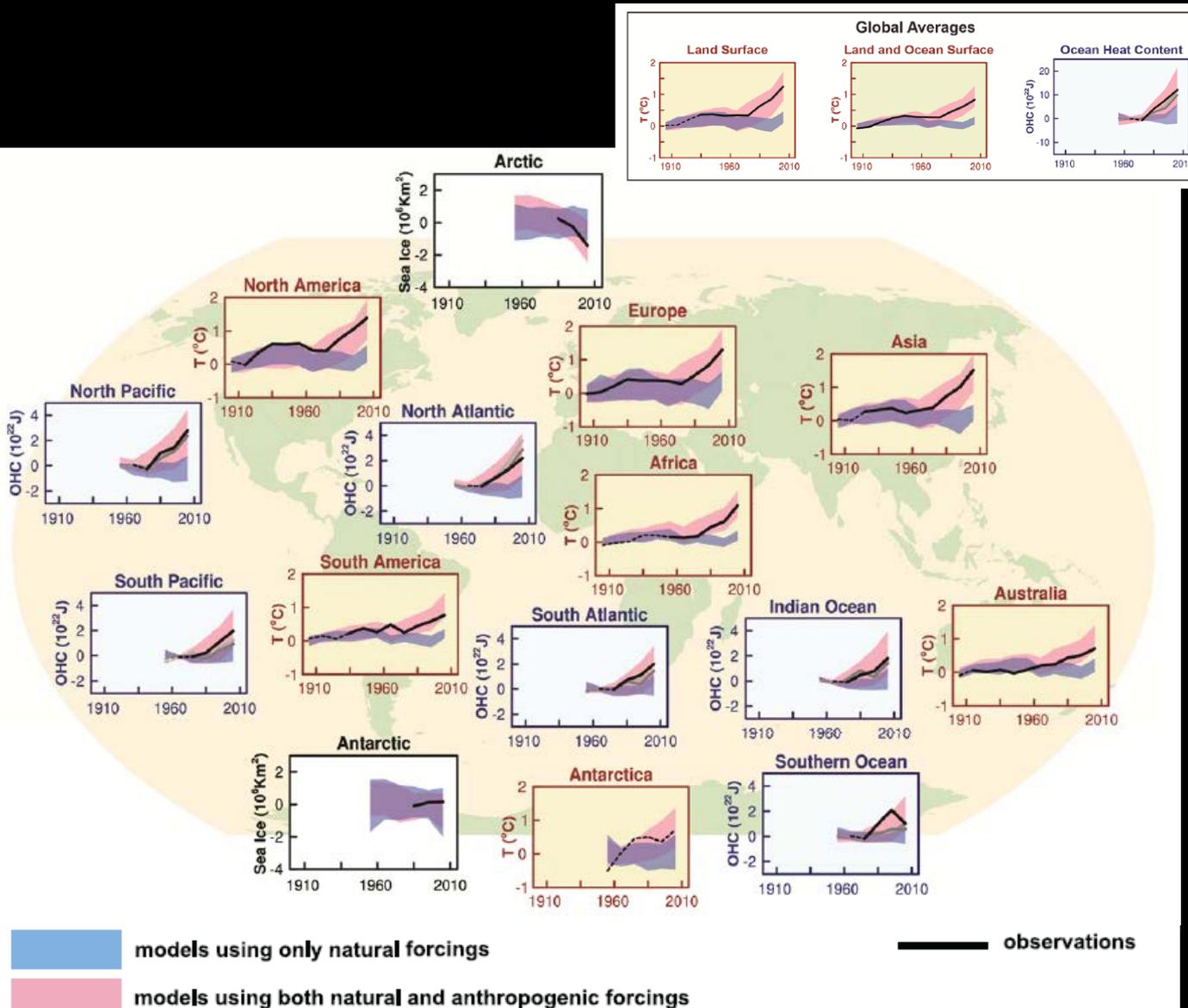


Most of the observed increase in global average temperatures since the mid-20th century is **very likely** due to the observed increase in anthropogenic greenhouse gas concentrations. (IPCC/AR4, 2007)

models using only natural forcings
models using both natural and anthropogenic forcings

observations

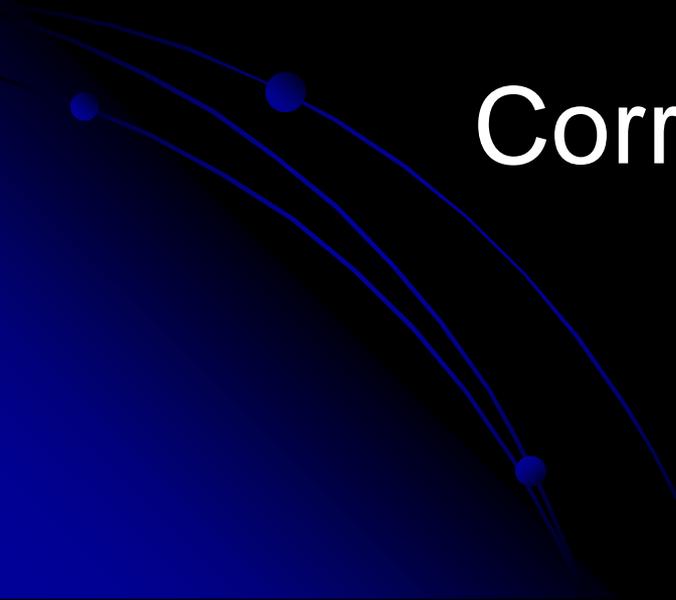
What does change the climate?



It is **extremely likely** that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. (IPCC/AR5, 2014)

As the climate system changes,
heavy rainfall events increase.

Correct or Incorrect?



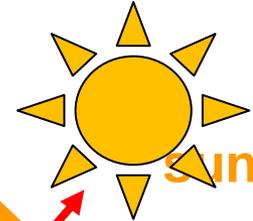
Variability of Climate and Water Cycle: Unique Roles of Water

Temperature \uparrow \rightarrow Saturated Water Vapor Pressure \uparrow \rightarrow Cloud Formation \downarrow
 \rightarrow Total Precipitation \uparrow

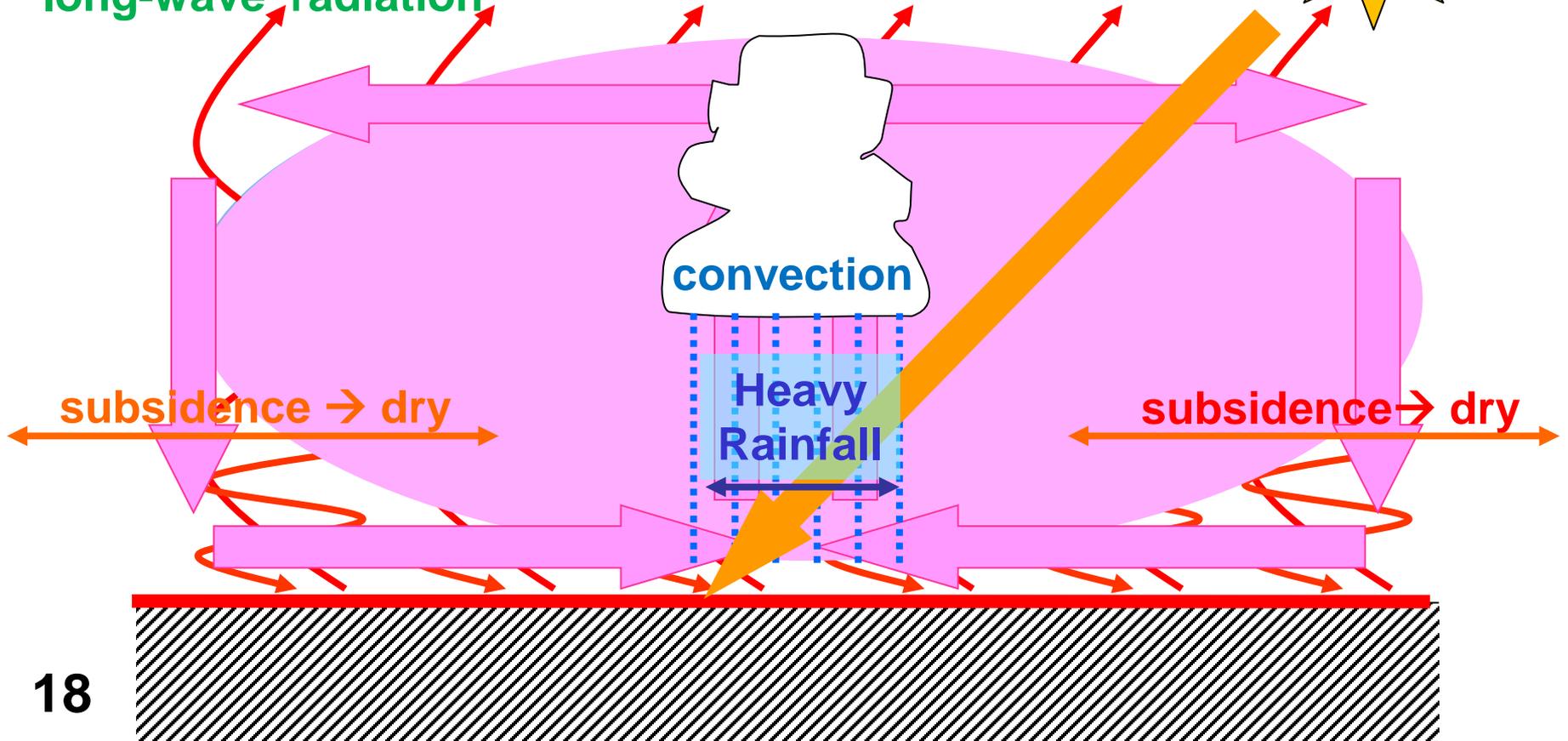
radiation --- **convection** **equilibrium**

(green house effect)

long-wave radiation

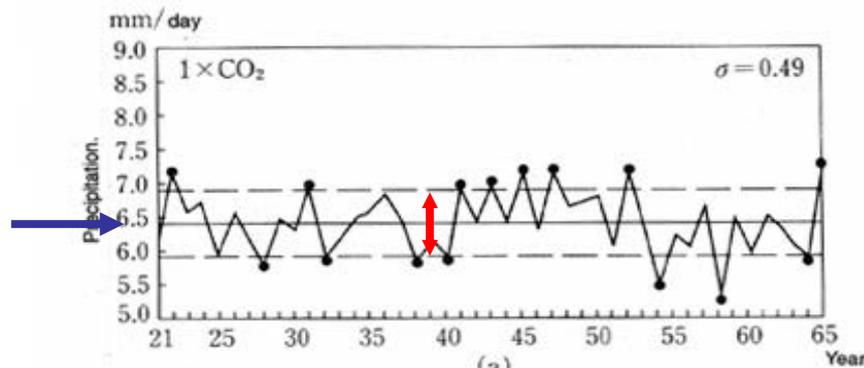
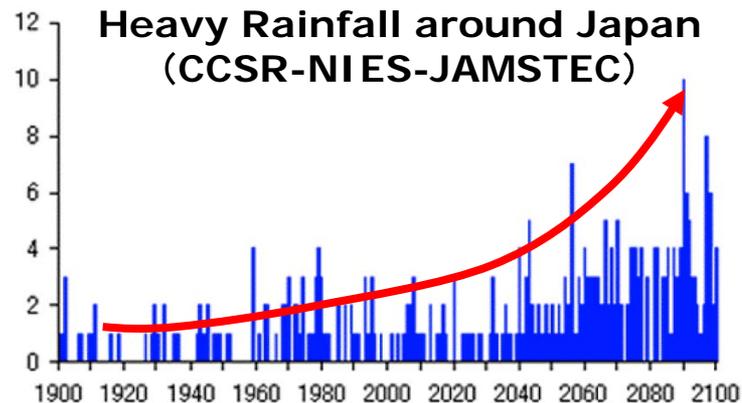
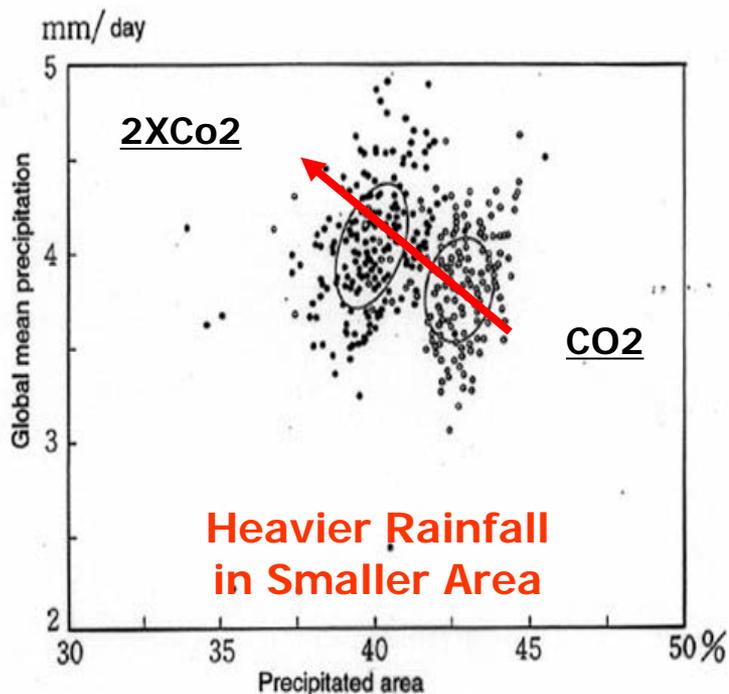


Sunshine

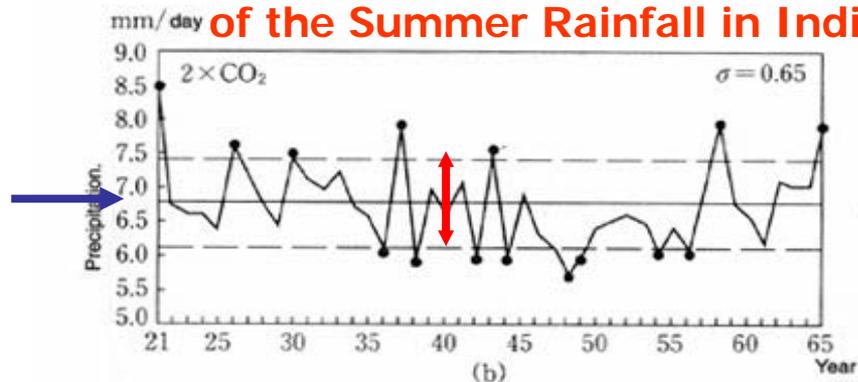


Variability of Climate and Water Cycle: Unique Roles of Water

Impacts of CO2 Increase on the Water Cycle Predicted by Models



Bigger Annual Variation of the Summer Rainfall in India



Change in water-related extremes

AR4(2007), SREX(2010), AR5(2013)

Phenomenon and direction of trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Likelihood of further changes
		Late 21st century
<u>Heavy precipitation events.</u> <u>Increase in the frequency, intensity, and/or amount of heavy precipitation.</u>	<i>Likely</i> more land areas with increases than decreases (c) {2.6}	<i>Very likely</i> over most of the mid-latitude land masses and over wet tropical regions (12.4)
	<i>Likely</i> more land areas with increases than decreases <i>Likely over most land areas</i>	<i>Likely</i> over many areas <i>Very likely over most land areas</i>
<u>Increases in intensity and/or duration of drought</u>	<i>Low confidence</i> on a global scale <i>Likely</i> changes in some regions (d) {2.6}	<i>Likely (medium confidence)</i> on a regional to global scale (h) (12.4)
	<i>Medium confidence</i> in some regions <i>Likely in many regions, since 1970 (e)</i>	<i>Medium confidence</i> in some regions <i>Likely (e)</i>
<u>Increases in intense tropical cyclone activity</u>	<i>Low confidence</i> in long term (centennial) changes <i>Virtually certain</i> in North Atlantic since 1970 {2.6}	<i>More likely than not</i> in the Western North Pacific and North Atlantic (j) (14.6)
	<i>Low confidence</i> <i>Likely (in some regions, since 1970)</i>	<i>More likely than not</i> in some basins <i>Likely</i>
<u>Increased incidence and/or magnitude of extreme high sea level</u>	<i>Likely</i> (since 1970) {3.7}	<i>Very likely</i> (l) (13.7)
	<i>Likely</i> (late 20th century) <i>Likely</i>	<i>Very likely</i> (m) <i>Likely</i>

As the climate system changes,
heavy rainfall events increase.

Correct or Incorrect?

Roles of Science and Technology
in Adaptation to the Change?

Three Key Global Agendas Agreed in 2015



Concerted Actions are Required

Resilience

Sustainability

Inclusiveness
Participatory

Three Key Global Agendas Agreed in 2015



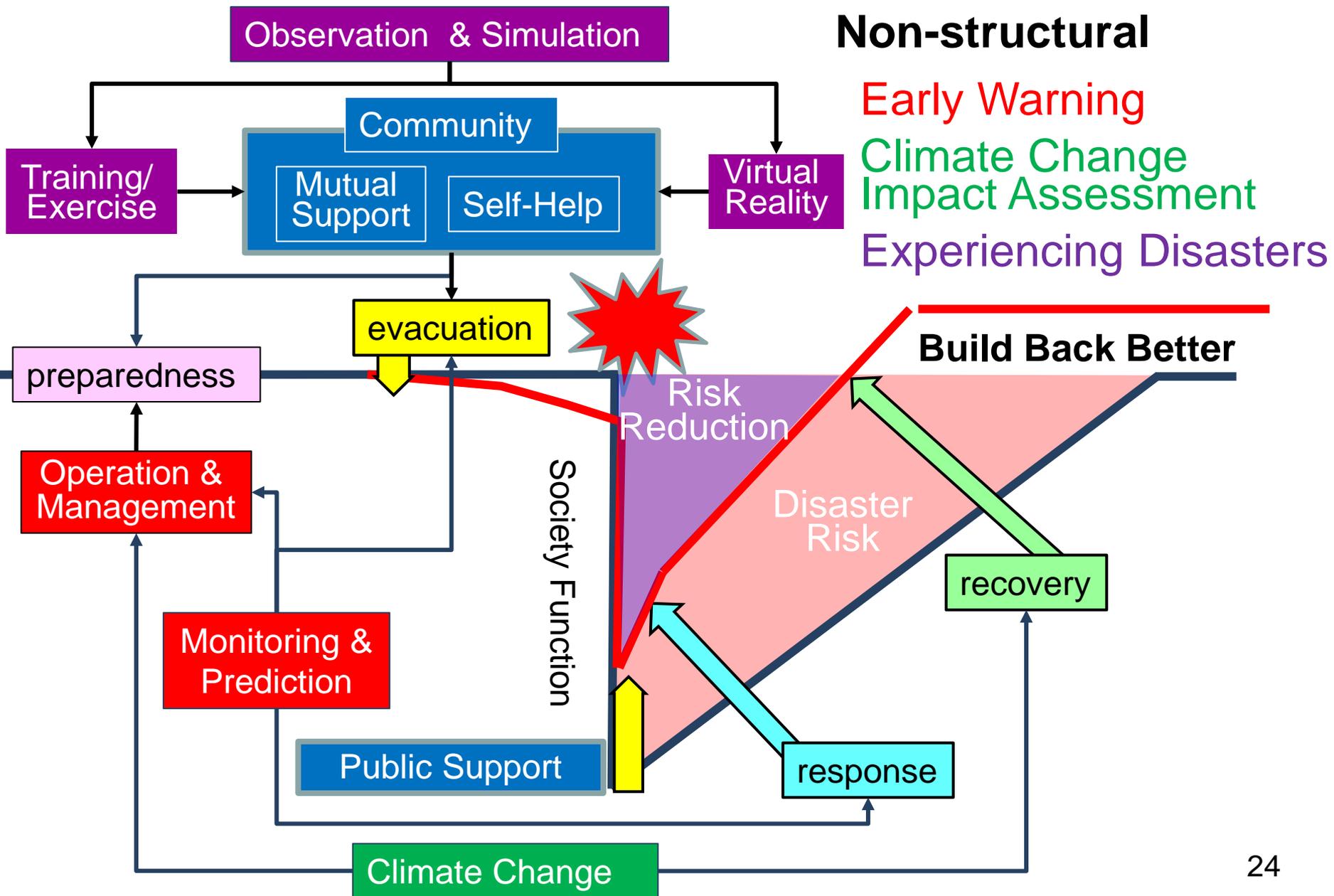
Concerted Actions are Required

Resilience

Sustainability

Inclusiveness
Participatory

Strengthening Disaster Resilience



Three Key Global Agendas Agreed in 2015



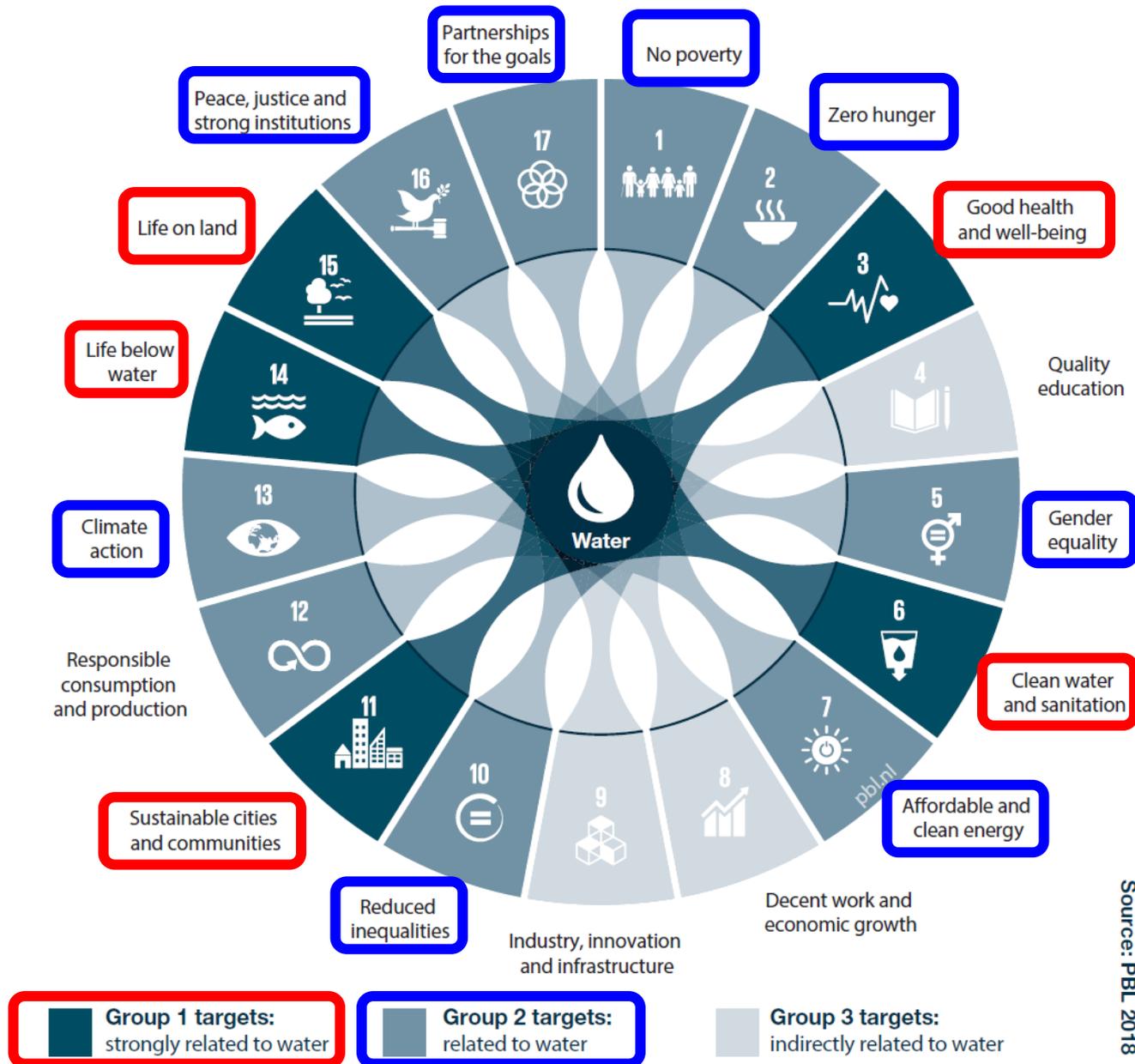
Concerted Actions are Required

Resilience

Sustainability

Inclusiveness
Participatory

Enabling Sustainable Development



Three Key Global Agendas Agreed in 2015



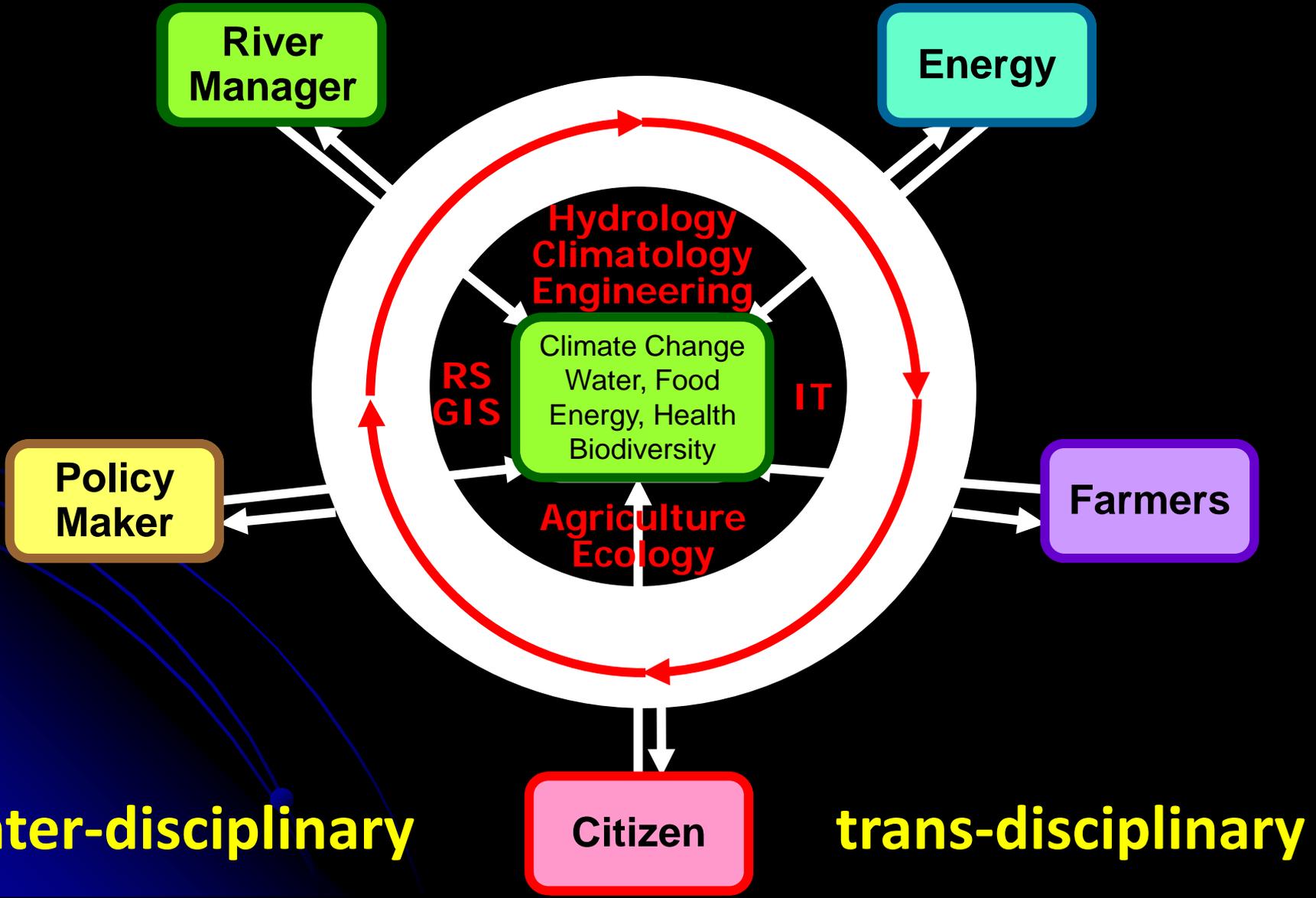
Concerted Actions are Required

Resilience

Sustainability

Inclusiveness
Participatory

Sharing Data and Information Exchanging Knowledge, Experiences and Ideas Working Together

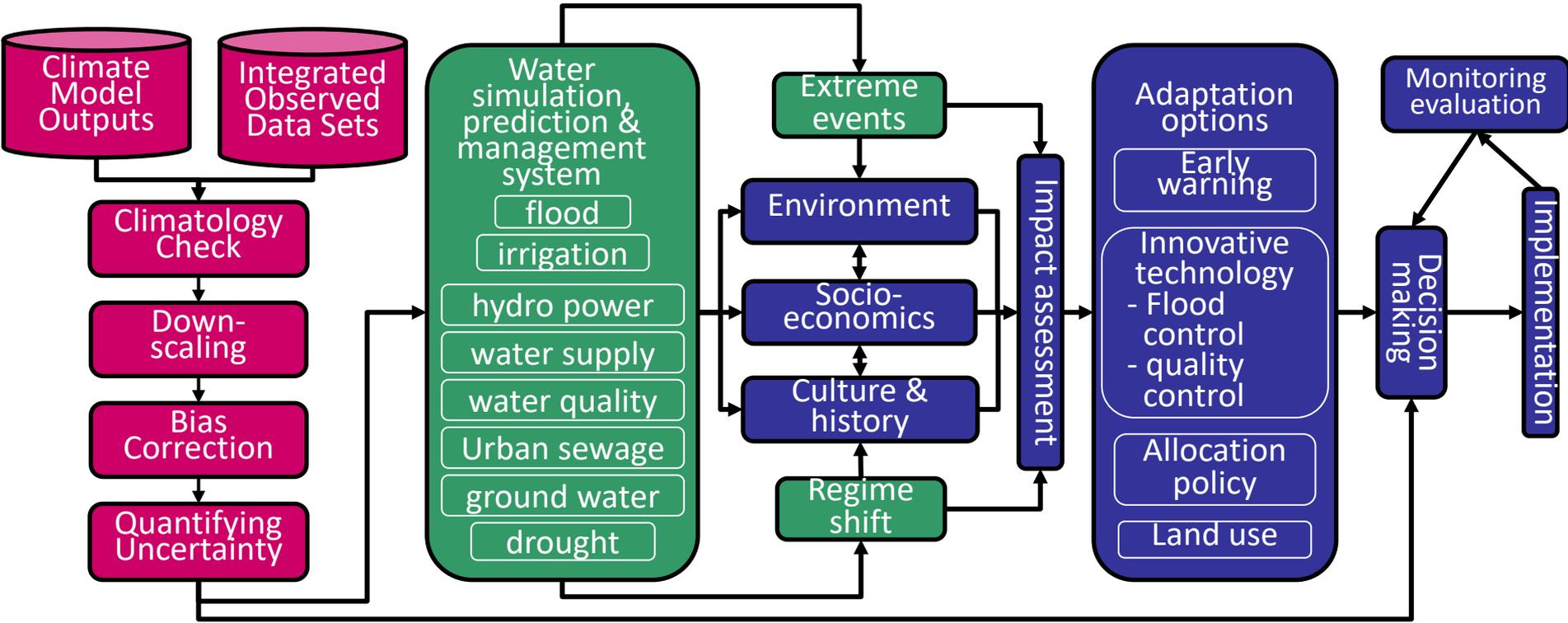


End to End Approach on Climate Change Adaptation

Scientific Approach

Engineering Approach

Socio-economical Approach

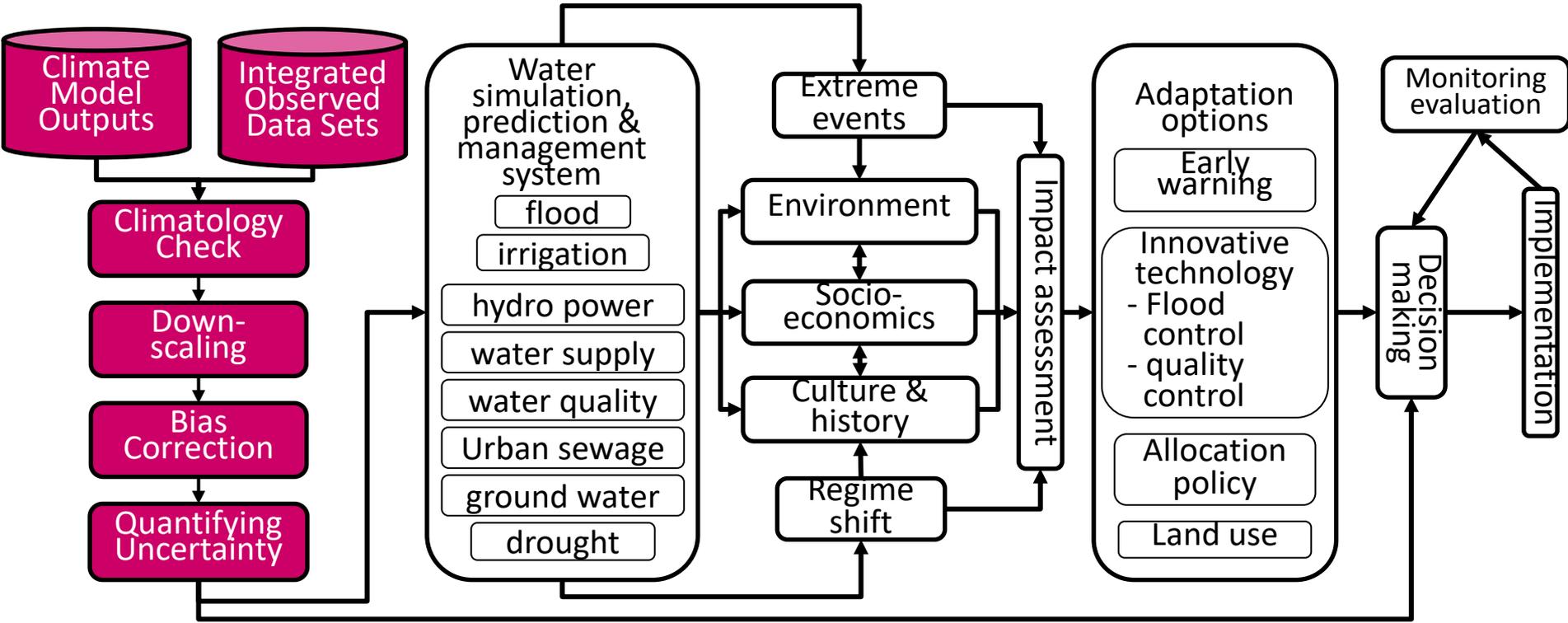


End to End Approach on Climate Change Adaptation

Scientific Approach

Engineering Approach

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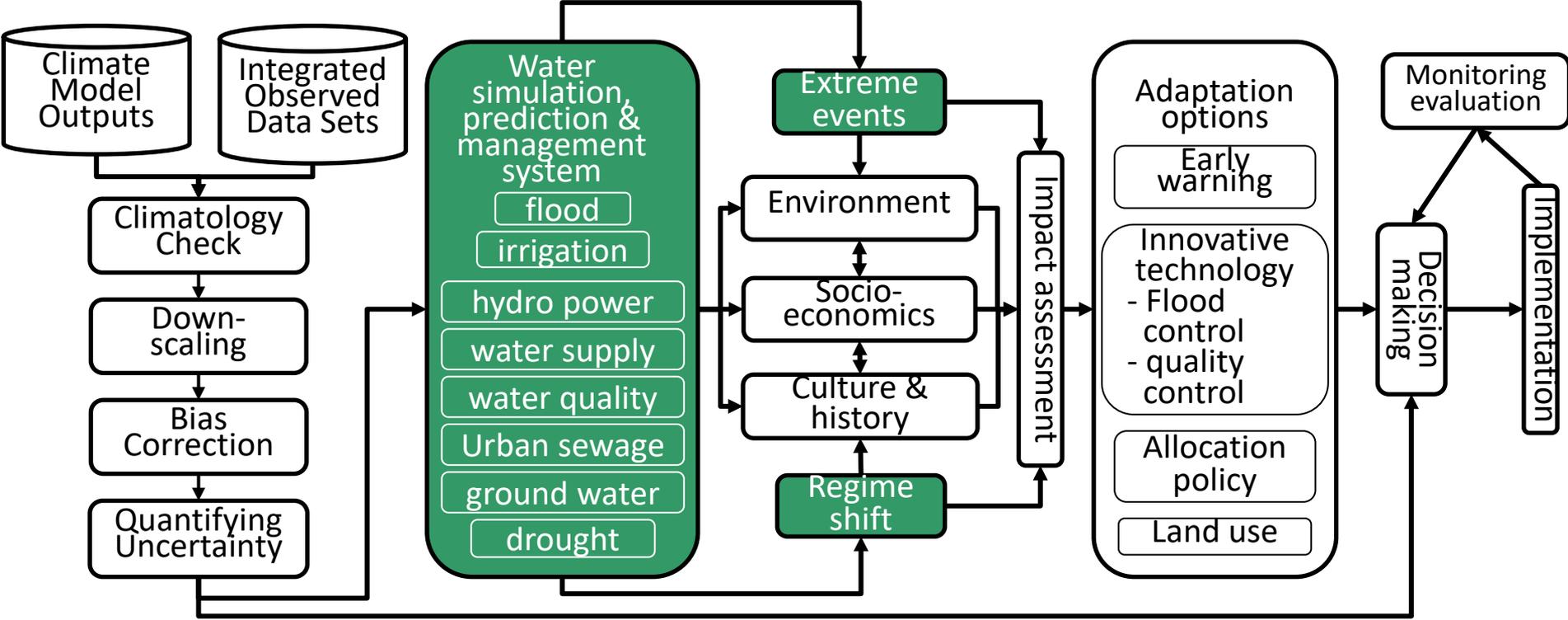


End to End Approach on Climate Change Adaptation

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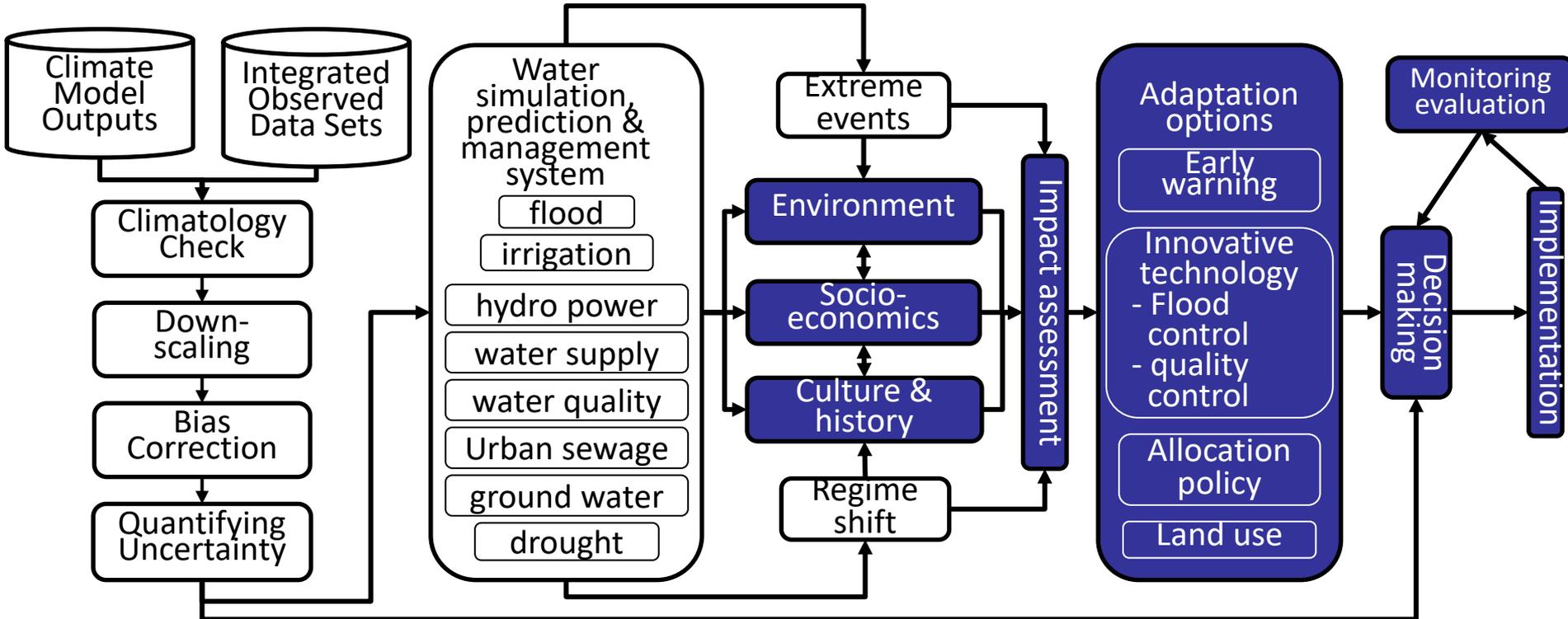


End to End Approach on Climate Change Adaptation

Scientific Approach

Engineering Approach

Socio-economical Approach



Evidence-based Contingency Planning

Case study in Calumpit Municipality in Pampanga River Basin in the Philippines

1. Understand Current status

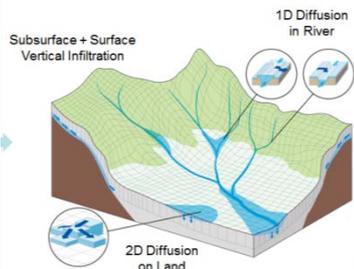


Interview Survey



Field Survey

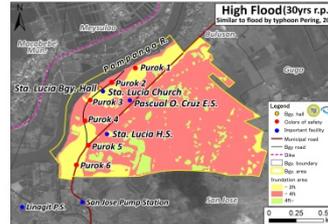
2. Identify Risk (with National and Provincial govt.)



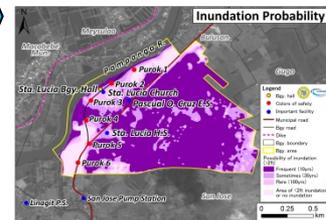
Flood Simulation by RRI Model
(Use of 5m IfSar Dem data)



Resource Map



Inundation Map (30 Years)



Inundation Probability Map

Flood Case	Point 1		Point 2		Inundation depth (m)
	1st	2nd	1st	2nd	
Ordinary Flood	0.00	0.00	0.00	0.00	0.00
High Flood (30yr r.p.)	0.00	0.00	0.00	0.00	0.00
Extreme Flood	0.00	0.00	0.00	0.00	0.00
Public and Stat.	0.00	0.00	0.00	0.00	0.00
Ordinary Flood	0.00	0.00	0.00	0.00	0.00
High Flood	0.00	0.00	0.00	0.00	0.00
Extreme Flood	0.00	0.00	0.00	0.00	0.00
Public and Stat.	0.00	0.00	0.00	0.00	0.00
Ordinary Flood	0.00	0.00	0.00	0.00	0.00
High Flood	0.00	0.00	0.00	0.00	0.00
Extreme Flood	0.00	0.00	0.00	0.00	0.00
Public and Stat.	0.00	0.00	0.00	0.00	0.00

Inundation Water Chart

3. Analyze Flood Impact



Workshop at Communities
(July, 2015)

5. Develop and 6. Share the Plan



Final Workshop at Municipality (Feb, 2016)



Example of Community Contingency Plan

4. Develop Response Strategy at Communities

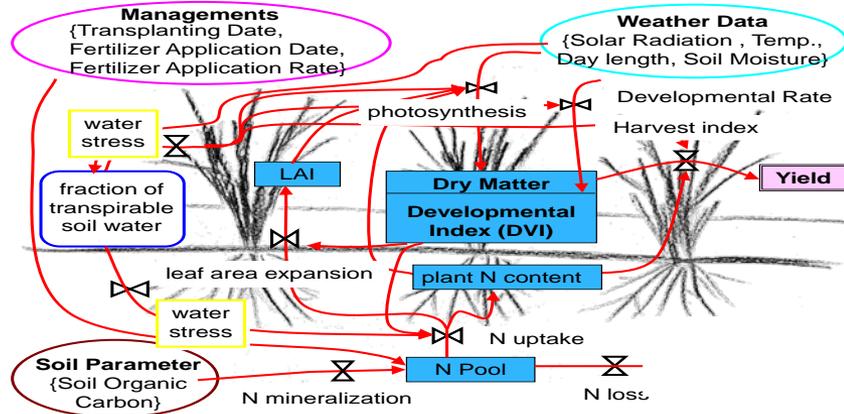
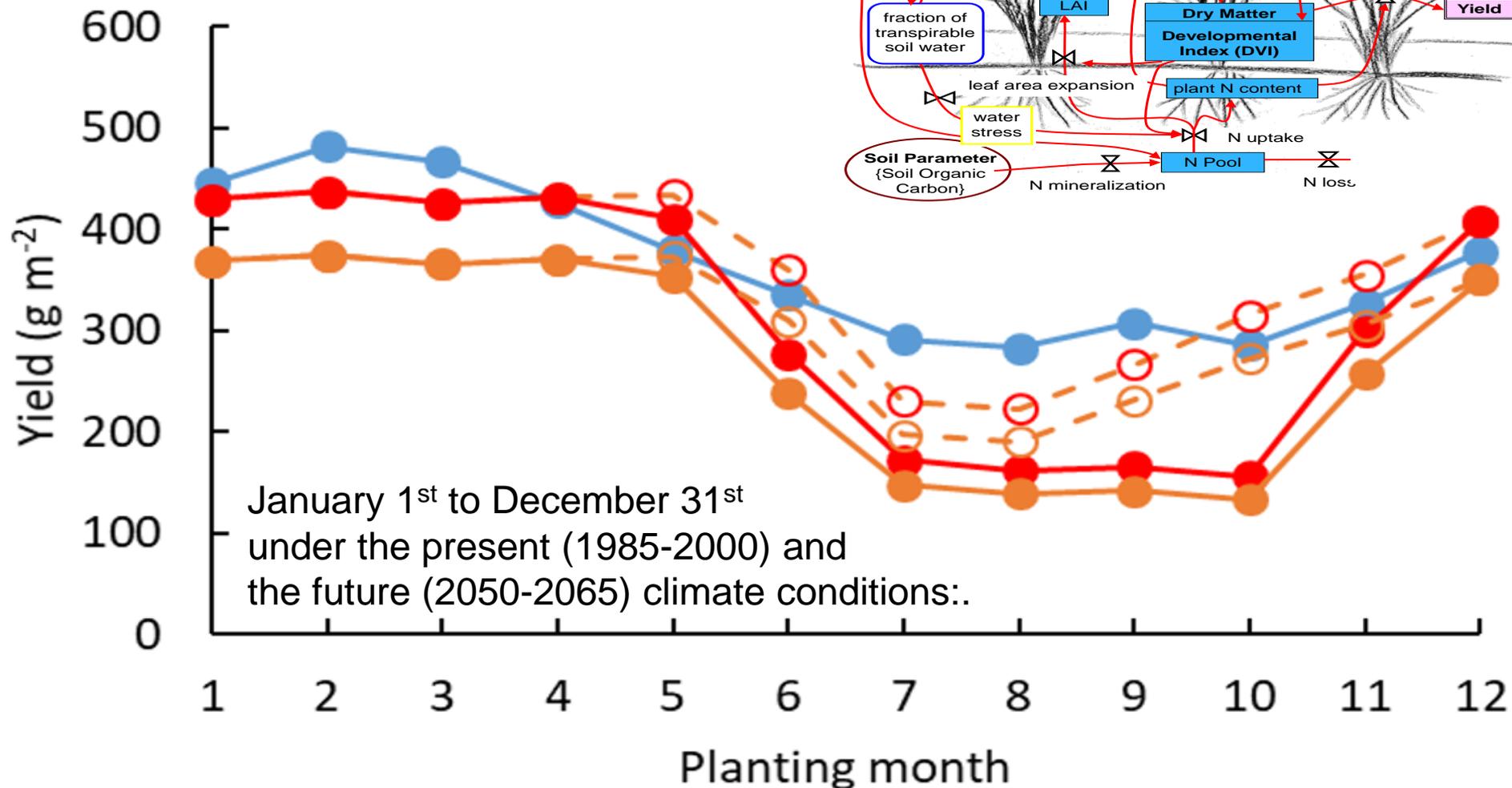


Workshop at Communities (Jan, 2016)



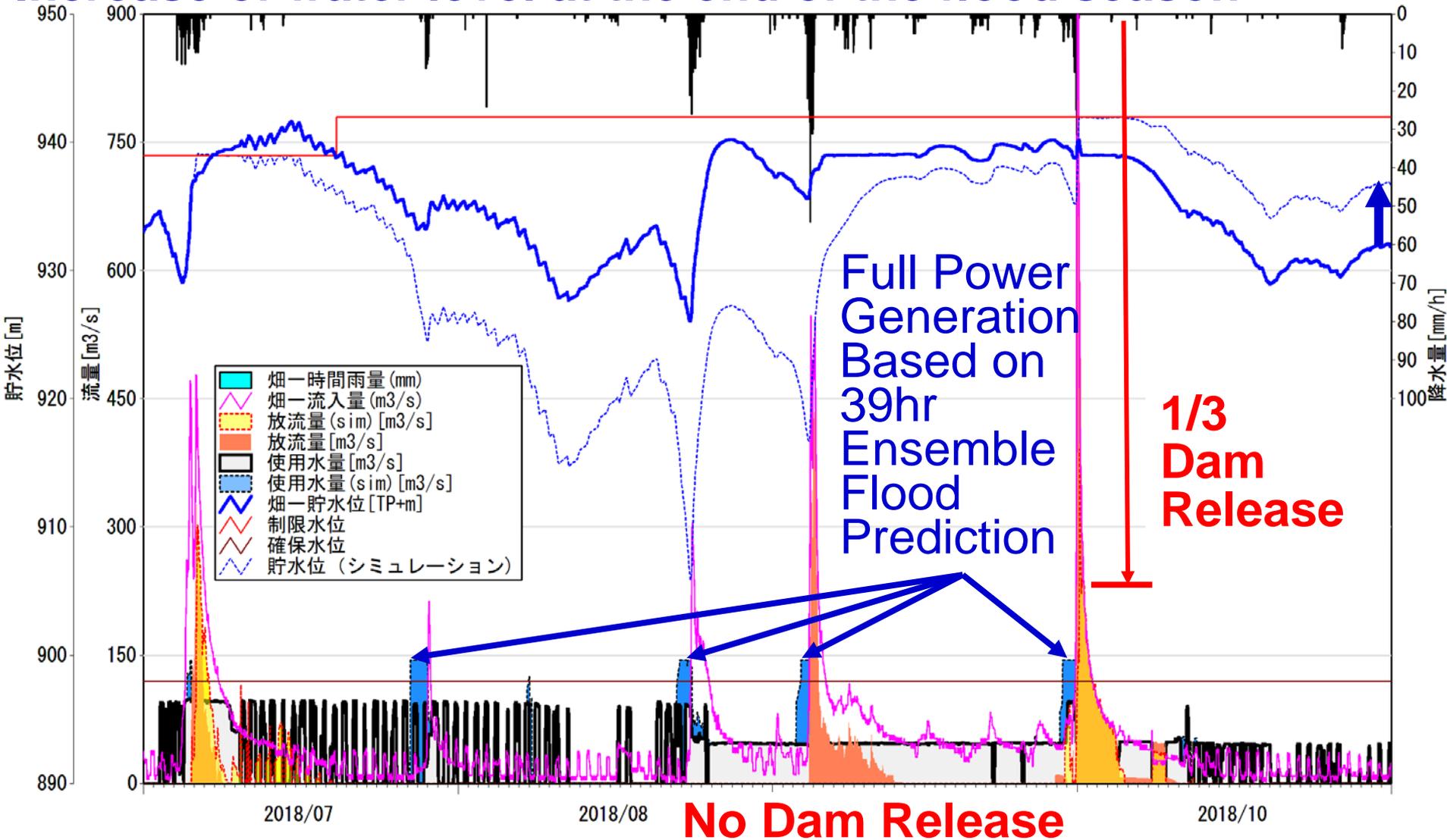
Proposal of Strategy

Effect of planting month on rice yield at Leumping (Rainfed ecotype)



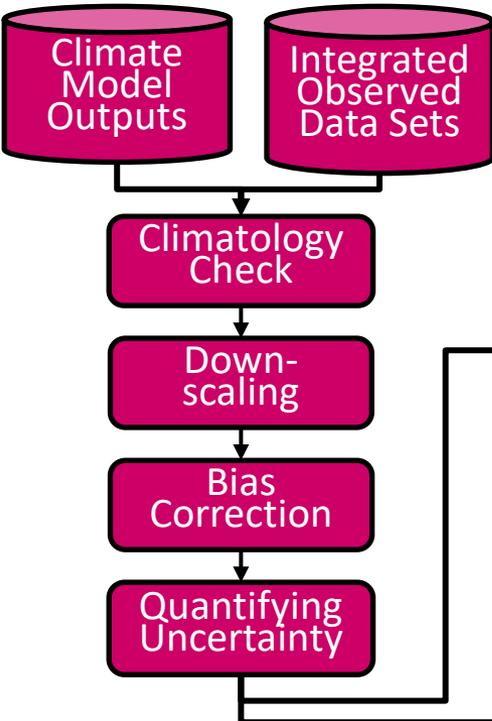
- Present management under present climate;
- Present management under future climate;
- + 50% increase of fertilizer under future climate.
- Drought tolerant cultivar under future climate;
- Drought tolerant cultivar + 50% increase of fertilizer under future climate.

Increase of power generation
Actual: 378MCM → Optimized: 437MCM +16%
Increase of water level at the end of the flood season

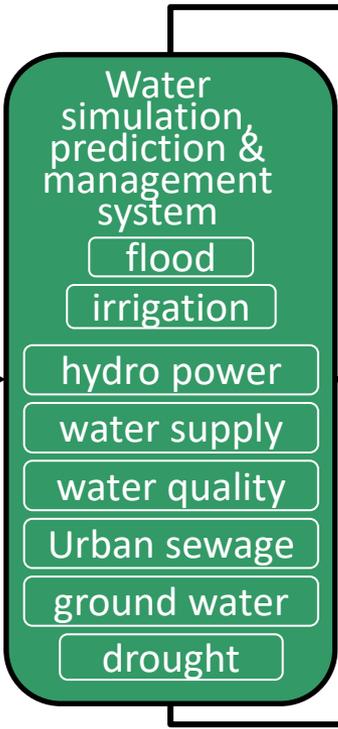


End to End Approach on Climate Change Adaptation

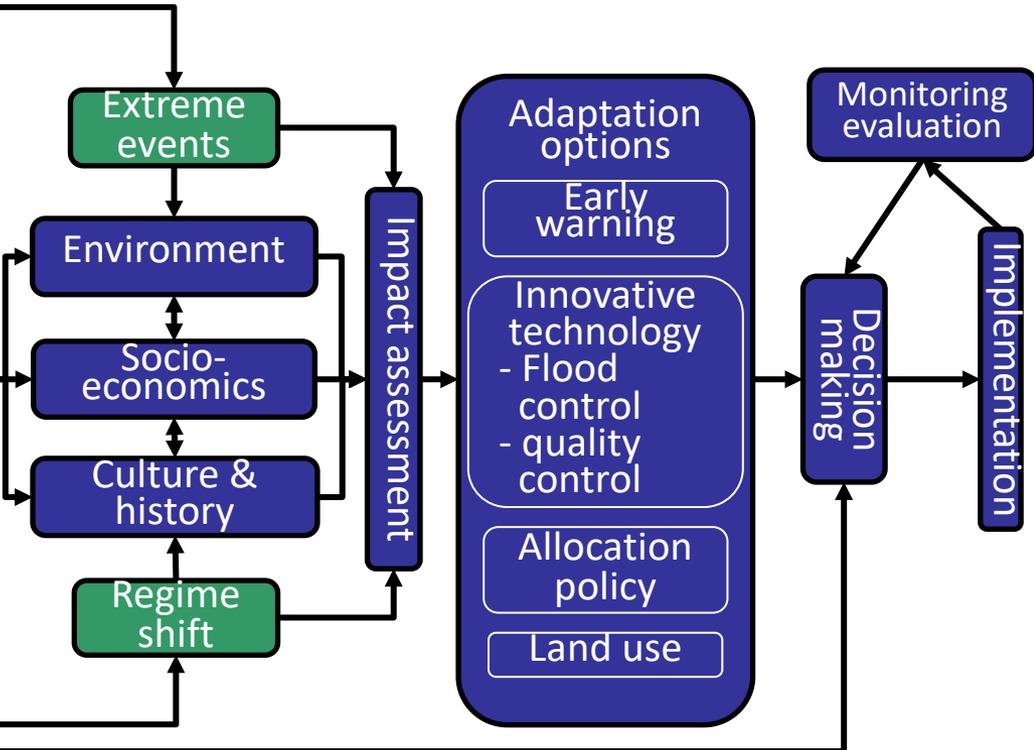
Scientific Approach



Engineering Approach



Socio-economical Approach



volume

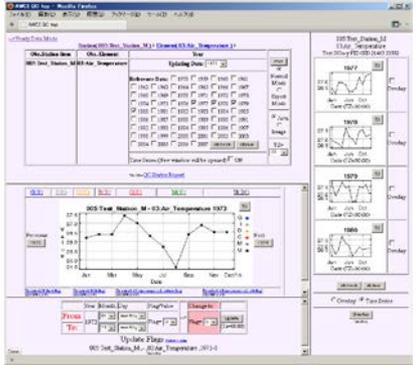
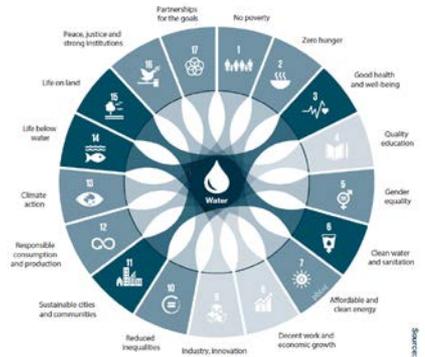
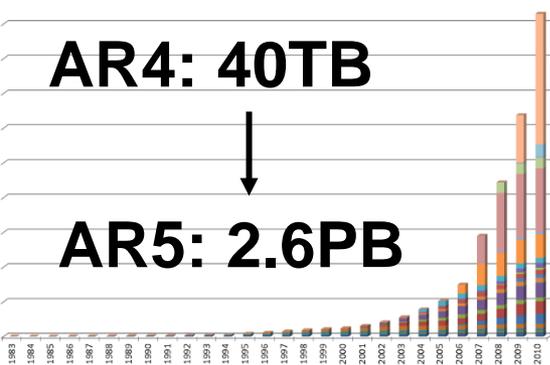
variety

veracity

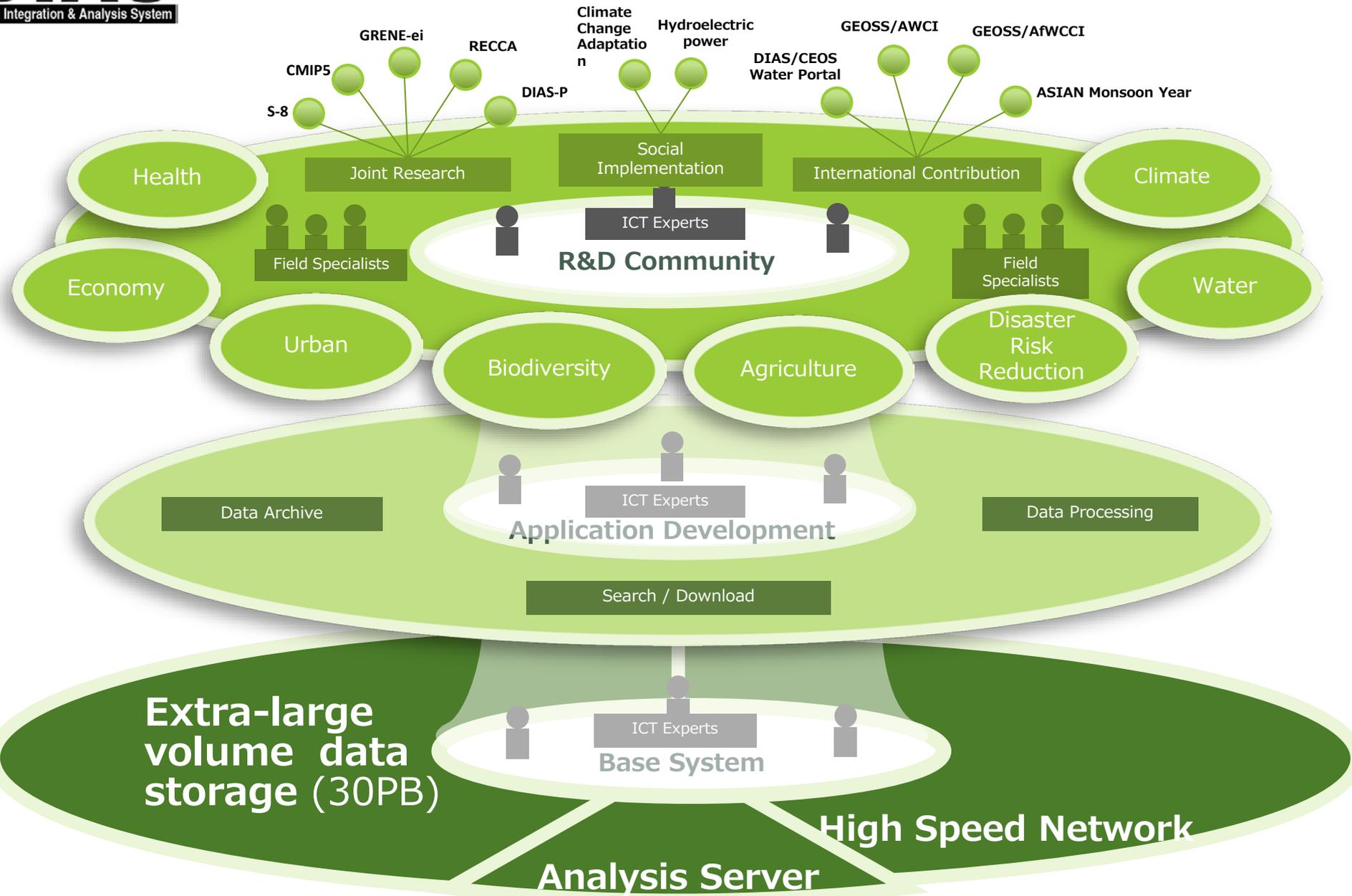
velocity

AR4: 40TB

AR5: 2.6PB



Challenges to variety, volume, velocity and veracity.



Let's Build a Resilient and Sustainable Society under Climate Change



Orientation Seminar on Climate Change Adaptation
in the Pilot Case of Solo River Basin

Introduction of IFI Platform and Climate Change

Strengthening Resilience and Enabling Sustainable Development under Climate Change

Toshio Koike

Director, International Centre for Water Hazard and Risk Management (ICHARM)

Professor Emeritus, the University of Tokyo

Council Member, Science Council of Japan (SCJ), Cabinet Office of Japan

Chair, Japan National Committee on Earth Observation, MEXT

Chair, River Council of Japan, MLIT