DROUGHTS: A WORKBENCH IN MONITORING AND PREDICTION

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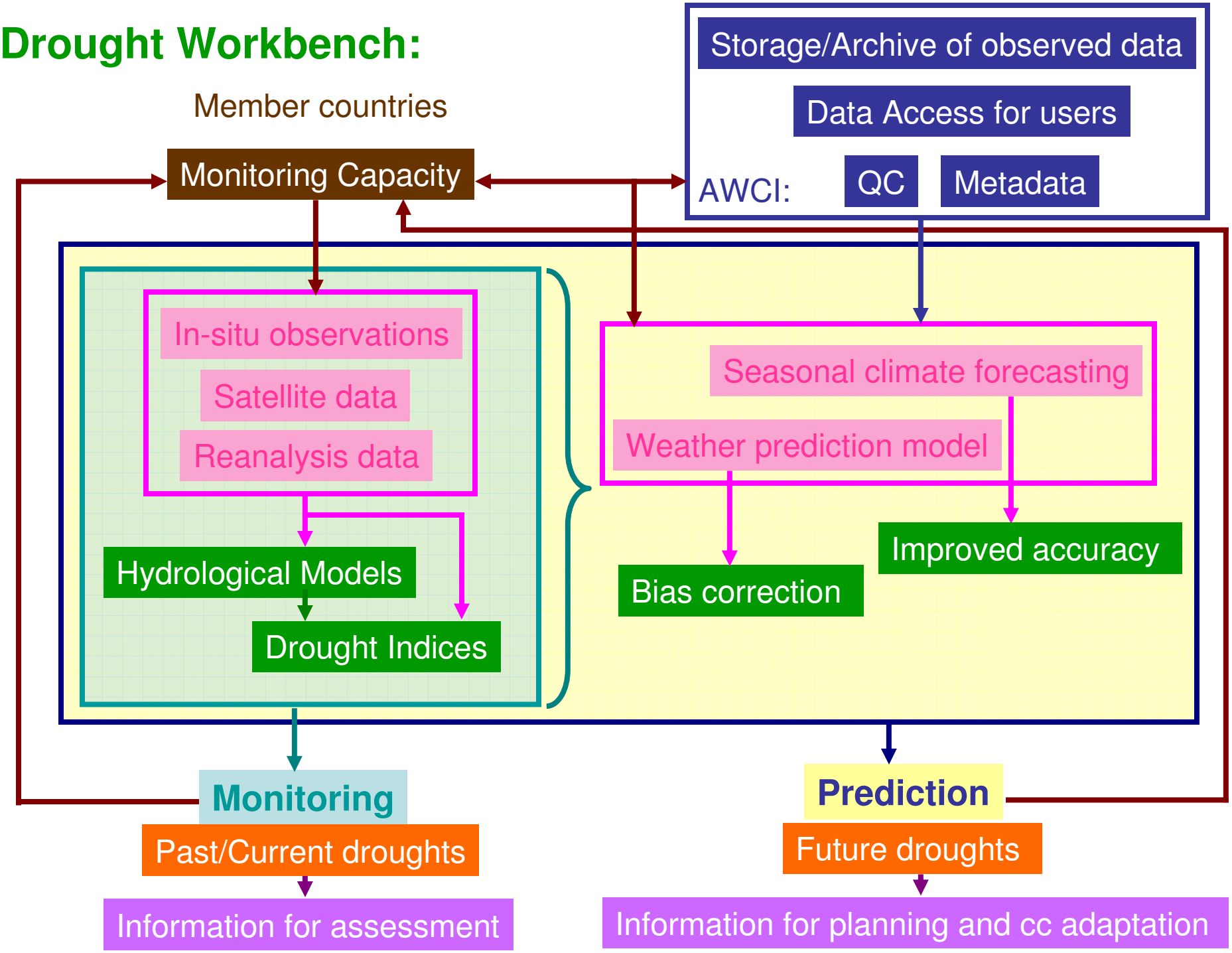
Drought Workbench:



What is drought?

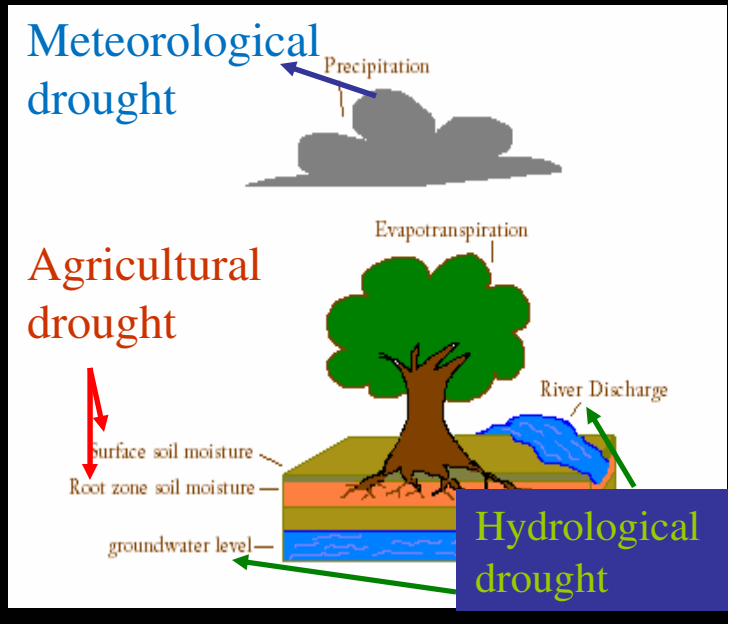
Drought

- prolonged absence or marked deficiency in precipitation resulting in water shortage for some activity; causing serious hydrological imbalance (*Heim, 2002; IPCC AR4WG1, 2007*)
- regional in nature; critical when there is an extreme shortage of water for long durations over large areas (*Tallaksen, et al., 1997*)

What are the different types of drought?

- **Agricultural Drought**: moisture deficits in the topmost one meter or so of soil (the root zone) that impact crops
- **Meteorological Drought**: a prolonged deficit of precipitation
- **Hydrologic drought** below normal streamflow, lake and groundwater levels

IPCC, ARWG1, 2007



What are other indicators of drought?

- ↓ land precipitation and ↑ temperature = ↑ evapotranspiration and drying
- In the tropics: SST through associated changes in the atmospheric circulation and precipitation
- In western USA, diminishing snow pack and reductions in soil moisture
- In Australia and Europe, direct links to global warming inferred from extremely high temperatures and heat waves in recent droughts

Issues: Past Droughts

Drought Monitoring Details:

Member countries

Monitoring Capacity

Storage/Archive of observed data

Data Access for users

AWCI: QC Metadata

In-situ observations

Satellite data

Reanalysis data

Hydrological Models

Drought Indices

Monitoring

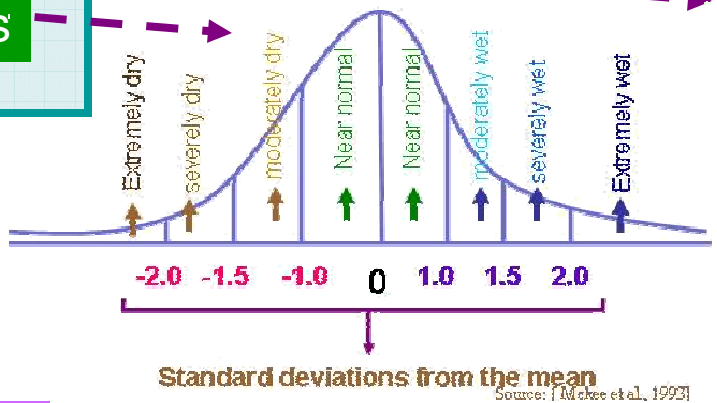
Past/Current droughts

Information for assessment

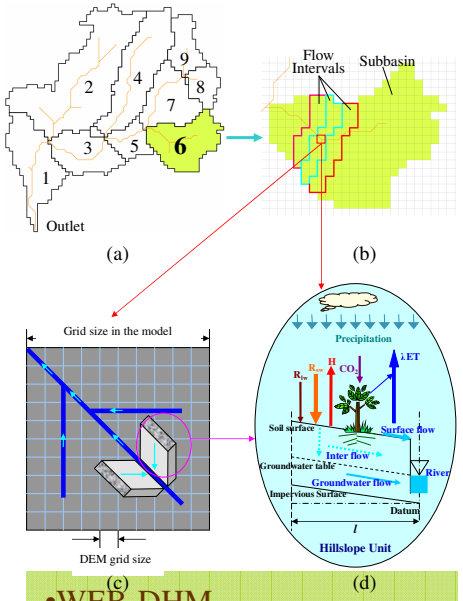
(Long-term)
- Rainfall
- Temperature
- Evapotranspiration
- Discharge
- Soil Moistures
- Groundwater

- GRACE (total water)
- TRMM (rainfall)
- GsMap (combined satellite + obs)
- APHRODITE
- SSM/I (microwave brightness temperature)
- MODIS (LAI/FPAR)
- AVHRR (LAI/FPAR)
- GMS= MTSAT (met. Parameters)
- AMSR-E (brightness temp. converted to soil moisture)

- JRA25; JRA55
- NCEP/NCAR

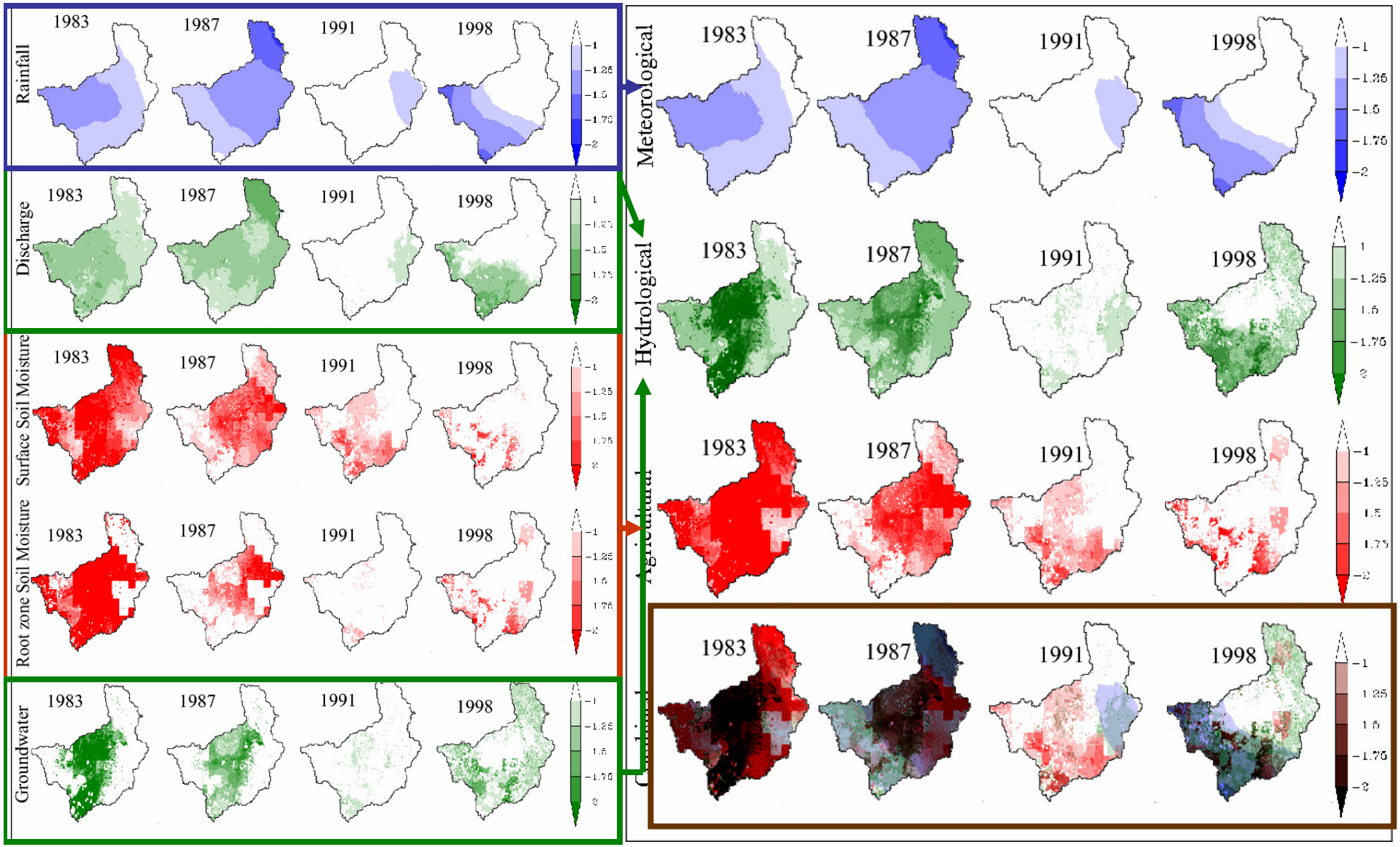


SA

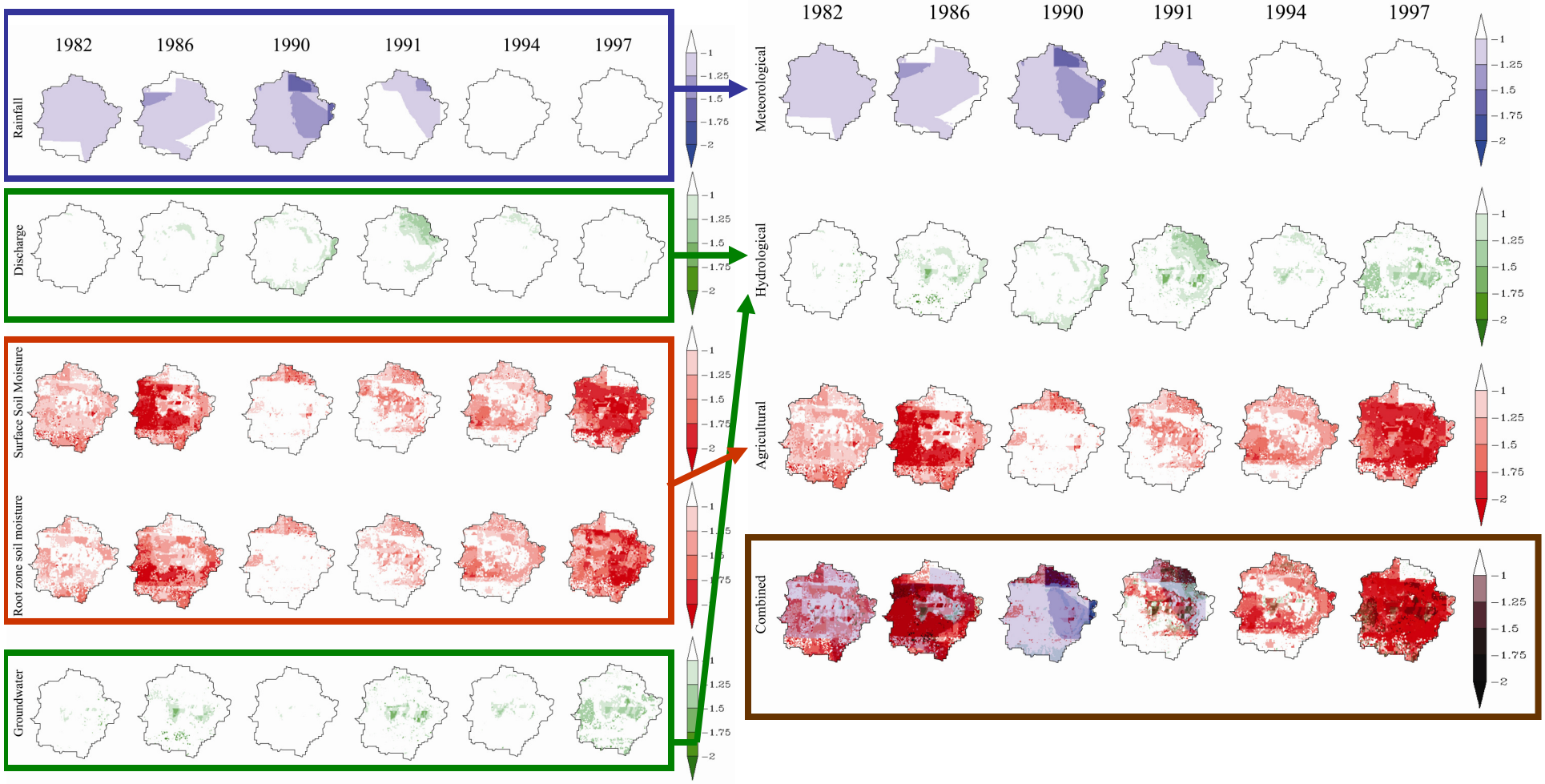


- WEB-DHM
- Multi-model ensemble (Bae sensei's)

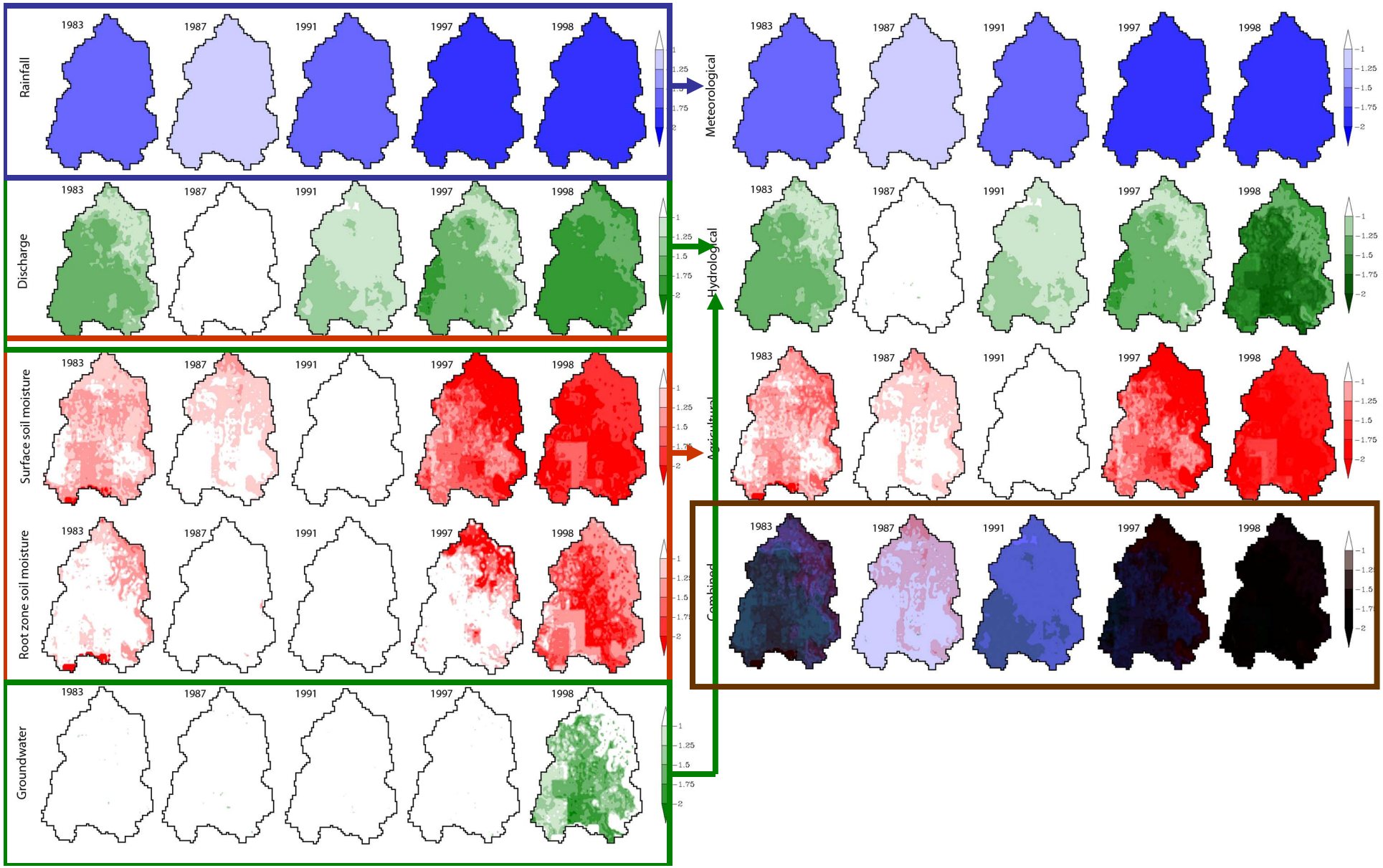
SPATIAL SA FOR THE PAMPANGA RIVER BASIN



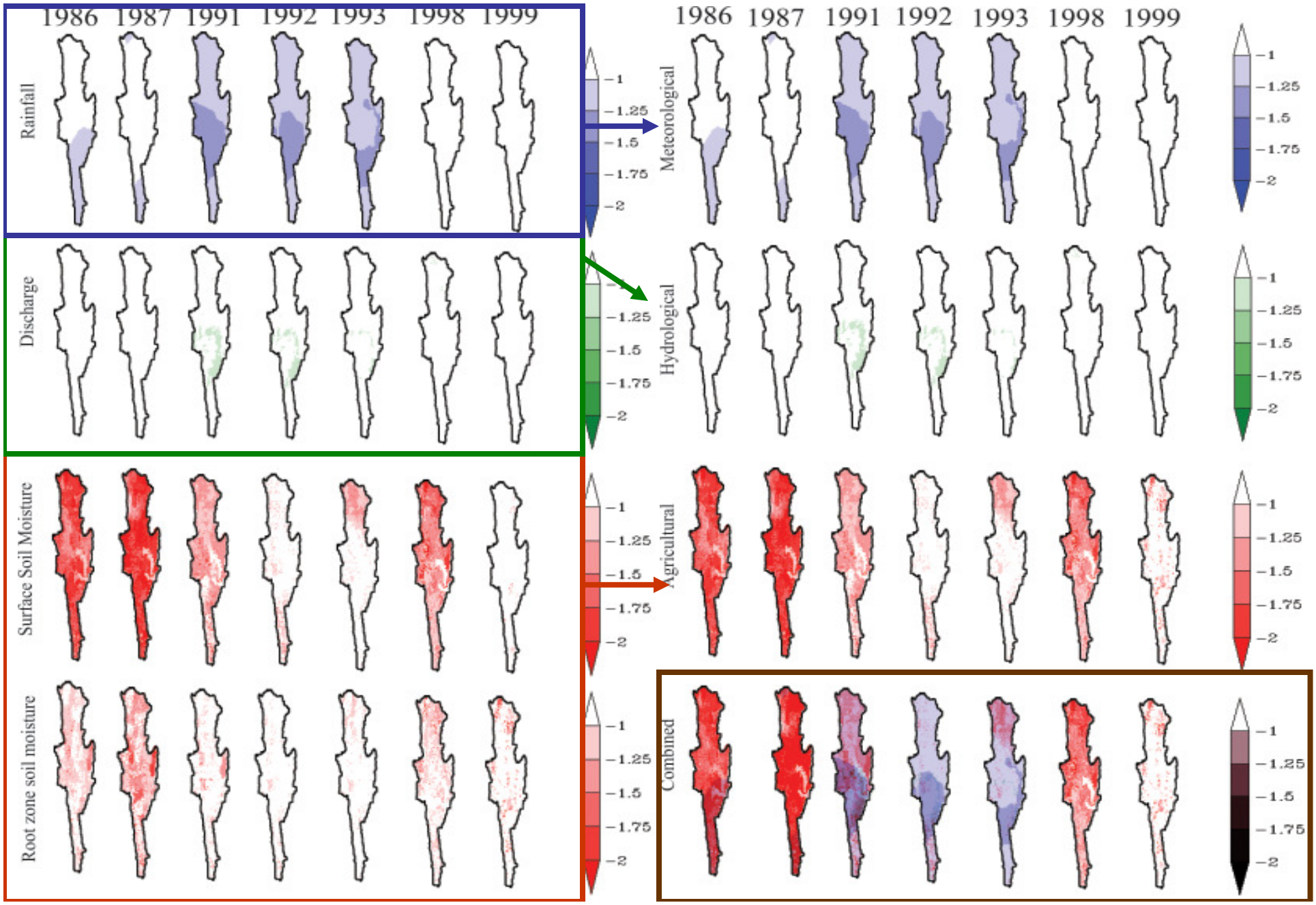
SPATIAL SA FOR THE UPPER CITARUM RIVER BASIN



SPATIAL SA FOR LANGAT WATERSHED



SPATIAL SA FOR PING RIVER BASIN

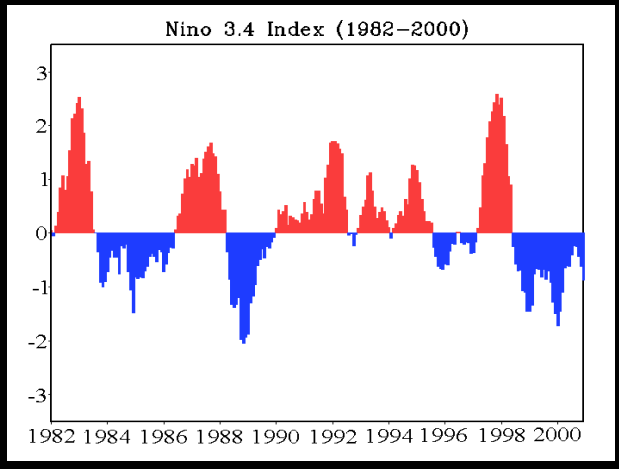


ENSO SIGNIFICANT EFFECTS ON THE HYDROLOGICAL PARAMETERS

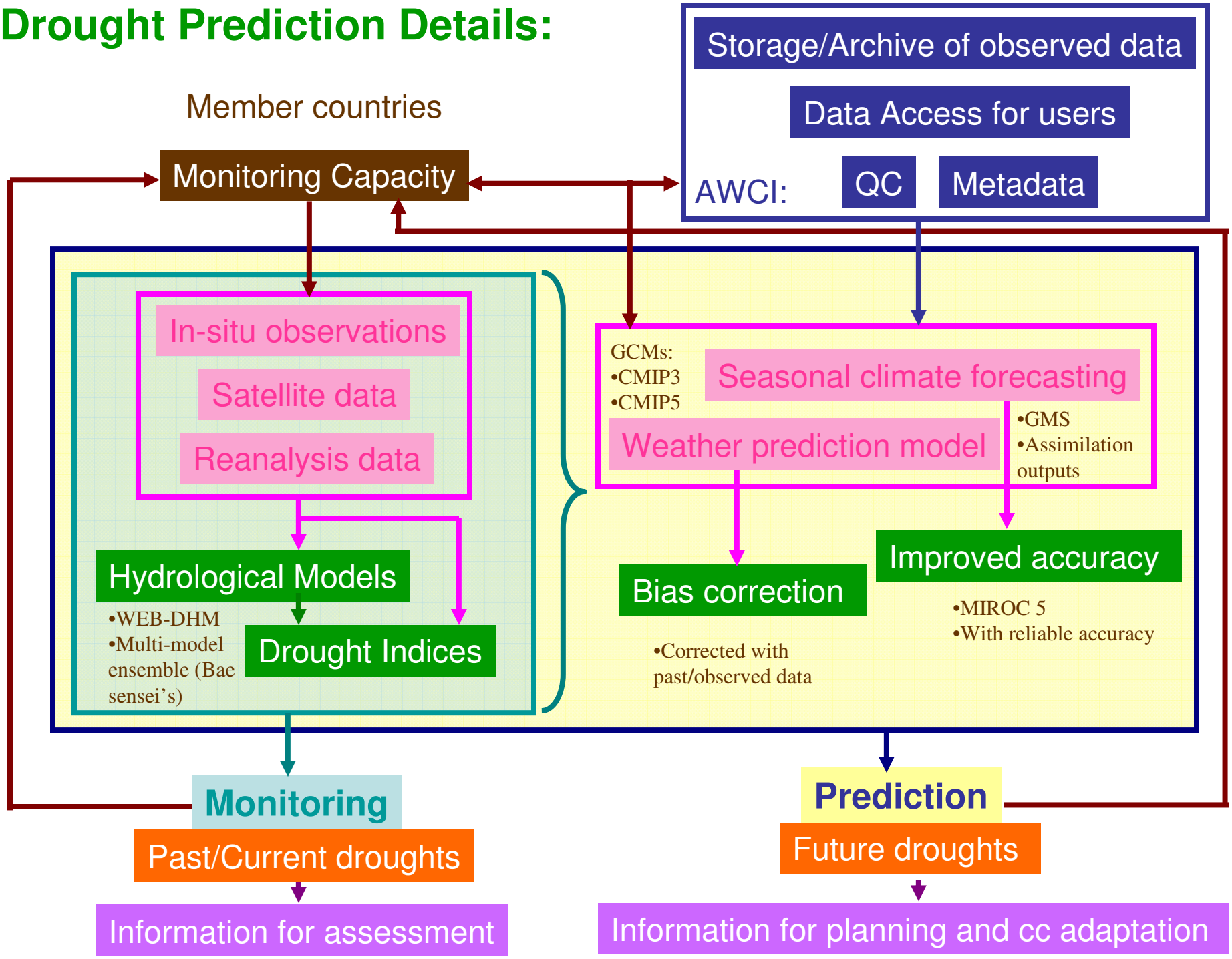
Basin	First year	Second Year	Time delay
Pampangga	Oct-Nov	Feb-August	1 to 7 months
Langat	April-August	Dec	1 to 4 months
Ping	--	--	--
Upper Citarum	--	June-August	1 to 3 months

List of warm (El Niño) and cold (La Niña) ENSO events considered in the two-year composites for the years 1982-2000 (*Jaranilla-Sanchez et al., 2009, JSCE*).

Warm ENSO events, or El Niño *(6 cases)*	1982/83, 1986/87, 1991/92, 1992/93, 1994/95, 1997/98
Cold ENSO events, or La Niña *(4 cases)*	1984/85, 1988/89, 1995/96, 1999/2000



Drought Prediction Details:

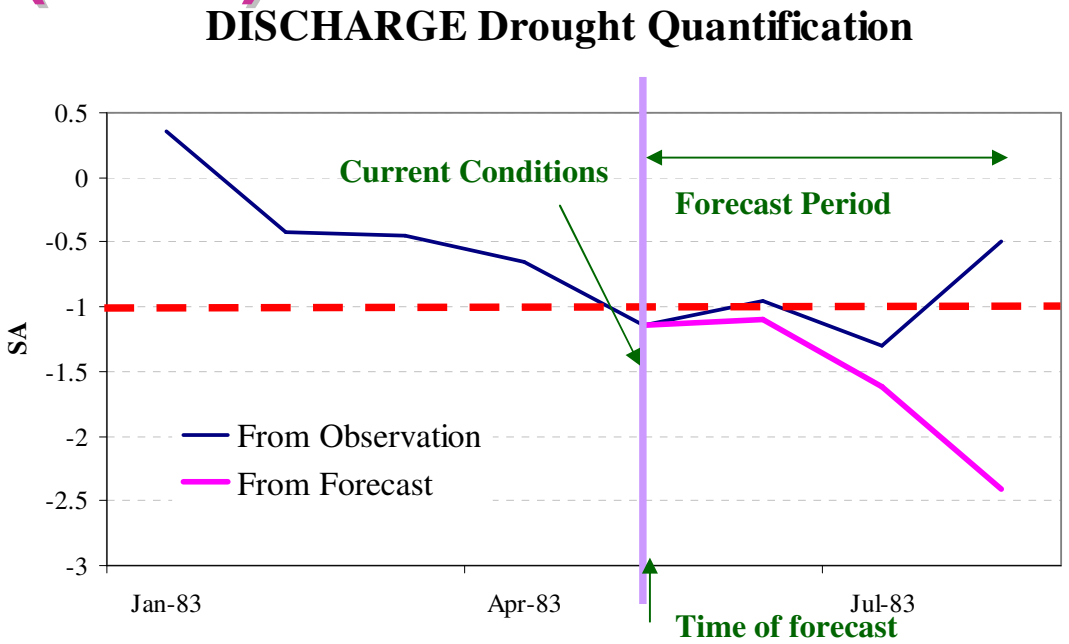


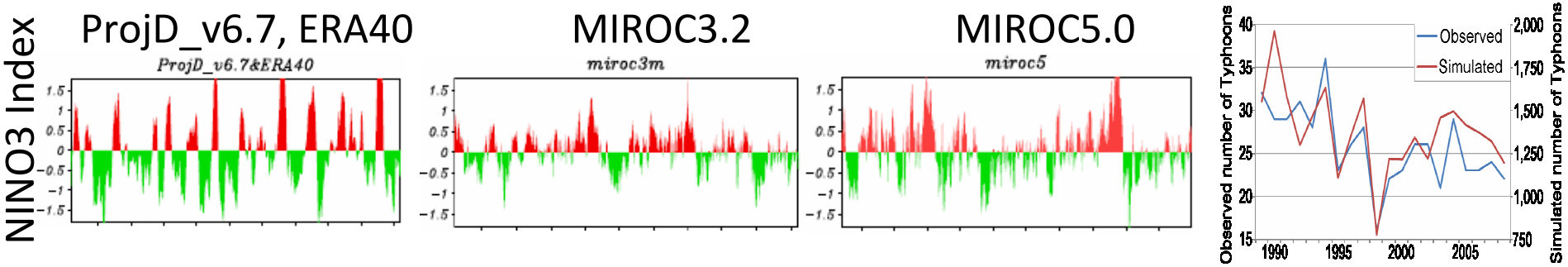
IV. SEASONAL CLIMATE FORECASTING (SCF)

drought conditions can be forecasted

Month	SA Q_{obs}	SA $Q_{forcast}$
June	-0.954	-1.010455
July	-1.30505	-1.61425
August	-0.4937	-2.41276

Too extreme because high rainfall cannot be captured by the forecast in this grid scale





Figures were reproduced from Kimoto, et al. presentation 2010.

Dataset: MIROC (SPAM) by CCSR
MIROC by NIES-JAMSTEC

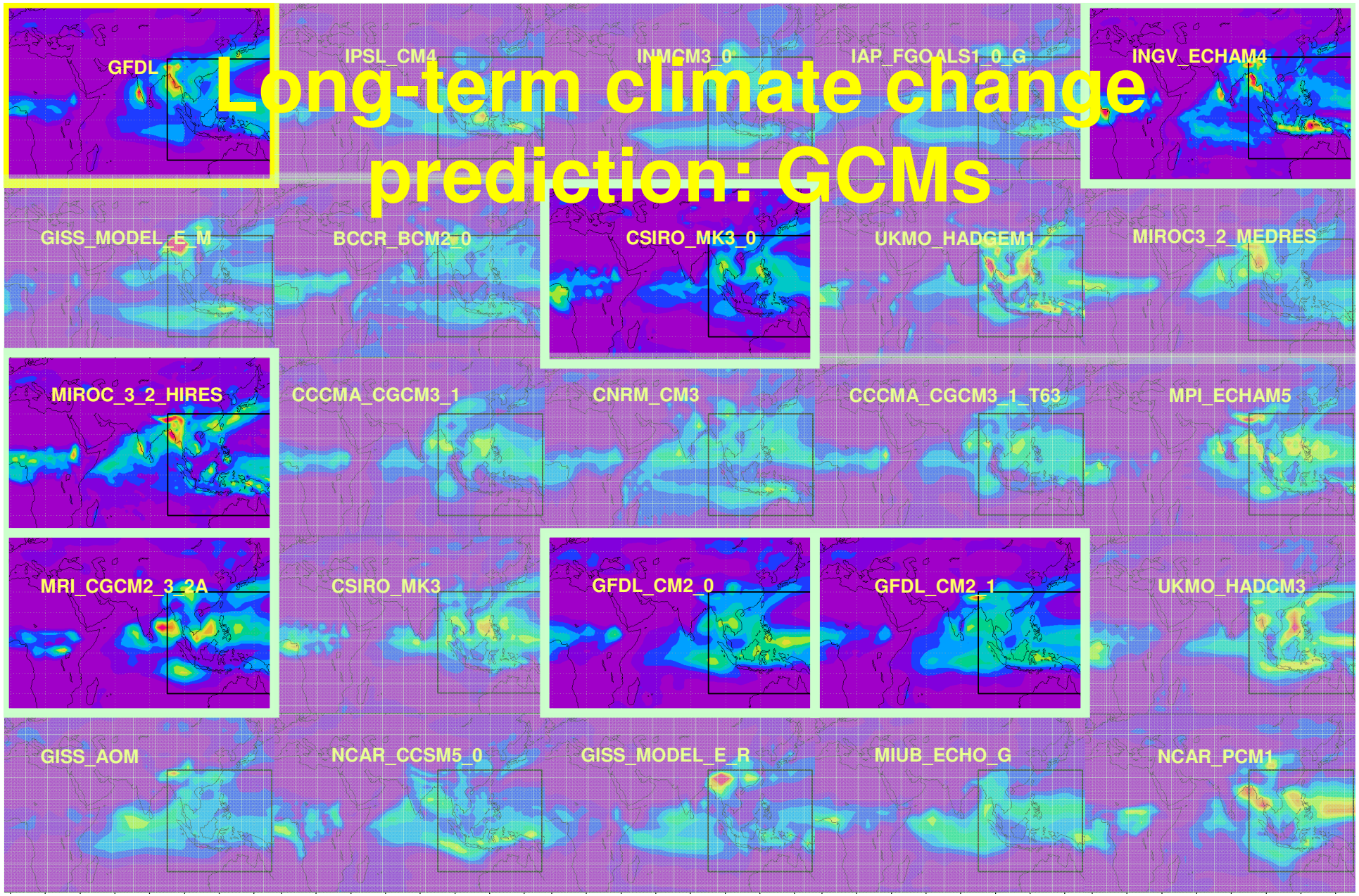
Discharge: Observed VS. SCF

	Months	1st		2nd		3rd	
	Year	Observed	SFC	Observed	SCF	Observed	SCF
El Niño year	1983	↗	↗	↘	↘	↗	↘
normal year	1991	↘	↘	↗	↗	↘	↘
El Niño year	1997	↘	↘	↘	↘	↘	↘
La Niña year	1999-2000	↗	↘	↗	↗	↗	↗

ARROW Legends: **red**= drought; **green**=normal; **blue**=wet

e.g. increase towards drought conditions ↗

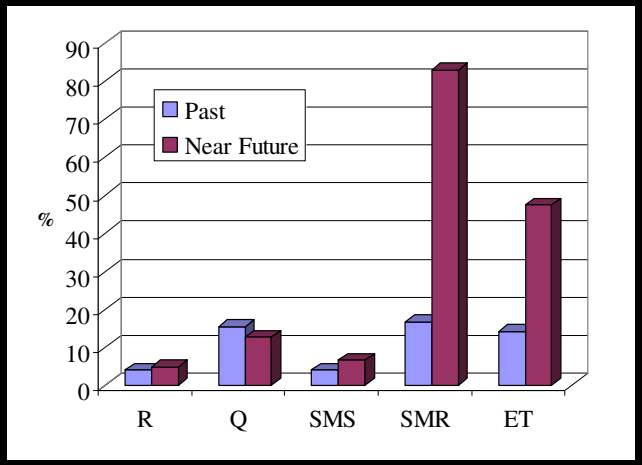
Long-term climate change prediction: GCMs



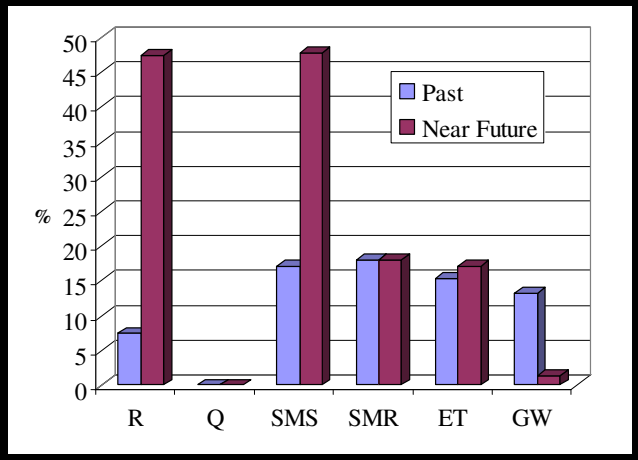
Global Circulation Model selection: PRECIPITATION June 1982-2000

GCM Projection 2046-2064: SA trends

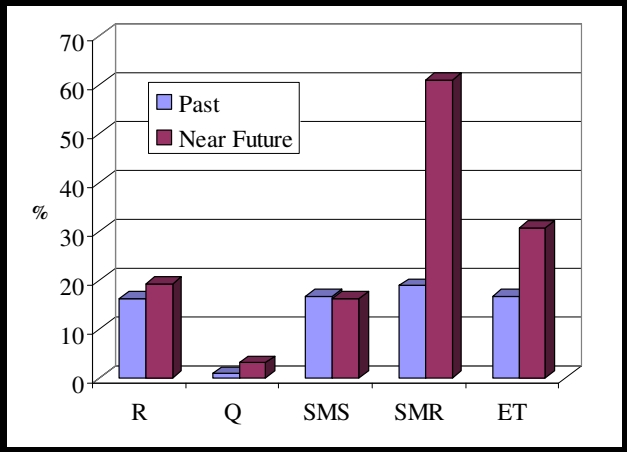
Philippines



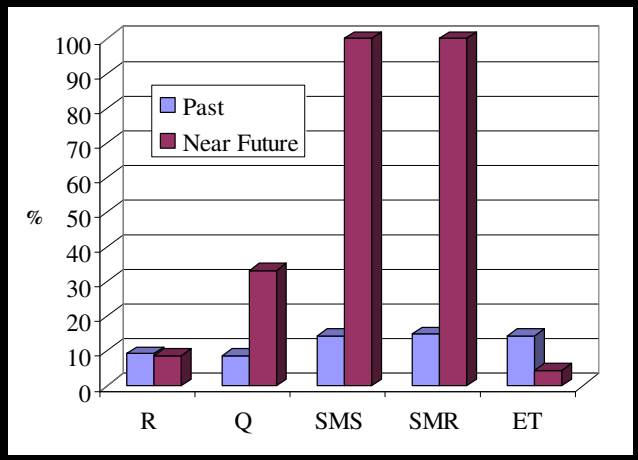
Indonesia



Thailand



Malaysia



R=rain; Q=discharge; SMS=soil moisture at the surface; SMR= soil moisture at the root zone; ET=evapotranspiration; GW=groundwater

Useful information we can get from this workbench:

Monitoring:

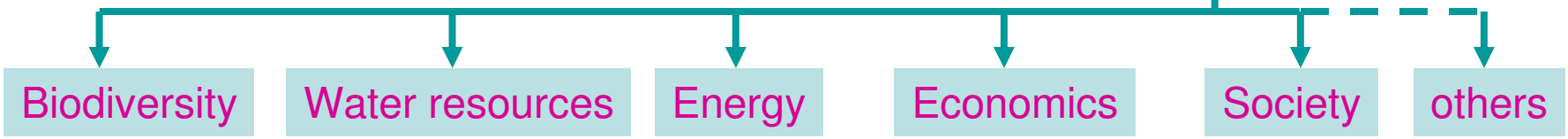
- When?
- Where?
- How severe?
- Timing?

Prediction:

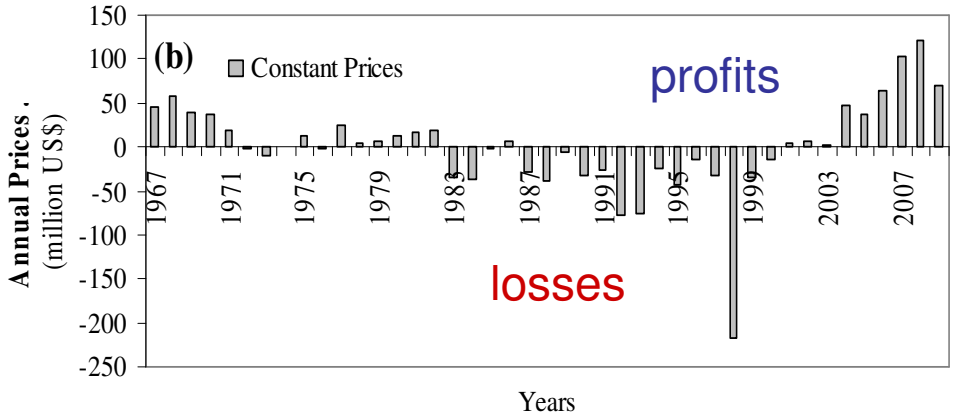
- Increasing/decreasing trend? (frequency/severity)

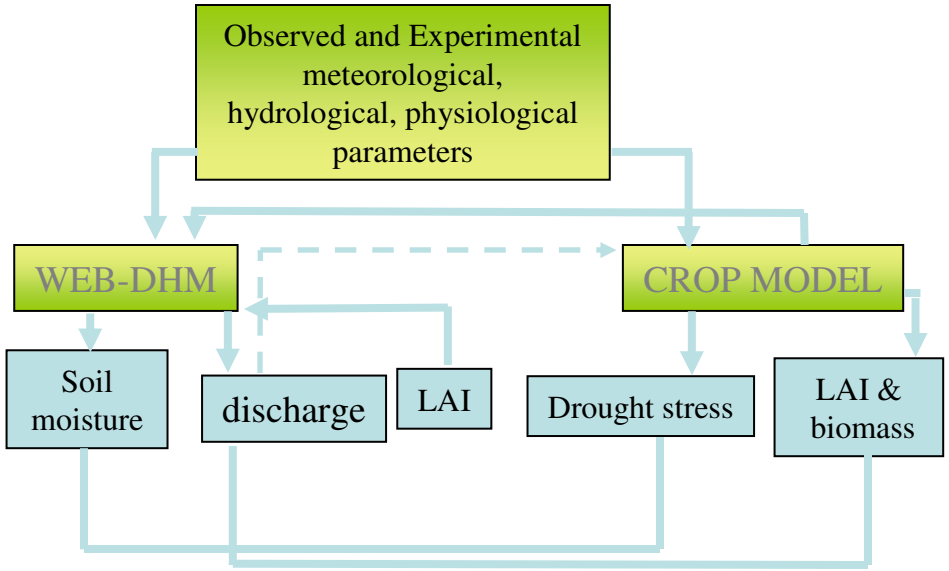
What can we do?

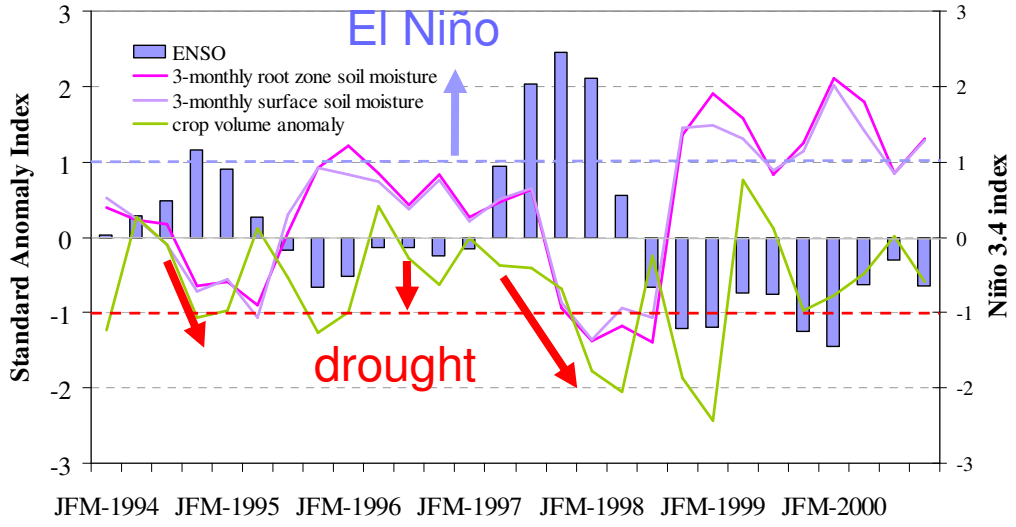
Basin appropriate planning and adaptation



Sample Application: Agricultural Production and Drought Monitoring







Sample output for rice production simulation:

year	Actual	simulated
1983	--	7012 kg/ha
1987	--	7247kg/ha
1991	--	6900kg/ha
1998	**34164** metric tons (BAS, 2011)	6903kg/ha (**34116** metric tons)

FUTURE???

Together we can do this…
shall we?

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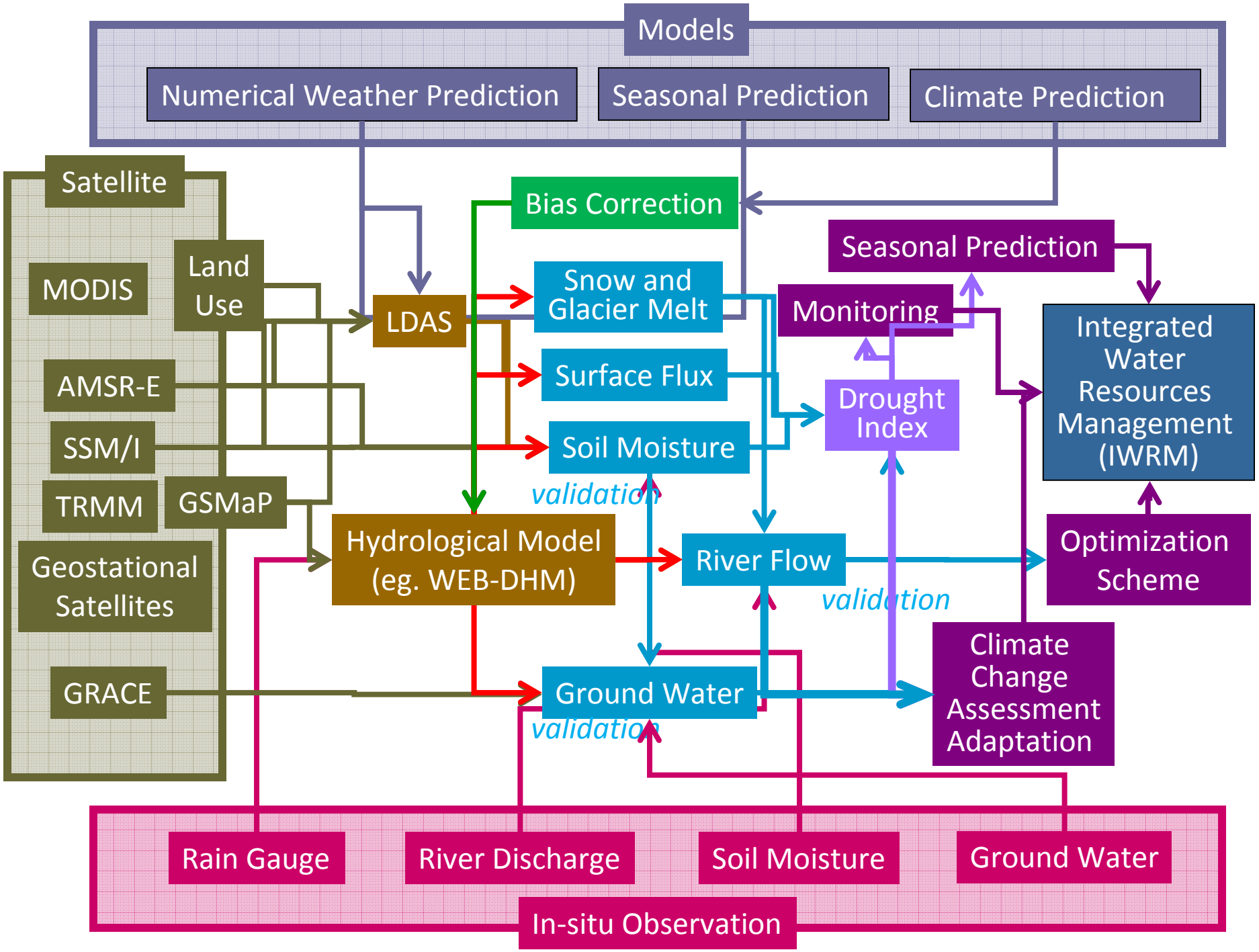
Sama-sama, tulong-tulong, kaya natin to…


Models
Numerical Weather Prediction
Seasonal Prediction
Climate Prediction
Satellite
MODIS
Land Use
AMSR-E
SSM/I
TRMM
GSMaP
Geostational Satellites
GRACE
Bias Correction
LDAS
Snow and Glacier Melt
Surface Flux
Soil Moisture
validation
Hydrological Model (eg. WEB-DHM)
River Flow
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Ground Water
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