Overview on assessment of climate change impacts on Mekong hydrological regime

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- BDP and CC scenarios
- GCM and RCM
- BDP-CC scenario analysis framework
- MRC DSF – advantages & limitations

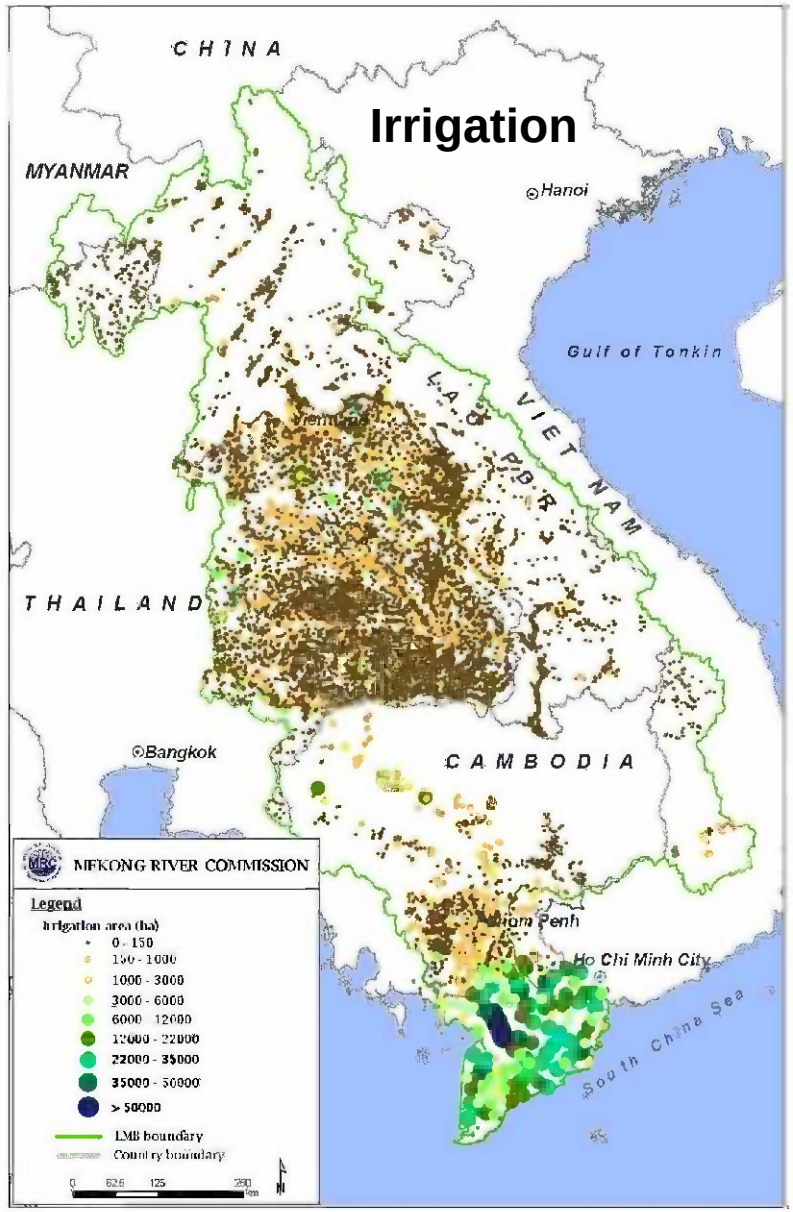
Scenario?

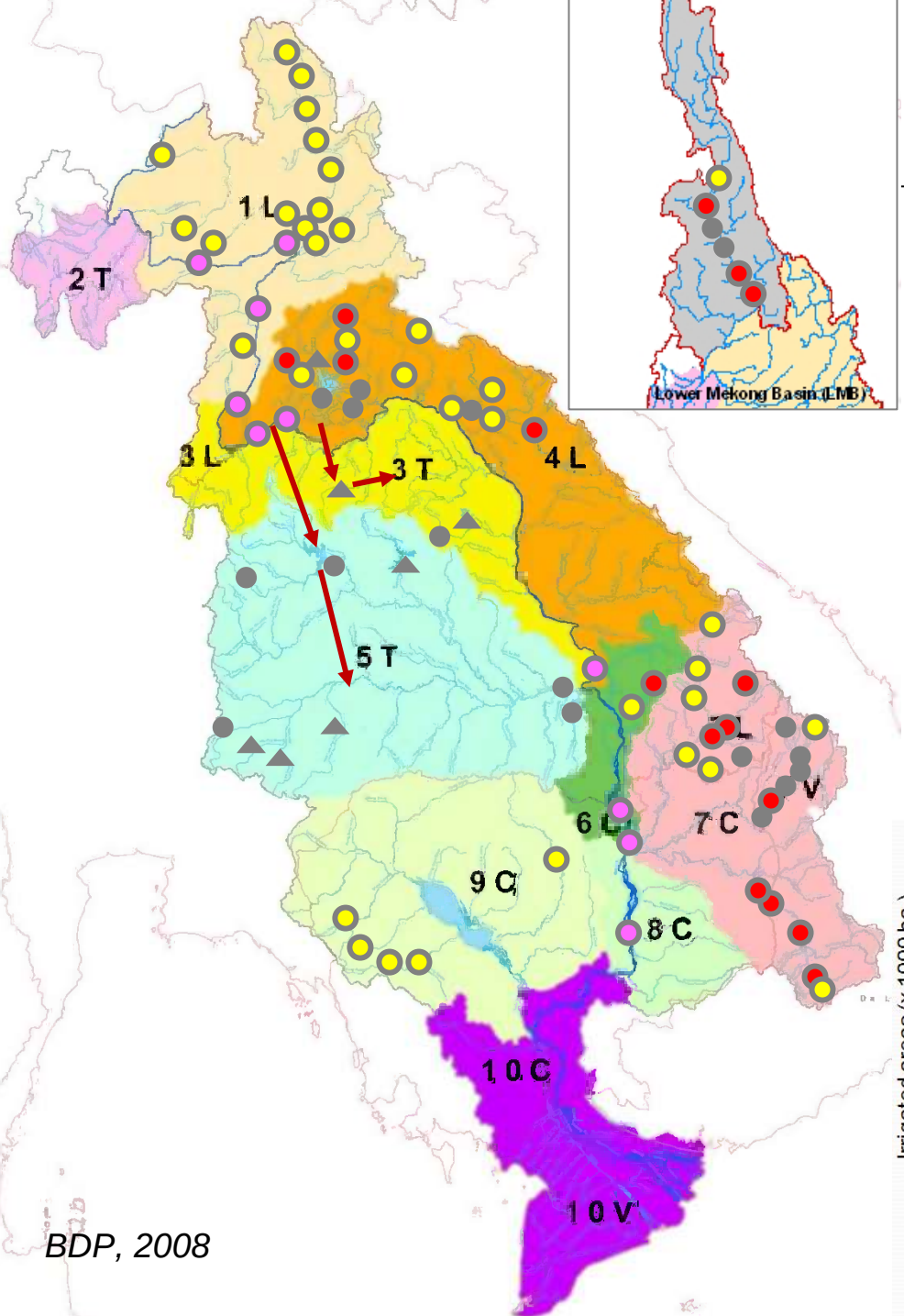
A scenario is:

"a coherent, internally consistent and plausible description of a possible future state of the world" (Parry and Carter, 1998)

- ☞ Not a forecast or a prediction
- ☞ A series of pictures of what the world could look like in the future

Basin development plan (BDP)



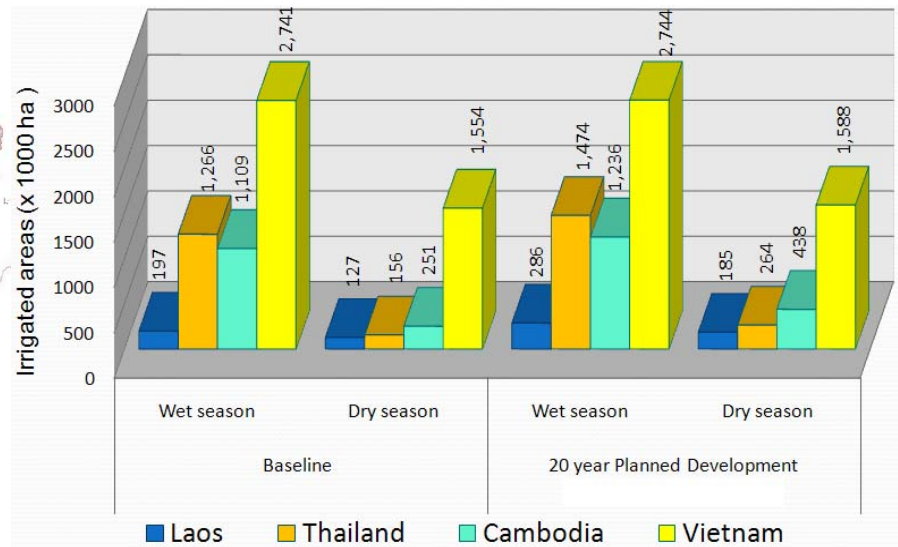


BDP, 2008

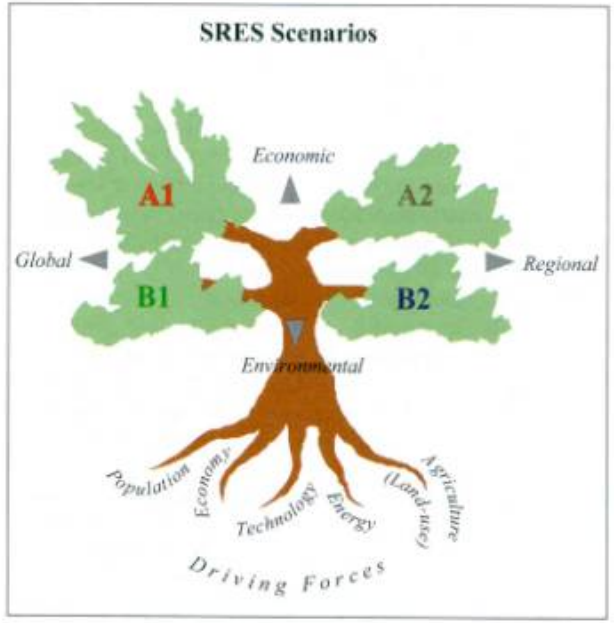
Hydropower

Scenario	No Project	Installed Capacity (MW)	Active Storage (MCM)
Baseline	11	1,553.2	9,638.2
Upper Mekong Dam	17	17,003.2	32,871.2
Definite Future	35	21,073.2	44,003.9
LMB Mainstream Dam	45	35,152.2	48,909.9
LMB Tributary Dam	70	26,728.2	71,936.9
LMB 20-year Plan	80	40,807.2	76,843.9

Irrigation



IPCC scenarios



IPCC basic scenarios:

A1: Low population growth, very rapid economic growth

A2: High population growth, slower economic growth

B1: Low population growth, introduction of clean, resource-efficient technologies

B2: Moderate population growth and economic development

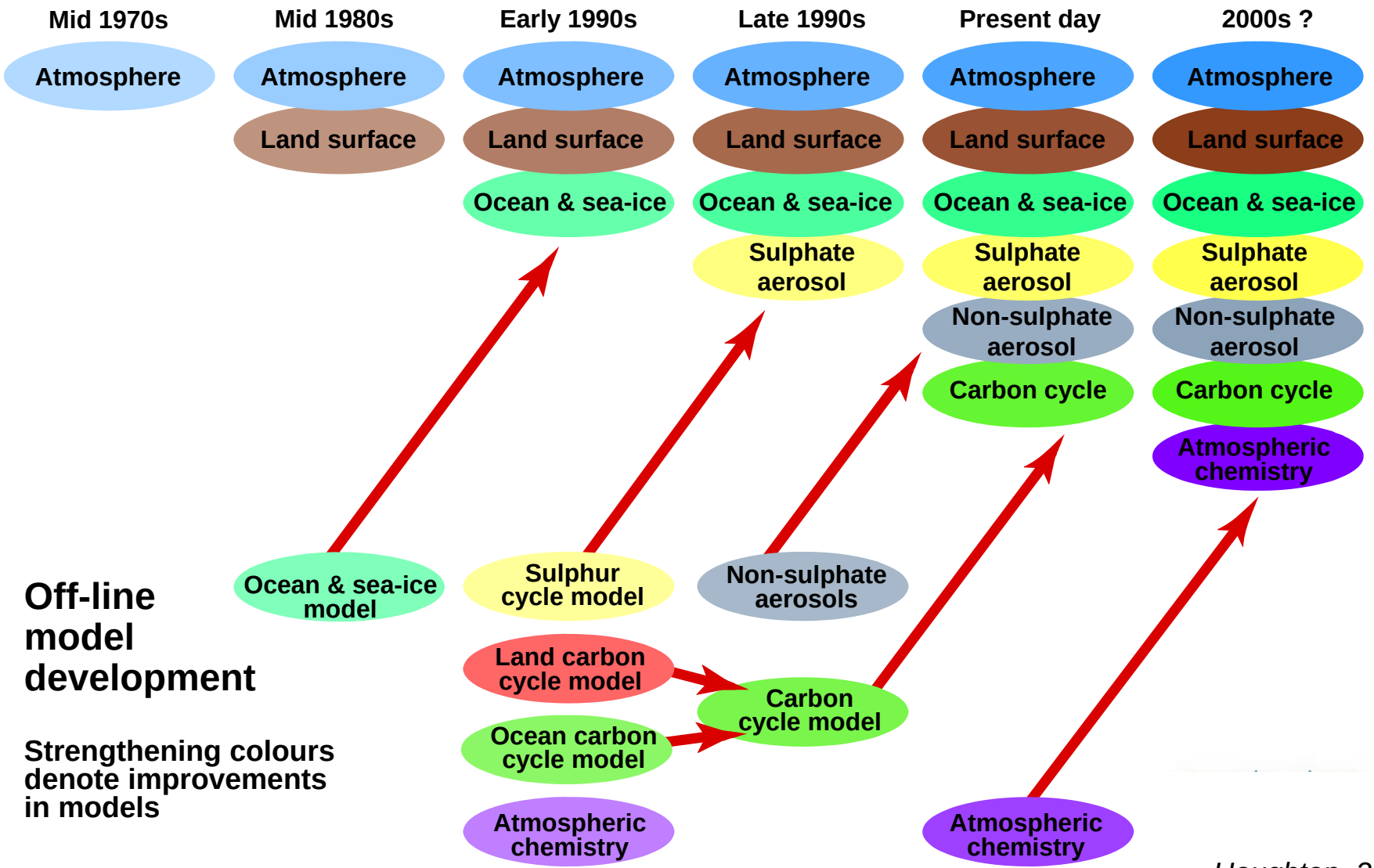
Additional scenarios:

- A1FI: fossil intensive
- A1T: non-fossil energy resources
- A1B: balance across all sources

Grouping:

Low emission scenarios:	B1, A1T
Medium emission scenarios:	B2, A1B
High emission scenarios:	A2, A1FI

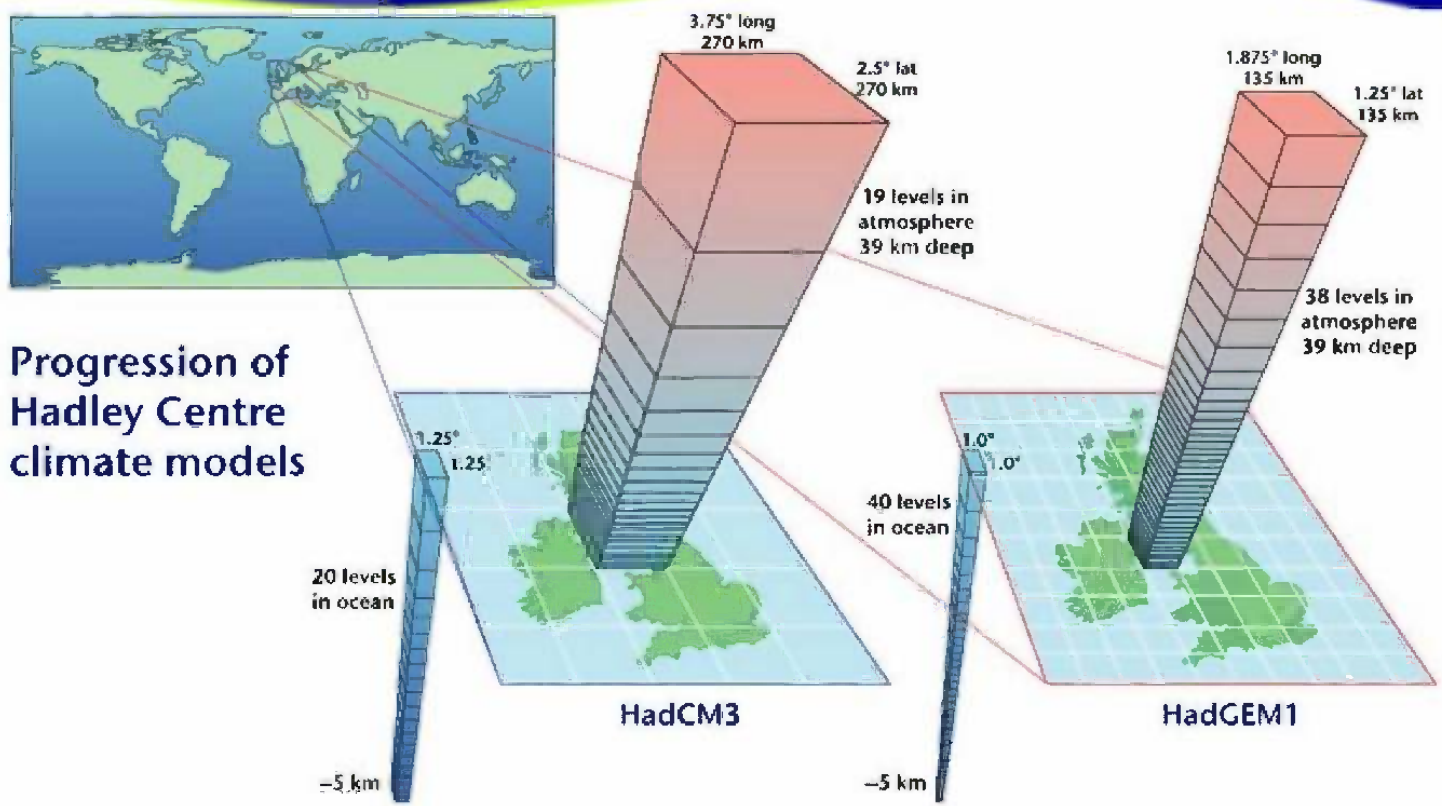
Climate models: past, present & future



Houghton, 2003

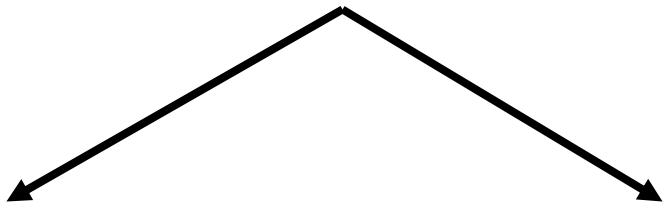
Climate change

GCMs – spatial and vertical resolution



Downscaling definitions

Simulation of sub-grid-scale climate based on output from global climate models



By developing a statistical relationship between local climate variables and model predictors

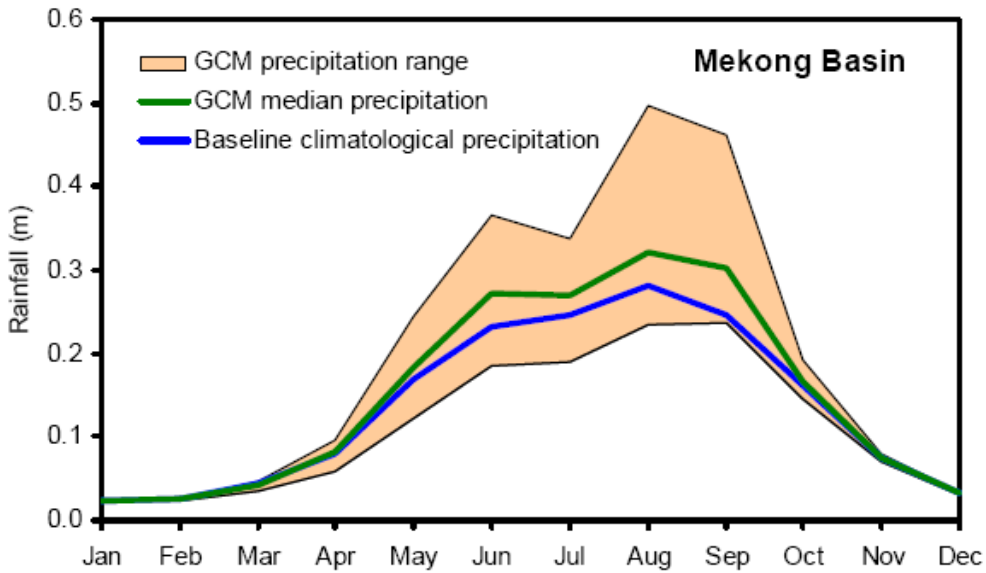
STATISTICAL DOWNSCALING

By explicit solving of process-based physical dynamics of the regional climate system

DYNAMIC DOWNSCALING

Regional Climate Model (RCM)

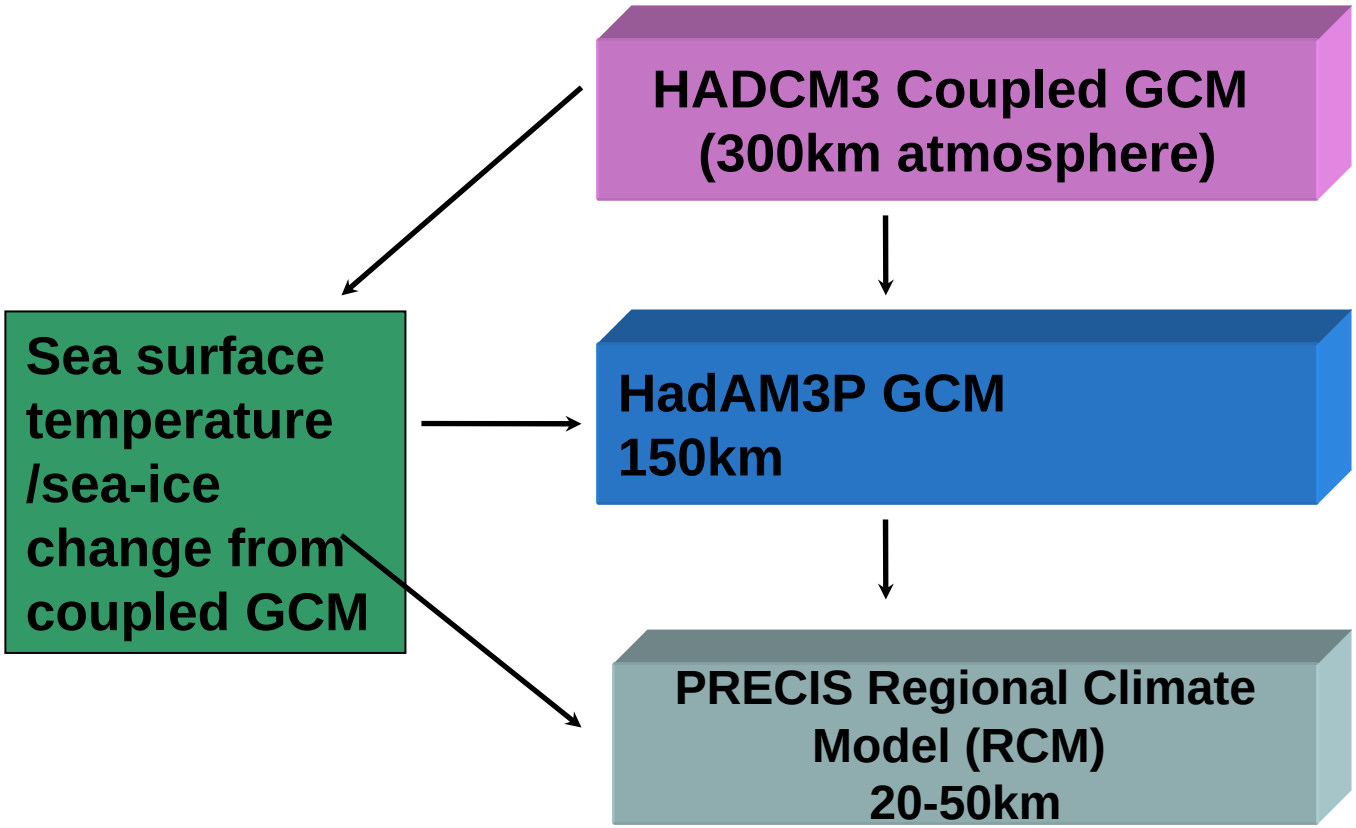
- High resolution (20-50 km) over limited area
- Takes account of local characteristics, e.g. mountains, coasts
- Better regional details, better prediction of extremes in weather
- Embedded in global model, so subject to same uncertainties (using many GCMs vs one RCM?)



Eastham et al., 2008

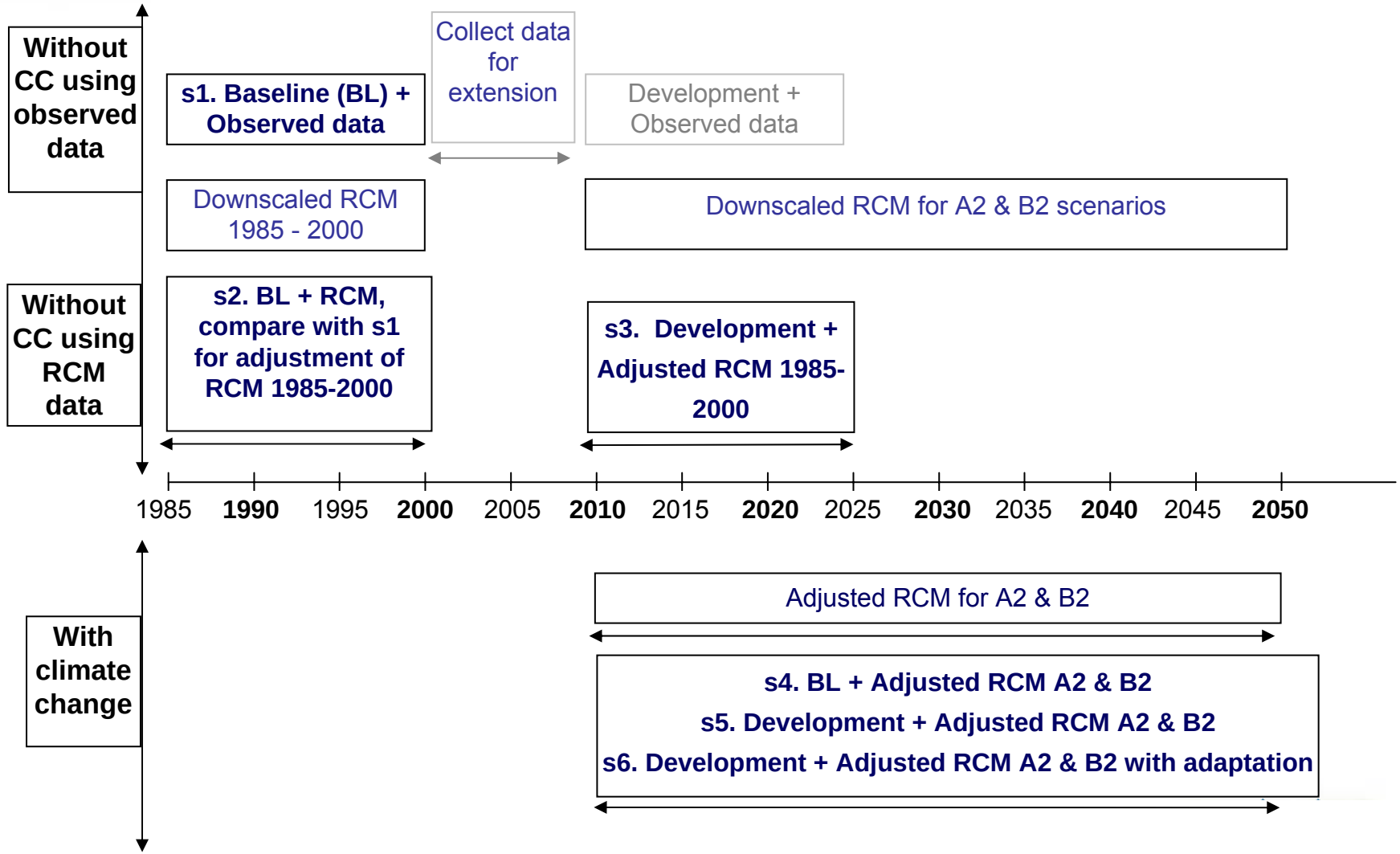
Figure 3.6. Baseline (1951-2000) versus future (2030) monthly mean precipitation.

PRECIS dynamic downscaling



PRECIS boundaries: atmospheric winds, temperatures and humidity outputed from a GCM.

Scenario analysis framework

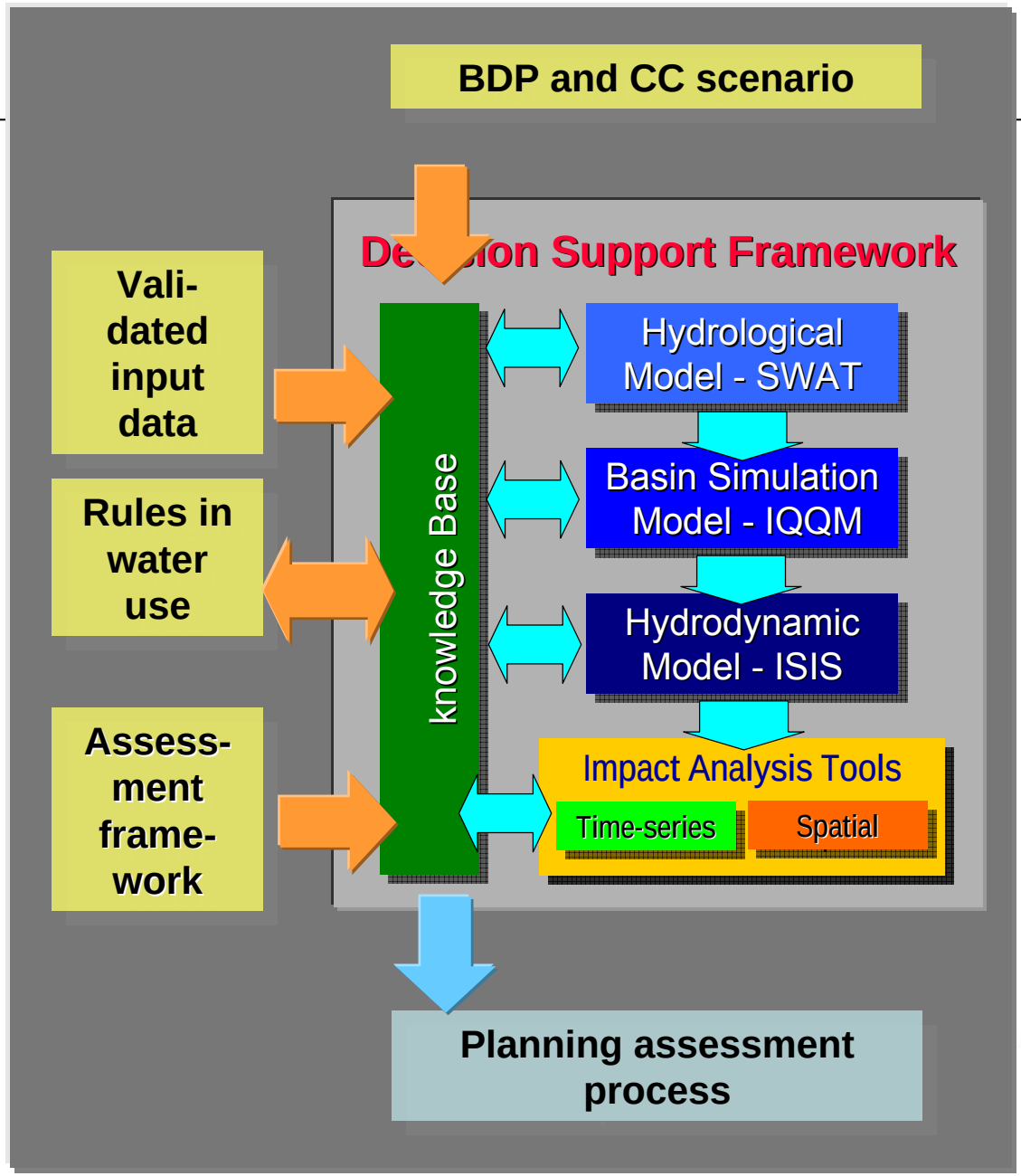


Scenario analysis framework

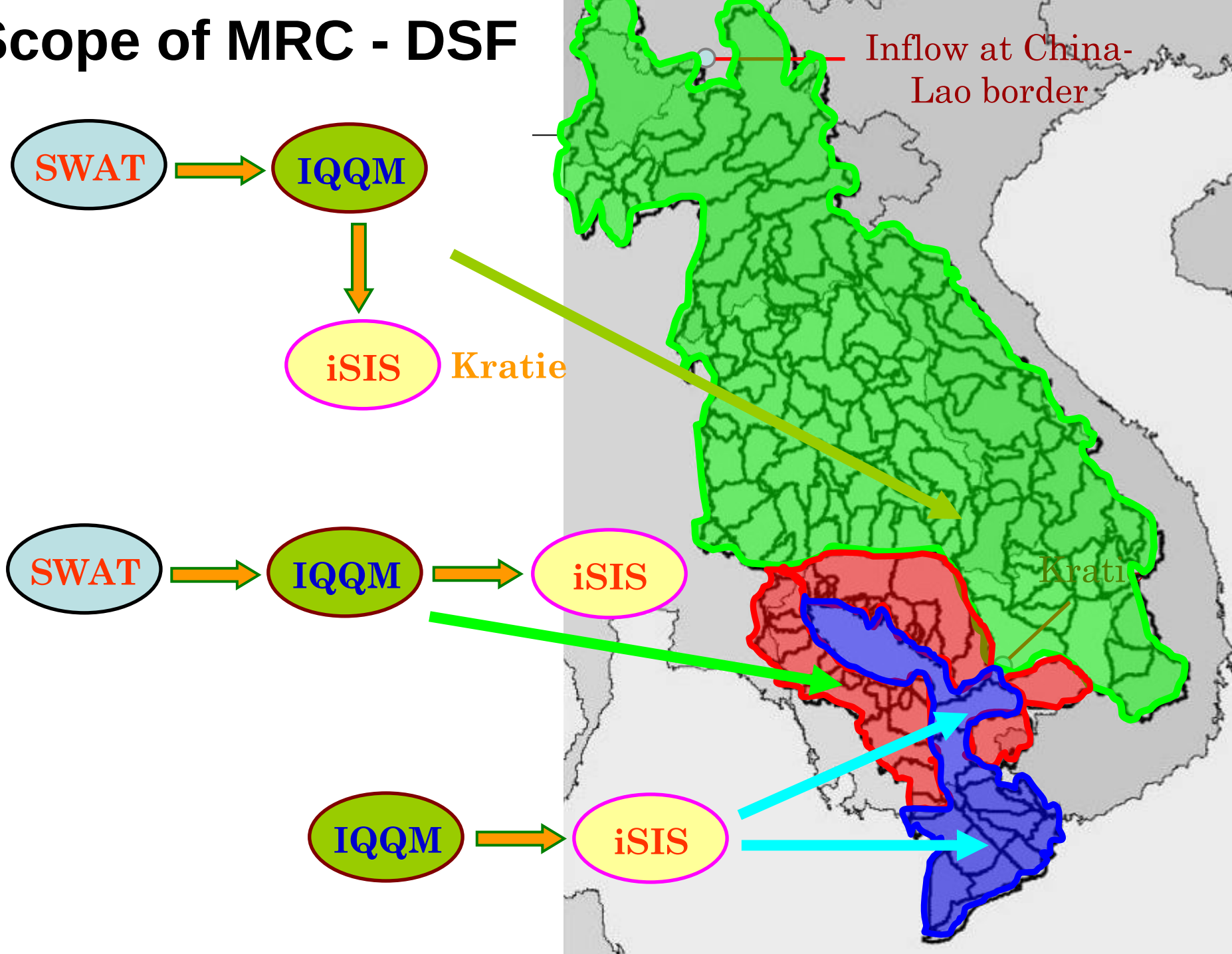
A model run scenario:

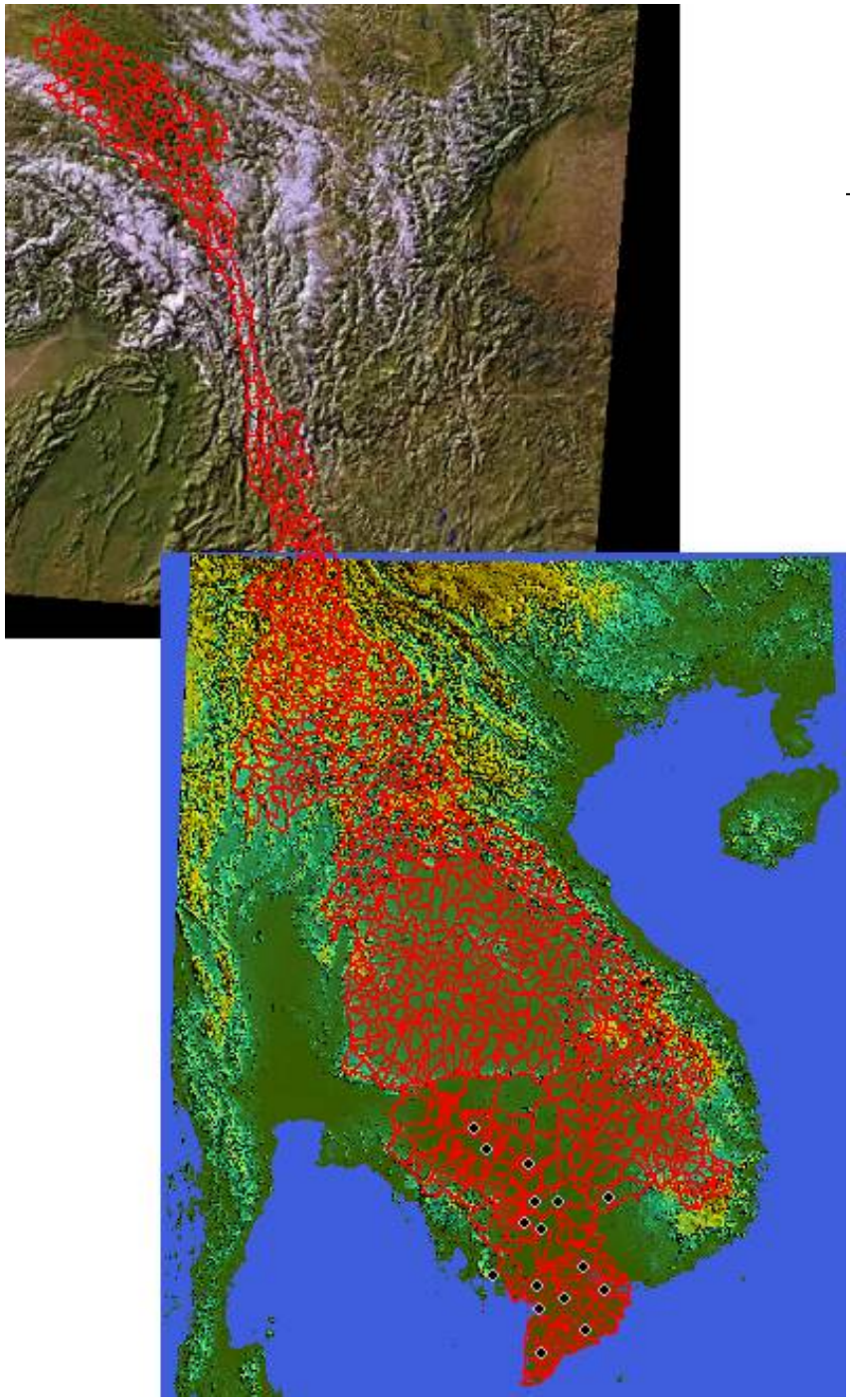
- With CC vs Without CC (which dataset?)
- 1985-2000 vs 2010-2050 (which period?)
- Development vs Baseline (which BDP?)
- With adaptation vs without adaptation (which action?)

This modeling study is only focusing on changing of flow regime



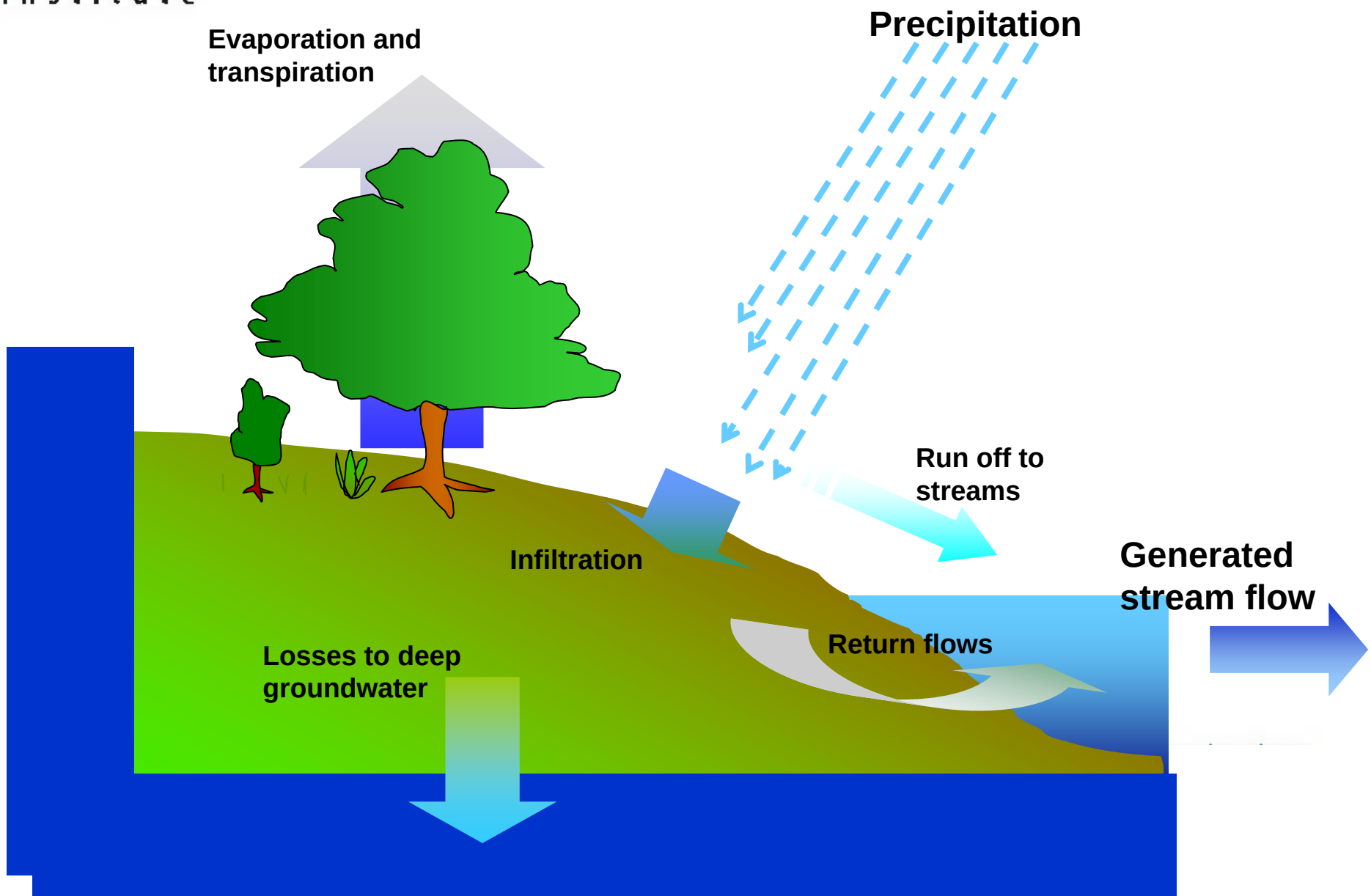
Scope of MRC - DSF



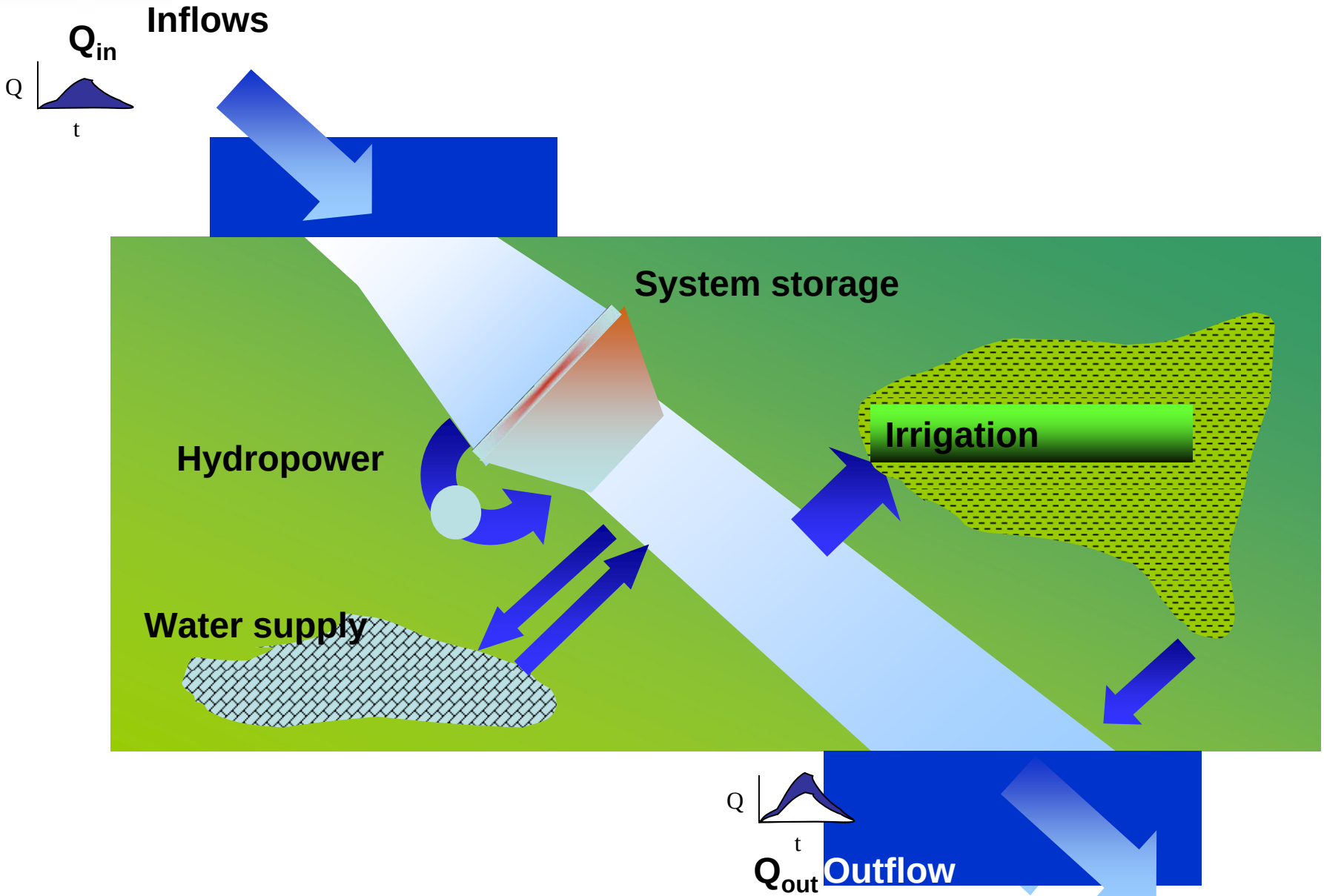


955 sub-basins covering the whole Mekong basin

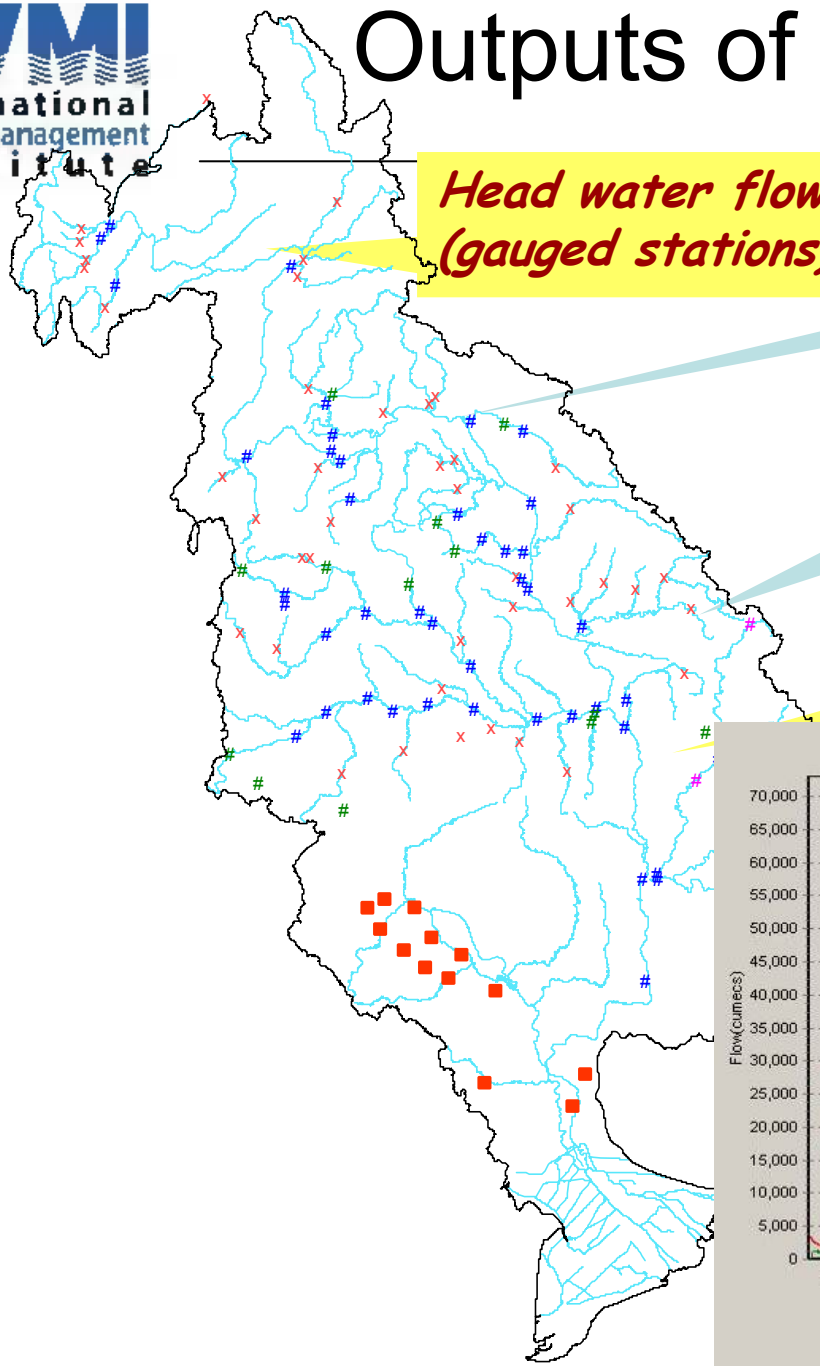
Hydrological Model (SWAT)



Basin Simulation Model (IQQM)



Outputs of SWAT/IQQM Model

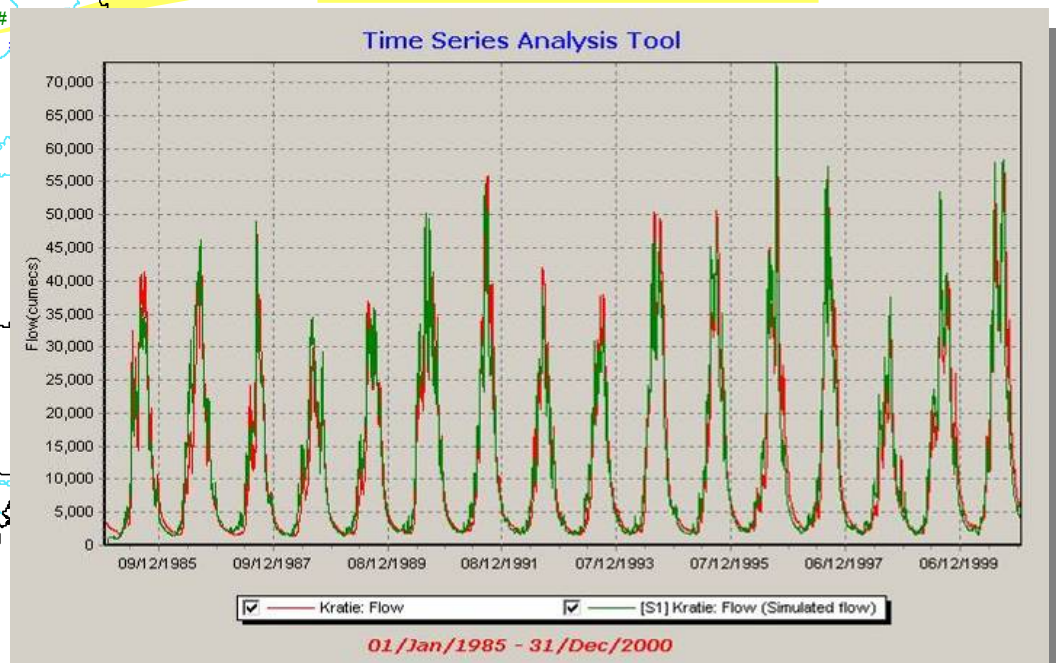


Head water flows (gauged stations)

Storage flows

Trans-boundary flows

Calibration inflows (SWAT outputs)



Hydrodynamic Model (ISIS)

SWAT Inflow in Great Lake

IQQM Inflow in Kratie

Extended Sections

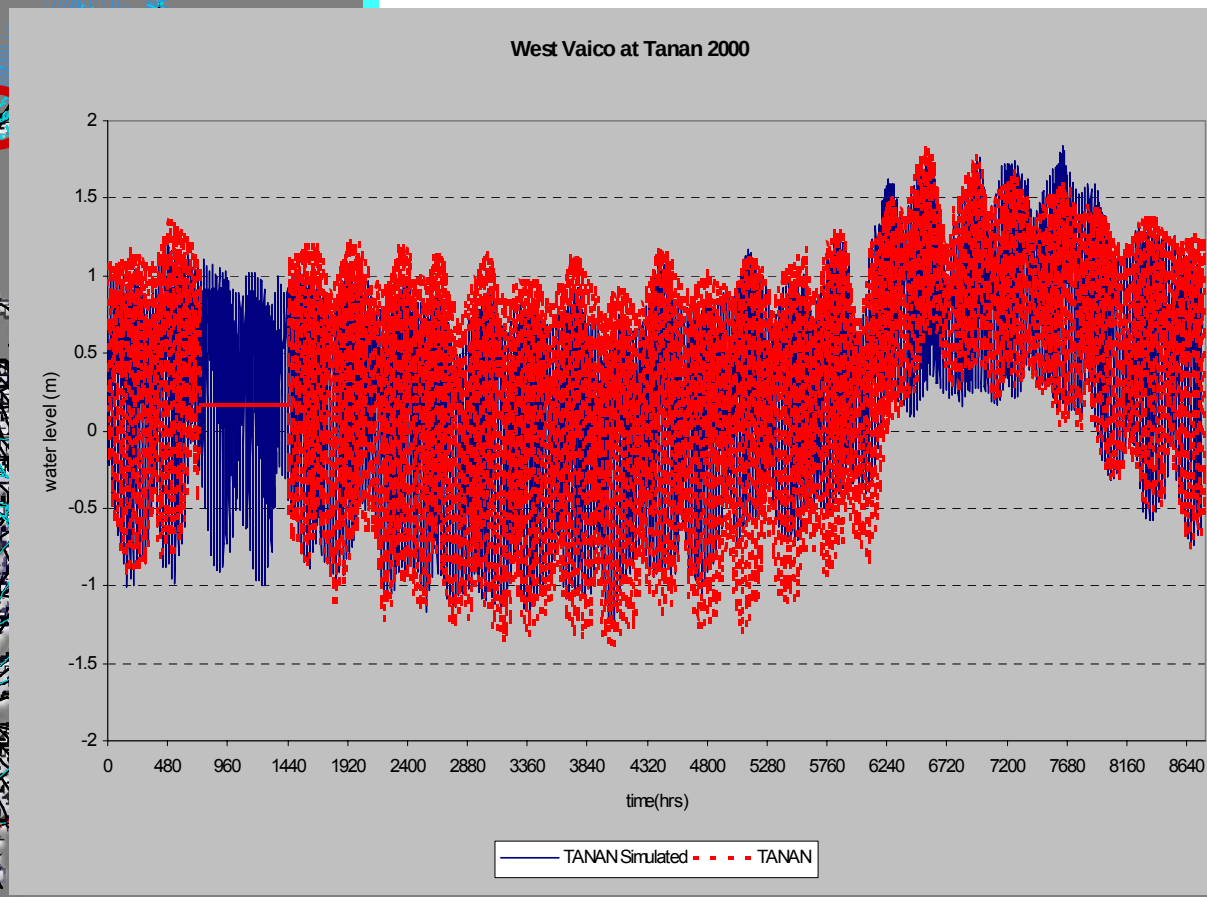
Rainfall over Delta

Flood Cells

Salinity Control Sluices

conditions

1D model: about 5000 nodes
- water level, flow & salinity
- hourly time step

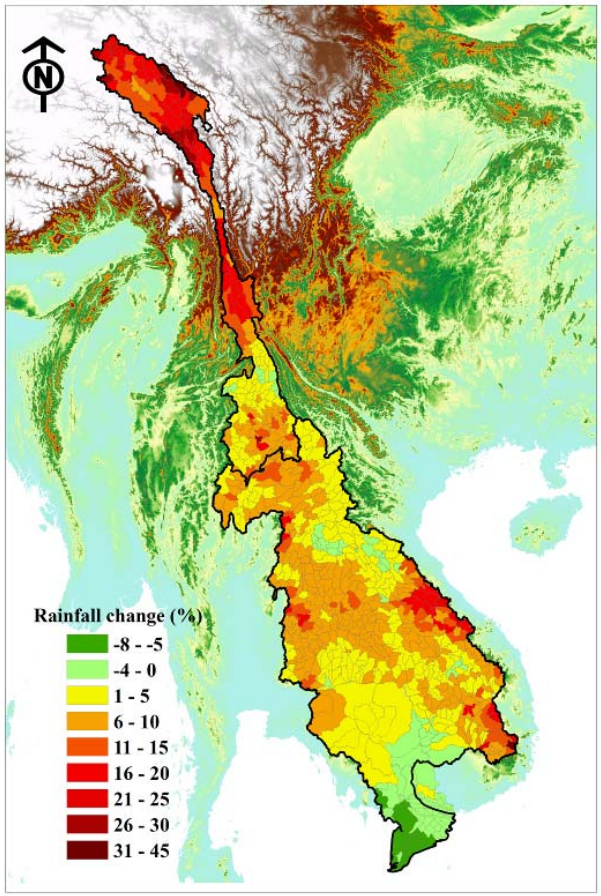


Technical options in CC scenarios

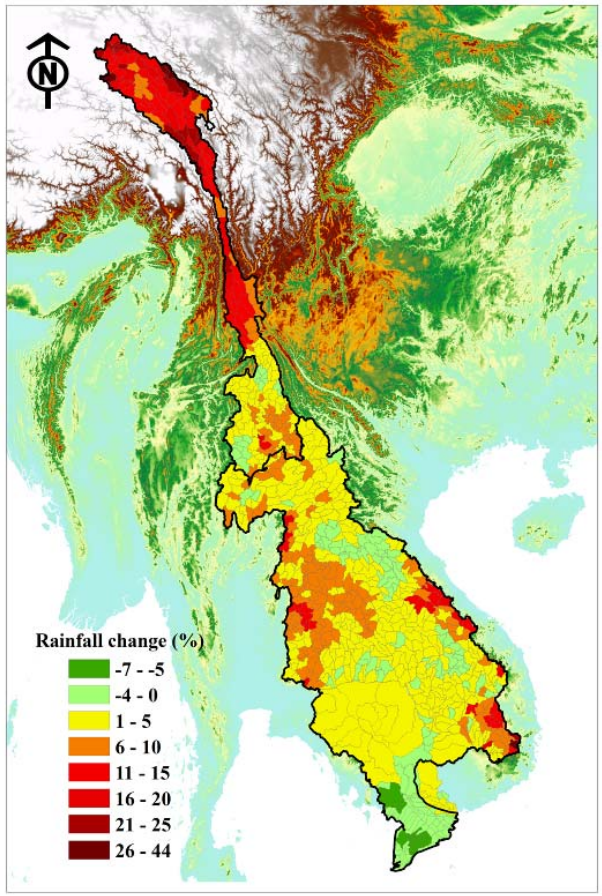
Replace observed data with CC projected data:

Option 1: Replace observed data at stations by CC projected data at corresponding cells (GCM).

Option 2: Replace observed data of sub-basins (processed by MQUAD) by CC projected data of corresponding sub-basins (RCM).

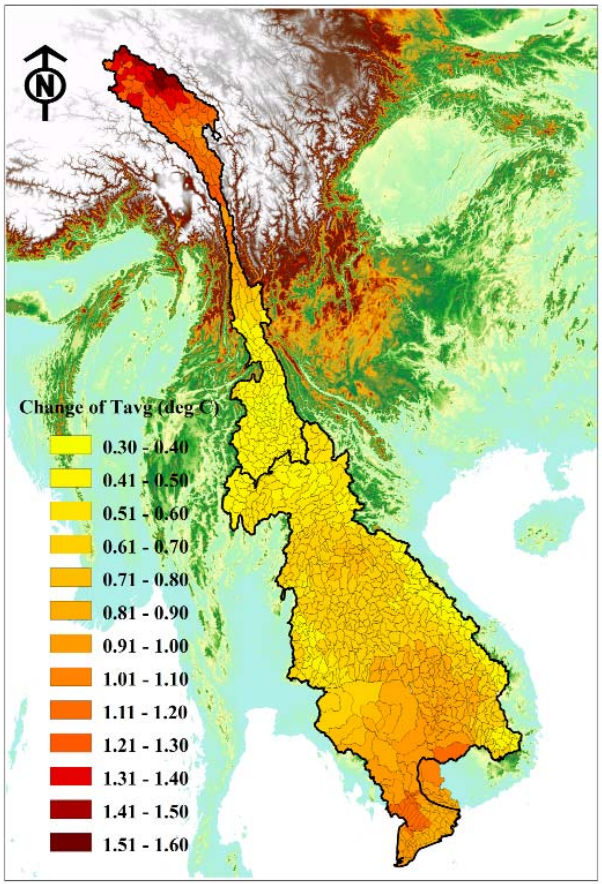


ECHAM4 A2

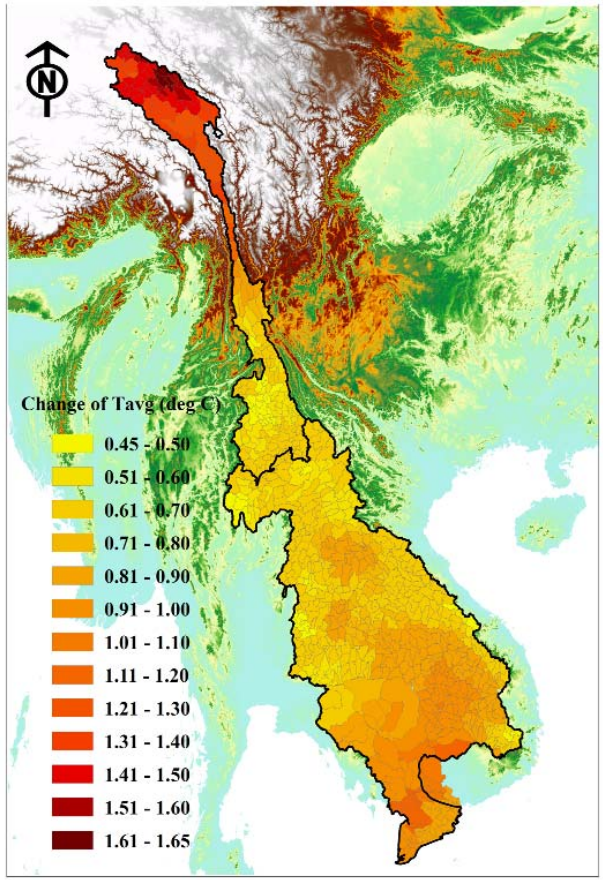


ECHAM4 B2

Change (%) of mean annual rainfall during 2010-50 relative to 1985-2000



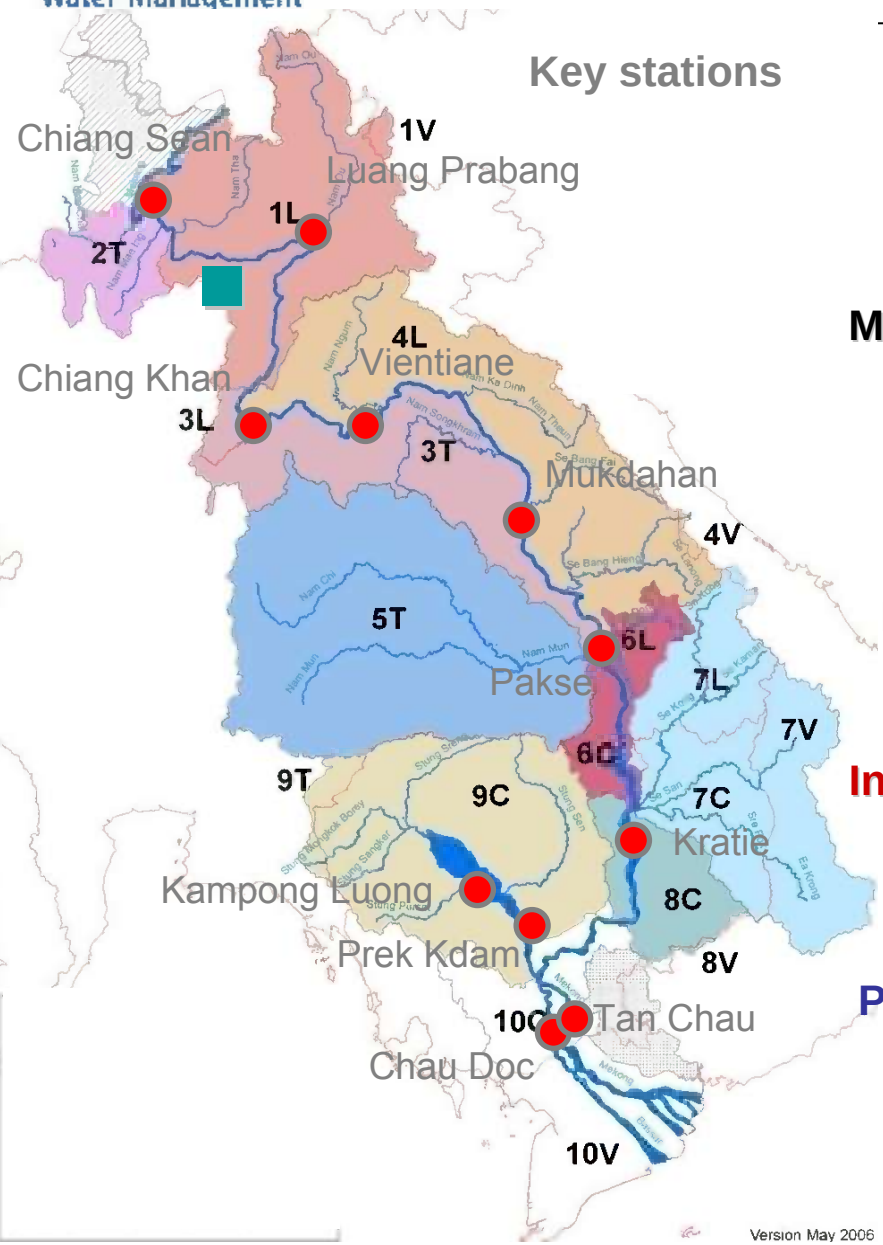
ECHAM4 A2



ECHAM4 B2

Change (°C) of mean annual daily average temperature during 2010-50 relative to 1985-2000

Outputs from DSF



With known boundary conditions (hydrological conditions, system demands and interventions)

Models can compute

	Upstream Kratie & around Great Lake	Downstream Kratie
Directly	***Daily flow***	***Hourly water level, flow & salinity***
Indirectly	***Daily water level*** *(using rating curve)*	
Possible	***Water Quality*** *(using WQ modules of SWAT and IQQM)*	***Other water quality*** *(using ISIS Quality and Sediment)*

Advantages in using DSF

- Models can simulate interventions:

- **Land use/ land coverage changes**
- **Climate change & sea level rise**
- **Water supply demands**
- **Aquaculture development**
- **Irrigation abstractions**
- **Changes in crop patterns**
- **Changes in reservoir operation**

- **New dams & reservoirs in LMB**
- **China dam cascade**
- **In-stream regulation structures**
- **Inter-basin diversion**
- **River improvement structures**
- **Flood control in floodplain & tributaries**
- **Salinity control (sluices, dike)**

Spatial: detailed sub-basins / nodes
Temporal: daily/hourly time steps

Limitations & difficulties

Limitations

- Available observed climate data
- Other data needs (land and water use…)
- Only focus on water, not other outputs as production (crop, electricity…)
- High standard models for specialists

Difficulties

- Large input & output datasets (20 GB for SWAT & IQQM, 400 GB for ISIS)
- ISIS run is slow and difficult in debugging
- Long time for rerun and analysis with corrected/updated input data
- Too many outputs for analysis and reporting
- Refinement of DSF models (IQQM, ISIS)

Comparison of model run scenarios

Model run scenarios

S1: Baseline BDP	**+ observed climate 1985-2000**
S2: Baseline BDP	**+ adjusted RCM data 1985-2000**
S3: Development BDP	**+ adjusted RCM data 1985-2000**
S4: Baseline BDP	**+ adjusted RCM A2/B2 2010-2050**
S5: Development BDP	**+ adjusted RCM A2/B2 2010-2050**
S6: Development BDP	**+ adjusted RCM A2/B2 2010-2050 + adaptation strategies (?)**

Comparison

S2 - S1: justify adjustement of RCM can be applied

S3 - S2: impacts of development BDP compared with baseline BDP without CC

S4 - S2: impacts of CC if baseline BDP is continued under CC

S5 - S4: impacts of development BDP compared with baseline BDP under CC

S6 - S5: effects of adaptation strategies on development BDP under CC (?)

Results: next presentation by Dr. Kittipong Jiraoot

THANK YOU
FOR YOUR ATTENTION