United Nations
Educational, Scientific and
Cultural Organization

The Fourth Meeting of the High-level Experts and Leaders Panel on Water and Disasters (HELP)

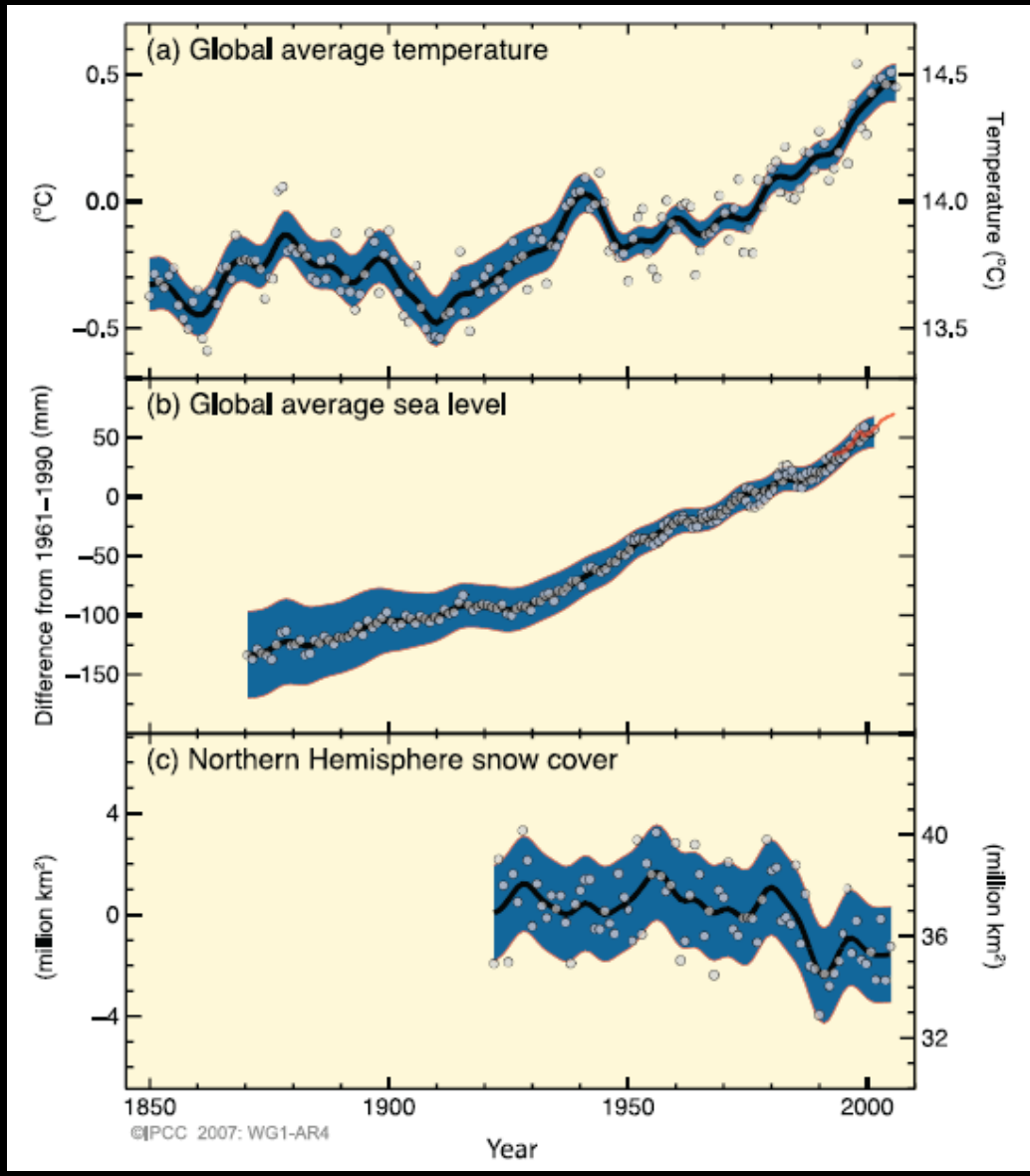
Latest scientific findings on climate change and water disasters

Toshio Koike
Director, ICHARM
Professor, University of Tokyo

Is the Climate Changing?

Warming of the climate system is unequivocal.

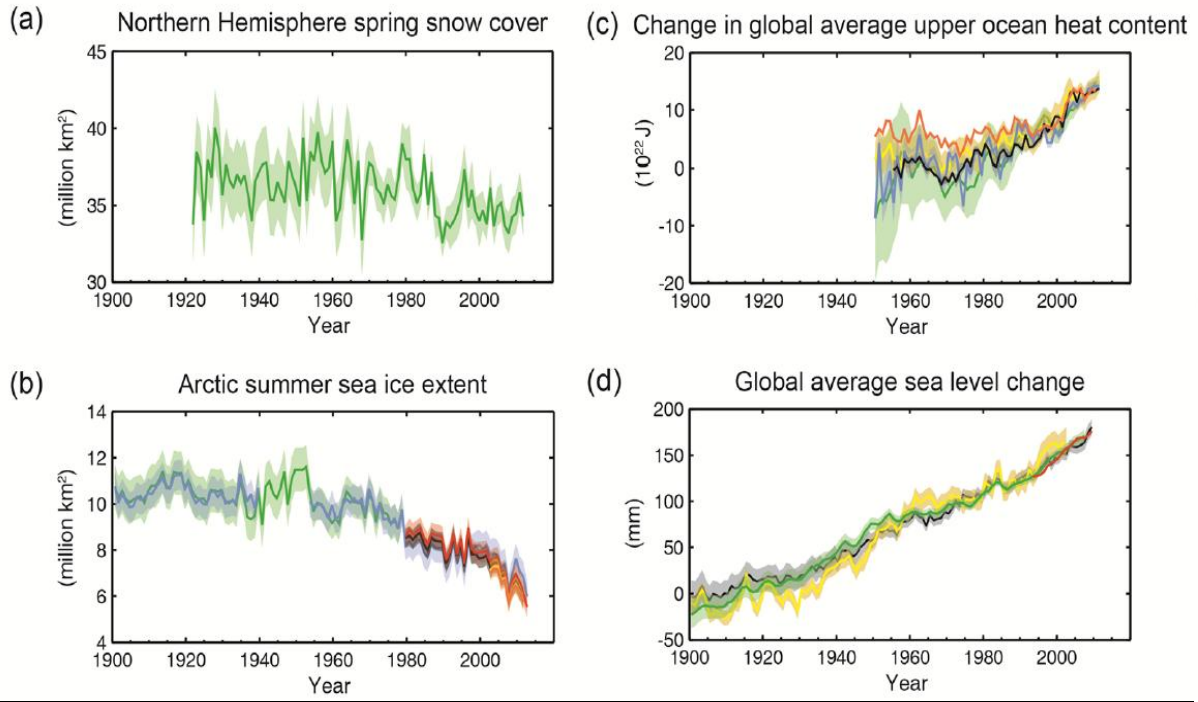
IPCC/AR4 (2007)

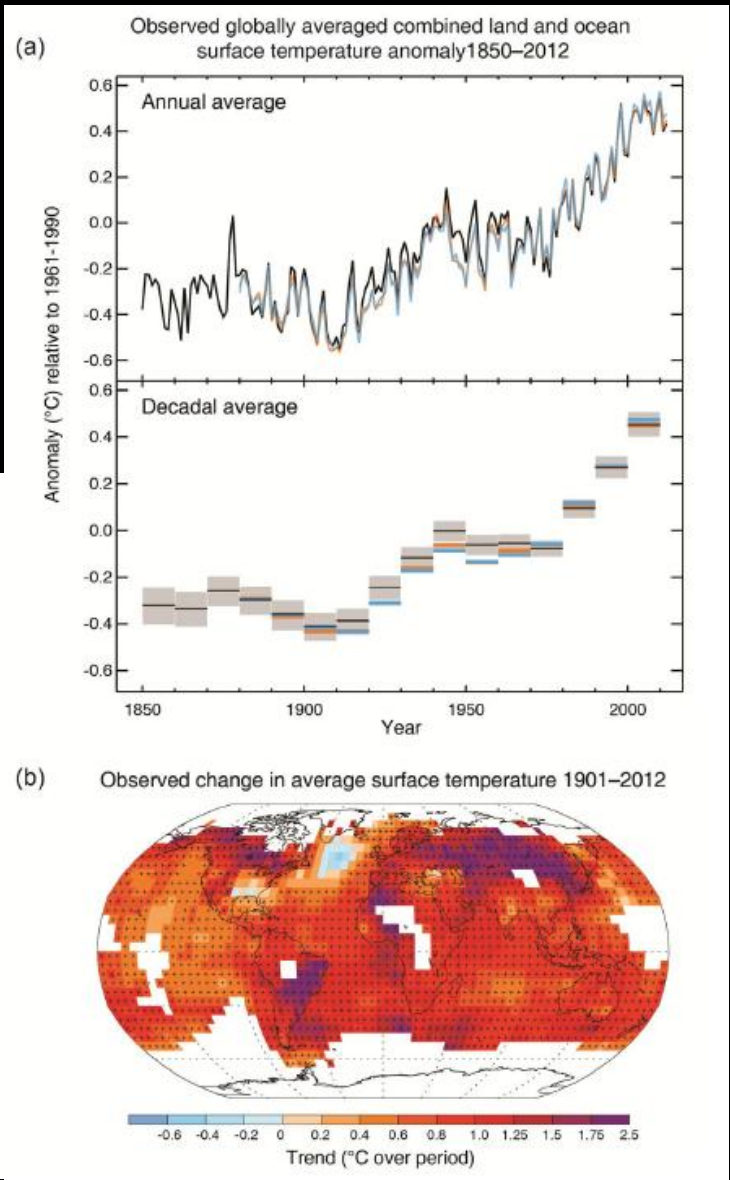


Is the climate changing?

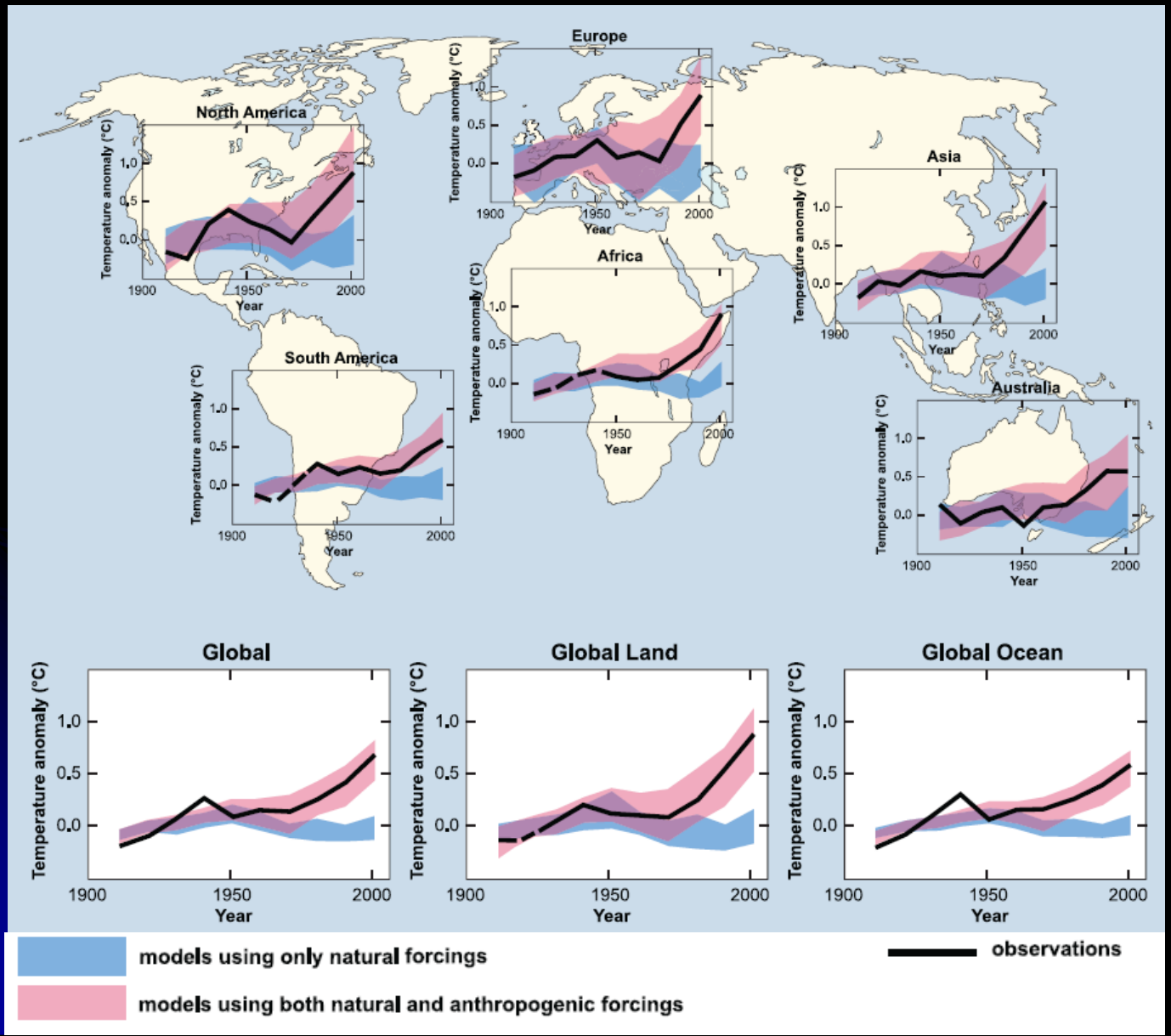
Warming of the climate system is unequivocal.

IPCC/AR5 (2013)



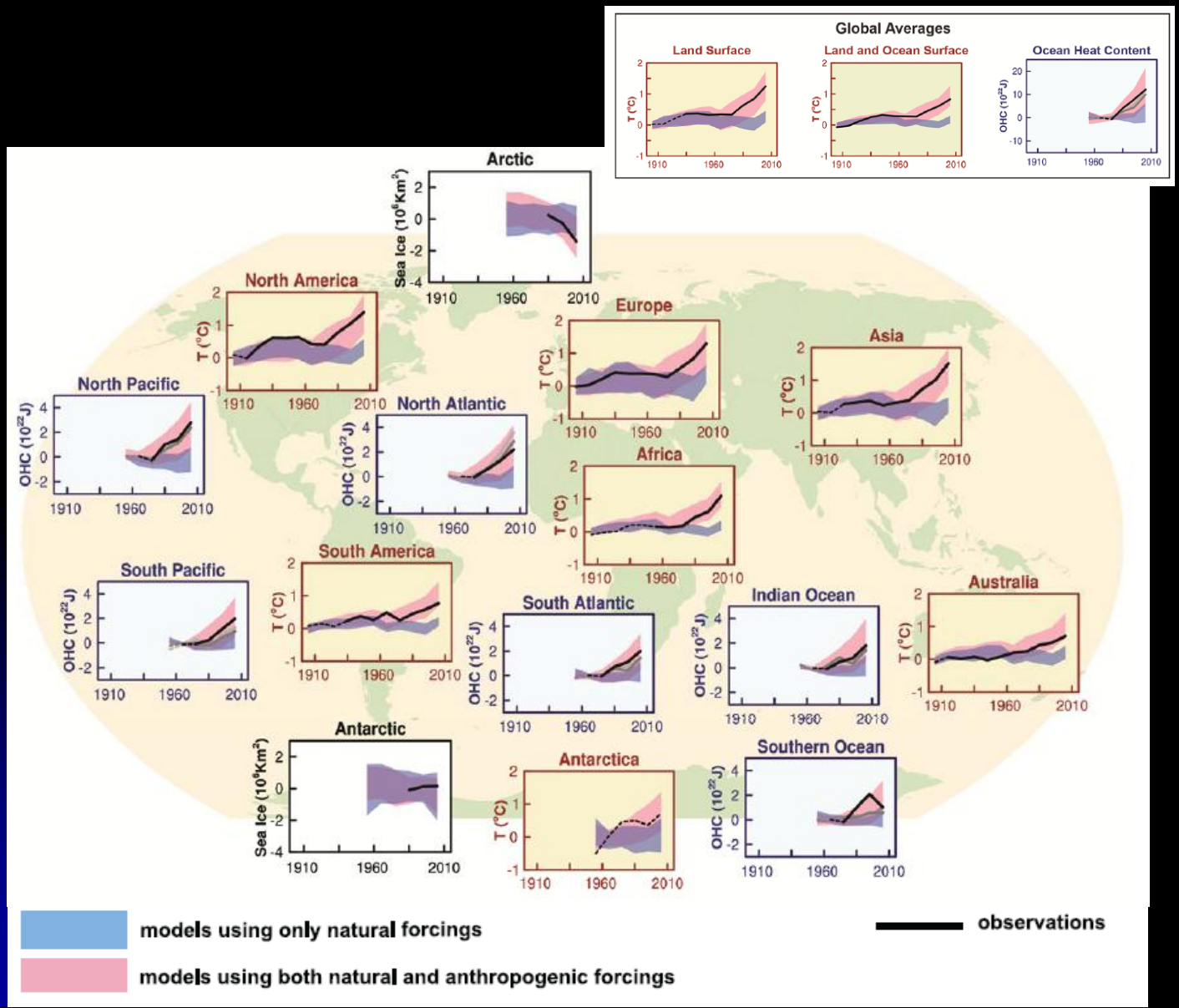


What does change the climate?



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)

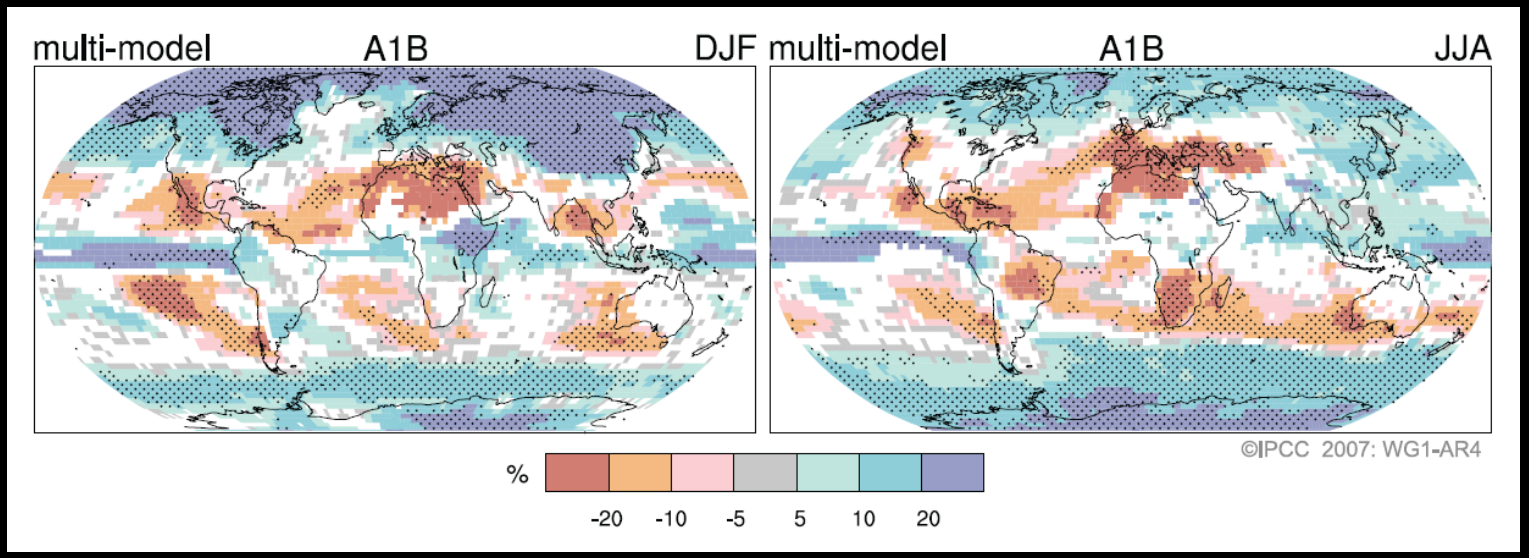
What does change the climate?



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)

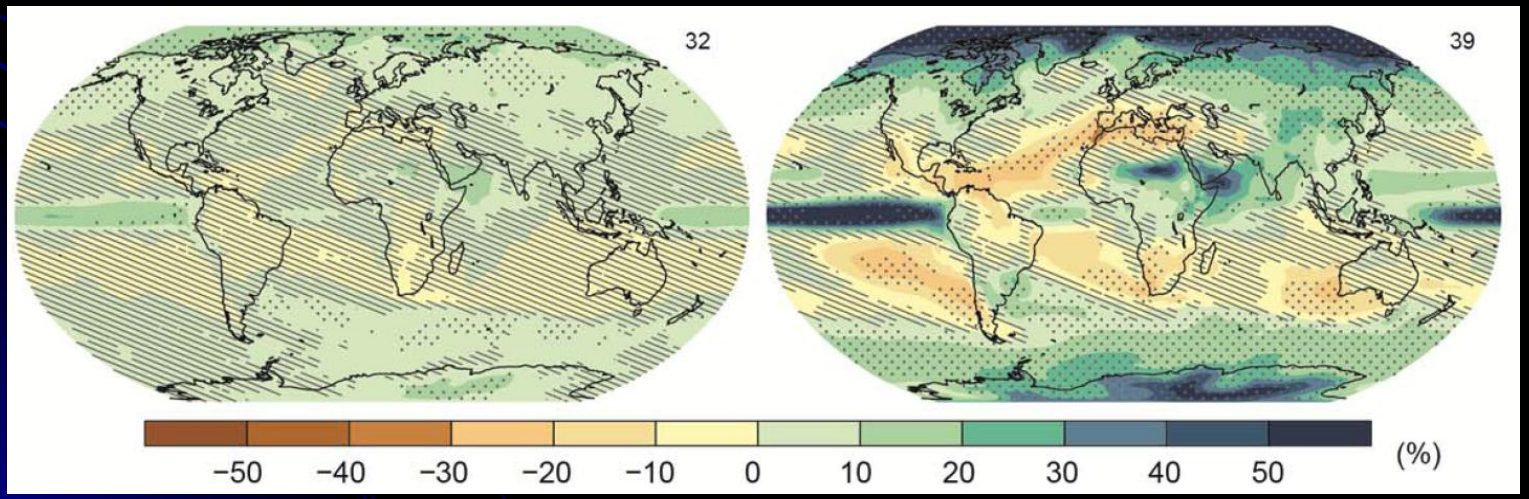
Change in average precipitation

IPCC/AR4 (2007)



(1980-1999 to 2090-2099)

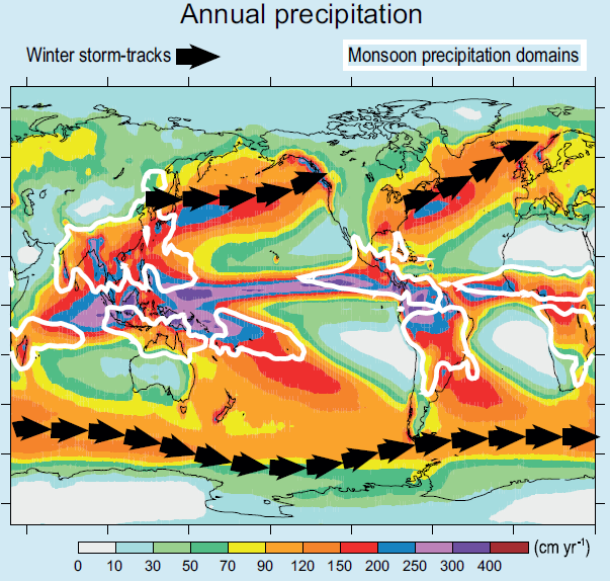
IPCC/AR5 (2013)



RCP2.6

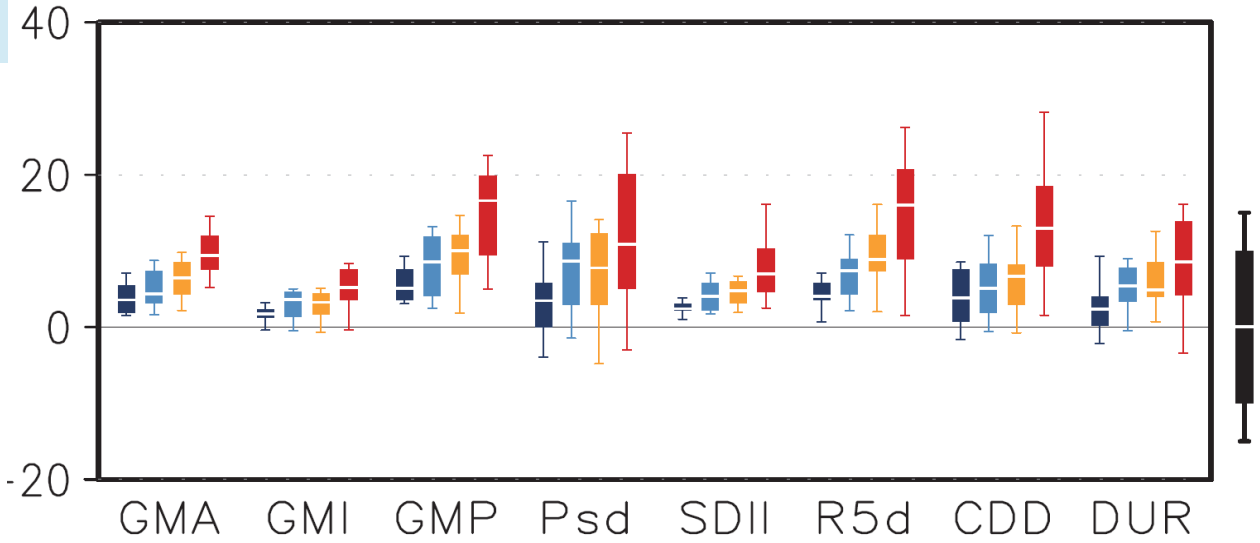
(1986-2005 to 2081 to 2100)

RCP8.5

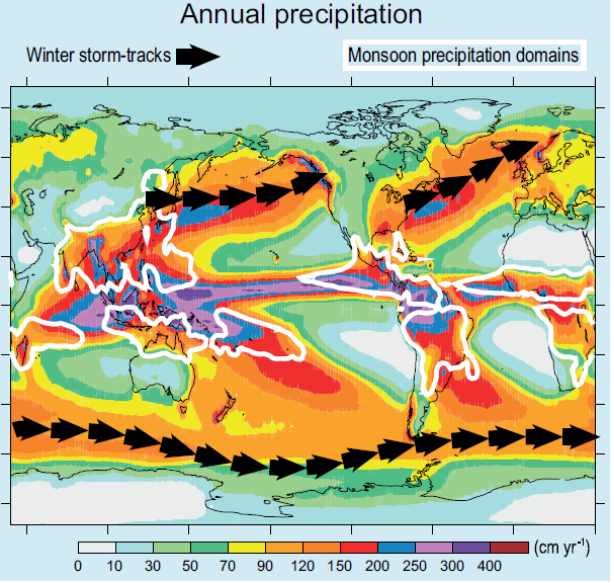


Projected changes in the global monsoon for the future (2080-2099) relative to the present day (1986-2005)

RCP2.6(18 models)
RCP4.5 (24 models)
RCP6.0 (14 models)
RCP8.5(26 models)

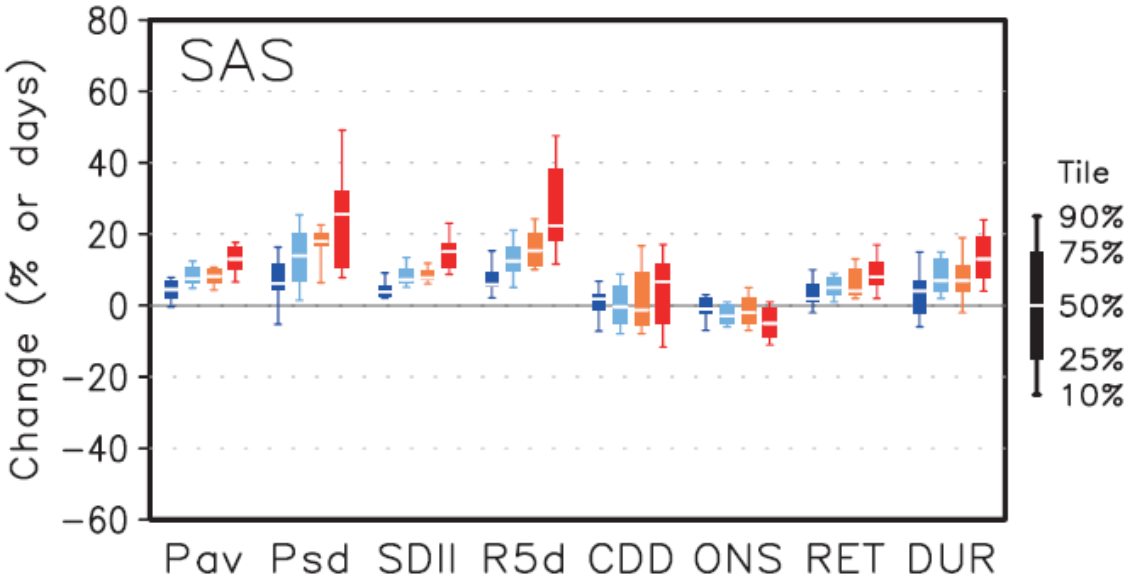


GMA: global monsoon area, **GMI**: global monsoon intensity. **GMP**: global monsoon total precipitation, **Psd**: standard deviation of interannual variability in seasonal average precipitation, **SDII**: simple daily precipitation intensity index, **R5d**: seasonal maximum 5-day precipitation total, **CDD**: seasonal maximum consecutive dry days, **DUR**: monsoon season duration



Projected changes in the Southern Asia monsoon for the future (2080-2099) relative to the present day (1986-2005)

RCP2.6(18 models)
RCP4.5 (24 models)
RCP6.0 (14 models)
RCP8.5(26 models)

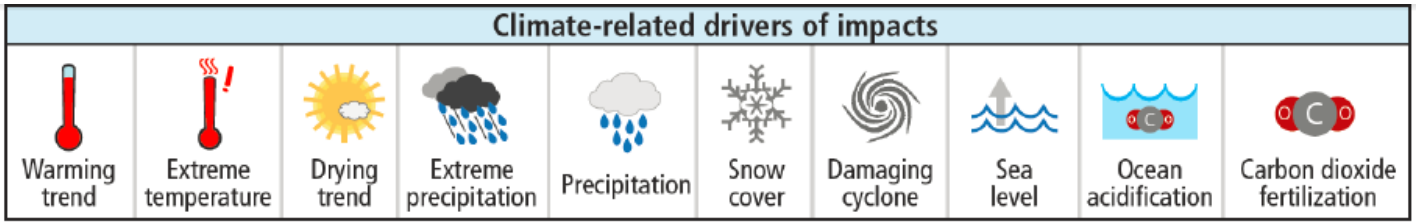


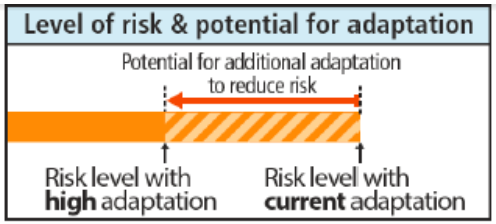
Pav: averaged precipitation, **Psd**: standard deviation of interannual variability in seasonal average precipitation, **SDII**: simple daily precipitation intensity index, **R5d**: seasonal maximum 5-day precipitation total, **CDD**: seasonal maximum consecutive dry days, **ONS**: monsoon onset date, **RET**: retreat date, **DUR**: monsoon season duration

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

Key regional risks from climate change and the potential for reducing risks through adaptation and mitigation





Africa

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation
Compounded stress on water resources facing significant strain from overexploitation and degradation at present and increased demand in the future, with drought stress exacerbated in drought-prone regions of Africa (*high confidence*) [22.3-4]	• Reducing non-climate stressors on water resources • Strengthening institutional capacities for demand management, groundwater assessment, integrated water-wastewater planning, and integrated land and water governance • Sustainable urban development		Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high
Reduced crop productivity associated with heat and drought stress, with strong adverse effects on regional, national, and household livelihood and food security, also given increased pest and disease damage and flood impacts on food system infrastructure (*high confidence*) [22.3-4]	• Technological adaptation responses (e.g., stress-tolerant crop varieties, irrigation, enhanced observation systems) • Enhancing smallholder access to credit and other critical production resources; Diversifying livelihoods • Strengthening institutions at local, national, and regional levels to support agriculture (including early warning systems) and gender-oriented policy • Agronomic adaptation responses (e.g., agroforestry, conservation agriculture)		Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high
Changes in the incidence and geographic range of vector- and water-borne diseases due to changes in the mean and variability of temperature and precipitation, particularly along the edges of their distribution (*medium confidence*) [22.3]	• Achieving development goals, particularly improved access to safe water and improved sanitation, and enhancement of public health functions such as surveillance • Vulnerability mapping and early warning systems • Coordination across sectors • Sustainable urban development		Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high

Large Uncertainty in Climate Projection

– why? –
– how to address? –

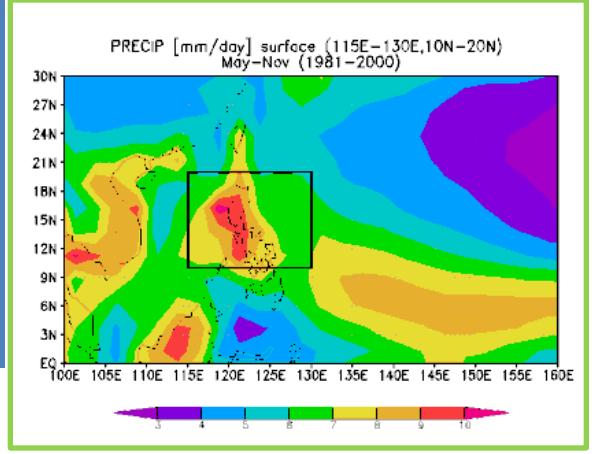
Computational Loads >> Computer Power

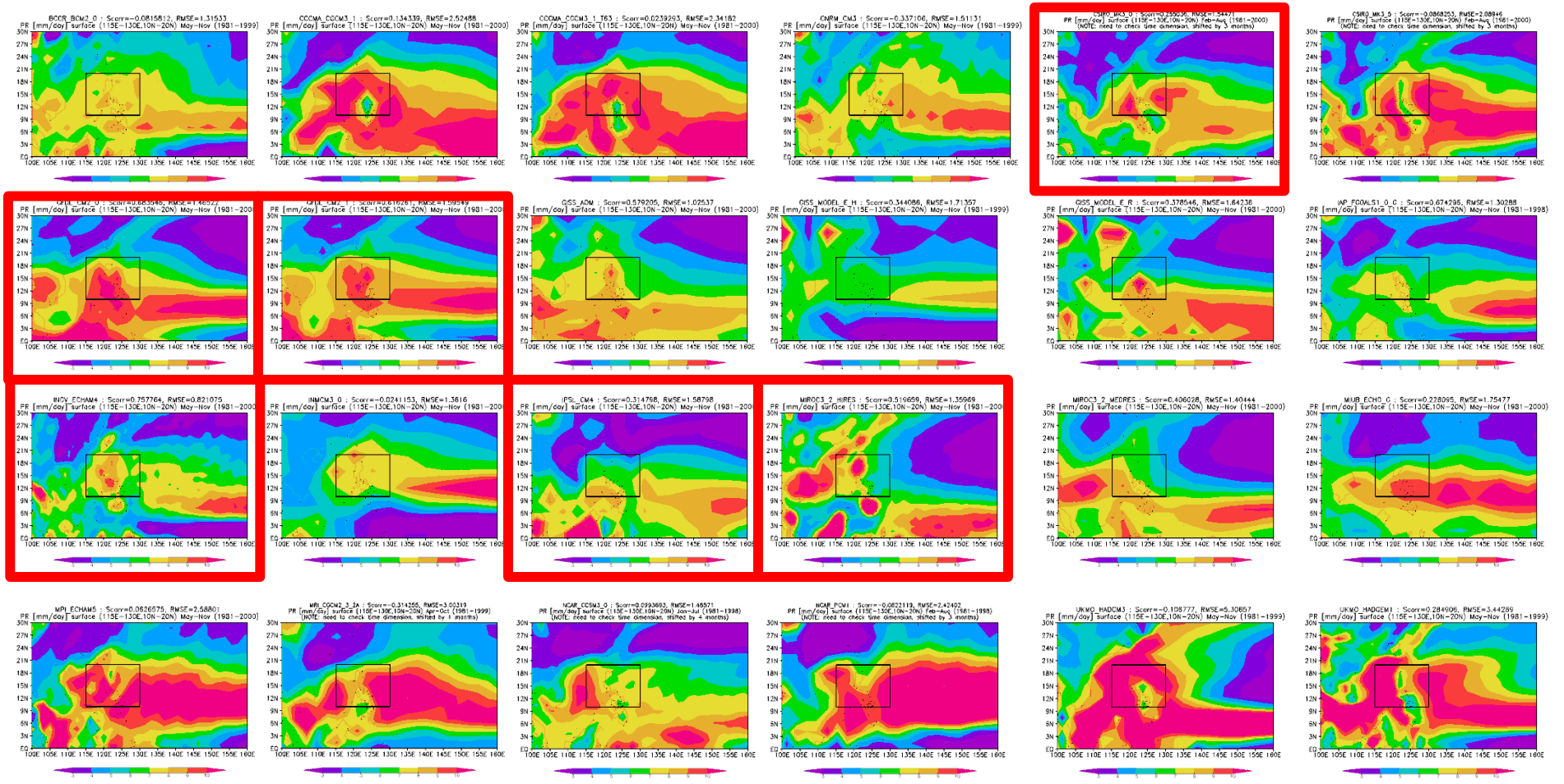
- **Time Integration**
  - weather prediction: one week
  - climate projection: one hundred years
- **Ocean Dynamics as well as Atmospheric Dynamics**
  - weather prediction: initial condition of atmosphere
  - climate projection: ocean & land boundary conditions

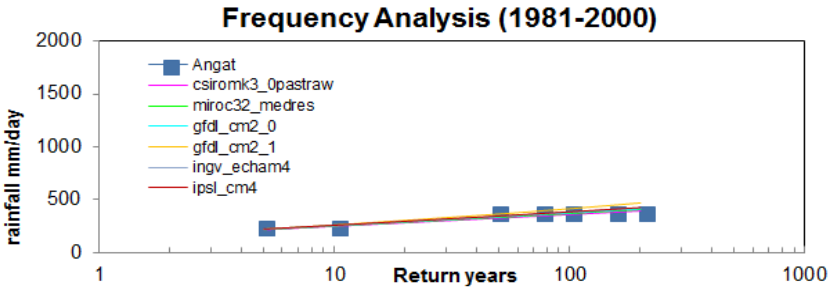
→ Coarse Spatial Resolution: several 10s km

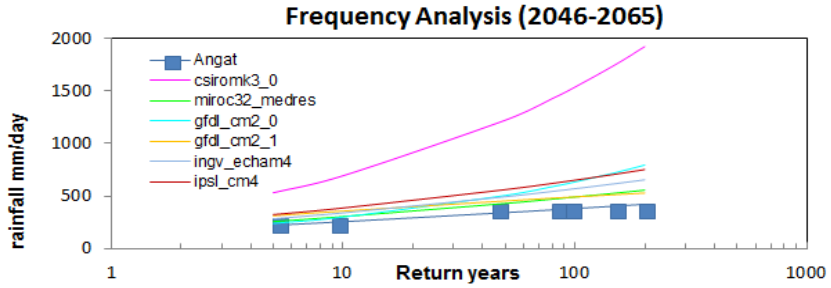
- can not express clouds physically
- can not express orographic effects

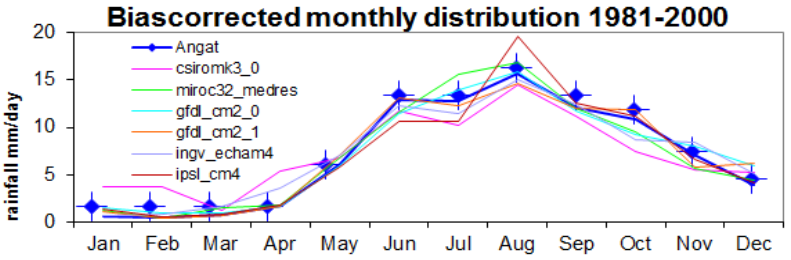
MODEL SELECTION: Precipitation (May-November)

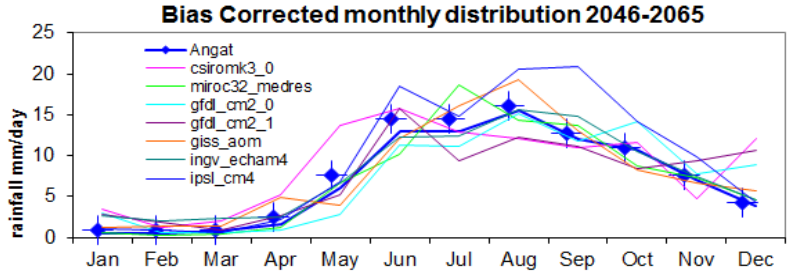


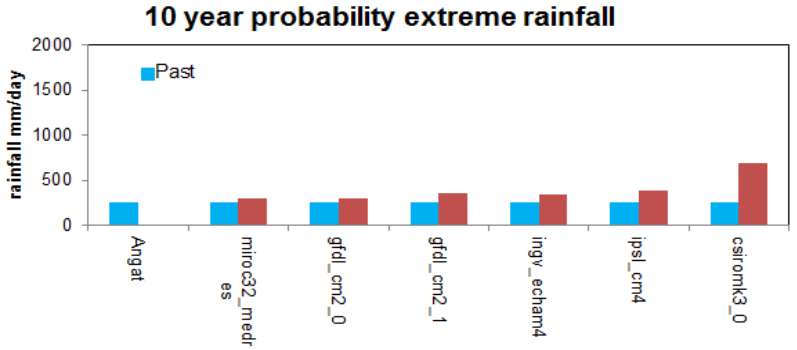


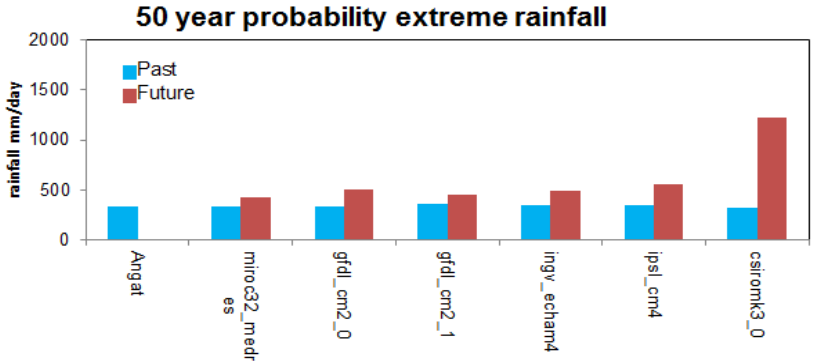

Frequency Analysis (1981-2000)
rainfall mm/day
2000
1500
1000
500
0
1
10
100
1000
Return years
Angat
csiromk3_0pastraw
miroc32_medres
gfdl_cm2_0
gfdl_cm2_1
ingv_echam4
ipsl_cm4

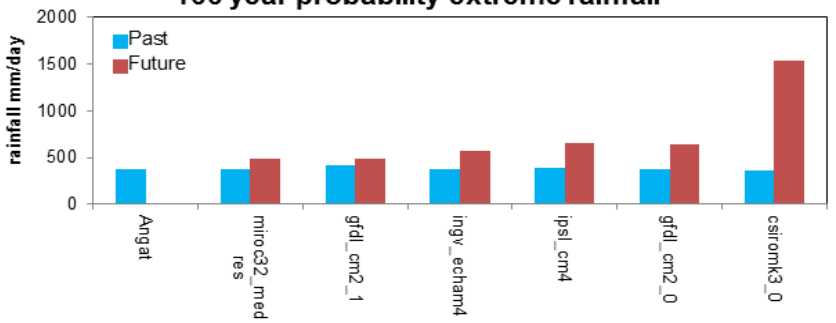

Frequency Analysis (2046-2065)
rainfall mm/day
2000
1500
1000
500
0
1
10
100
1000
Return years
Angat
csiromk3_0
miroc32_medres
gfdl_cm2_0
gfdl_cm2_1
ingv_echam4
ipsl_cm4

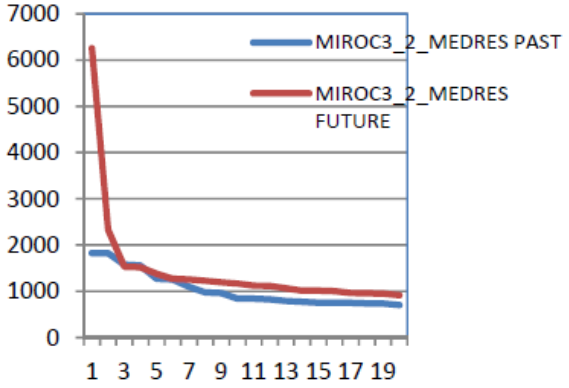

Biascorrected monthly distribution 1981-2000
rainfall mm/day
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Angat
csiromk3_0
miroc32_medres
gfdl_cm2_0
gfdl_cm2_1
ingv_echam4
ipsl_cm4

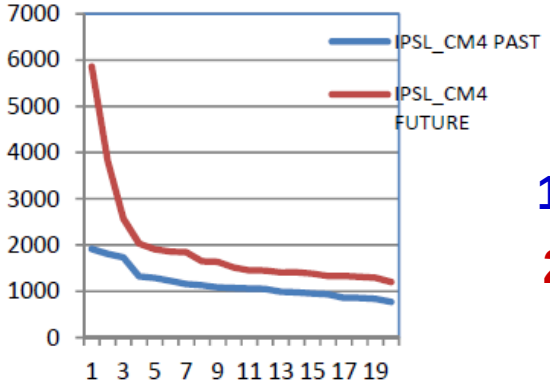

Bias Corrected monthly distribution 2046-2065
rainfall mm/day
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Angat
csiromk3_0
miroc32_medres
gfdl_cm2_0
gfdl_cm2_1
giss_aom
ingv_echam4
ipsl_cm4


10 year probability extreme rainfall
rainfall mm/day
2000
1500
1000
500
0
Past
Angat
miroc32_medres
gfdl_cm2_0
gfdl_cm2_1
ingv_echam4
ipsl_cm4
csiromk3_0


50 year probability extreme rainfall
rainfall mm/day
2000
1500
1000
500
0
Past
Future
Angat
miroc32_medres
gfdl_cm2_0
gfdl_cm2_1
ingv_echam4
ipsl_cm4
csiromk3_0

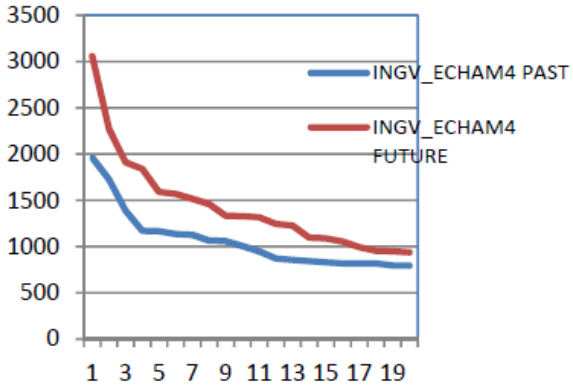

100 year probability extreme rainfall
rainfall mm/day
2000
1500
1000
500
0
Past
Future
Angat
miroc32_medres
gfdl_cm2_1
ingv_echam4
ipsl_cm4
gfdl_cm2_0
csiromk3_0

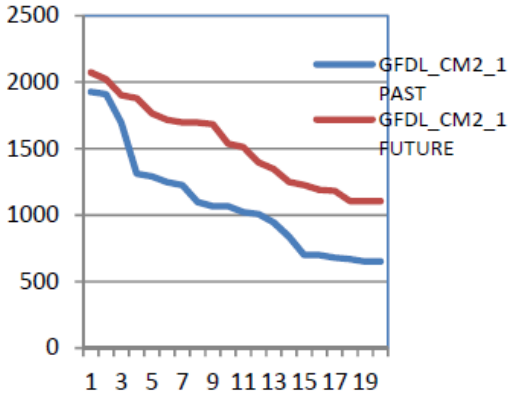


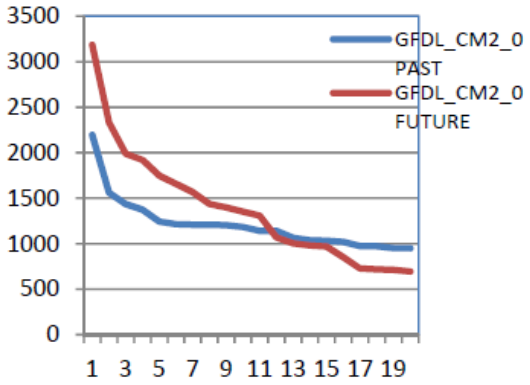


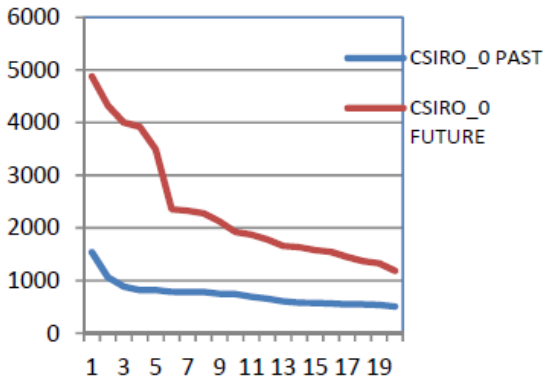
1981-2000

2046-2065





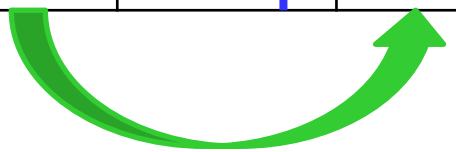




Changes of Flood in Angat Dam Basin

Past versus future Annual Average Discharge for each GCM for Angat dam inflow.

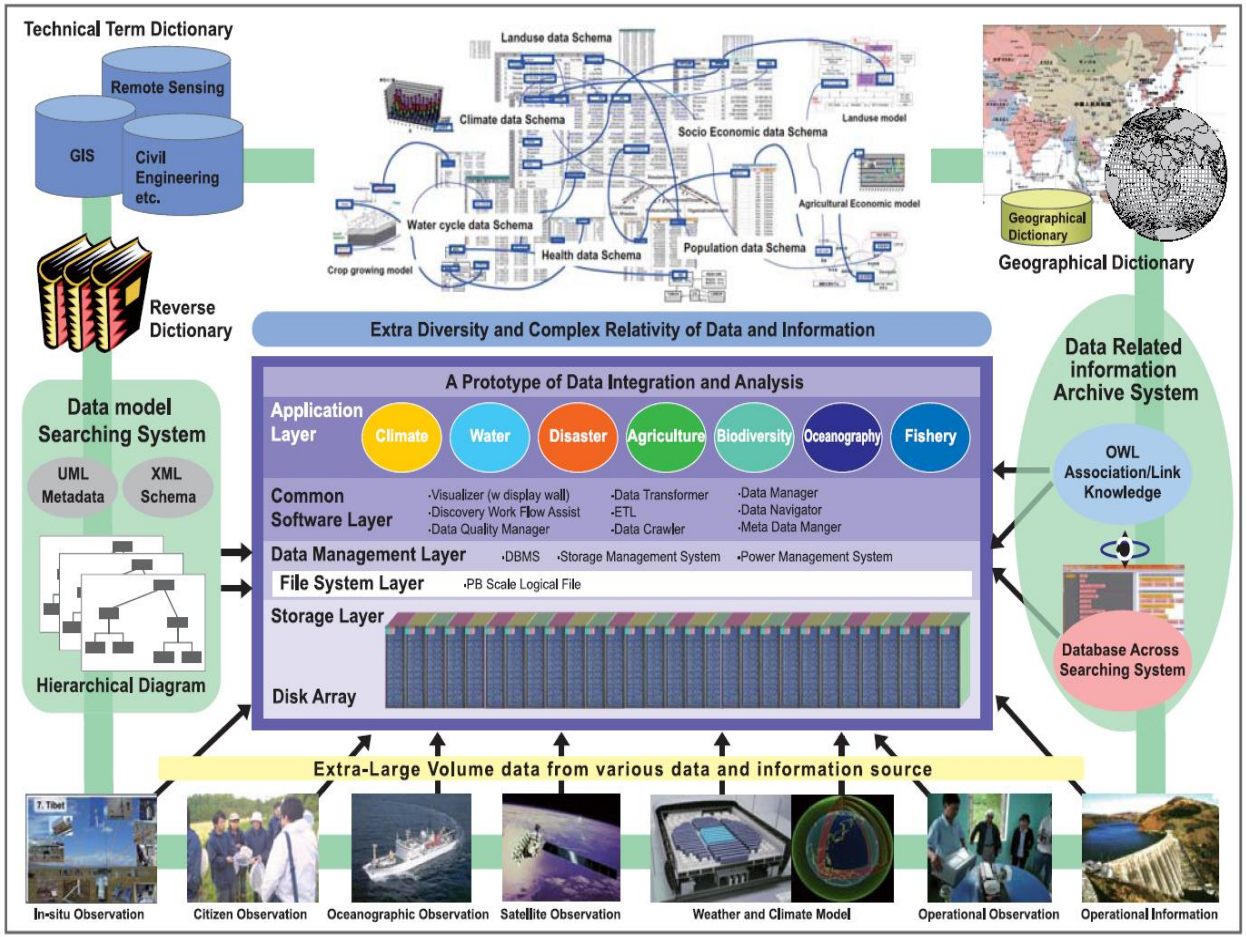
GCM	Annual Average Discharge (m^3/s)			
	Past		Future	
	Average	Stdev	Average	Stdev
MIROC	28.3	80.3	27.8	114.6
IPSL	35.3	94.4	63.7	159.7
INGV	32.8	85.0	35.4	105.4
GFDL_1	32.6	85.4	31.3	109.79
GFDL_0	35.0	90.3	34.2	101.66
CSIRO	28.5	67.1	30.3	152.80



Data Integration and Analysis System

a legacy for Japan's contributions to GEOSS

To create knowledge enabling us to solve the Earth environment problems including climate change impacts and to generate socio-economic benefits.

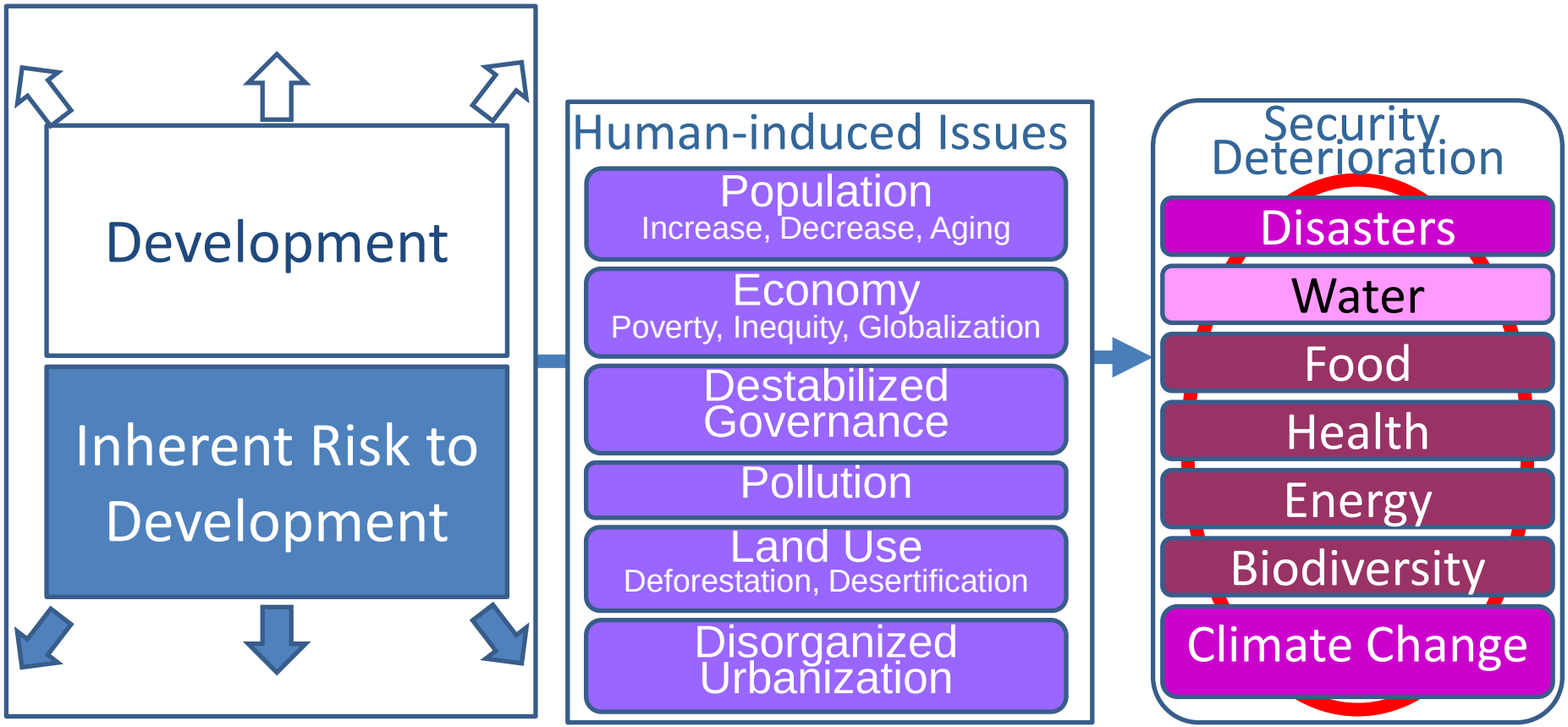


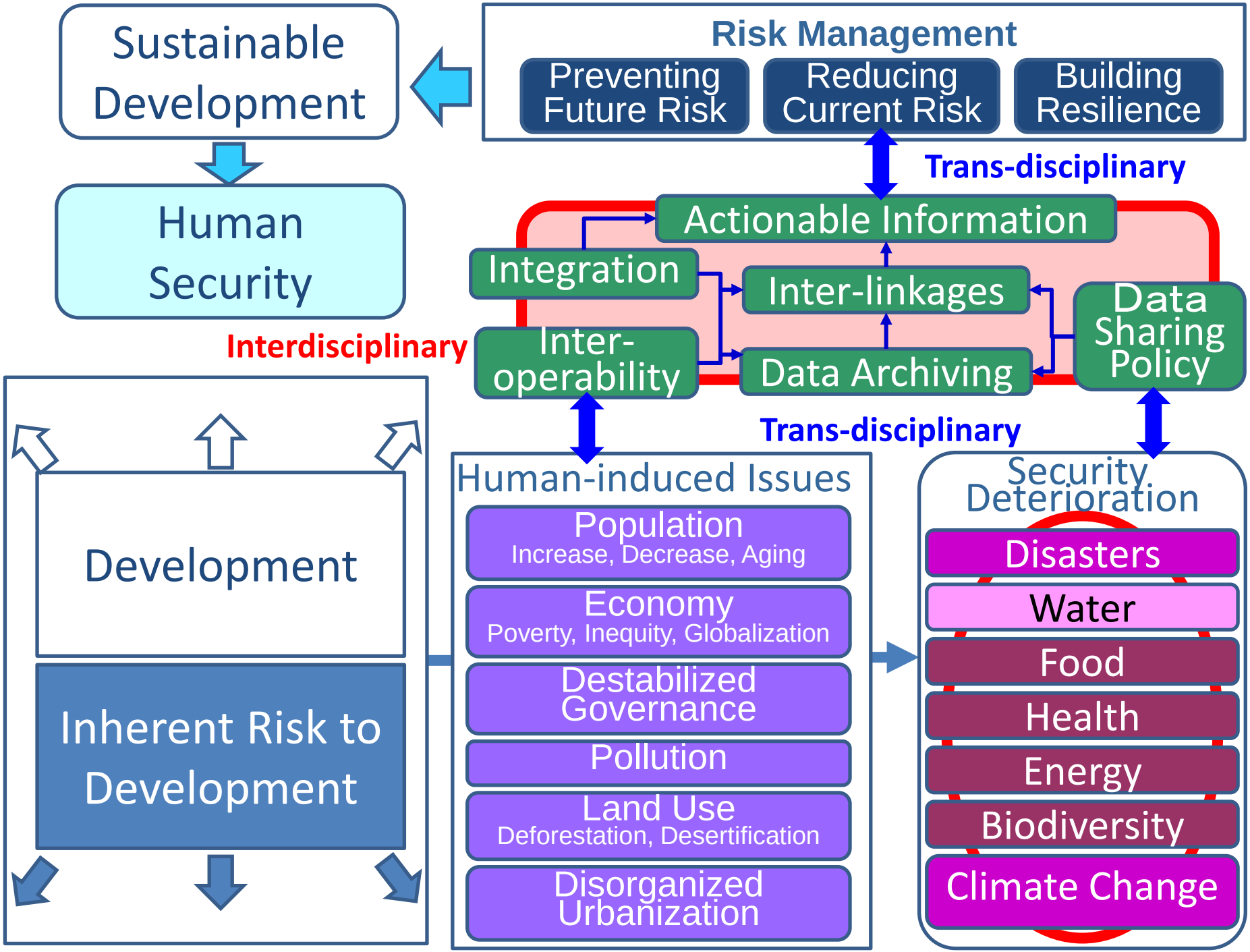
Sustainable Development

Risk Management

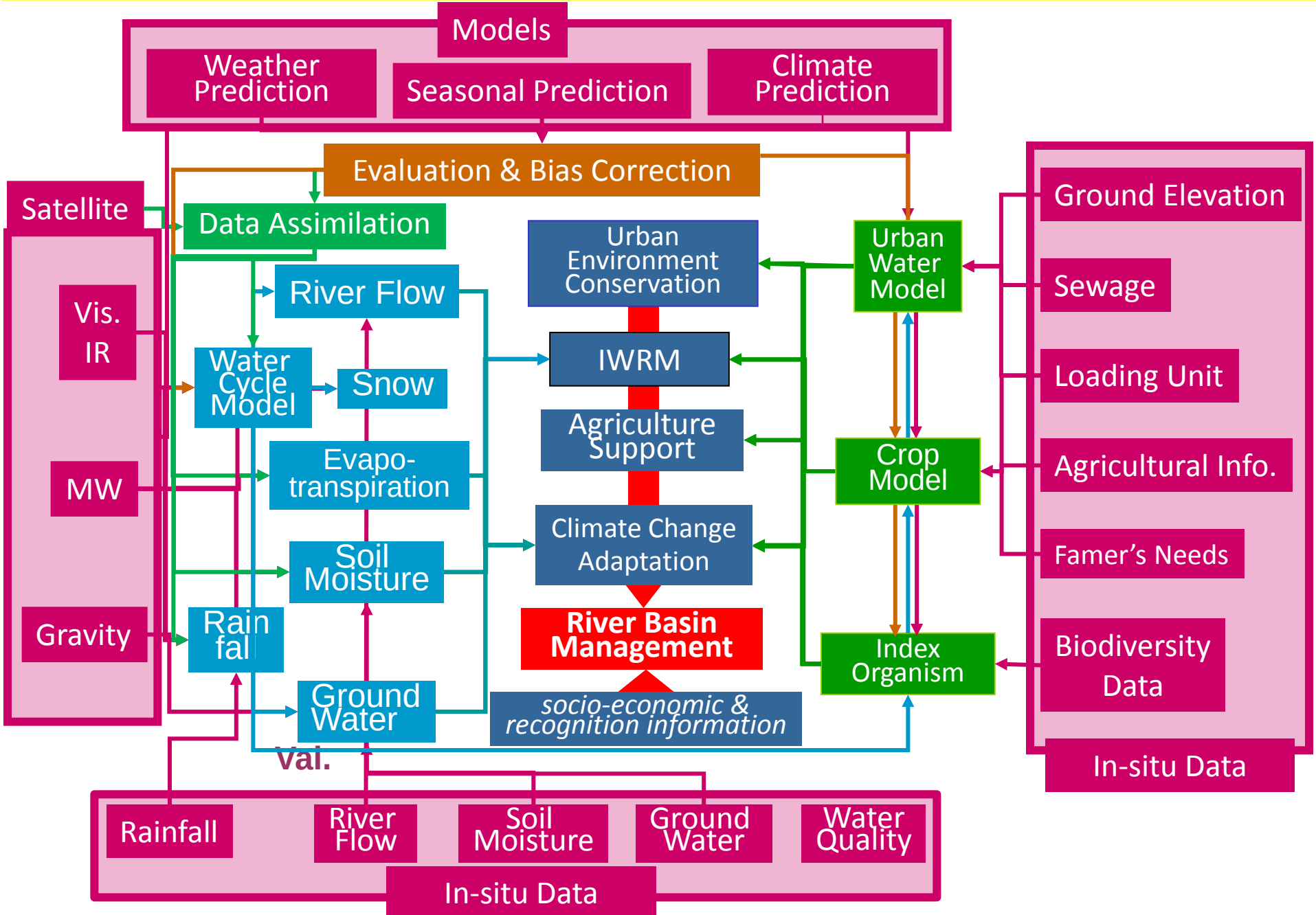
- Preventing Future Risk
- Reducing Current Risk
- Building Resilience

Science and Technology

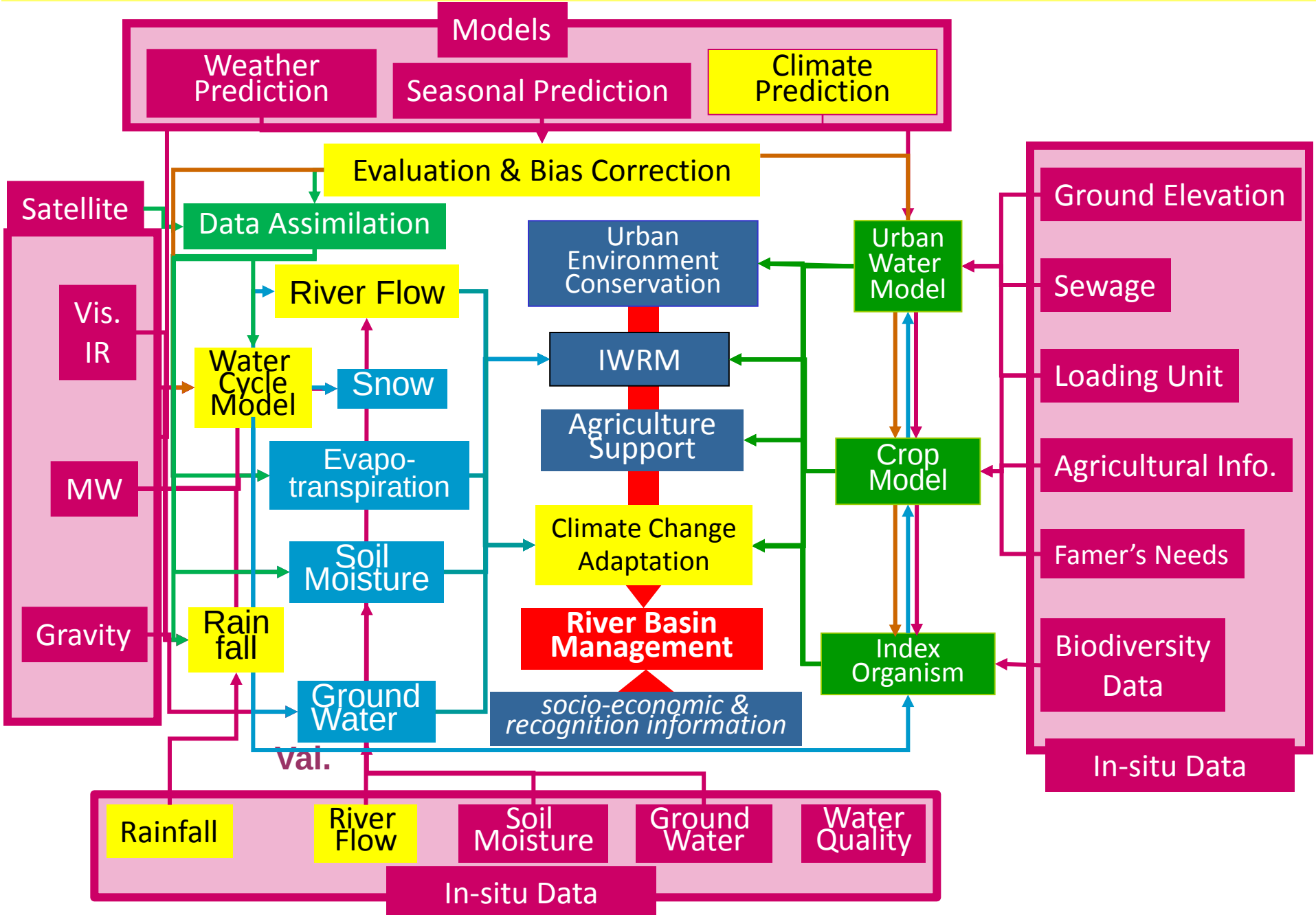



Sustainable Development
Human Security
Risk Management
Preventing Future Risk
Reducing Current Risk
Building Resilience
Trans-disciplinary
Actionable Information
Integration
Inter-linkages
Data Sharing Policy
Inter-operability
Data Archiving
Interdisciplinary
Trans-disciplinary
Development
Inherent Risk to Development
Human-induced Issues
Population
Increase, Decrease, Aging
Economy
Poverty, Inequity, Globalization
Destabilized Governance
Pollution
Land Use
Deforestation, Desertification
Disorganized Urbanization
Security Deterioration
Disasters
Water
Food
Health
Energy
Biodiversity
Climate Change

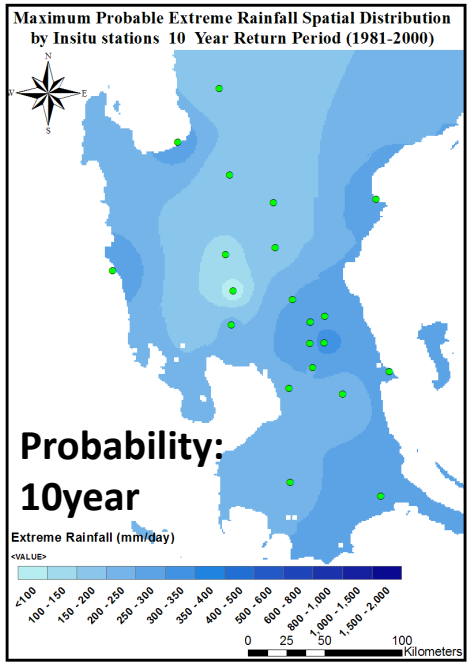
Water Cycle Integrator



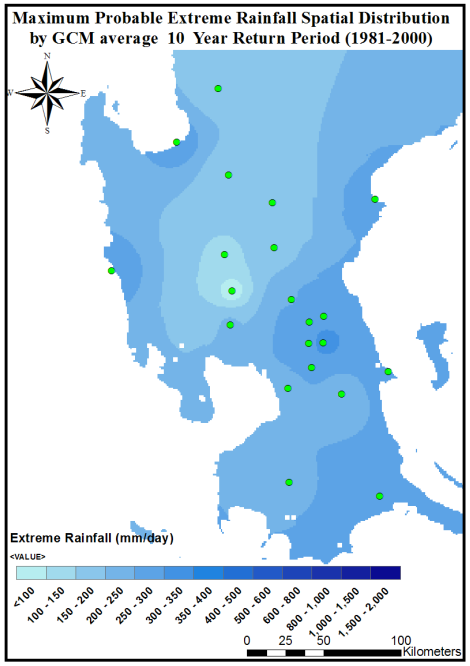
Water Cycle Integrator



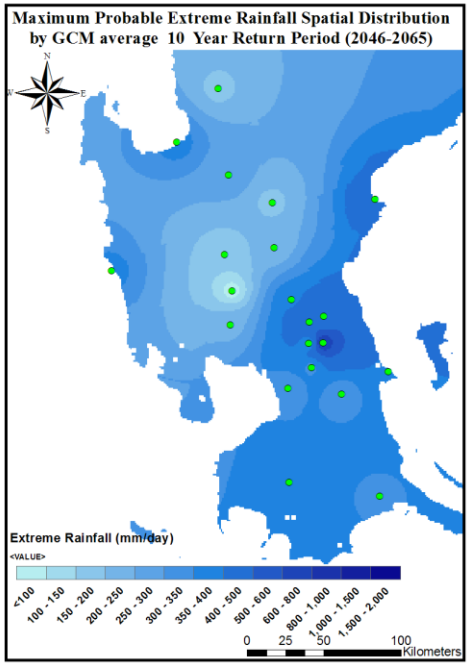
Insitu-station



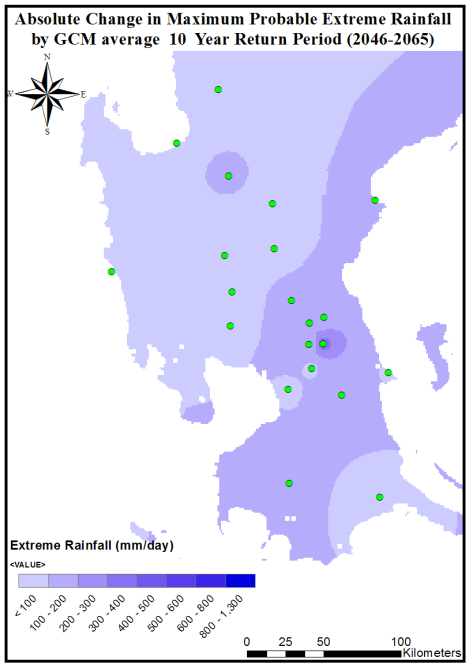
Corrected GCMavg

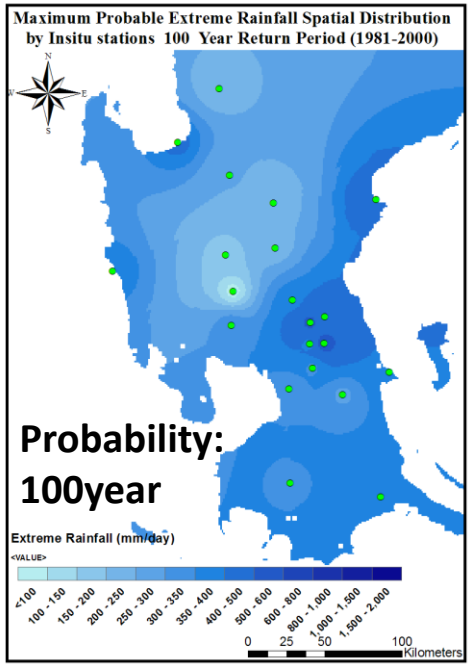


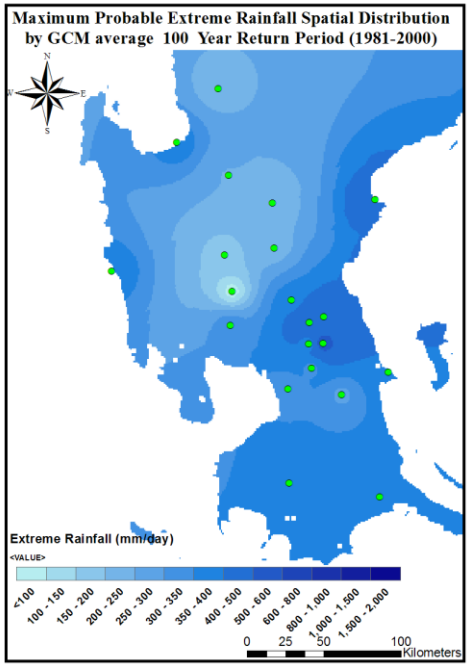
Future Corr_GCMavg

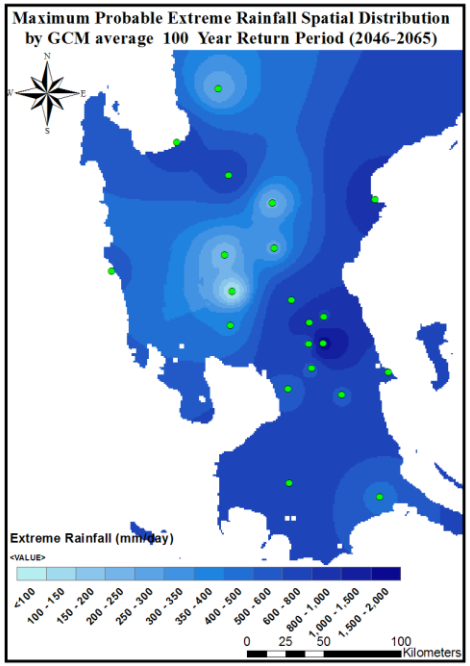


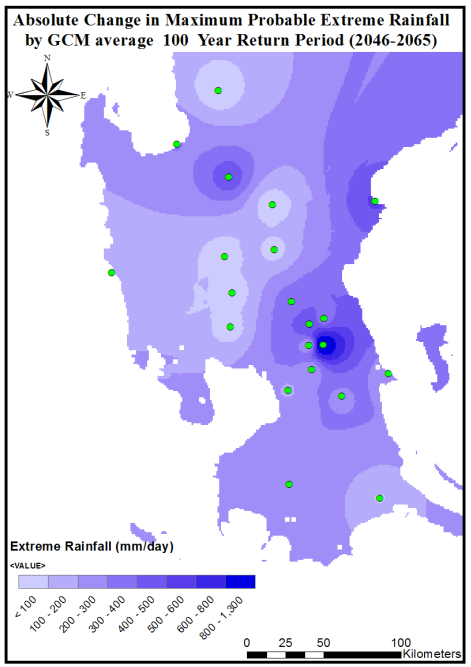
Future - Past







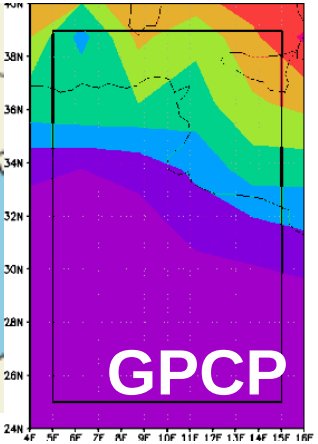


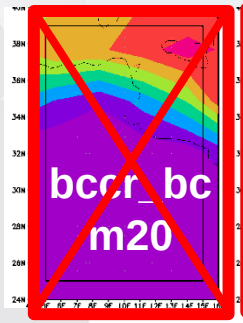


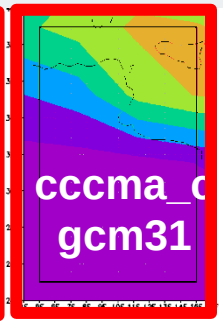
Mejerda River

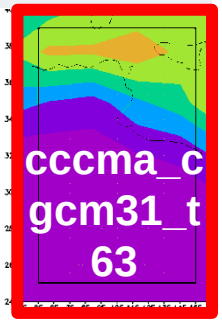
Oct – Jan

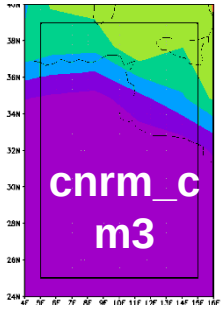
(1981-2000)

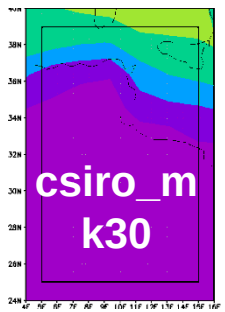


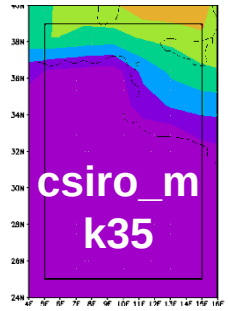


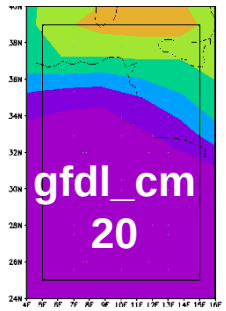


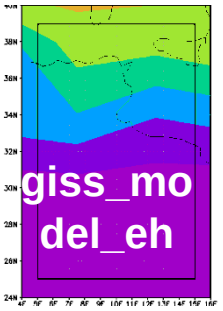


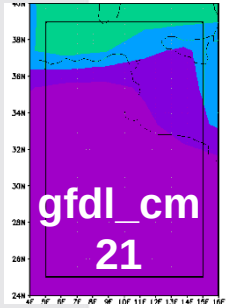


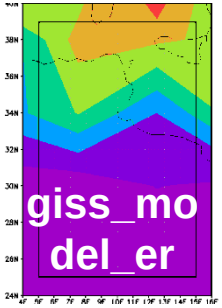


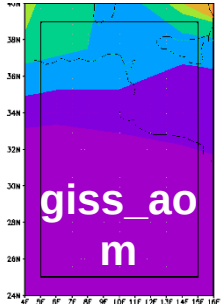


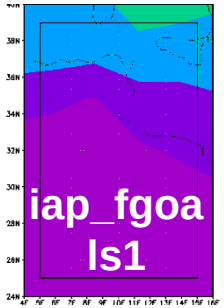


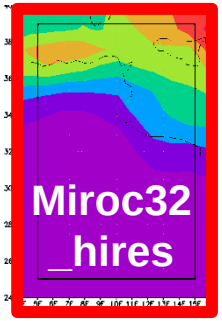


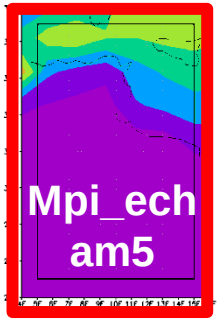


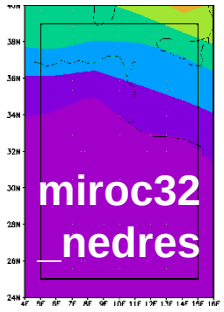


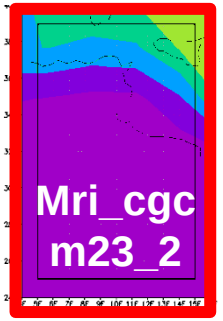


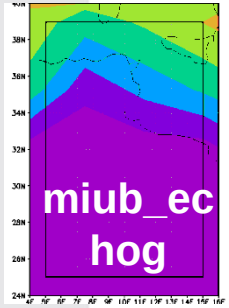


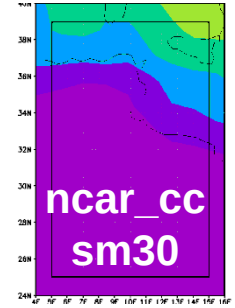


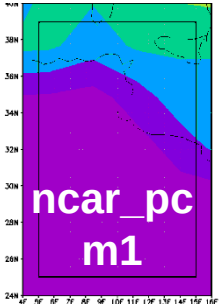


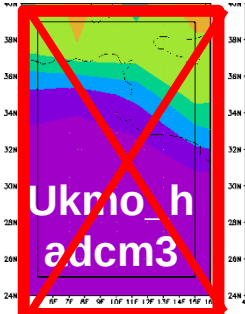


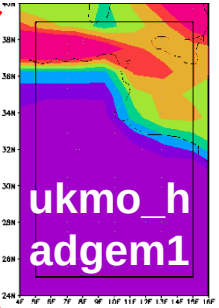


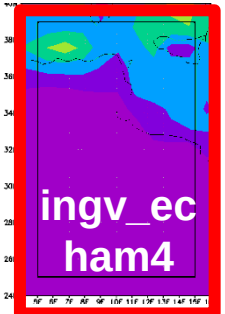


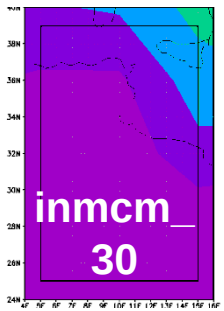


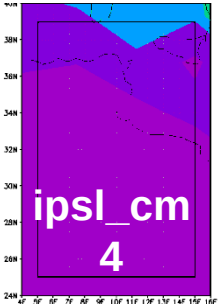






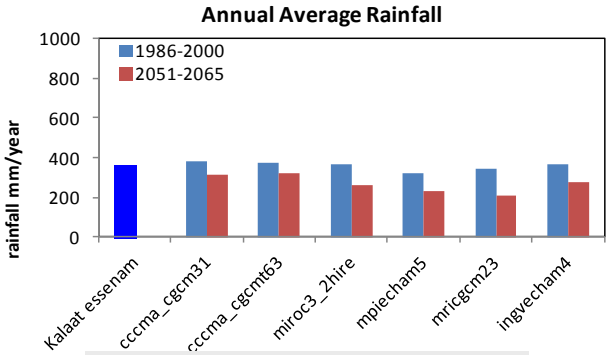




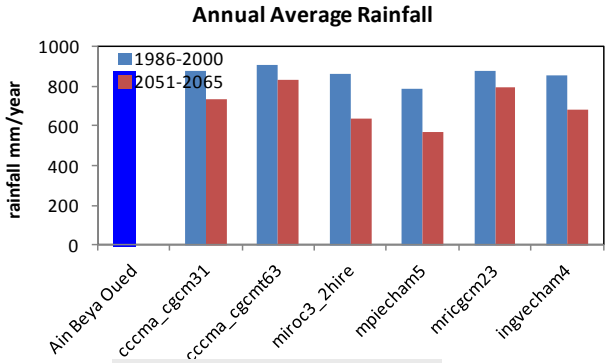


Mejerda River

It is virtually certain that drought will become more severe.



KALAAT ESSENAM



AIN BEYA OUED