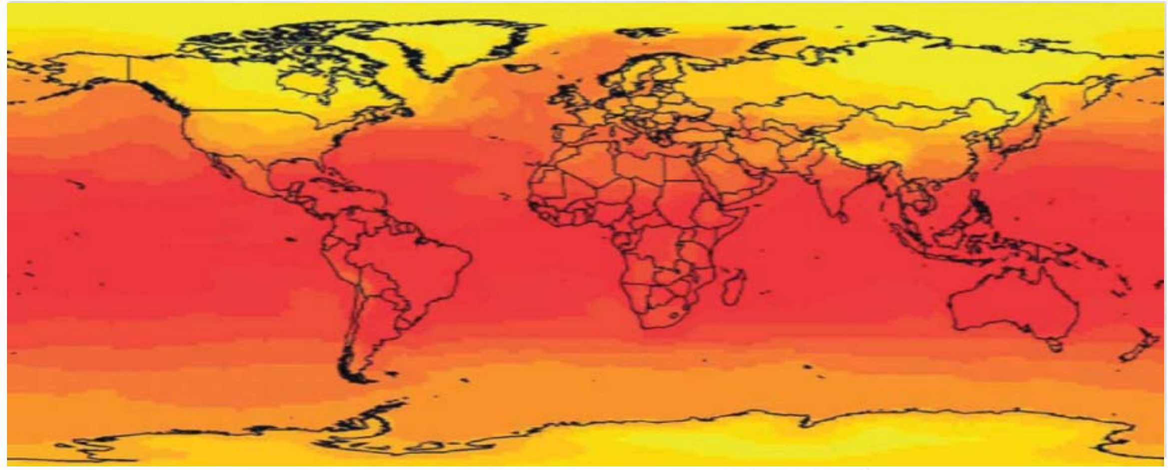


Flood Behavior and Climate Change Adaptation to future flooding in the Lower Mekong Basin

1st Rhine-Mekong Symposium
"Climate change and its influence on water and related sectors"
8-9 May 2014, Koblenz, Germany

Nico Bakker,
Flood Management and Mitigation Programme,
Mekong River Commission

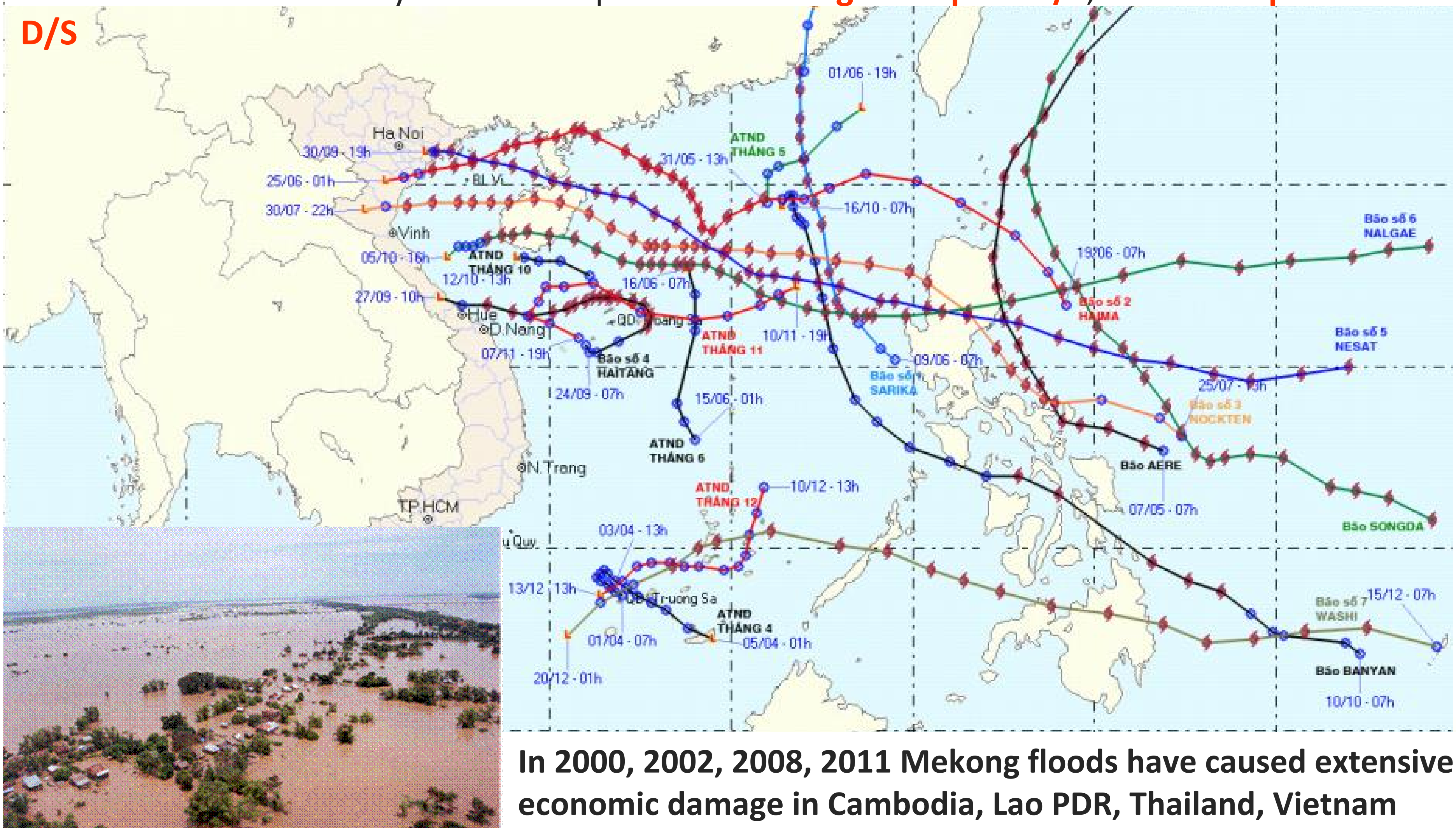
i. Flood Characteristics

Tropical climate with two monsoon seasons:

Northeast: Nov – mid Mar; **Southwest: mid May – mid Oct causes heavy and frequent rain**

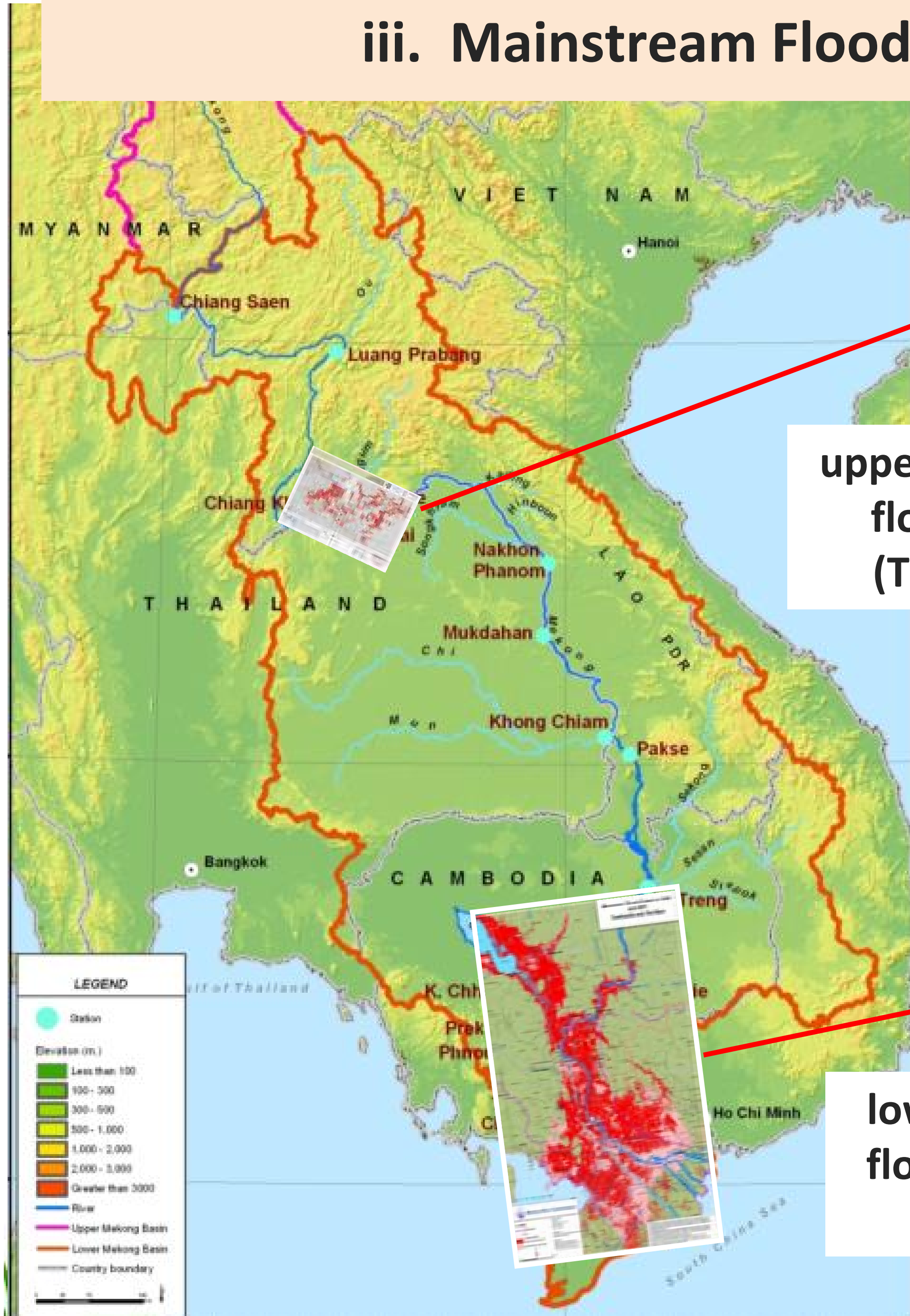
Mean annual rainfall ranges: 1000 – 4000 mm

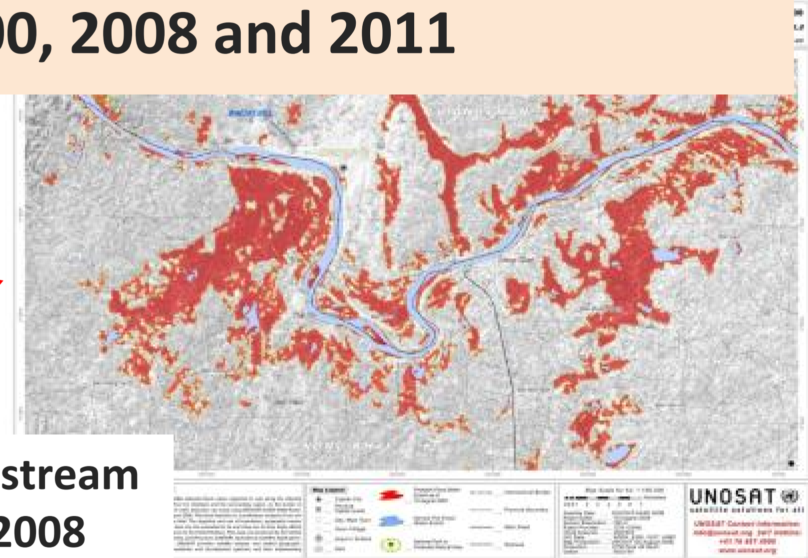
WL rises in May and attains peak level in **Aug. or Sep. at U/S**, while in **Sep. or Oct. at D/S**



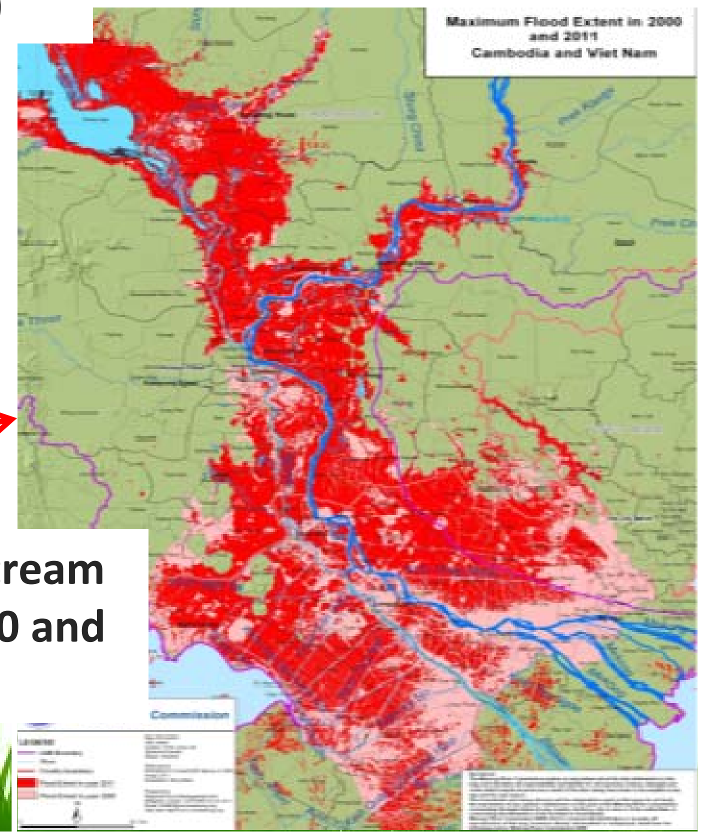
In 2000, 2002, 2008, 2011 Mekong floods have caused extensive economic damage in Cambodia, Lao PDR, Thailand, Vietnam

iii. Mainstream Floods 2000, 2008 and 2011



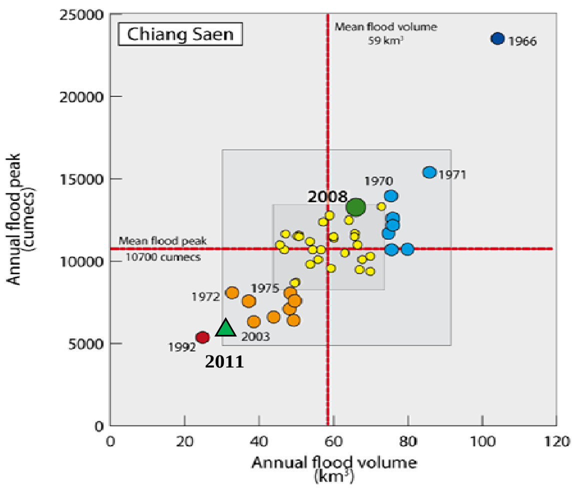


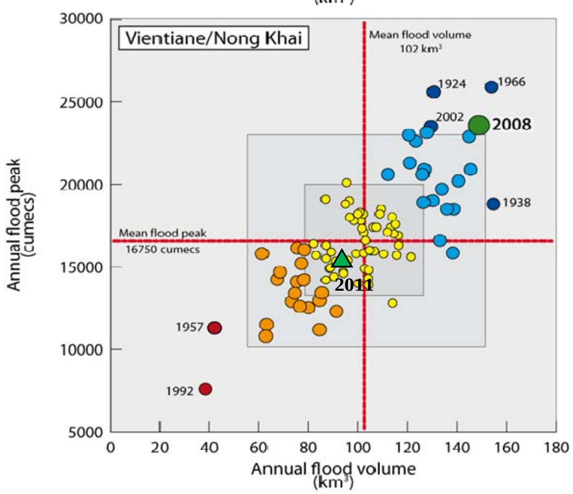
upper mainstream flood in 2008 (TS Kanmuri)

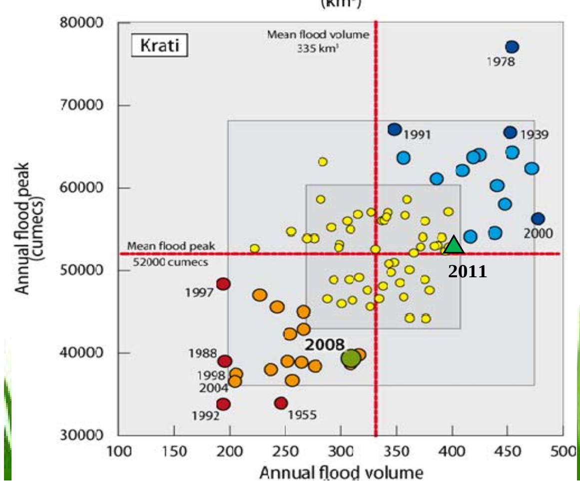


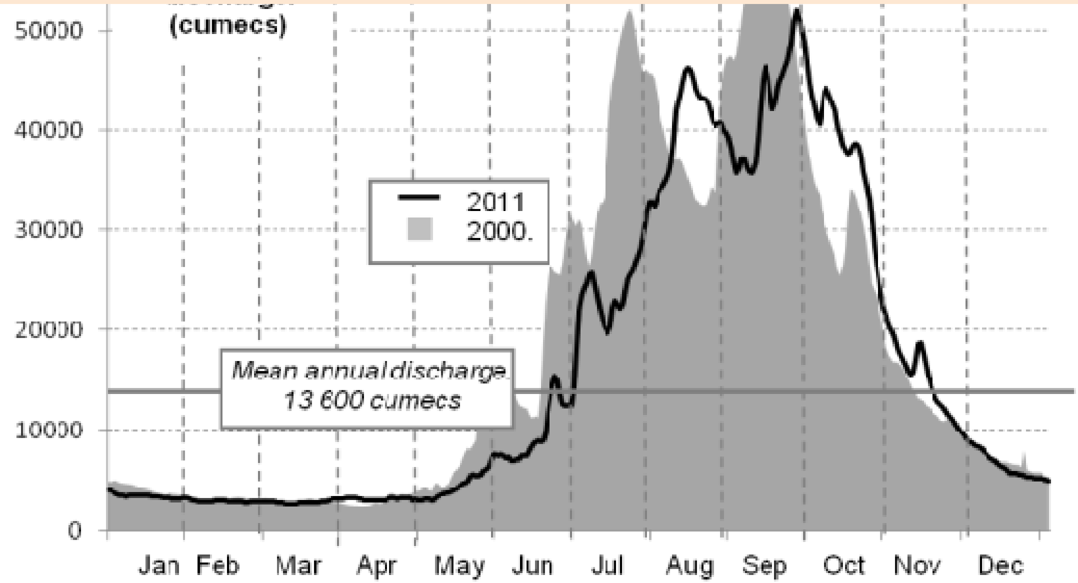
lower mainstream floods in 2000 and 2011

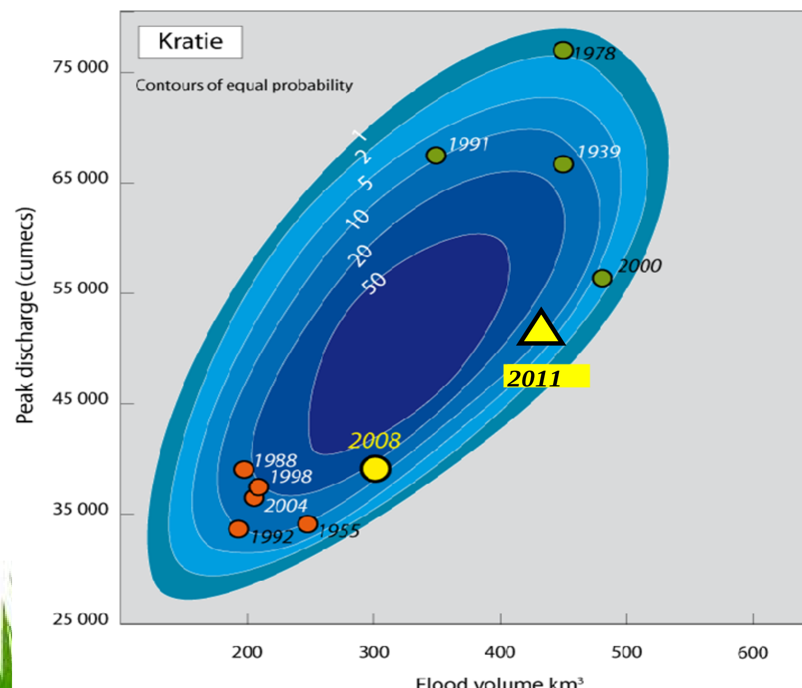
iv. Flood Statistics











v. Transboundary Floods in the LMB

MRC focuses on ‘transboundary flooding’ and less on ‘national floods’…

•***Coastal Flooding*** (Storm Surge, Tidal) – Viet Nam & Cambodia

•***Lower Mainstream Floods*** – Viet Nam & Cambodia; transboundary effects

•***Upper Mainstream Floods*** – Cambodia, Lao PDR &Thailand; principally national floods but may have transboundary effects

•***Tributary Floods*** – all four countries; common national floods; may have transboundary effects

•***Flash Floods*** – all four countries; common national floods; may have transboundary effects

•***Combined Floods***:

- Coastal/Lower Mainstream –Viet Nam & Cambodia
- Mainstream/Tributary – Exacerbates impacts of national floods in all four countries

•***Upstream Dams*** – transboundary effects

•***Floodplain Infrastructure*** – can have transboundary effects

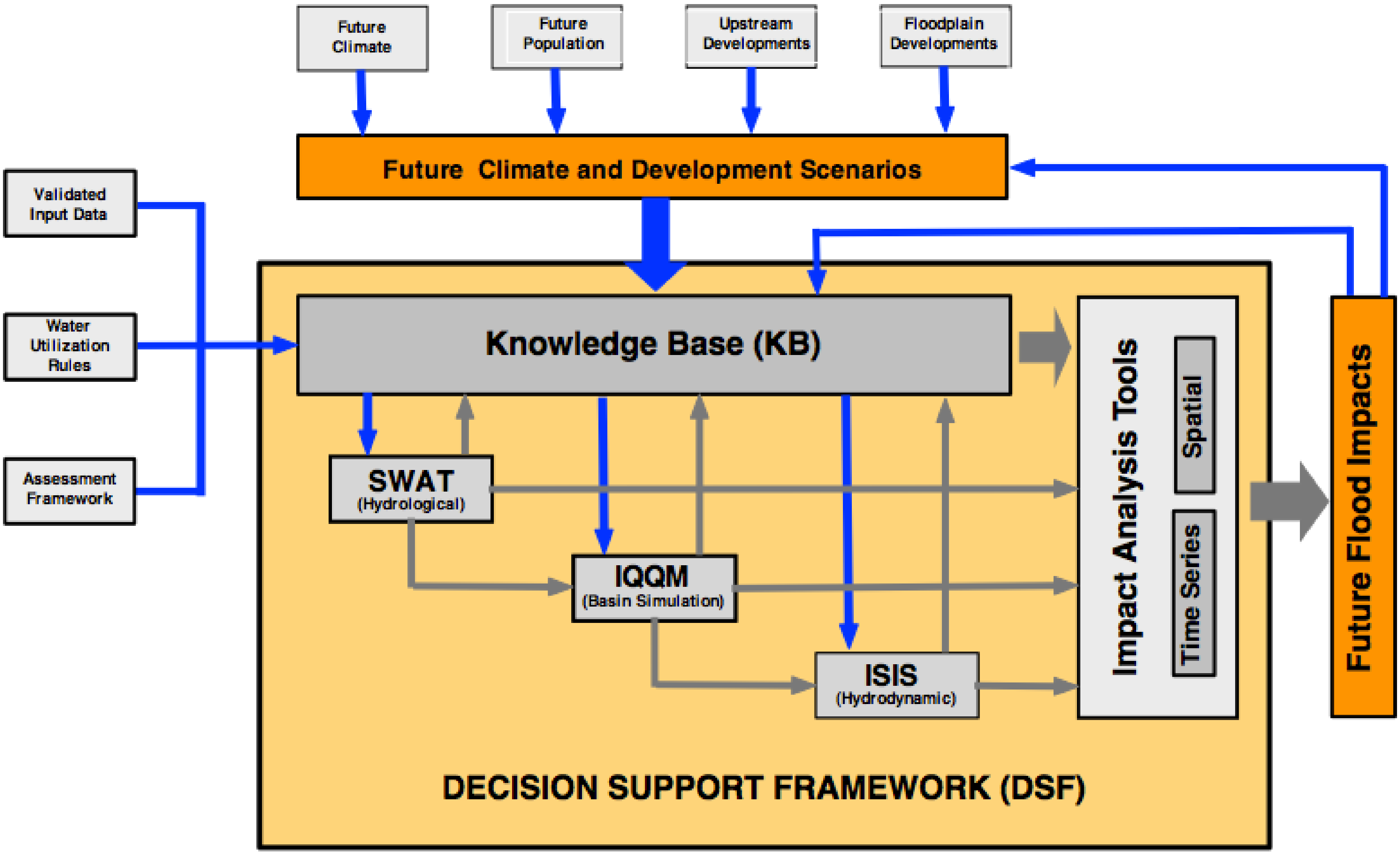
vi. Approach & Methodology

Impact of climate change on short and long-term flood and drought behavior and risk and climate change adaptation systemized in RFMMC and Member Countries (FMMP Output 2.4)

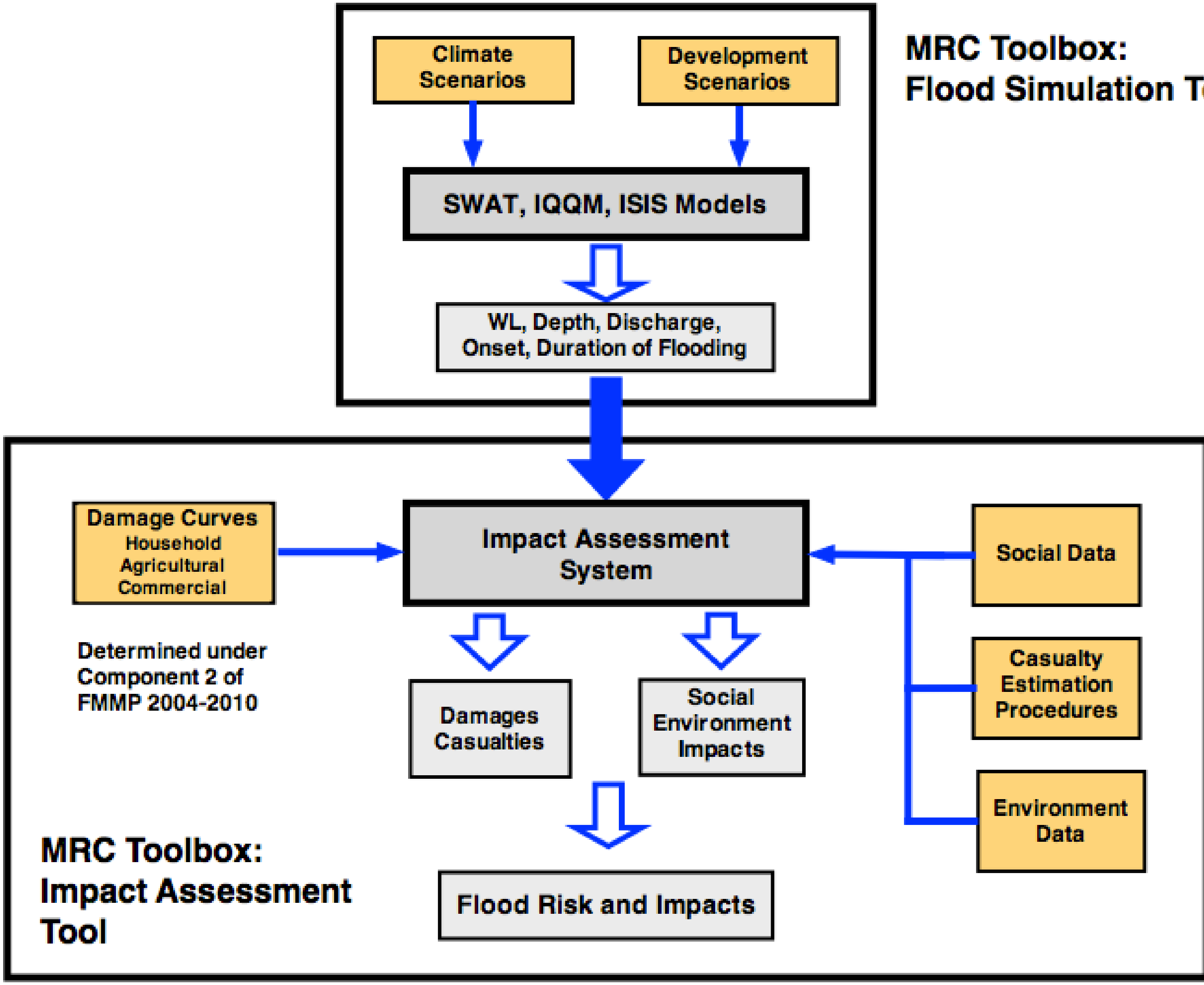
On the basis of regionally linked climate data and information systems, the relevant line agencies of the four lower Mekong riparian countries Cambodia, Laos, Thailand and Vietnam improve their flood forecasting and management capacities.

	Climate data and information	**Annual flood forecasting under CC conditions**	**Medium- and long-term flood simulations under CC conditions**	**Adaptation planning and mainstreaming**	**Implementation of pilot measures**
Specific Objectives	Access to, the regional exchange and the joint use of flood-related climate data and information by the relevant line agencies is facilitated and improved.	The accuracy of the MRC flood forecasting system is enhanced by the use of climate data and information.	MRCS provides the national ministries with state-of-the-art medium-term and long-term flood forecasting models .	Line Agencies use the medium-term and long-term climate-sensitive flood models and a comprehensive vulnerability analysis for important planning processes.	The flood risk has decreased in particularly vulnerable pilot areas through the cooperation in implementing carefully selected climate-sensitive flood protection measures.

vii. The MRC Decision Support Framework and Toolbox



viii. The Flood Simulation and Impact Assessment System



ix. The River Basin Simulation Models

SWAT

•Rainfall – Runoff Model. Used to assess impact of Climate Change, Land-use Change and Basin Development on runoff.

•Comprises 870 sub-basins from China down to Great Lake in Cambodia.

•Estimates daily flow from 1985 – 2008 (Climate Change Baseline Period).

IQQM

•Basin Simulation Model (Water Balance). Used to simulate water use (Irrigation, water supply, hydro-power, in-stream demands, etc.) and rout SWAT inflows downstream.

•More than 800 nodes with gauged or computed flow (not water level).

ISIS

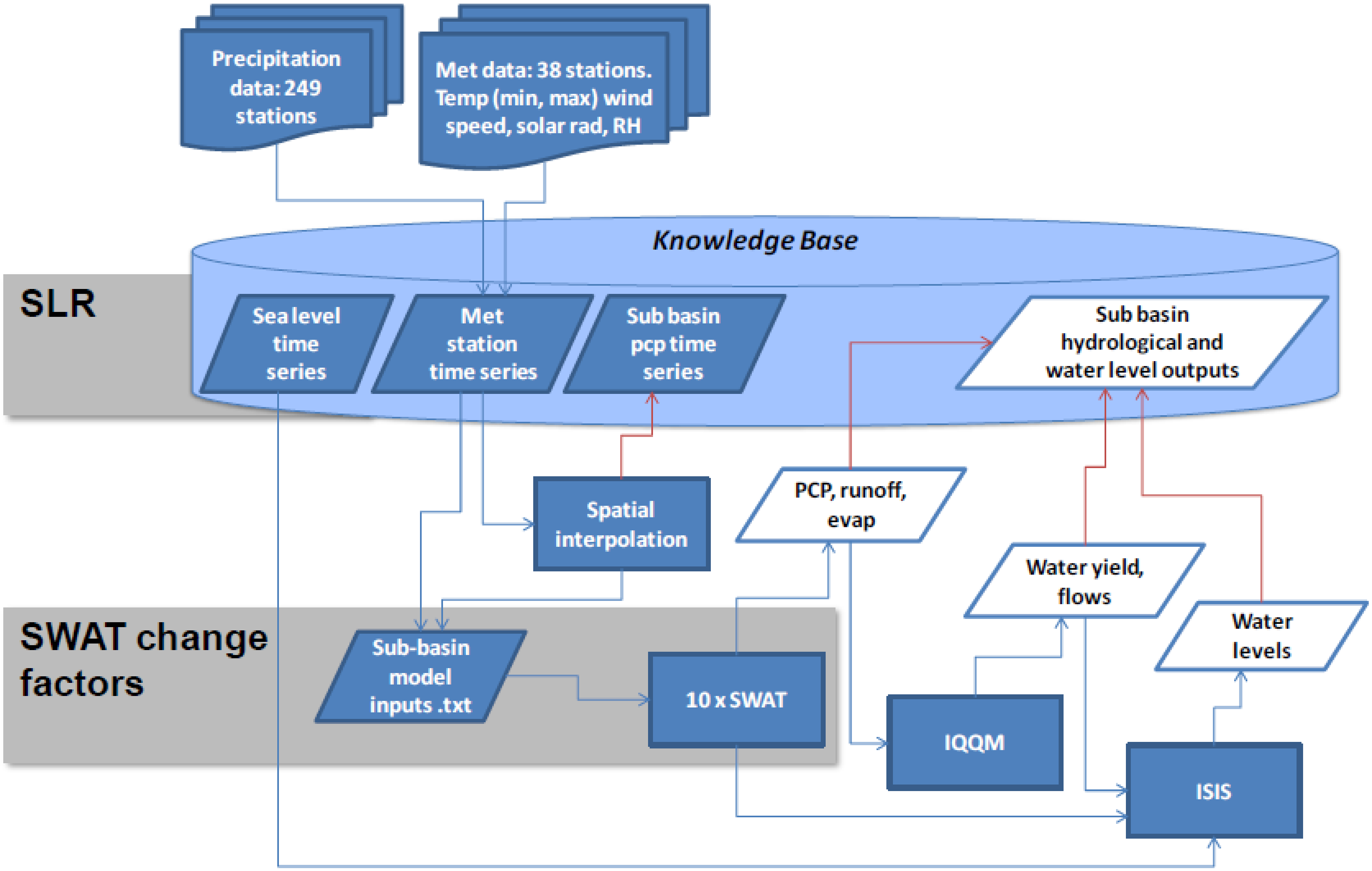
•Hydro-dynamic Model. Used to simulate water levels and discharges along river-canal systems and across floodplains.

•As applied downstream of Kratie, consists of some 2,900 cross-sections, 600 floodplain cells, 800 reservoir cells linked by some 450 hydraulic links/junctions.

•Output consists of 6-hourly WL data at nearly 2000 locations.

•DS boundary conditions include tidal, storm surge and sea level rise effects.

x. Application of monthly change factors in SWAT



xi. Estimating Climate Change (1)

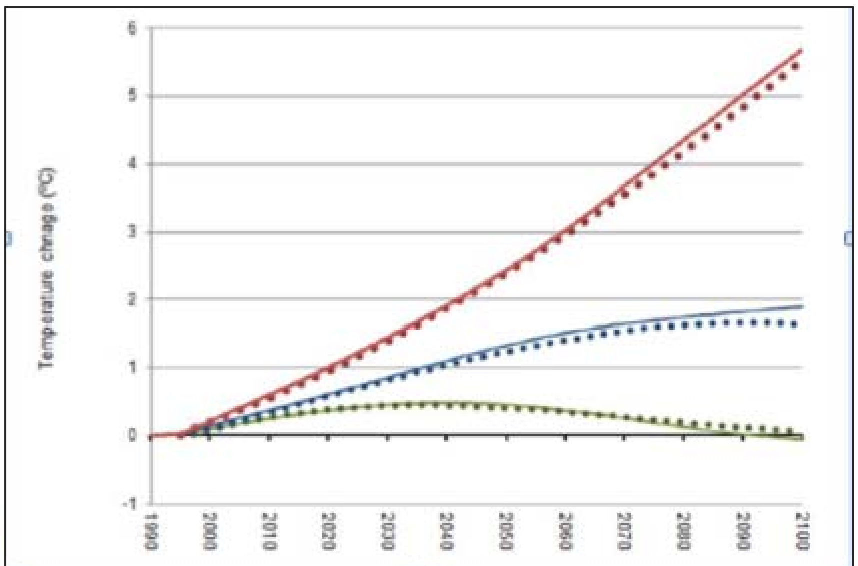
- **Average monthly 'Change Factors'** were applied to a 23-Year **historical Baseline Period 1985-2007** to provide an indication of possible future climates (RF, T, SR, RH) in the 2020s, 2050s and 2080s.

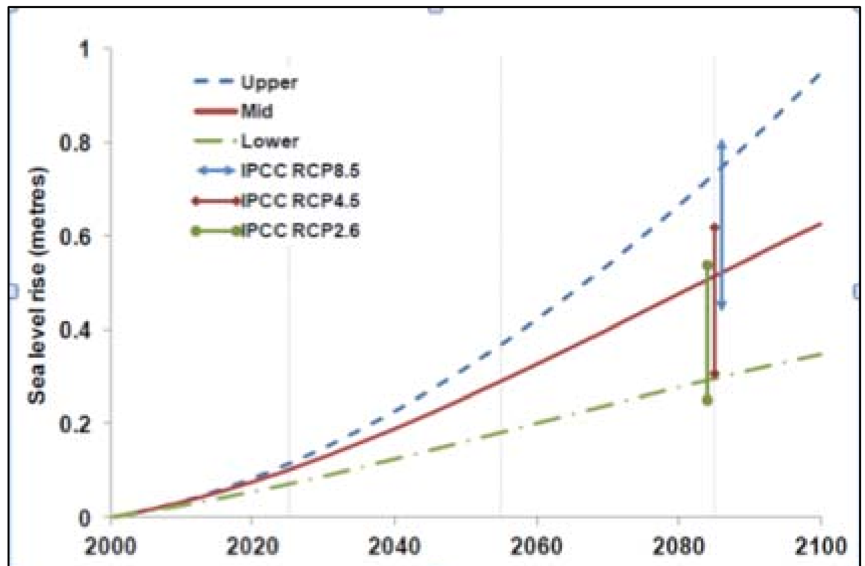
Change Factors were calculated as follows:

- Three representative GCMs generating **High, Medium and Low basin-wide rainfalls** were used to generate **Synthetic Climate Time Series** through to 2100 for **Upper, Middle and Lower Climate Change scenarios** (3 synthetic time series in total), regionally down-scaled to each SWAT sub-basin.
- **Average monthly climate factors** were determined from **synthetic series** for 23-year periods, centered on the 2020s, 2050s and 2080s.
- The **Change Factors** were applied to the climate of the baseline period to generate **23-year period projections of future climates**.

xii. Estimating Climate Change (2)

Climate Change Scenario	Adopted GCM Synthesized Results	GW Climate Sensitivity	Atmospheric Forcing Scenario	Increase in Wet Season Rainfall
Upper rank	GFDL-ESM2M	High	RCP 8.5	27.05%
Mid rank	CanES2M2	Medium	RCP 4.5	12.39%
Lower rank	GFDL-CM2.1	Low	RCP 2.6	8.93%



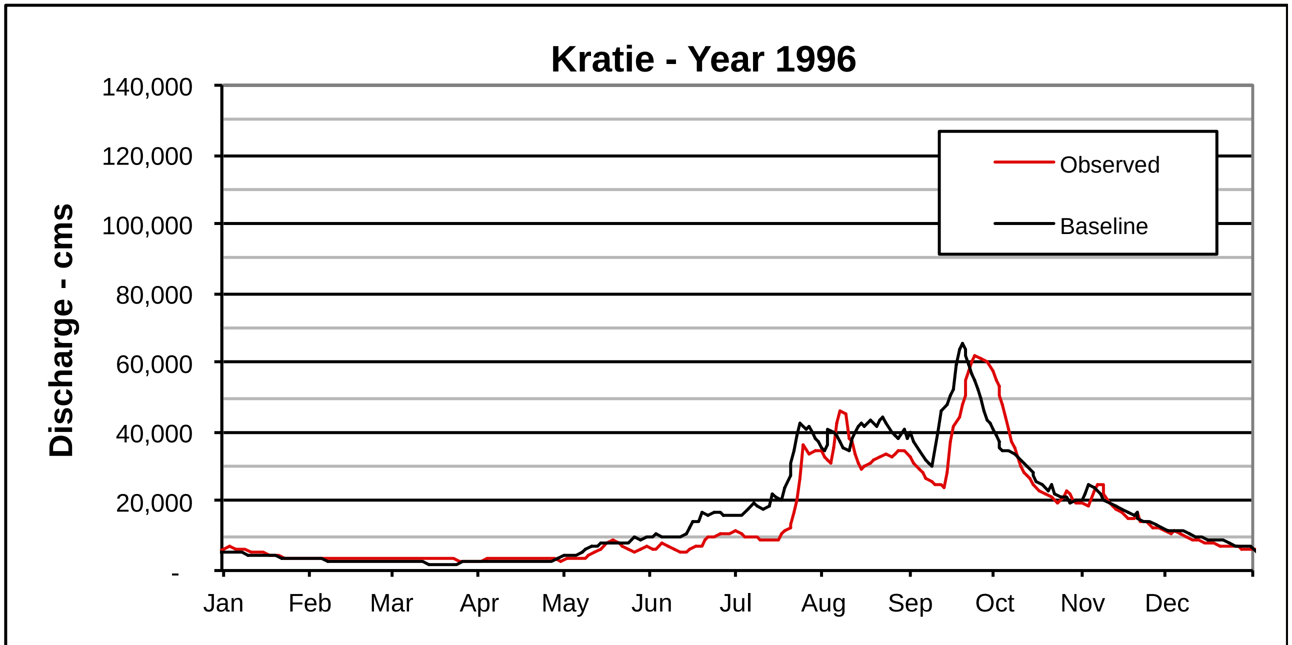


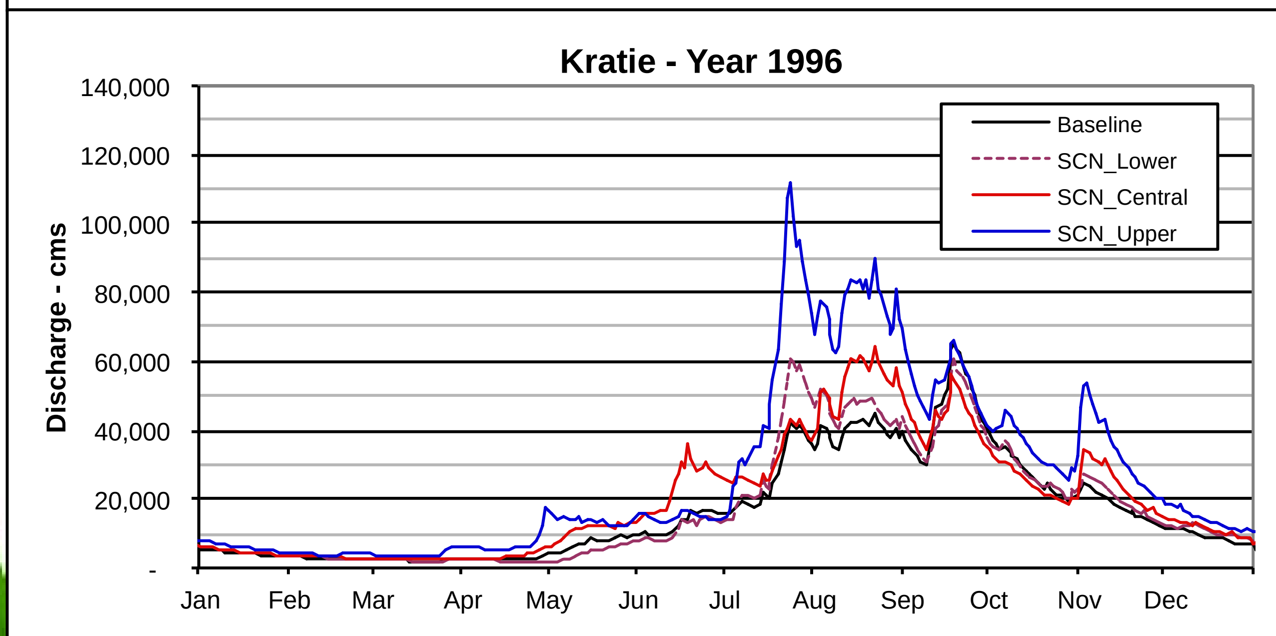
xiii. Estimating Climate Change - SWAT Results (3)

SWAT simulated discharges at **Kratie** of the Year 1996 Flood of the Baseline Period:

(i) Observed and Simulated Results.

(ii) Effect of the 3 CC Scenarios on the Simulated Year 1996 Flood in the 2080s.





xiv. Other Factors Affecting Future Flood Behaviour and Flood Risk

In addition to possible future climate change, ***a number of other factors*** will also affect future and residual flood risks:

•**Population Growth** – Increases Risk

•**Increases in Standard of Living** – Increases Risk

•**Change to more vulnerable Land-use** – Increases Risk

•**Upstream Infrastructure Developments** - eg. Dams will affect flood behaviour and reduce/increase flood risk

•**Floodplain Infrastructure Developments** - eg. Embankments will affect flood behaviour and increase/reduce flood risk

Representative estimates are required of the above future changes and developments for the 2020s, 2050s and 2080s

xv. Impact Assessment of Future Changes on Flood Behavior and Flood Risk

- By **applying Change Factors** to the Baseline Period and running the **modified climatic inputs** through the Flood Simulation Tool, it will be possible to generate a sequence of 23-year periods of **flood and flow behaviour** representative of conditions in the 2020s, 2050s and 2080s.
- Results for the **Upper and Lower Climate Change Scenarios** will allow the effects of uncertainty in climate change estimates to be investigated and used for '**Stress-Testing**'.
- By incorporating expected future changes to 'other factors' in the models, the **significance of all factors** affecting future and residual flood risks can be assessed.
- The **number** of climate change / other factor **scenarios** to be simulated rapidly becomes large. Discussions will be held with interested parties to determine their needs and **a judicious selection** of scenarios will be made.
- The results of all simulations will be archived **for future use** by other MRC Programmes and LMB practitioners.

xvi. Demonstration Projects (1)

Strategic Directions for the Management of Future and Residual Flood Risks

- It is proposed to finalize and expand **three flood focal area** projects developed under FMMP 2004-2010 and use these projects to demonstrate the possible nature, extent and severity of future and residual flood risks in the 2020s, 2050s and 2080s and determine **strategic directions** for the management of these risks.

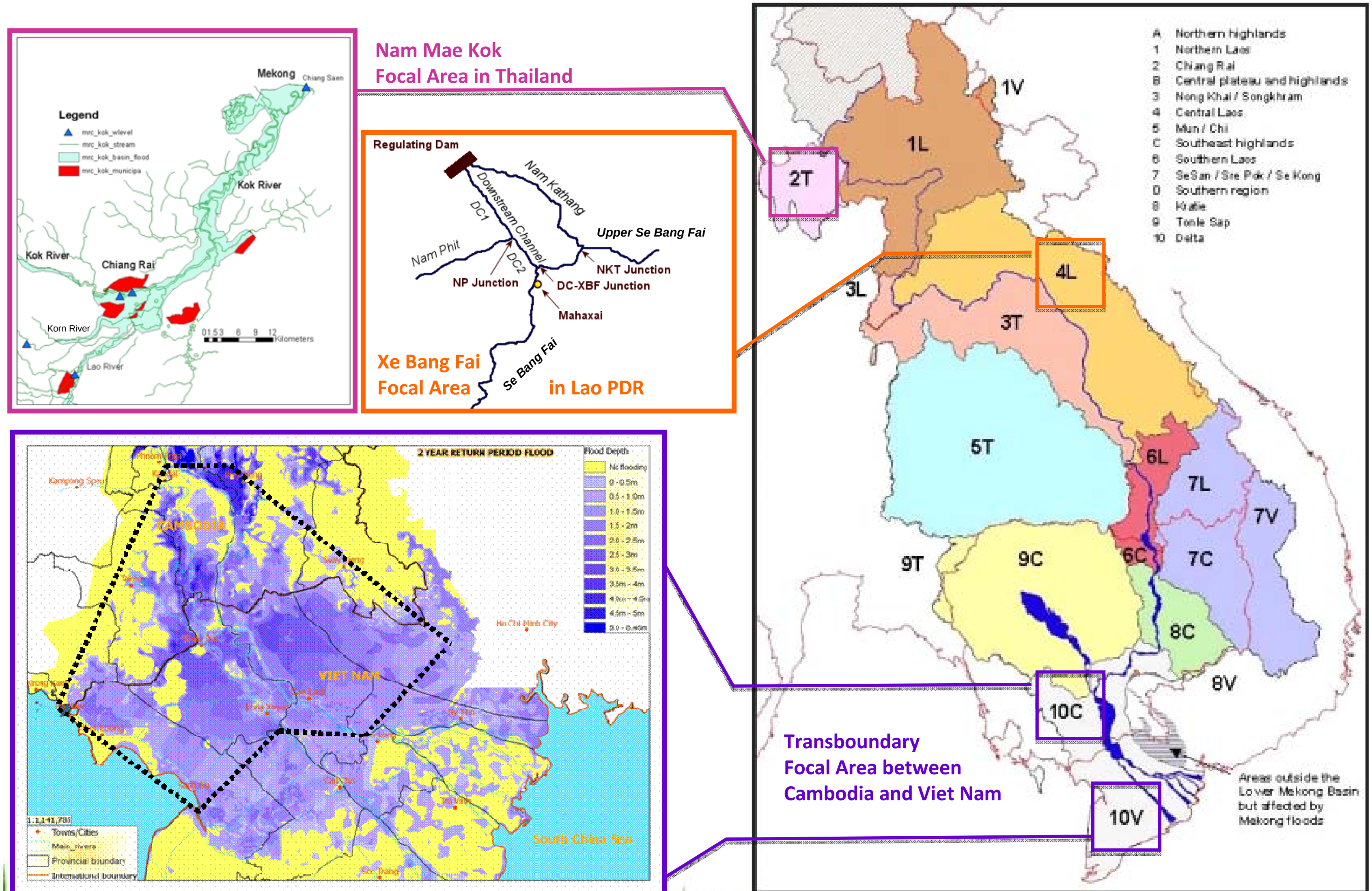
The 3 Projects are:

  - The **Nam Mae Kok River Basin** Study of *Thailand*
  - The **Xe Bang Fai River Basin** Study of *Lao PDR*
  - The **Flood Risk Management** Study of *the Border Zone between Cambodia and Viet Nam*

- Purpose is to **raise awareness** of national governments of the nature and severity of these future risks and the **likely effectiveness** of structural and non-structural flood risk management measures.

xvii. Demonstration Projects (2)

Locations



xviii. Conclusions

- **A simple, pragmatic methodology,** based on '**Change Factors**' and changes in aggregated, basin-wide wet-season rainfalls over the LMB, has been adopted to provide **Upper, Mid and Lower rank estimates** of **possible future climates** over the LMB.

- In addition to Climate Change, **other factors** affecting future and residual flood risks have been identified and included in the study.

- The **Flood Simulation and Impact Assessment System**, as part of the **MRC DSF / Toolbox**, provides a comprehensive and **promising vehicle** for assessing the impacts of future changes and developments on future and residual flood risks.

- It is expected that a) **Integrated Land-Use- / Spatial Planning** will prove to be the most effective means of limiting the growth in **future** flood risk, and b) **flood forecasting, and the effective uptake and response to flood warnings**, will emerge as a key management measure to address **residual** flood risk.

Thank you for your attention!

this presentation was made possible through the much appreciated cooperation and support from:
- ***IKMP*** *Nguyen Dinh Dat, Ornanong Vannarart and Inthavy Akkarath*
- ***CCAI*** *Nguyen Huong Thuy Phan, Thanapon Piman and Tran Mai Kien*
- ***FMMP*** *Vu Minh Thien*

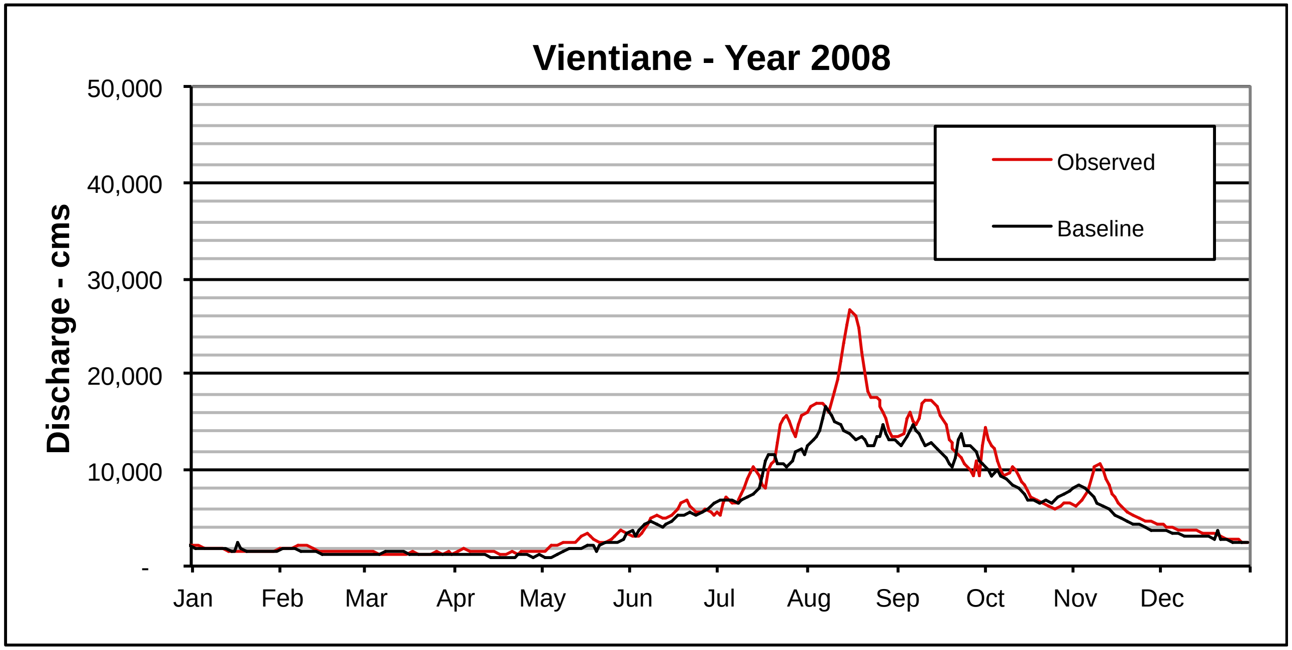
Details of Observed and Simulated Baseline Period Floods and Simulated Floods in the 2080s under the three CC Scenarios

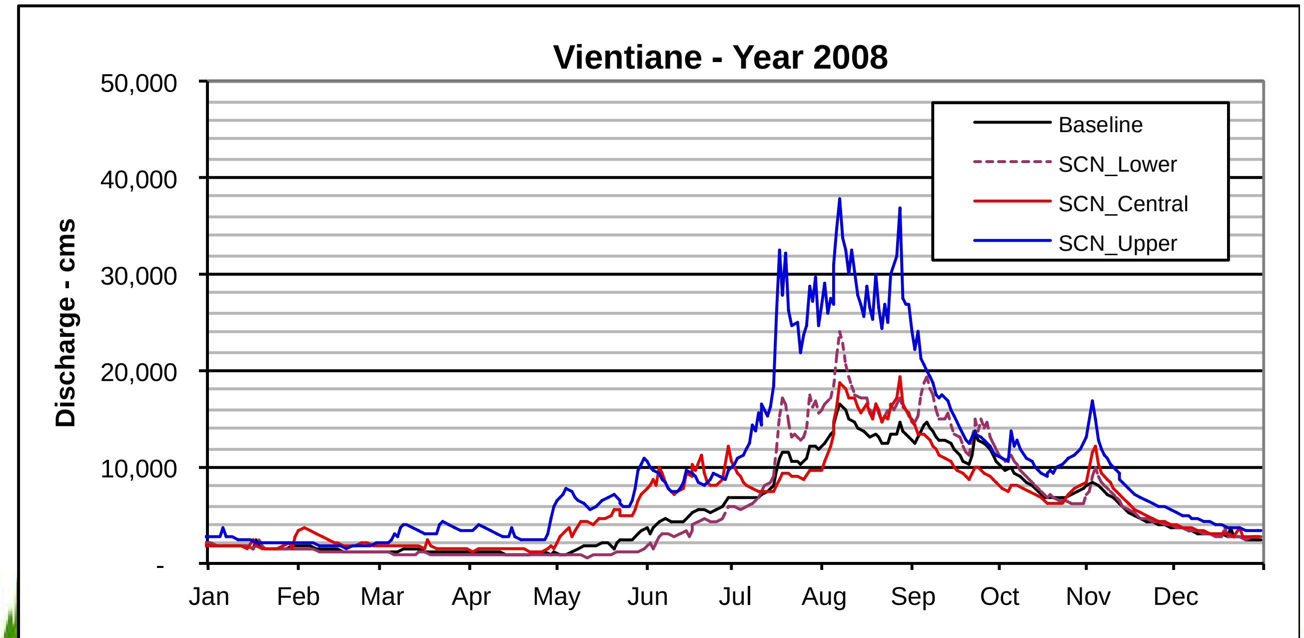
Location	Flood	Flood Characteristic	Observed Values	SWAT Simulated Results			
				Baseline	Lower CC Scenario	Mid CC Scenario	Upper CC Scenario
Vientiane	2008	Q-Peak (m^3/s)	26,750	16,560	23,940	19,240	37,750
		WL-Peak (m)	15.18	11.67	14.31	12.70	18.13
		Date	16-Aug-08	7-Aug-08	7-Aug-08	27-Aug-08	7-Aug-08
Pakse	2000	Q-Peak (m^3/s)	45,109	42,000	46,650	53,810	77,560
		WL-Peak (m)	13.59	12.91	13.92	15.41	19.91
		Date	14-Sep-00	3-Sep-00	4-Sep-00	31-Aug-00	31-Aug-00
Kratie	1996	Q-Peak (m^3/s)	61,938	65,230	61,090	64,690	111,600
		WL-Peak (m)	25.39	26.04	25.22	25.93	33.92
		Date	24-Sep-96	19-Sep-96	24-Jul-96	22-Aug-96	24-Jul-96

SWAT simulated discharges at **Vientiane** of the Year 2008 Flood of the Baseline Period:

(i) Observed and Simulated Results.

(ii) Effect of the 3 CC Scenarios on the Simulated Year 2008 Flood in the 2080s.

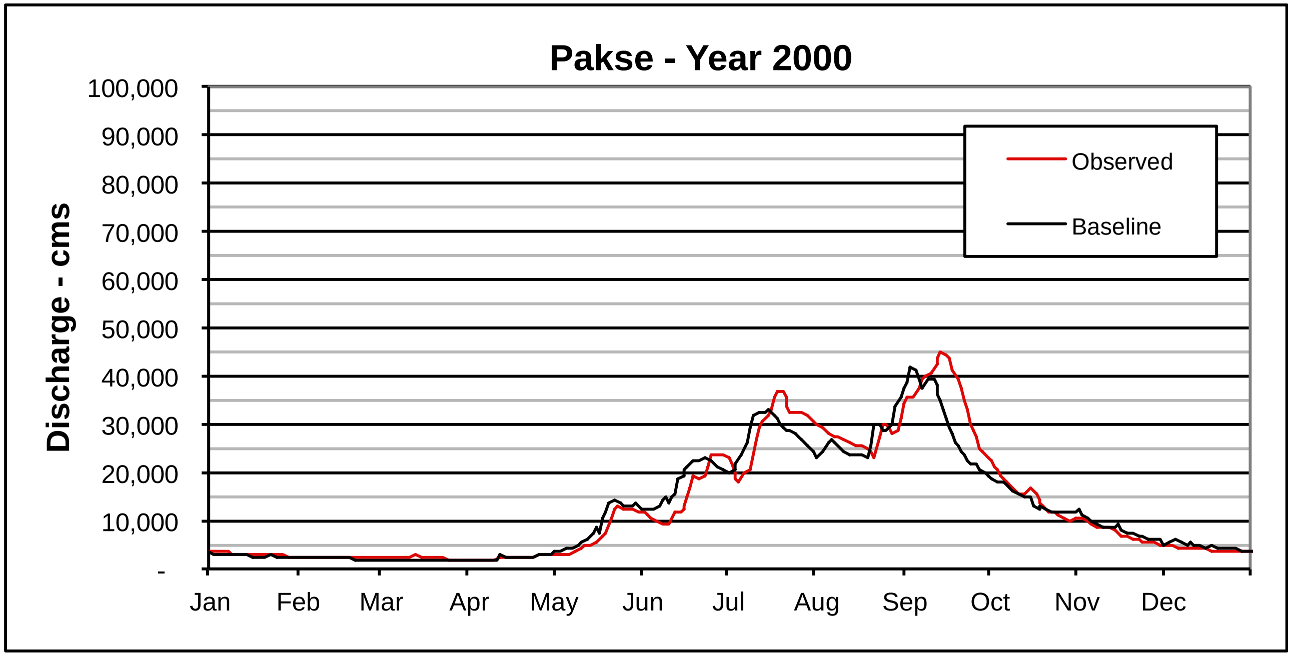


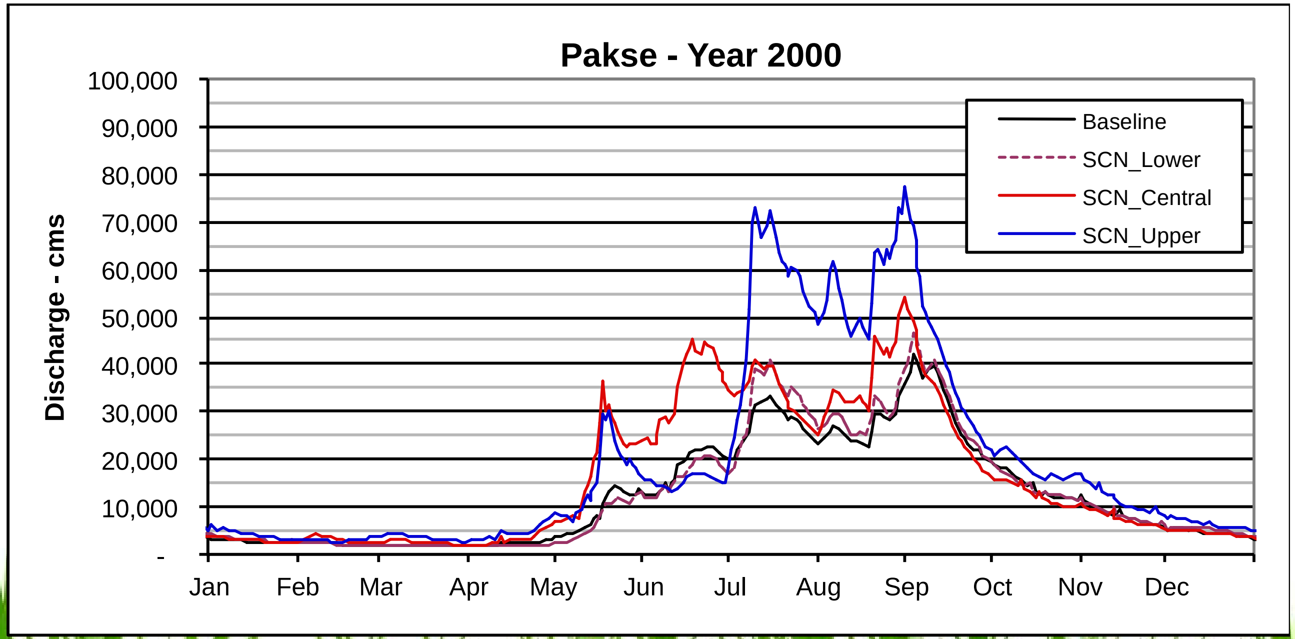


SWAT simulated discharges at **Pakse** of the Year 2000 Flood of the Baseline Period:

(i) Observed and Simulated Results.

(ii) Effect of the 3 CC Scenarios on the Simulated Year 2000 Flood in the 2080s.





SWAT simulated discharges at **Kratie** of the Year 1996 Flood of the Baseline Period:

(i) Observed and Simulated Results.

(ii) Effect of the 3 CC Scenarios on the Simulated Year 2000 Flood in the 2080s.