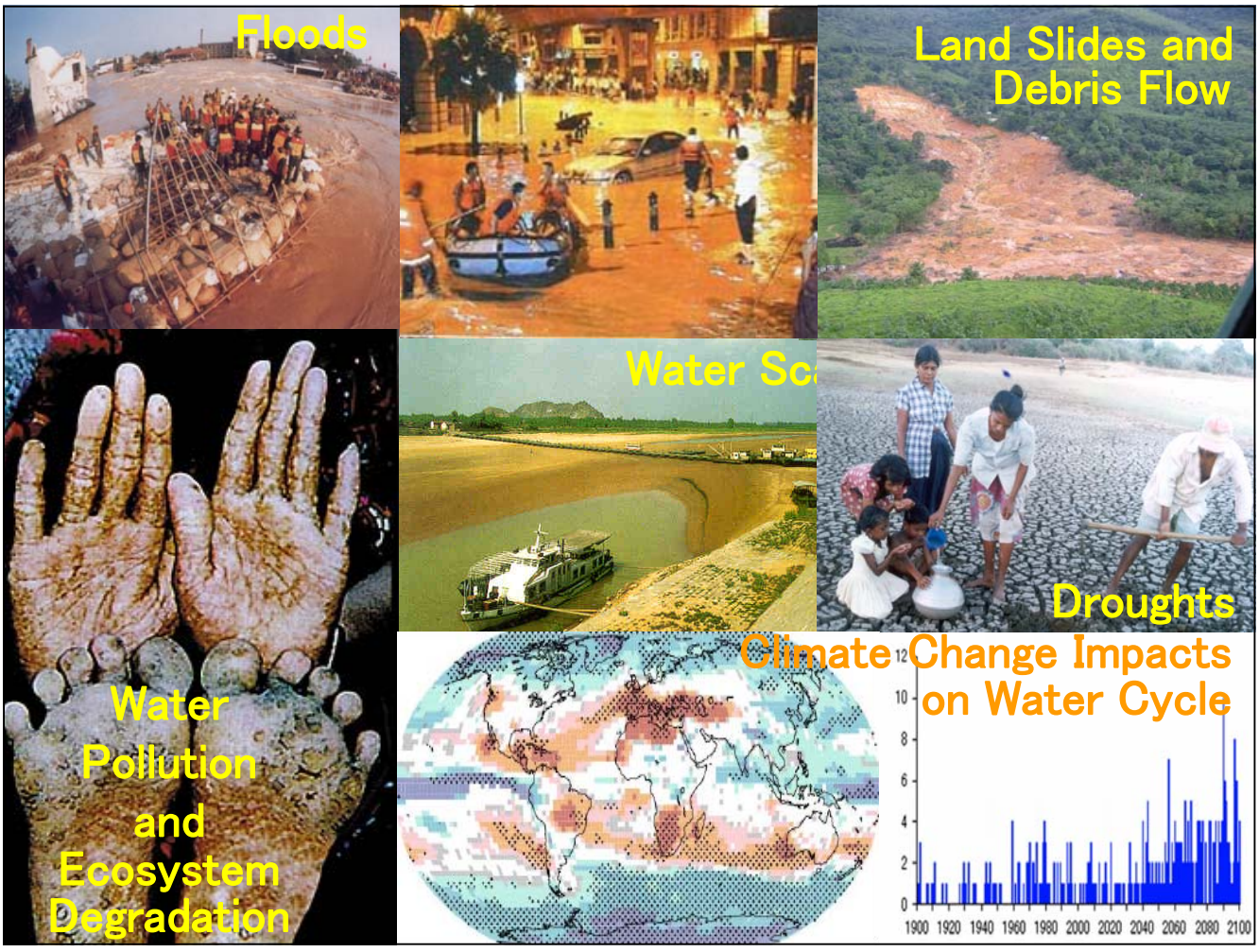
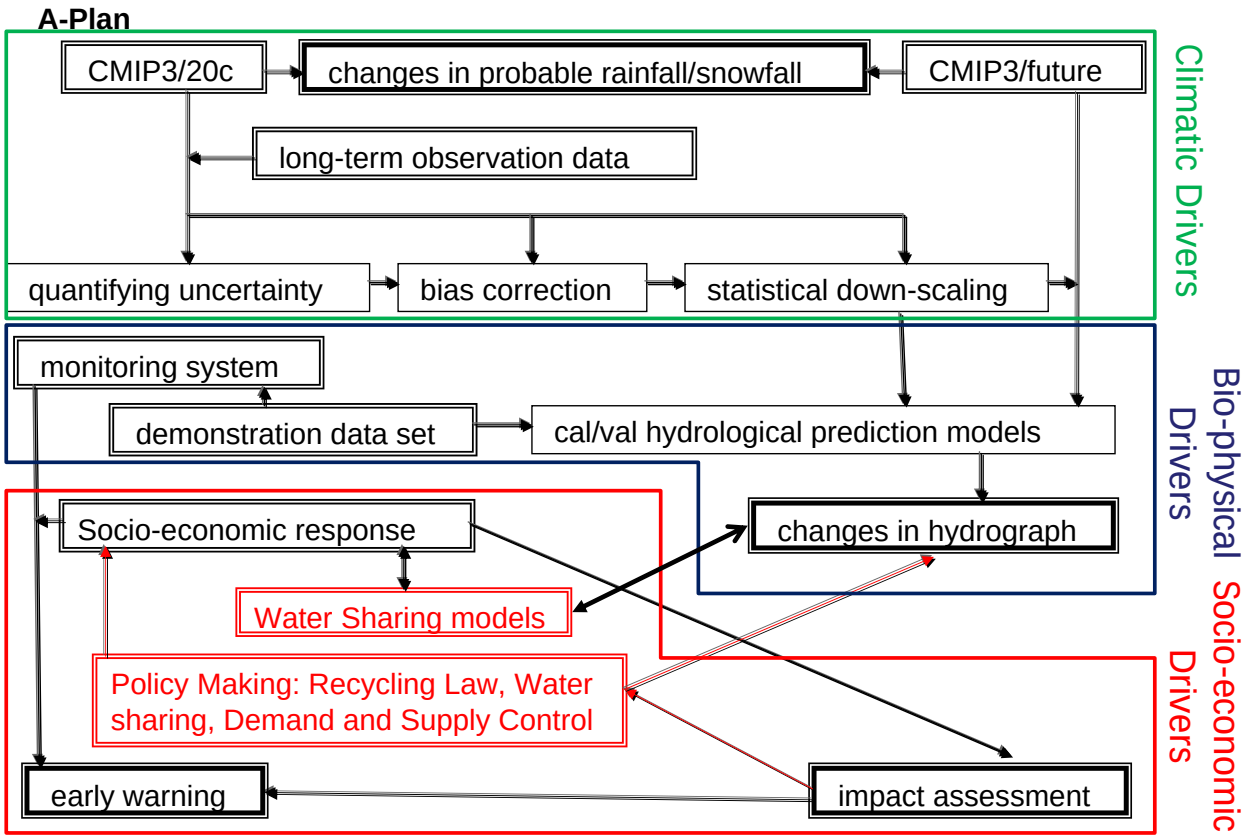
AWCI Training Course
"Climate Change Assessment and Adaptation Study"

1. Introductory Short Lecture

Toshio Koike, The University of Tokyo



Implementation Planning



Requirements for Climate Change Assessment and Adaptation

- Assessment of Changing Hazard
  usable information derived from climate projection models
- Assessment of Changing Hydrology
  integrated hydrological models with self-running capability
- Leading to Public Awareness and Effective Actions
  data integration for getting comprehensive knowledge

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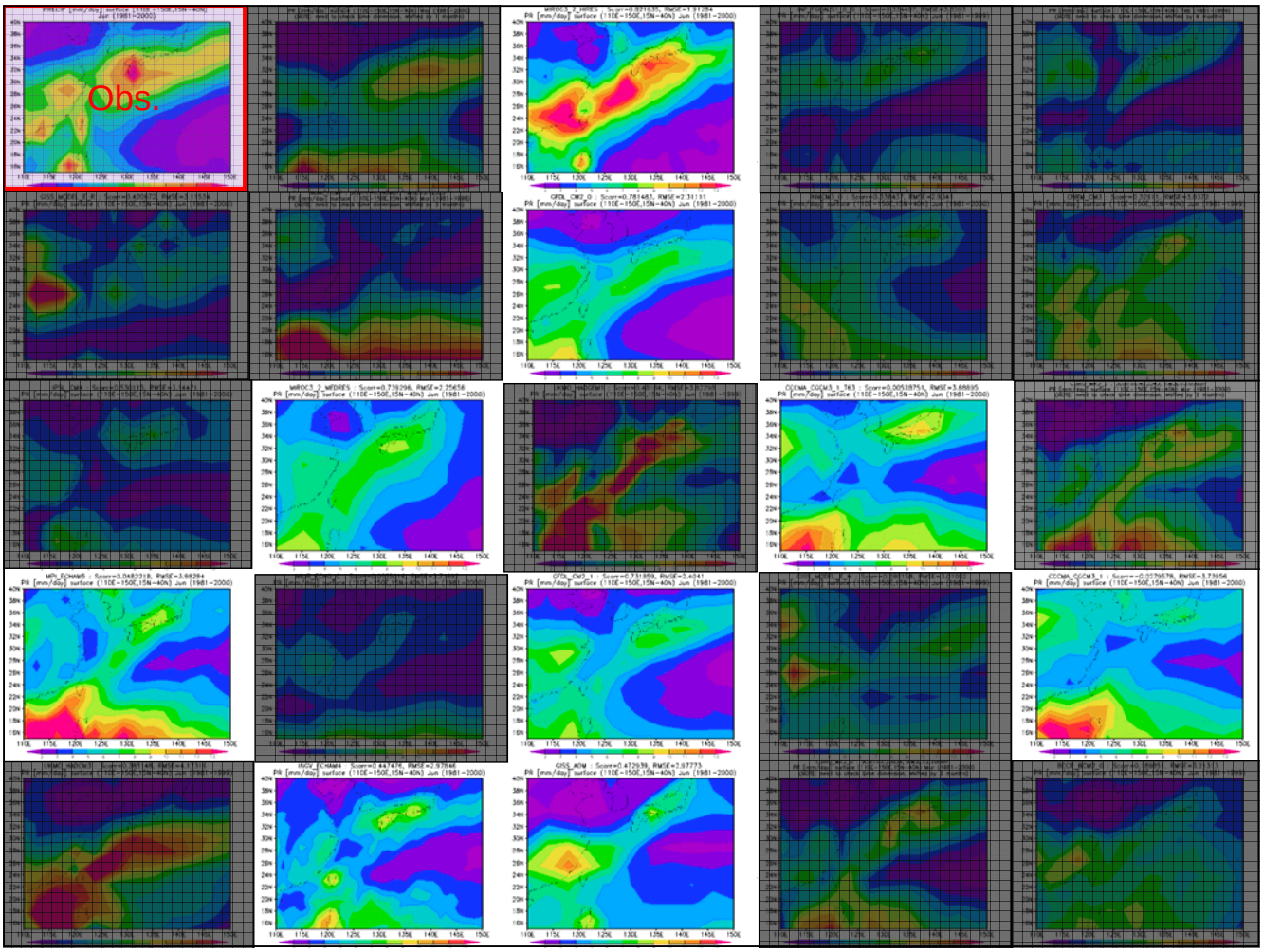
Obs.

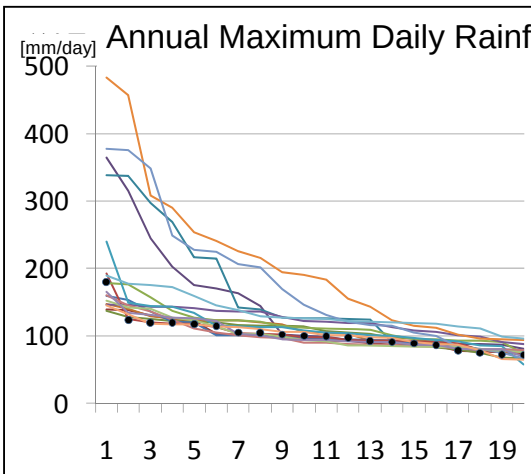
Evaluation for relative distribution:
Correlation coefficient(CC)

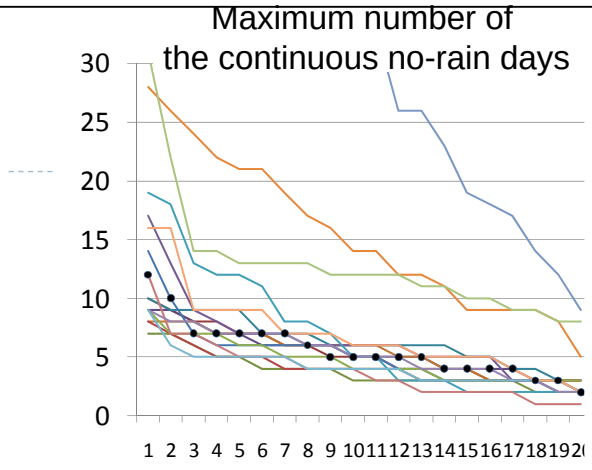
Evaluation of absolute value:
RMSE

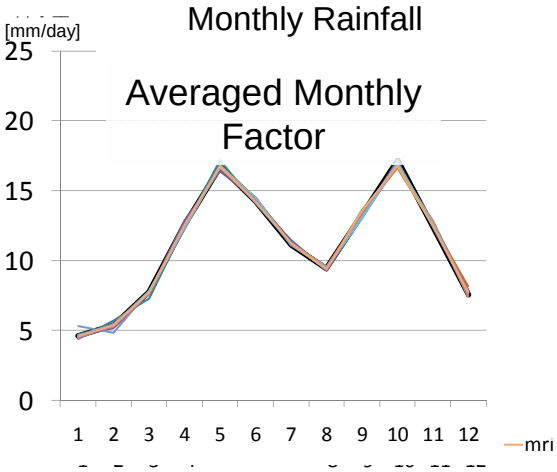
Scoring

CC and RMES are more than all GCM averaged value：1
CC or RMES are more than all GCM averaged value：0
CC and RMES are less than all GCM averaged value：-1









Main Problems with the GCM Outputs:

- Large Diversity
- Low Extreme Heavy Rainfall Rate
- Small Number of No Rainfall Day but Long Drizzle
- Low Seasonal Representation
- Low Spatial Distribution

→**Bias Correction, Downscaling, Multi-model Analysis Coupling with Hydrological Models**

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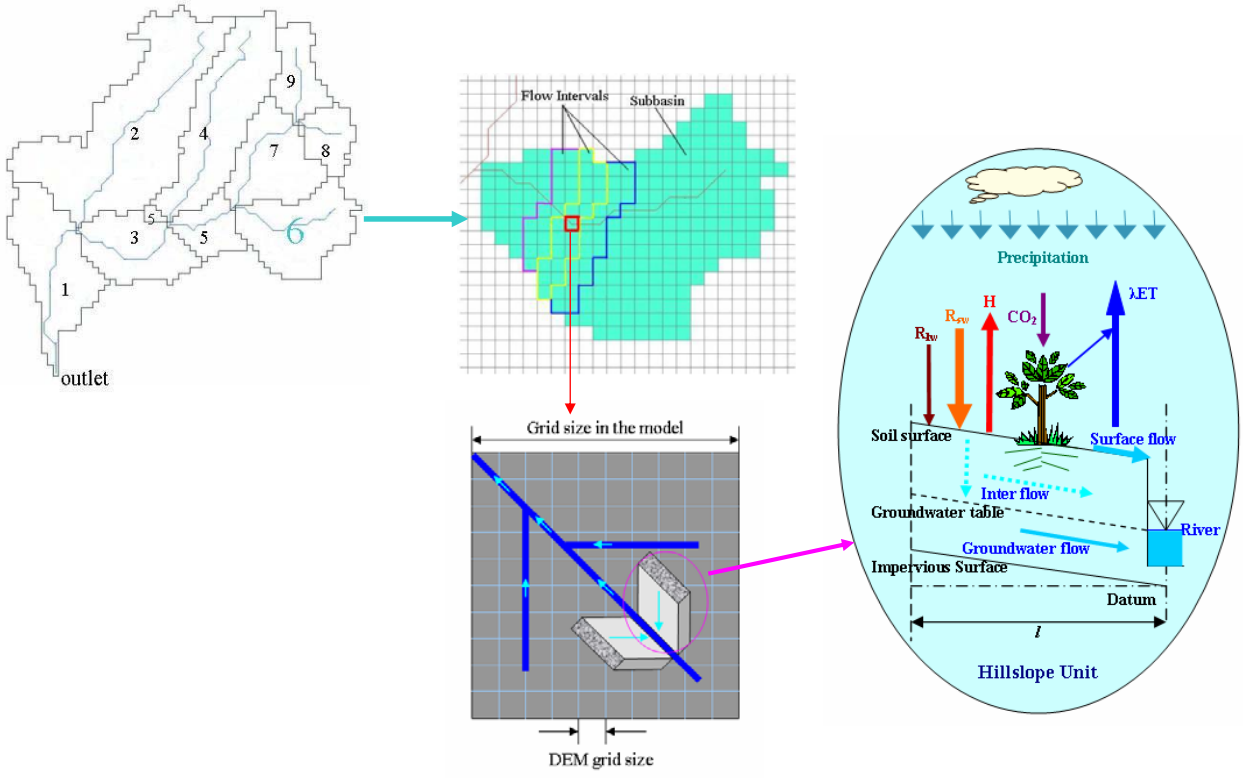
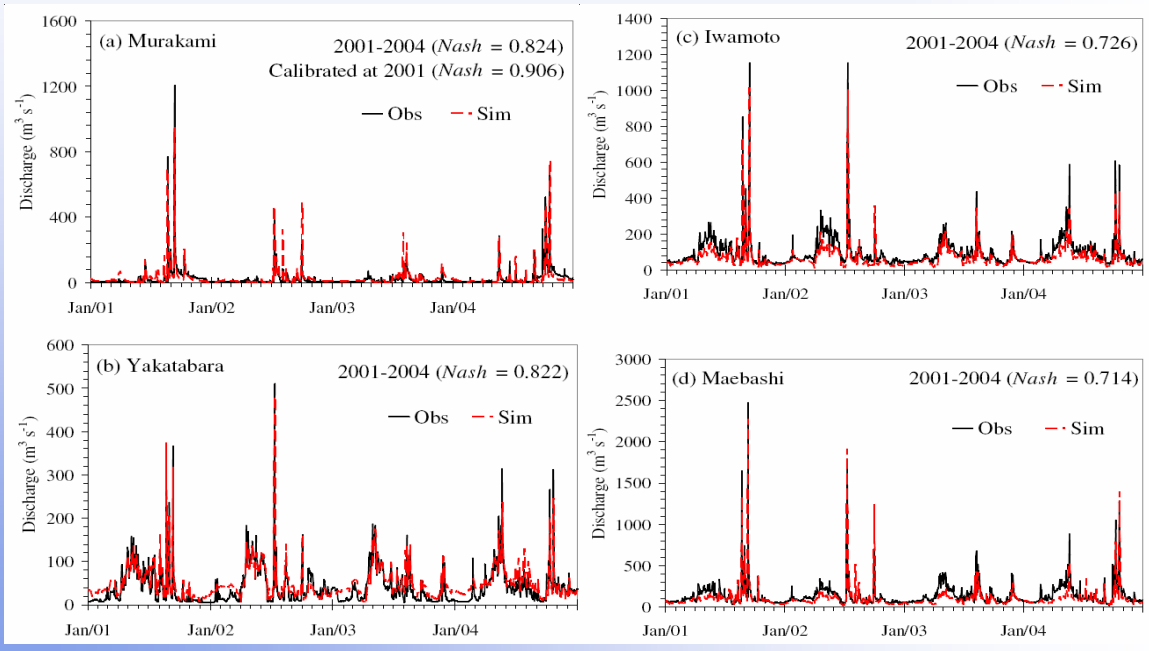
Wang, Koike et al. 2009

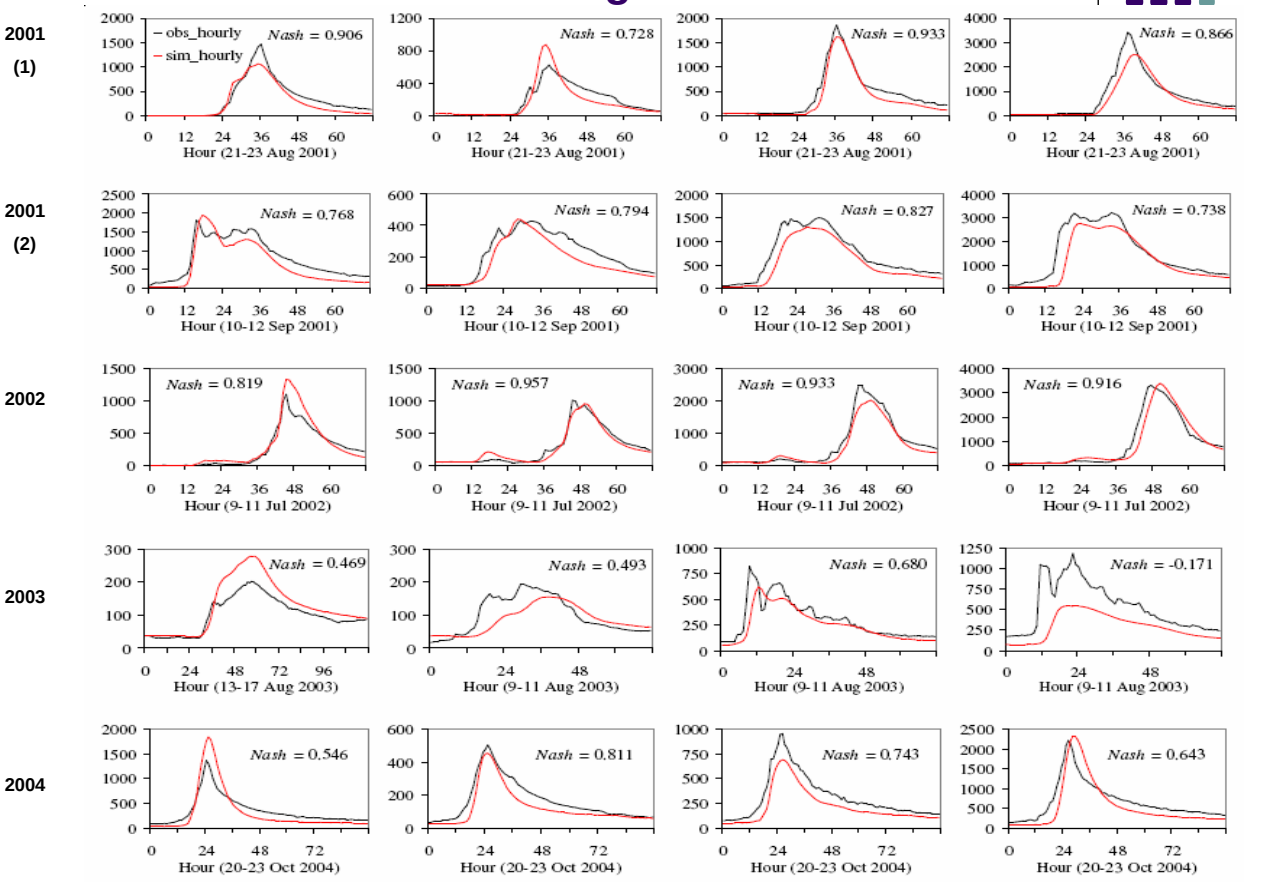
WEB-DHM
(Water and Energy Budget-based Distributed Hydrological Model)



Calibration and validation with discharges at main stream gauges



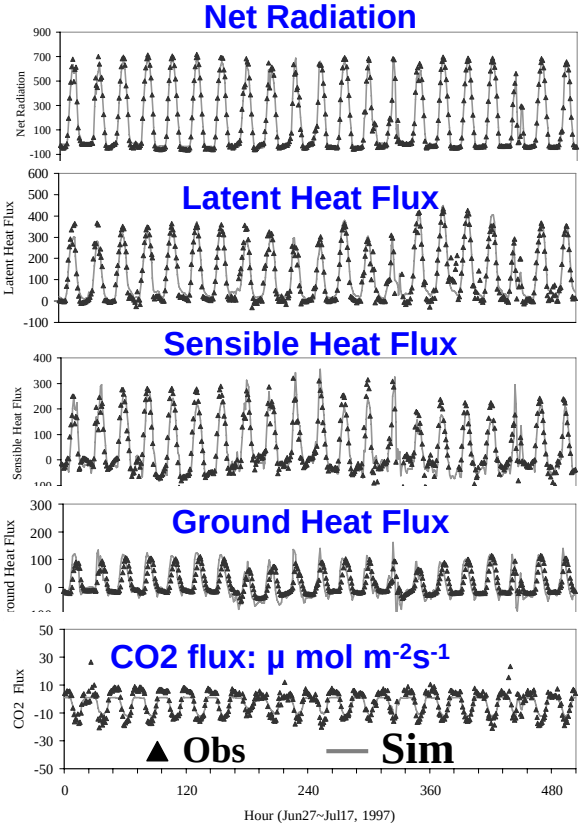
Annual Largest Flood Peaks

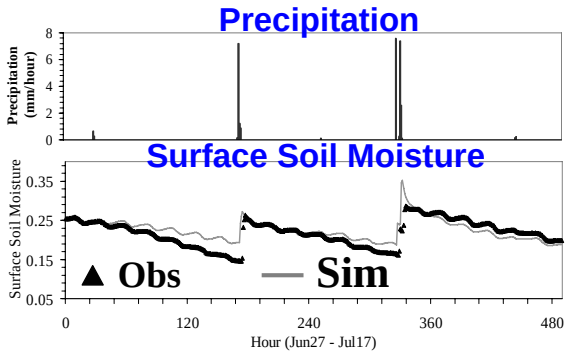


(a) Murakami **(b) Yakatabara** **(c) Iwamoto** **(d) Maebashi**

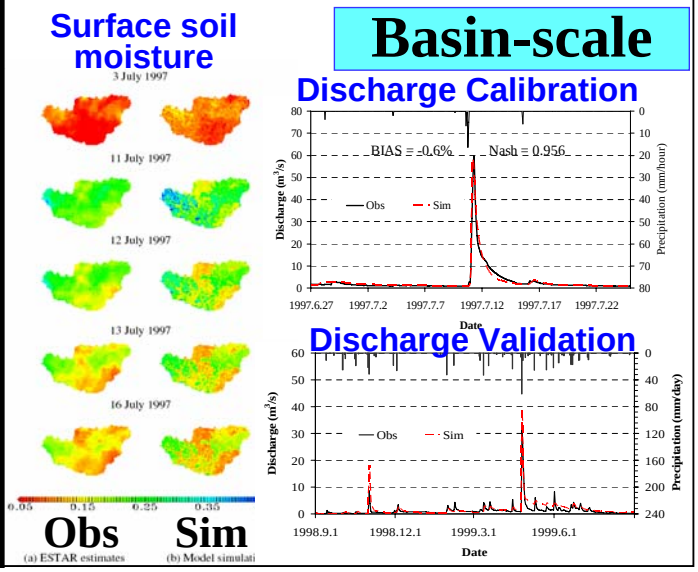
Model Evaluations with SGP97&SGP99 Observations

NOAA flux site

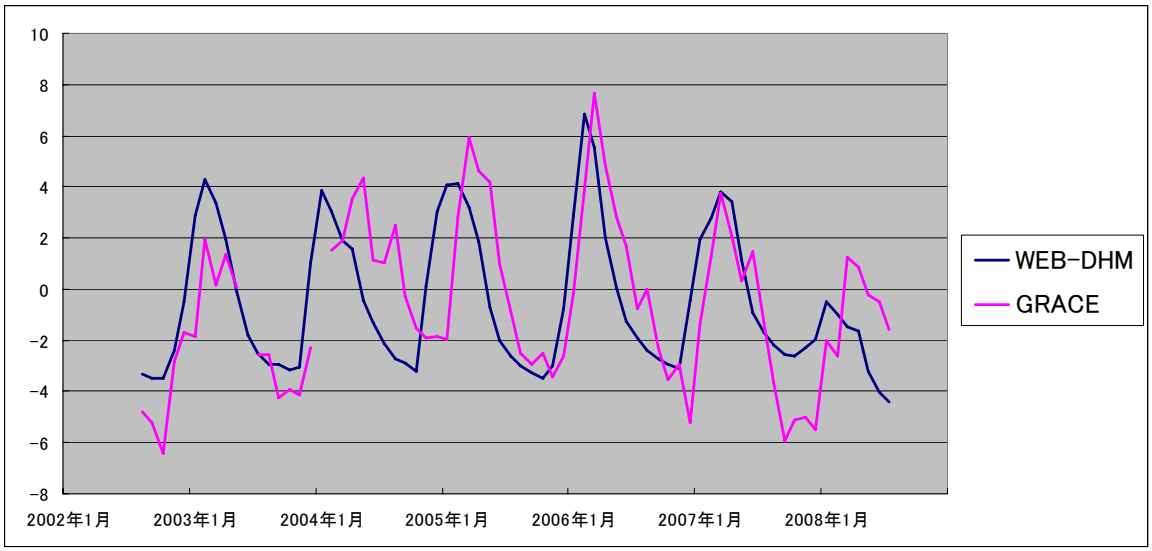




Basin-scale



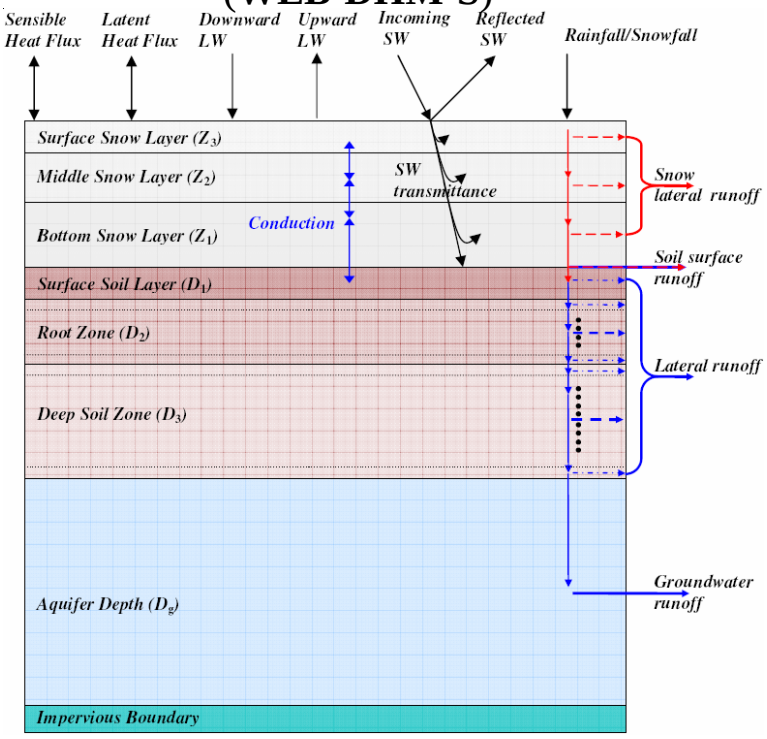
Model Simulation – Multi-Satellites Product (Ground Water in Semi-Arid Region)



Improving the snow physics of WEB-DHM

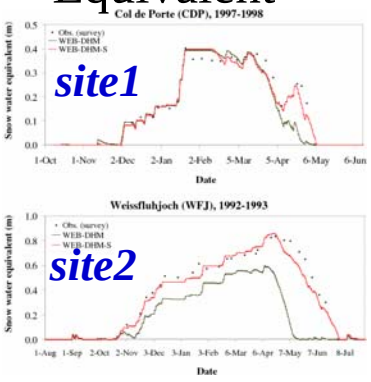
A three-layer snow model is added

(WEB-DHM-S)

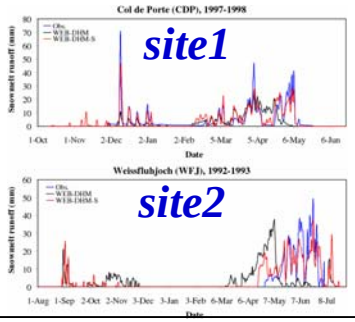


Shrestha, Wang, Koike et al., 2010

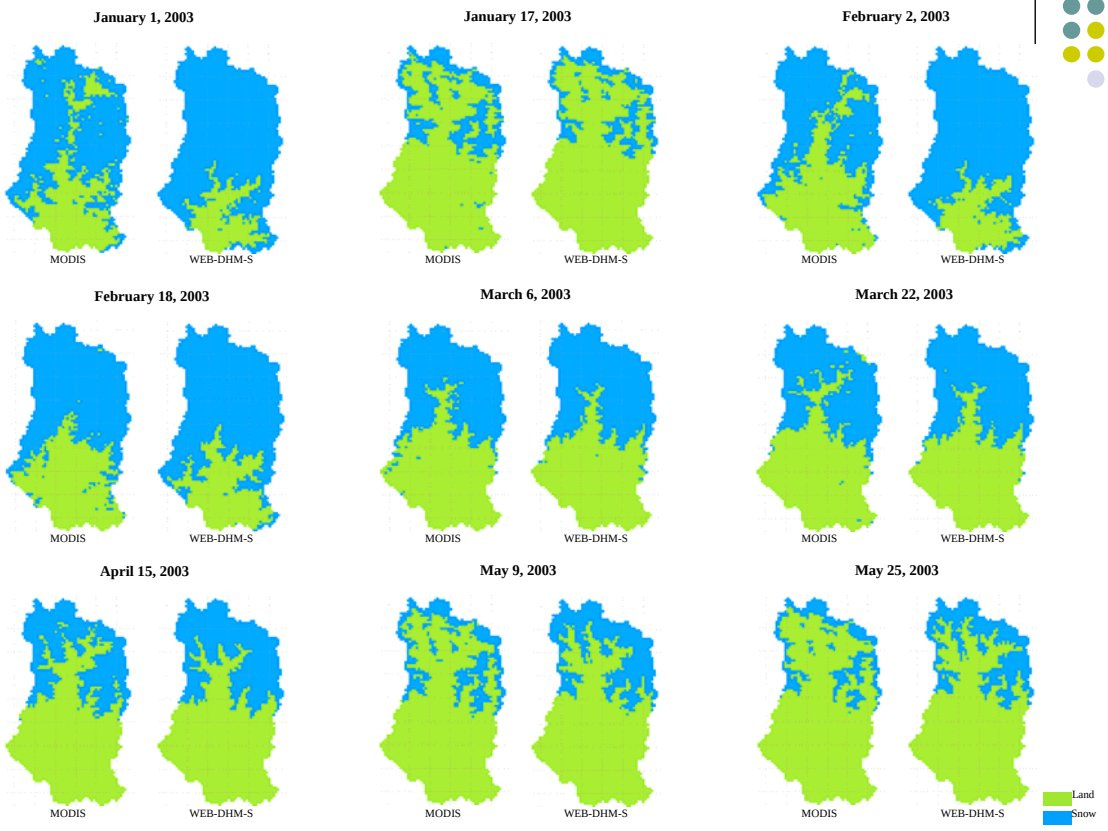
Snow Water Equivalent



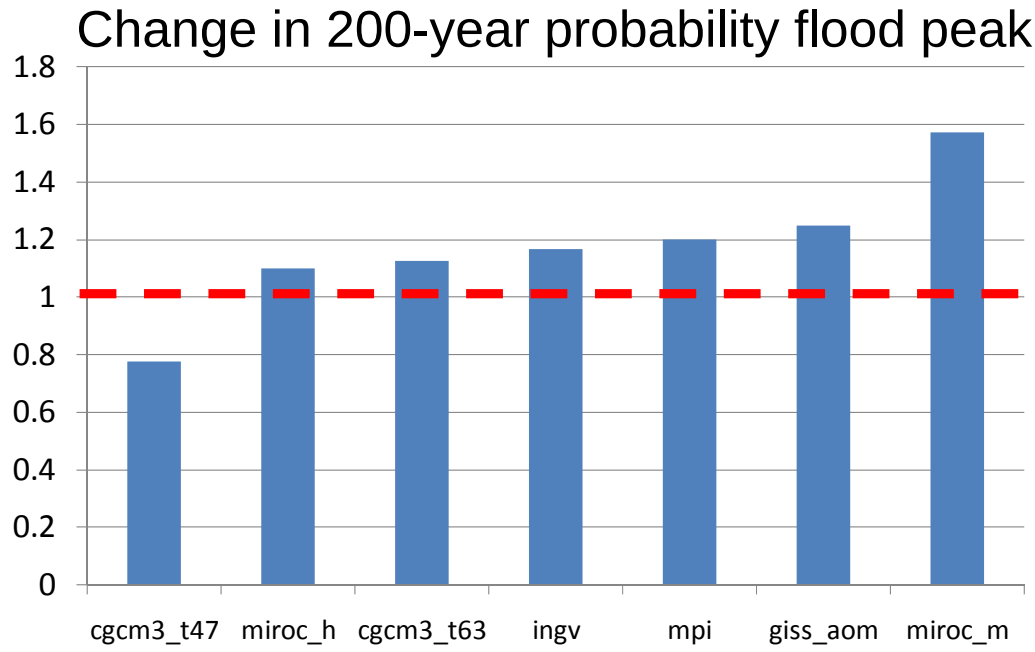
Snowmelt Runoff



Comparison with MODIS snow cover product



Climate Change Impact Assessment



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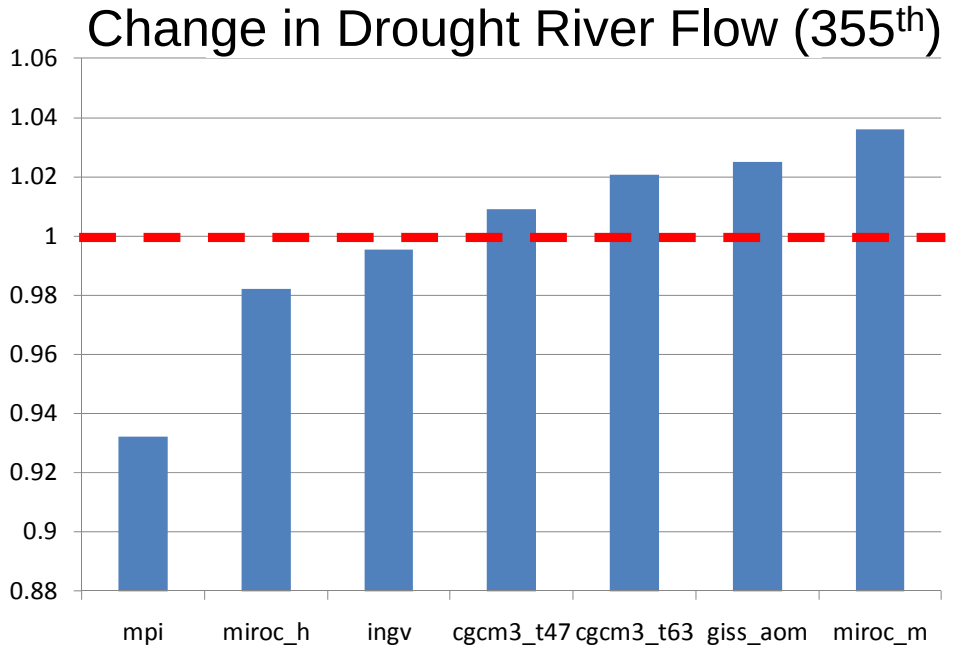
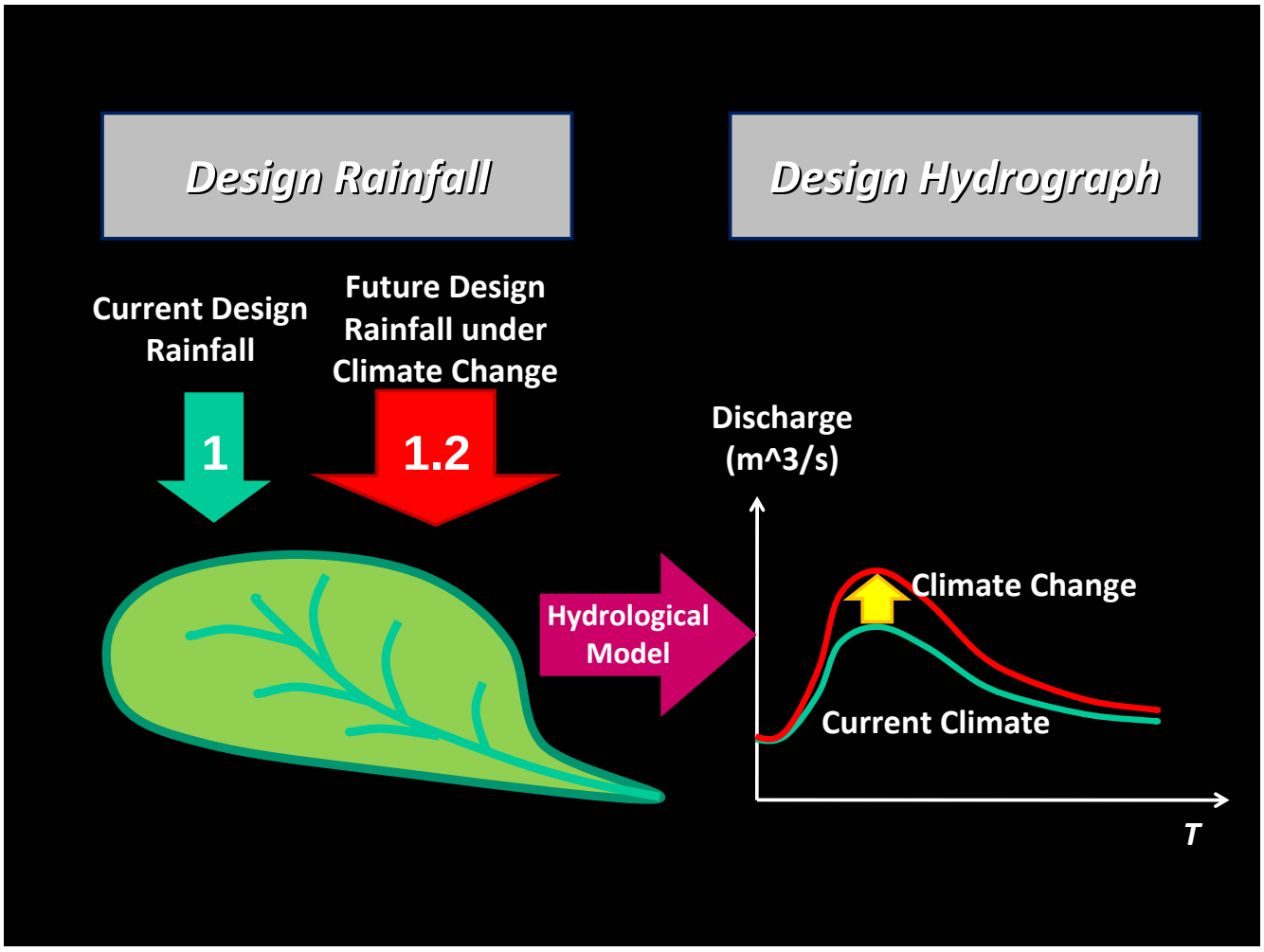
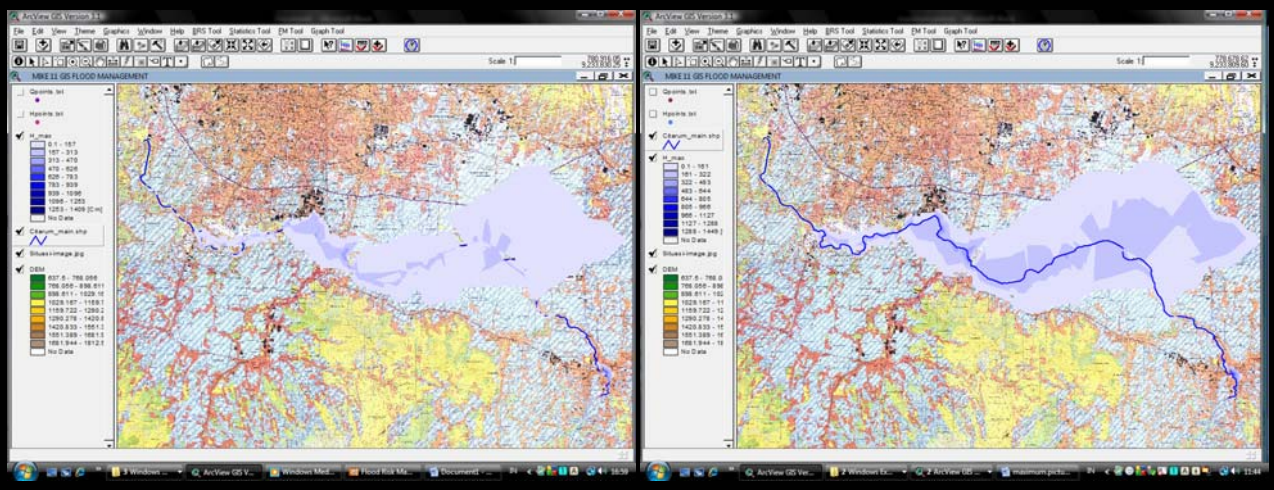




Climate Change Impacts on Flood Control Plan in Indonesia



10year Probable flood
Current Climate

10year Probable flood
50 years later

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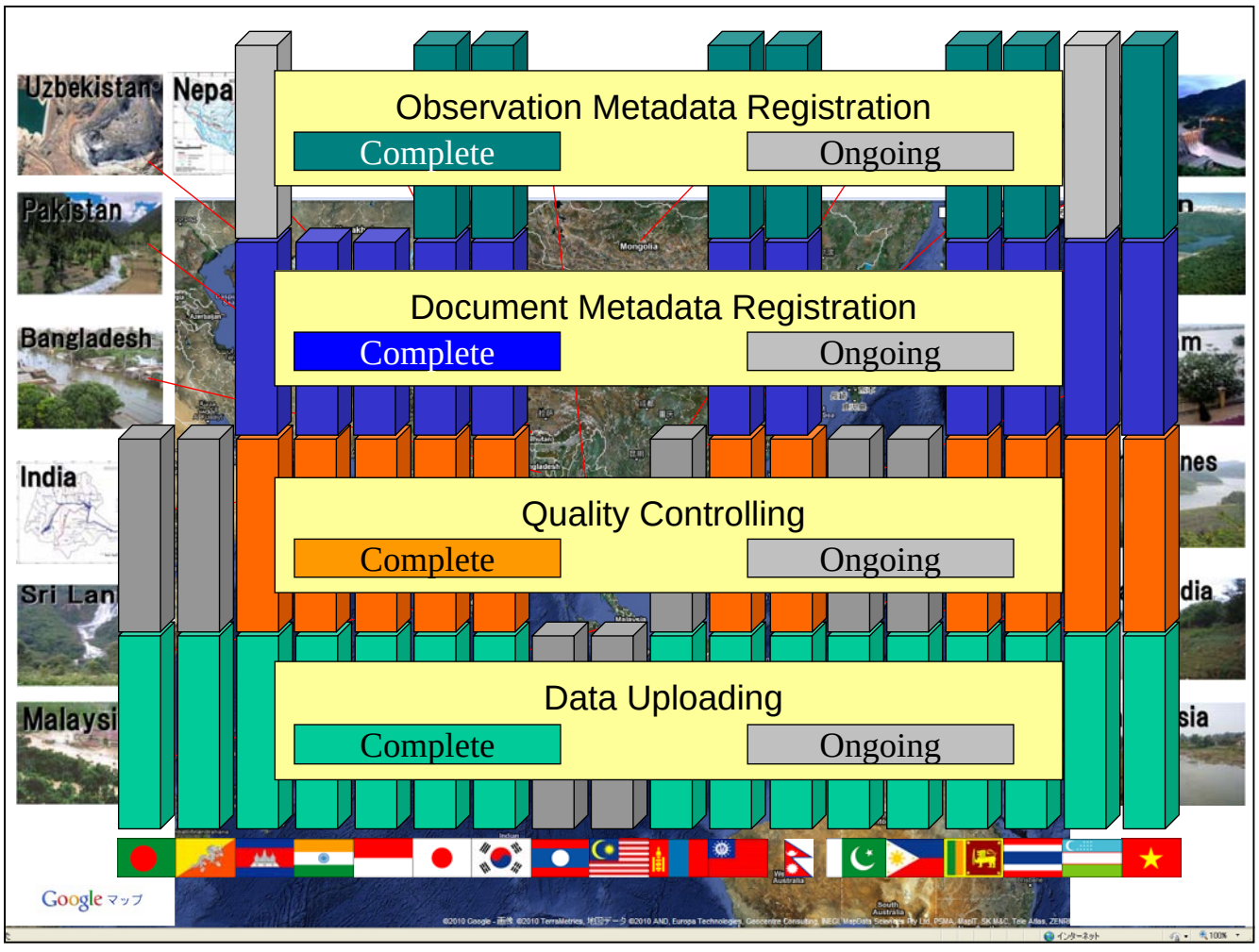
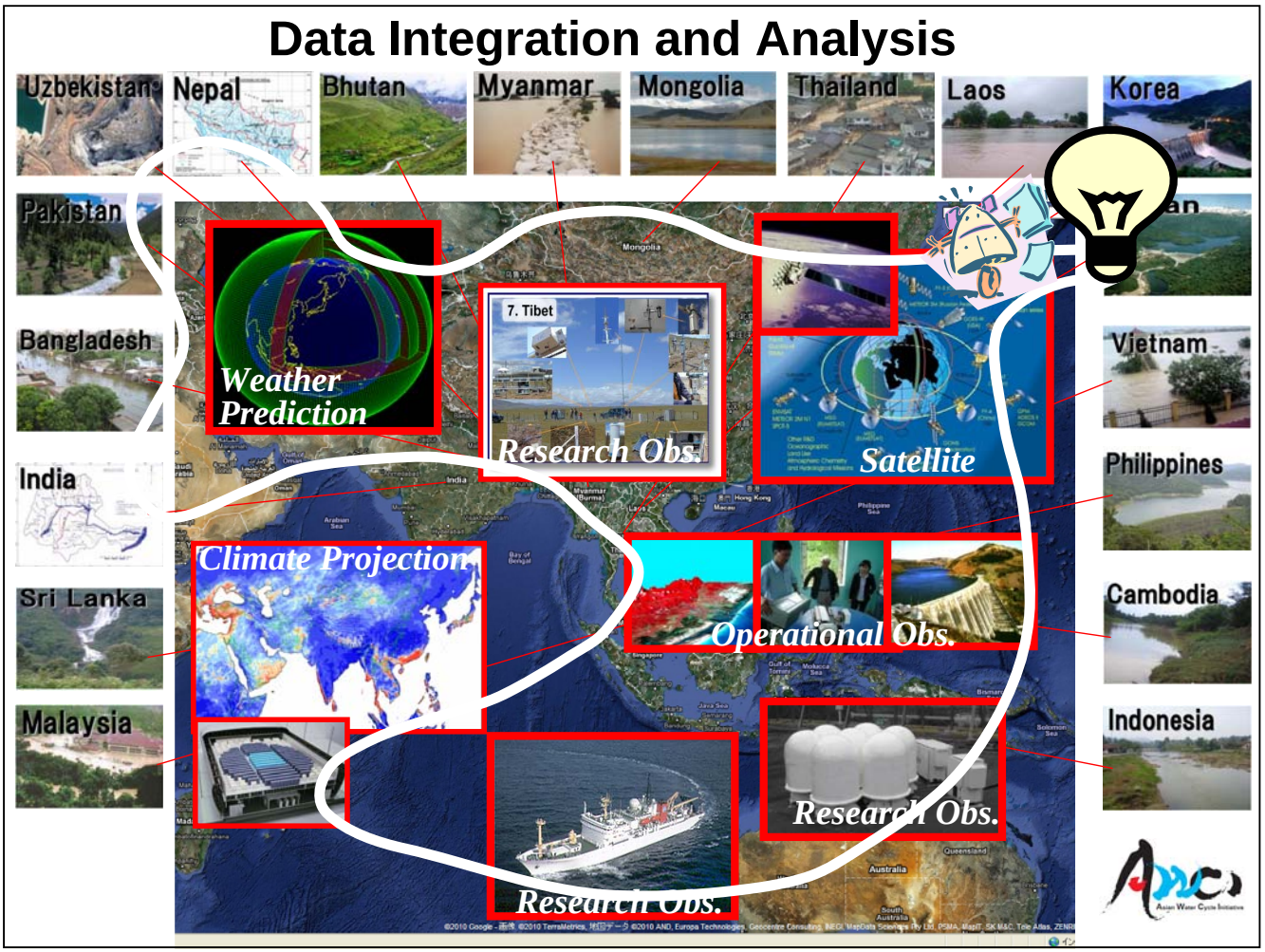
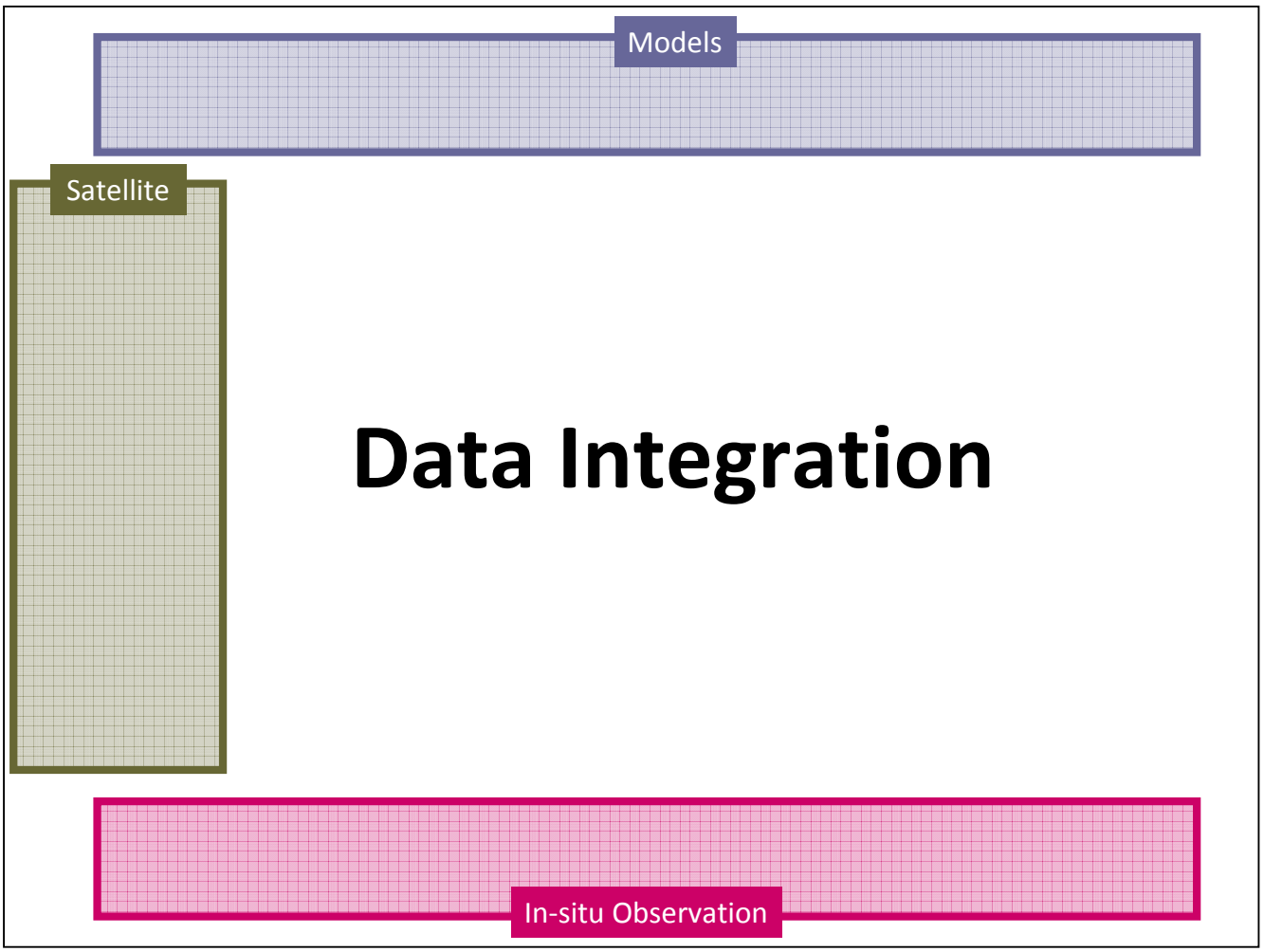
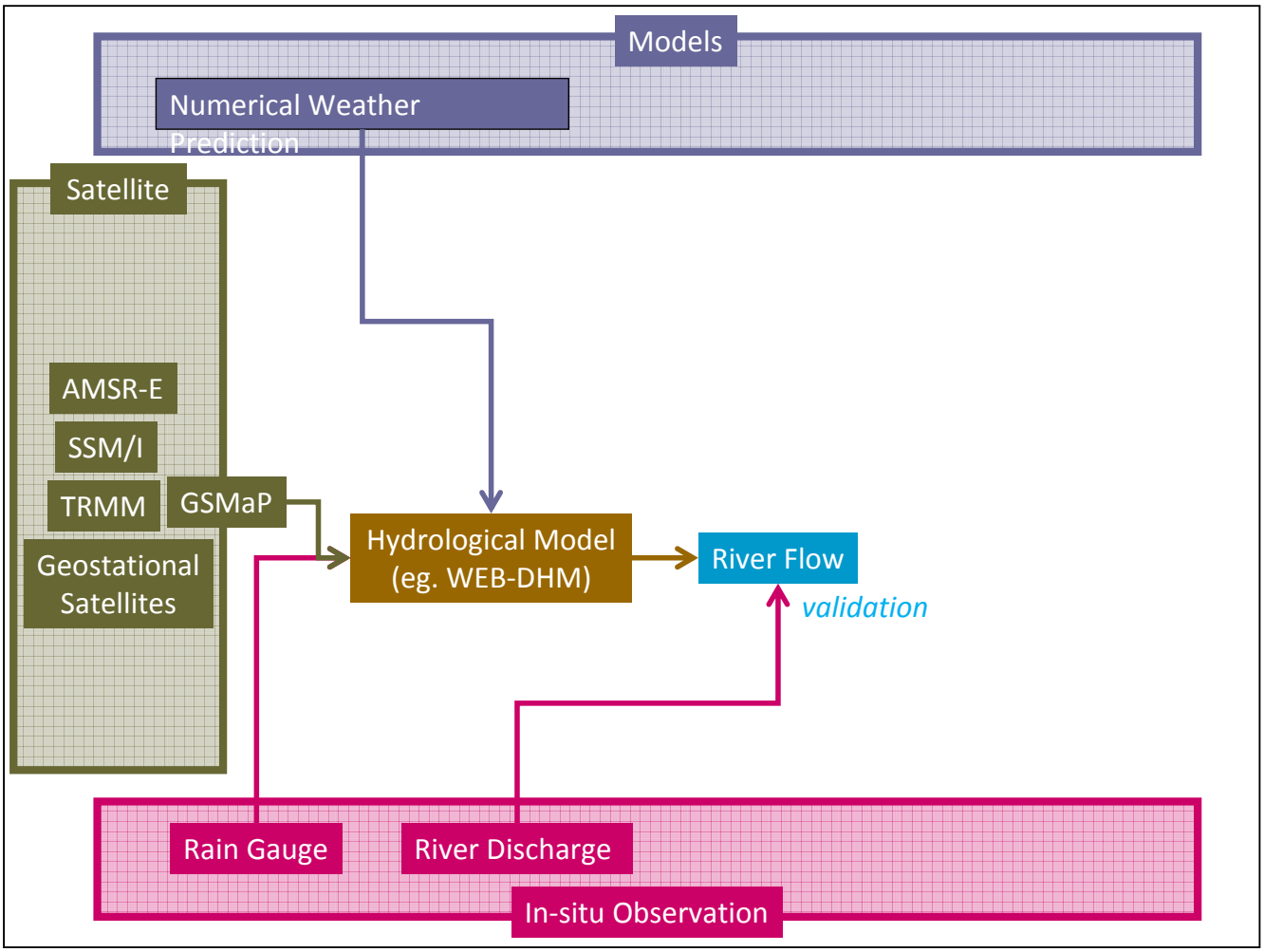



Data Integration and Analysis
Uzbekistan
Nepal
Bhutan
Myanmar
Mongolia
Thailand
Laos
Korea
Pakistan
Bangladesh
India
Sri Lanka
Malaysia
Vietnam
Philippines
Cambodia
Indonesia
Weather Prediction
7. Tibet
Research Obs.
Satellite
Climate Projection
Operational Obs.
Research Obs.
Research Obs.

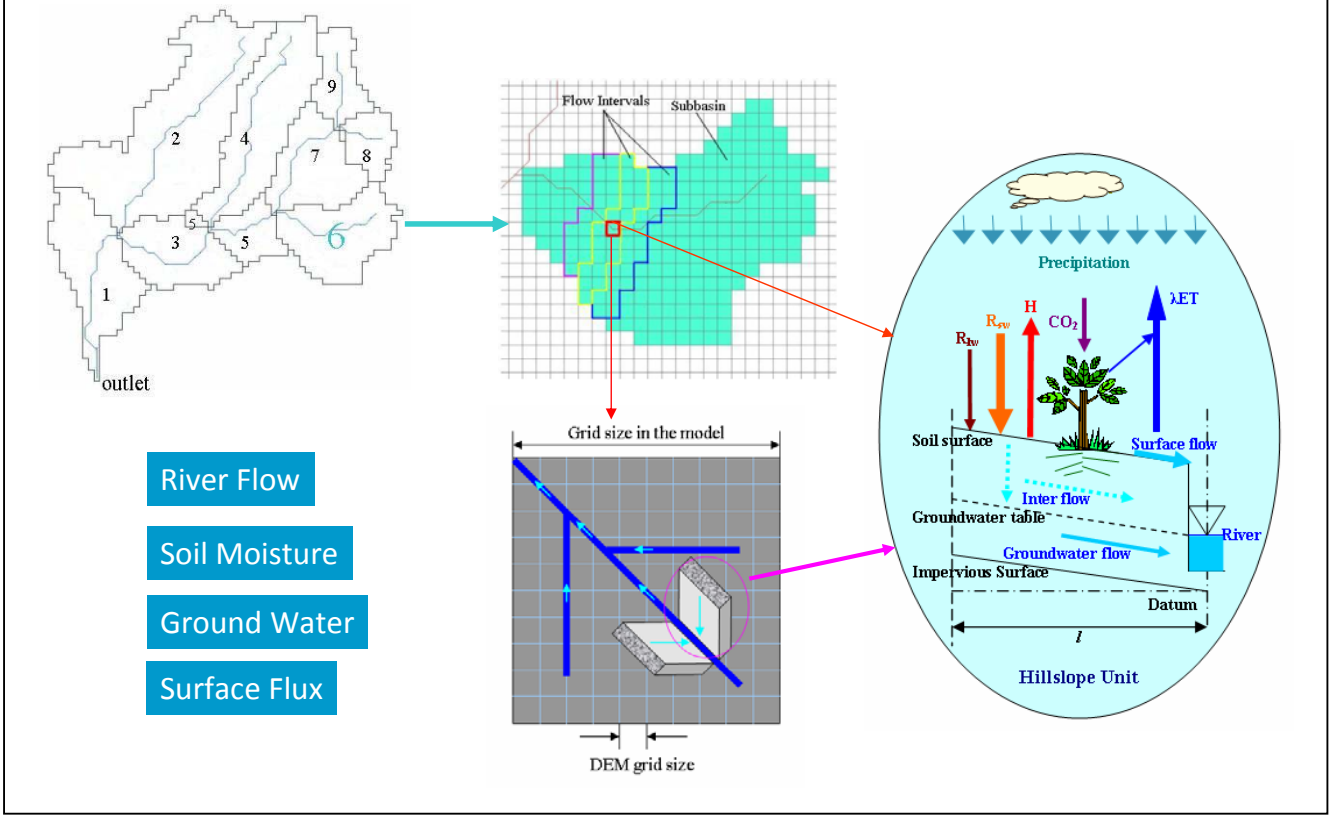

Models
Satellite
Data Integration
In-situ Observation



WEB-DHM

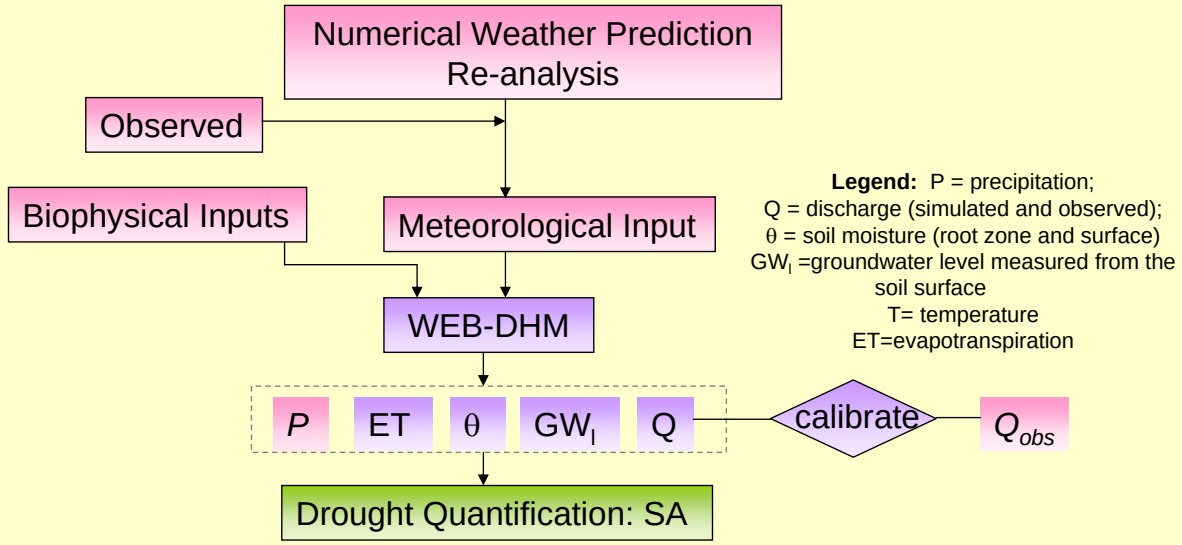
Wang et al. WRR, 2009

(Water and Energy Budget-based Distributed Hydrological Model)



Drought

Monitoring, Seasonal Prediction and Climate Change Impact Assessment



Drought Quantification: The Standard Anomaly Index

1) Transform the best-fit distribution pattern into a standardized distribution

$$x_{transformed} = \frac{x - \mu}{\sigma}$$

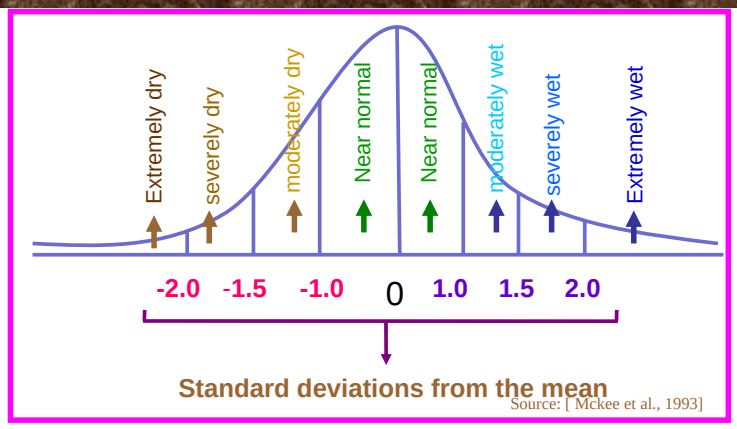
2) Normalize by calculating SA

$$SA = Z = \frac{x_{transformed} - \bar{x}_{transformed}}{\sigma_{transformed}}$$

$$\sigma = \sqrt{\mathrm{var}(x)}$$

$$\mathrm{var}(x) = \int (x-\mu)^2 f(x)dx$$

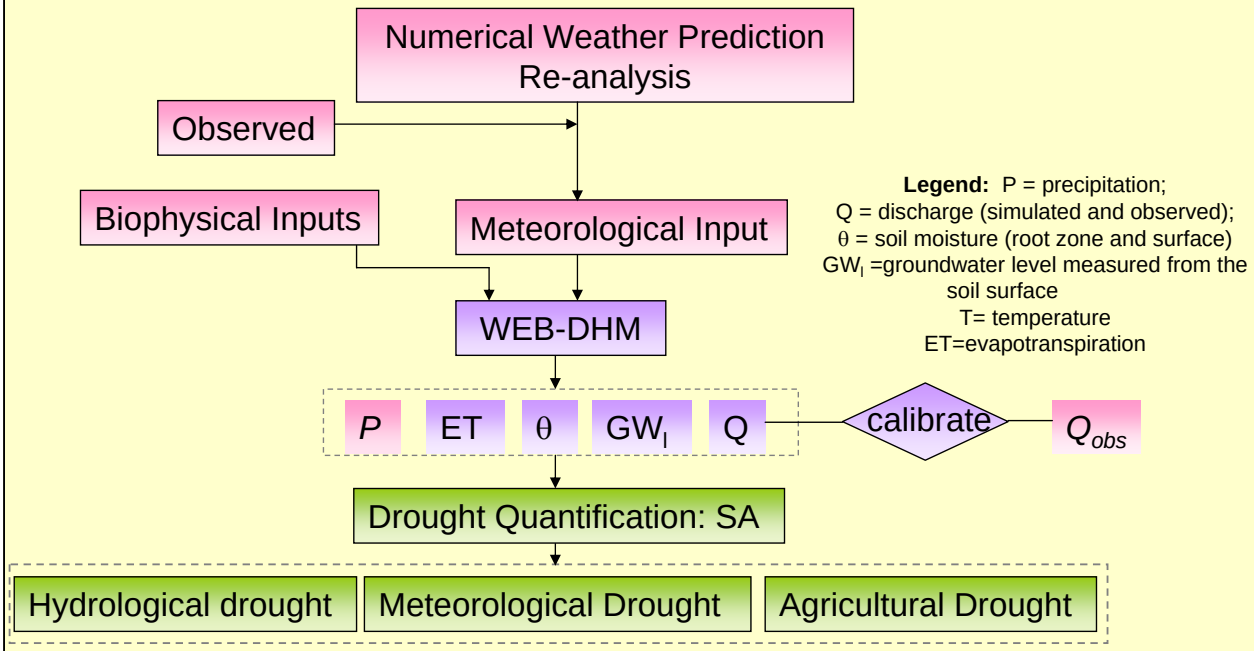
$$\mu = \int x f(x)dx$$



Jaranilla-Sanchez, P. A., et al. (2011), Water Resour. Res., in press.

Drought

Monitoring, Seasonal Prediction and Climate Change Impact Assessment



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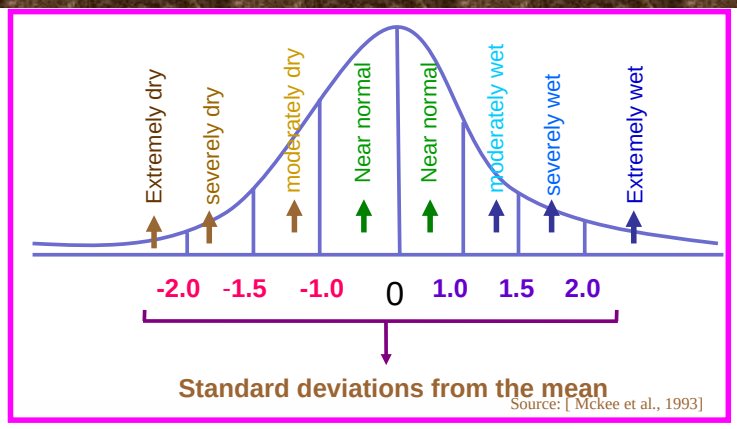
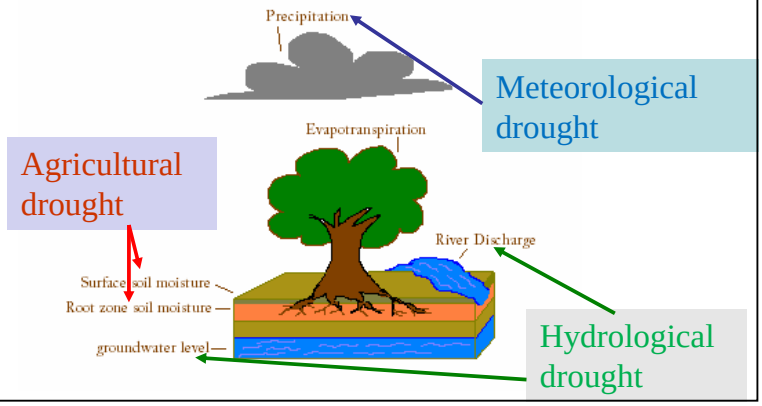
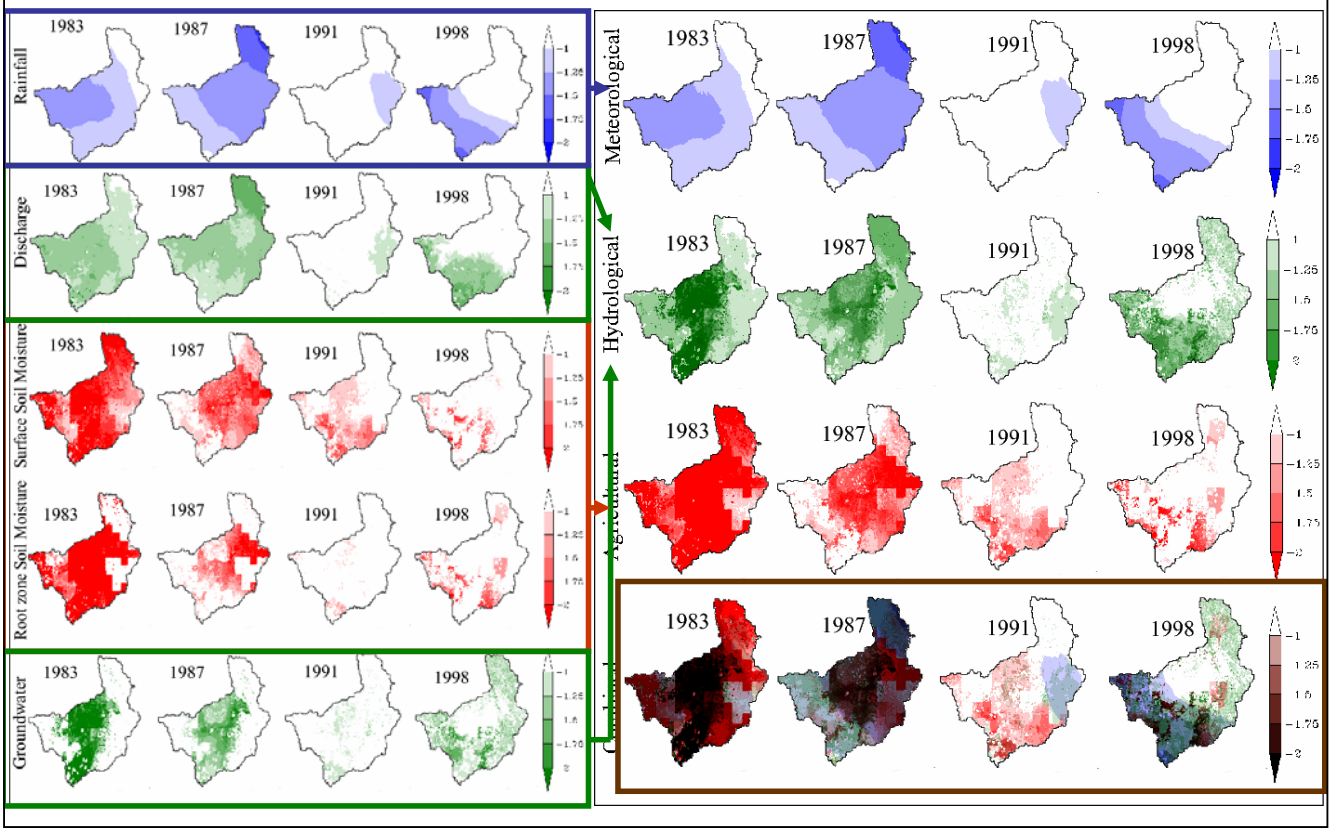




Spatial SA: Philippines



Drought

Monitoring, Seasonal Prediction and Climate Change Impact Assessment

Numerical Weather Prediction Re-analysis

Observed

Biophysical Inputs

Meteorological Input

WEB-DHM

P | ET | θ | GW_l | Q

calibrate

Q_{obs}

Legend: P = precipitation;
Q = discharge (simulated and observed);
θ = soil moisture (root zone and surface)
GW_l =groundwater level measured from the soil surface
T= temperature
ET=evapotranspiration

Drought Quantification: SA

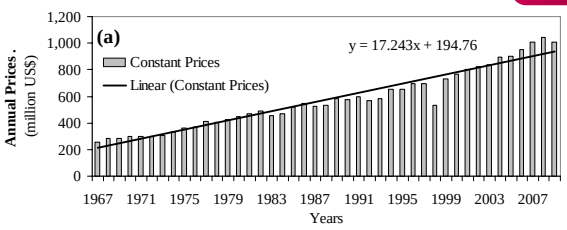
Hydrological drought | Meteorological Drought | Agricultural Drought

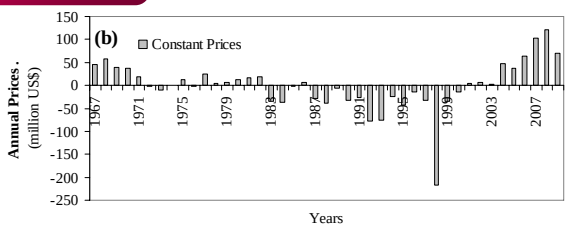
Rice Production

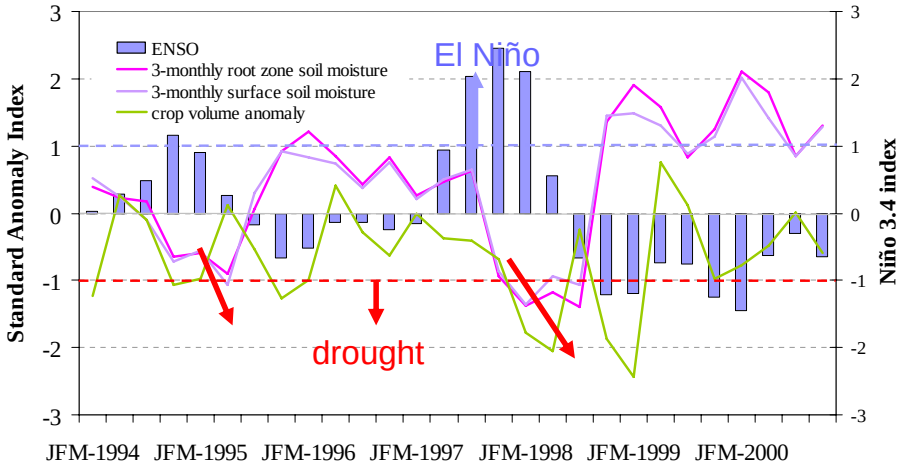
economics | physiology

Impacts of Drought in Agriculture: Philippines

economics







Combined economics, drought and ENSO indices

Drought

Monitoring, Seasonal Prediction and Climate Change Impact Assessment

Numerical Weather Prediction Re-analysis

Observed

Seasonal Prediction

Biophysical Inputs

Meteorological Input

Legend: P = precipitation; Q = discharge (simulated and observed); θ = soil moisture (root zone and surface) GW_l =groundwater level measured from the soil surface; T= temperature; ET=evapotranspiration

WEB-DHM

P ET θ GW_l Q — calibrate — Q_{obs}

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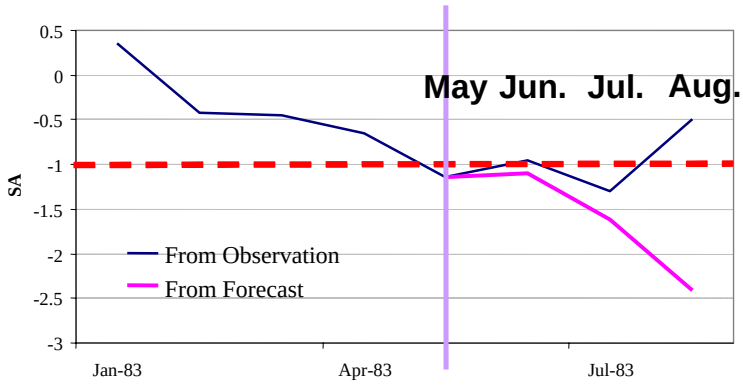
Rice Production

economics | physiology

Seasonal Drought Prediction

Month	SA FROM OBSERVED DISCHARGE	SA FROM FORECAST DISCHARGE
June	-0.954	-1.010455
July	-1.30505	-1.61425
August	-0.4937	-2.41276

Close enough, drought conditions can be forecasted

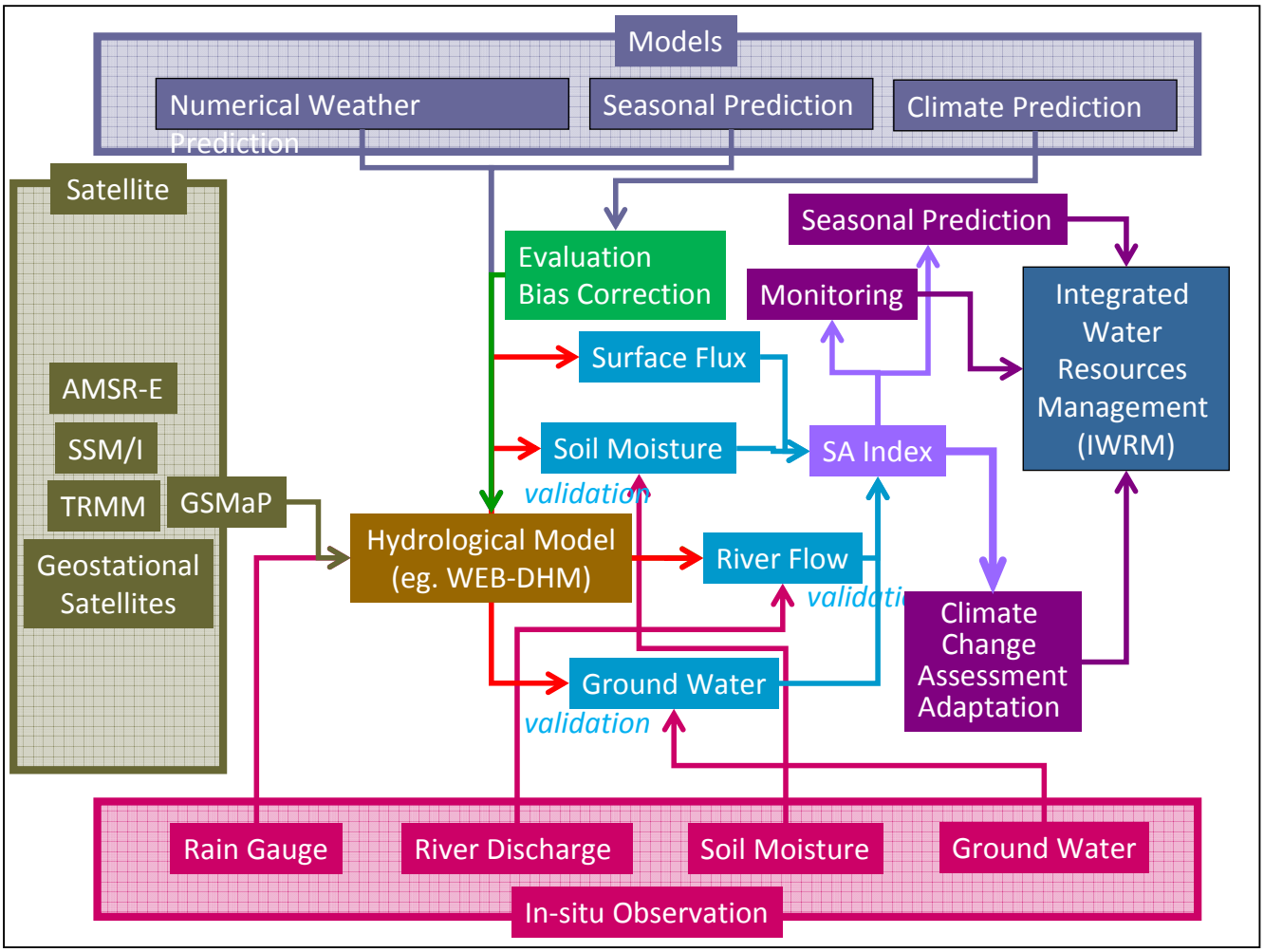


Seasonal Drought Prediction

Months	1st		2nd		3rd	
Year	Observed	SFC	Observed	SCF	Observed	SCF
1983	↗	↗	↘	↘	↗	↘
1991	↘	↘	↗	↗	↘	↘
1997	↘	↘	↘	↘	↘	↘
1999-2000	↗	↘	↗	↗	↗	↗

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

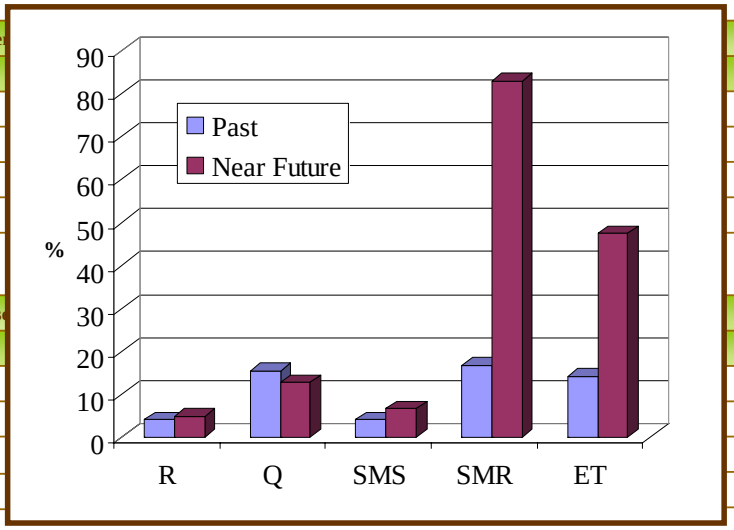
e.g. increase towards drought conditions ↗



SA Past and Near Future: Philippines

SA category	Past GCM ensemble		Near future GCM ensemble	
R	# of Months		# of Months	%
Mild	9		13	5.70
Moderate	0		2	0.88
Severe	0		0	0
TOTAL	9		15	6.58

SA category	Past GCM ensemble		Near future GCM ensemble	
SMS	# of Months		# of Months	%
Mild	20		37	16.22
Moderate	11		39	17.11
Severe	4		113	49.56
TOTAL	35		189	82.89



	Near future GCM ensemble	
	# of Months	%
	38	16.67
	38	16.67
	32	14.03
	108	47.37

Legend:

R=rainfall

Q=discharge

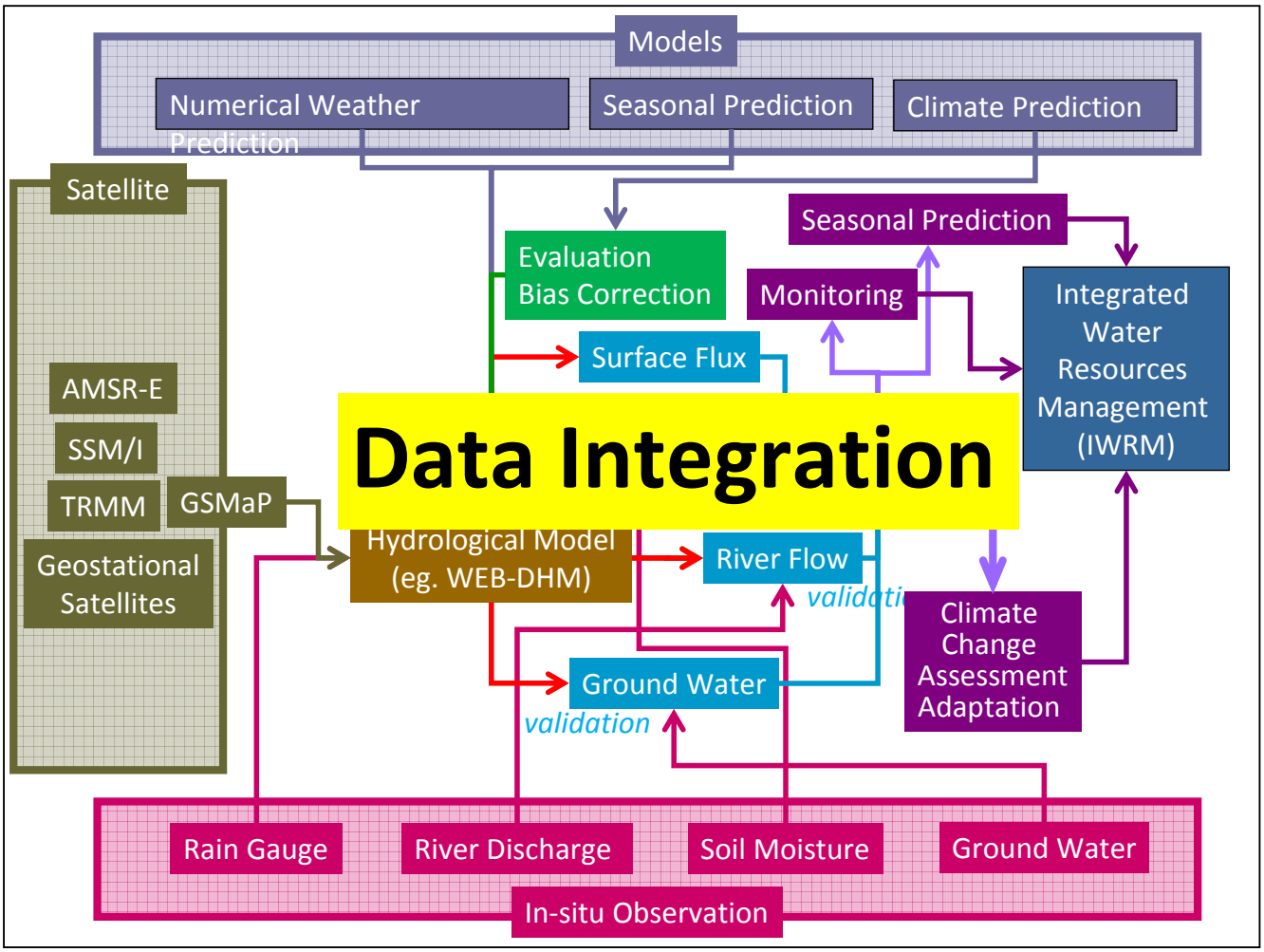
SMS=surface soil moisture

SMR=root zone soil moisture

ET=evapotranspiration

Large increase in severe drought conditions at the root zone in the near future

-translates to more severe agricultural drought



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