Effects of land-use change on hydrology of Mae Chaem river basin

ภรณี ธนภรรคภวิน (presenter)

สถาบันสารสนเทศทรัพยากรน้ำและการเกษตร

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H A I I

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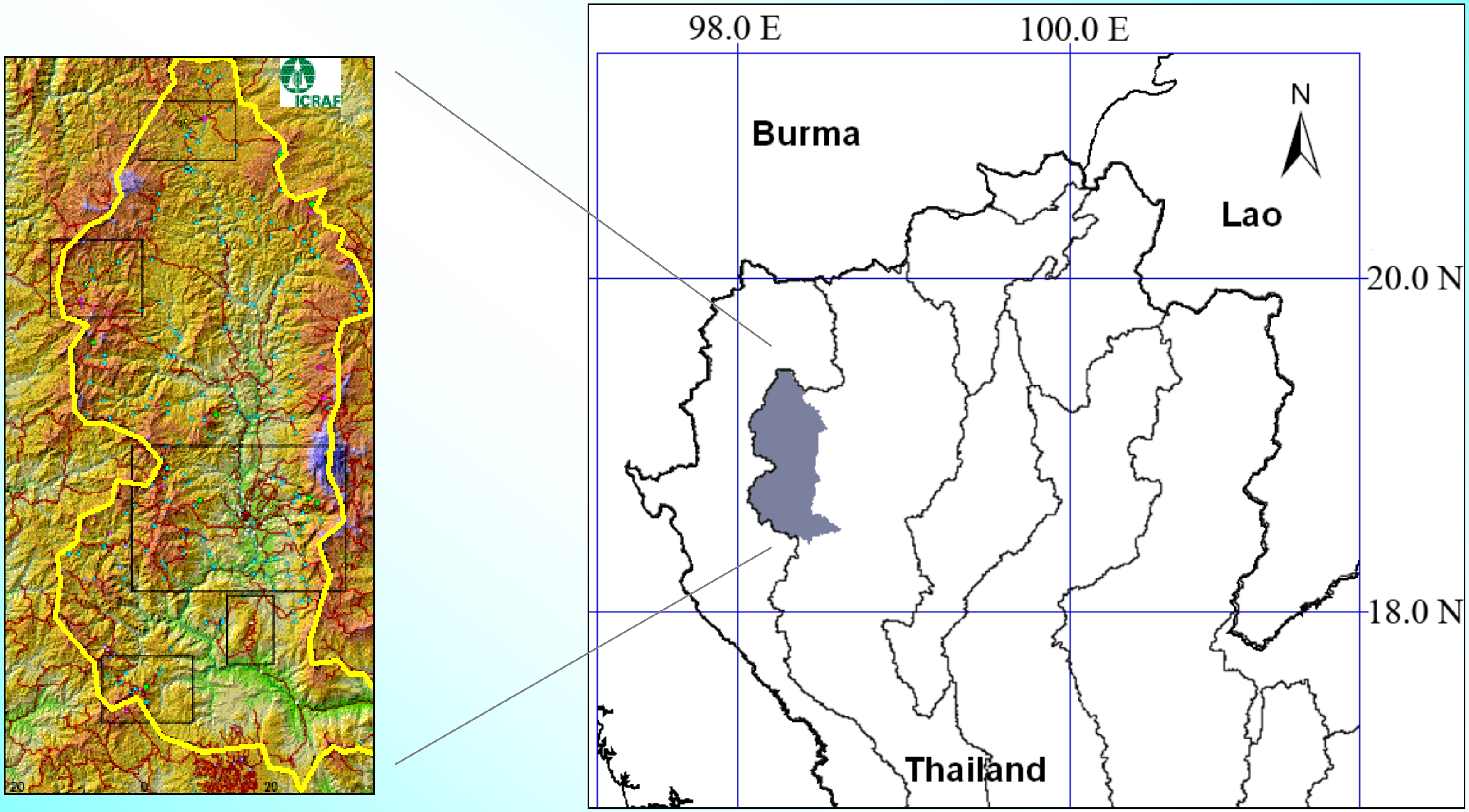
Outline

- Study site
- Research objectives
- Implementations
- Results
- Conclusions

พื้นที่ศึกษา : ลุ่มน้ำแม่แจ่ม จ. เชียงใหม่



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พื้นที่ศึกษา : ลุ่มน้ำแม่แจ่ม จ. เชียงใหม่

Picture by Jeff Richey


"Upland cultivation & deforestation cause storm flooding and less dry-season flow"
"Lowland agriculture has high water demand for irrigation"
Picture by Rinee Kidson

Research objectives

1. Evaluate basin hydrology using physical model

   - Current condition

   - study effects of landuse conversion between forest & crops

     Hypothetical landuse scenario analysis

2. Assess applicability of physical model for use as water resource tool, in basin with sparse data

Distributed Hydrology Soil-Vegetation Model

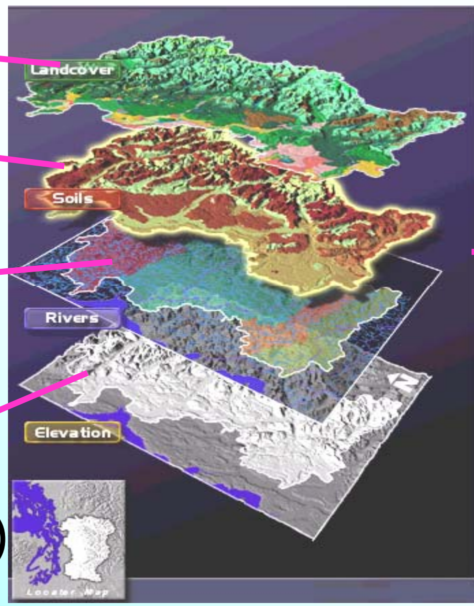
Input – GIS layers

Landcover

Soils

Stream network

DEM (Topography)

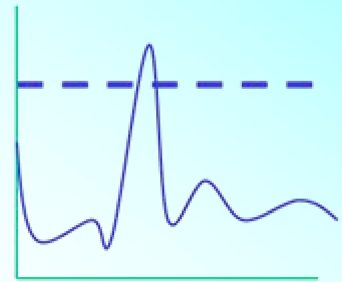


Model

Climate time series

Outputs

stream flow (runoff)

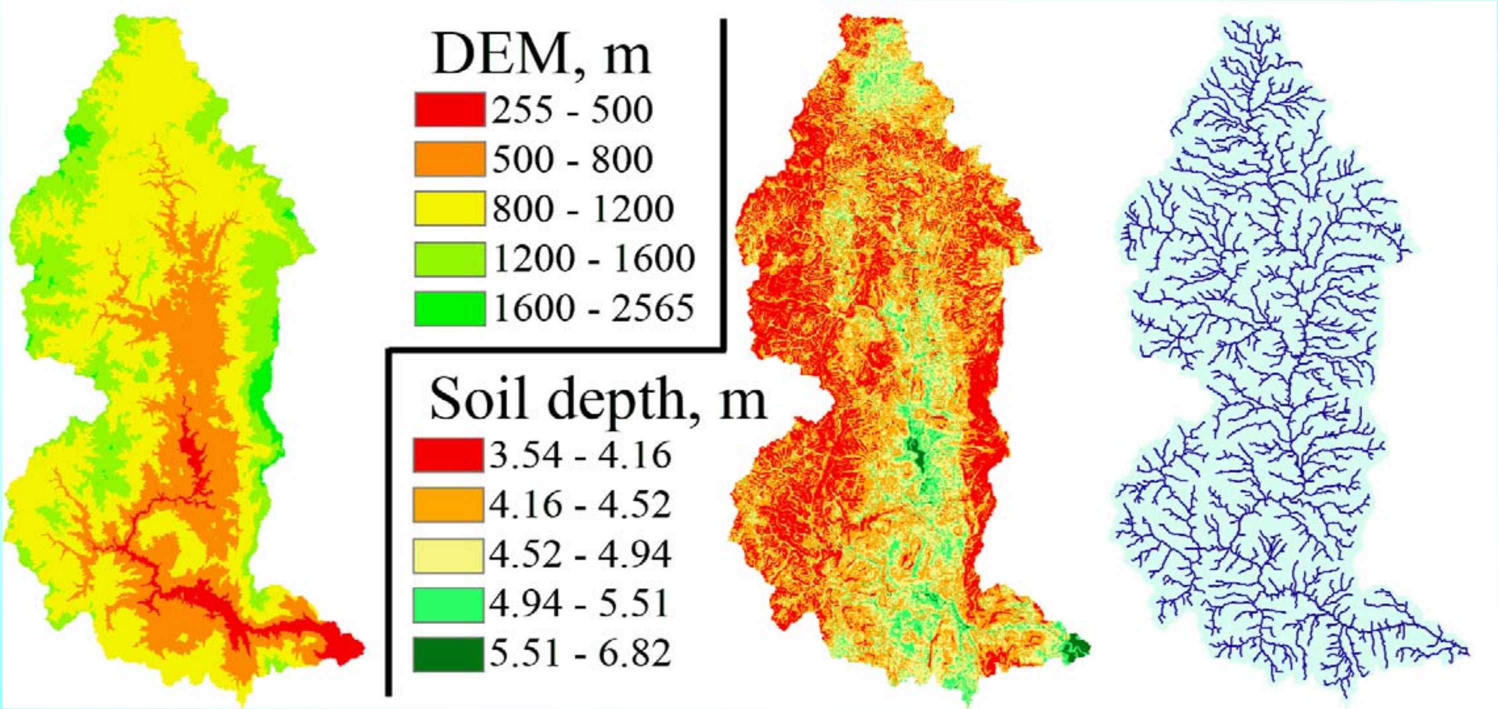


Soil saturation extent

Areal precipitation

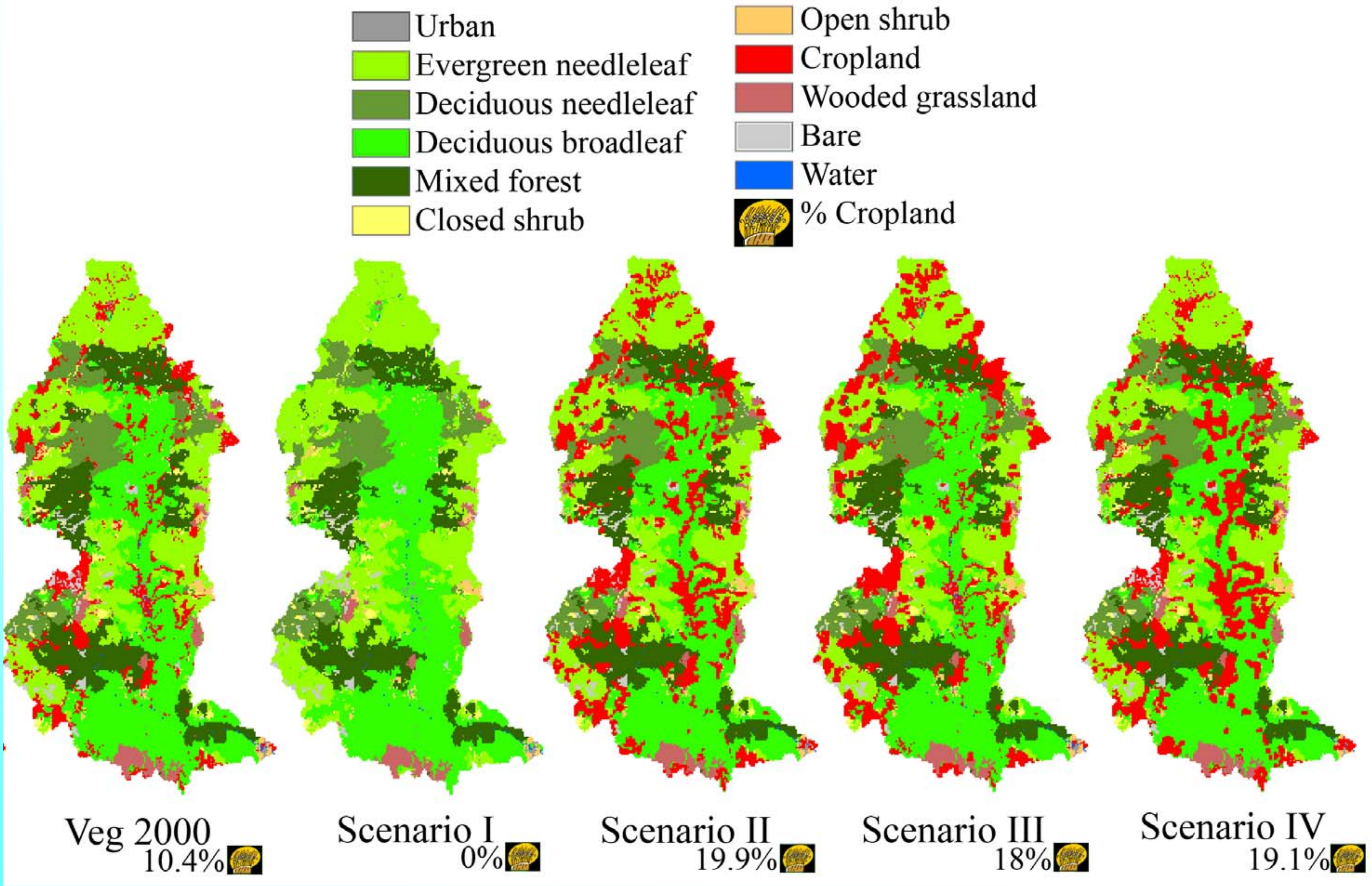
Evapotranspiration

ข้อมูล GIS ของแม่แจ่ม

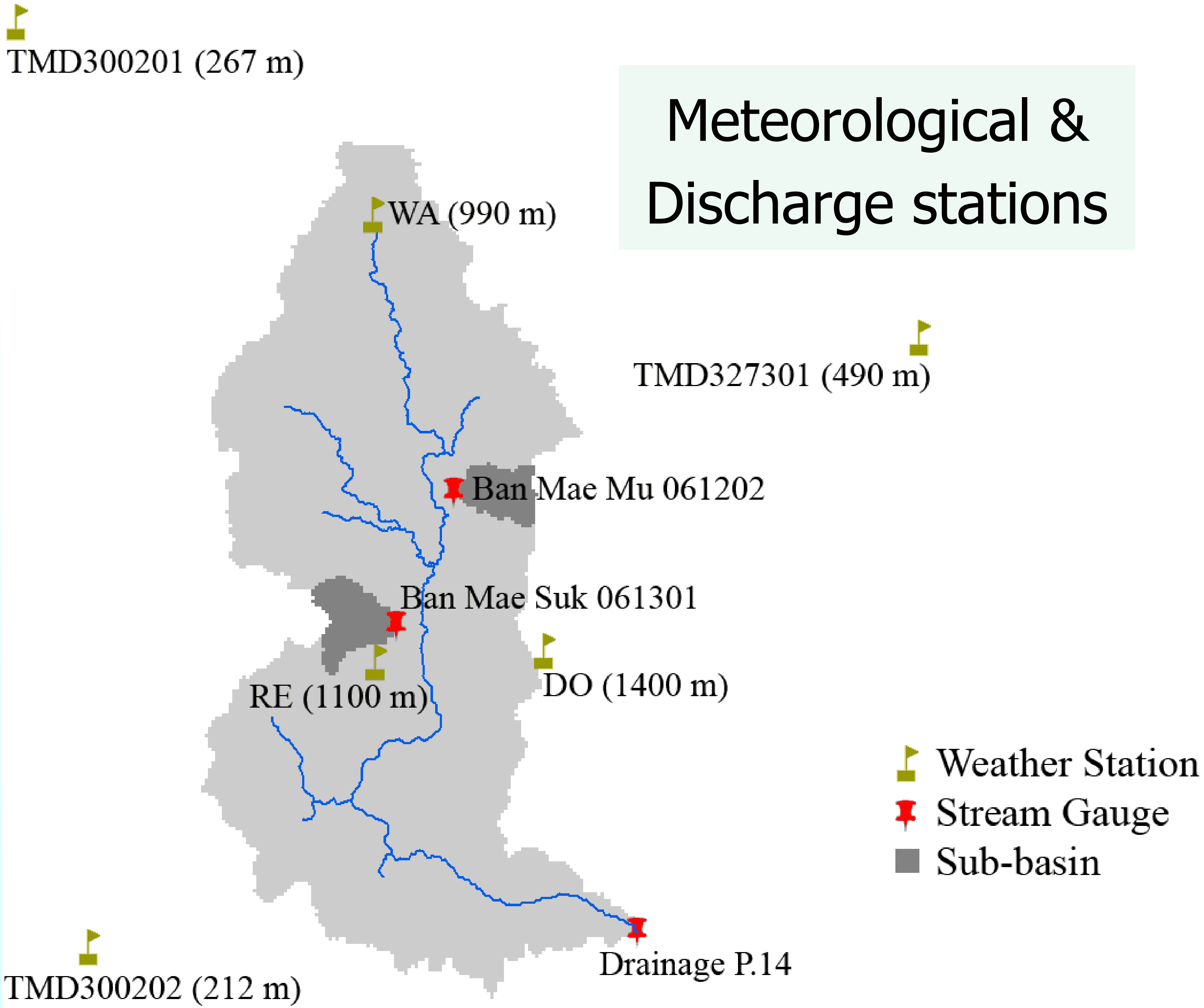


Elevation Soil depth Stream network

Landuse scenarios



Meteorological & Discharge stations

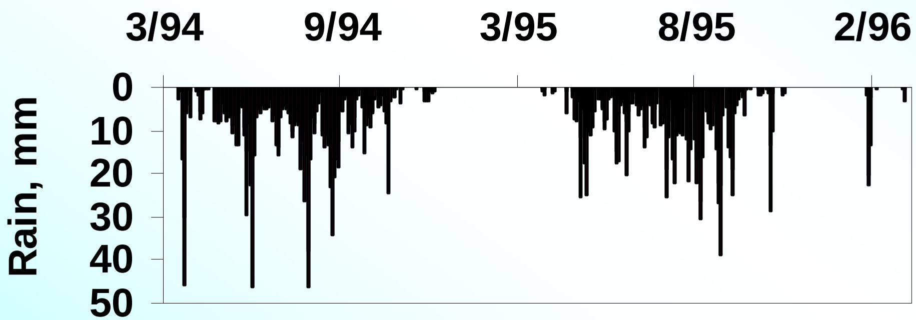


Results

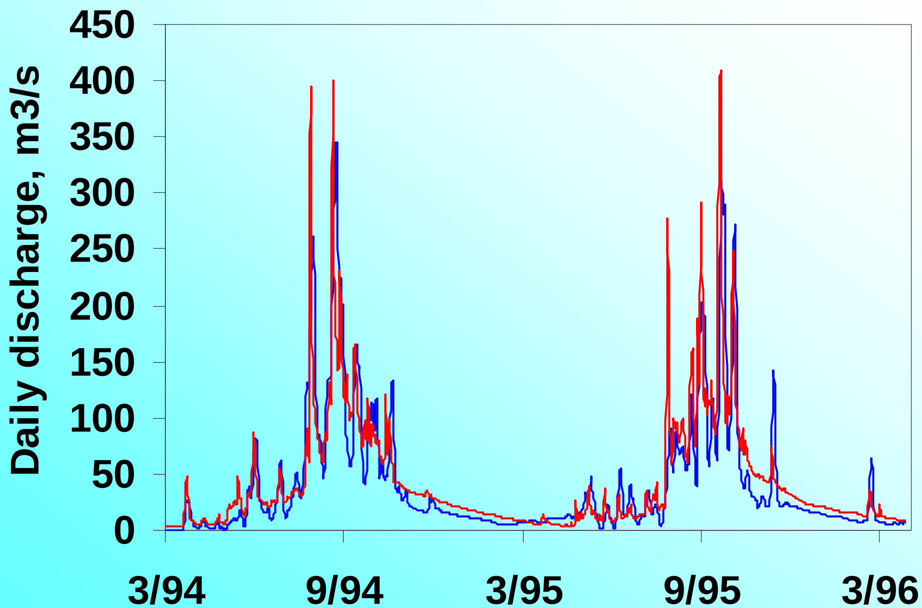
- Comparison of simulation & observation
- Current Mae Chaem hydrologic regime
  - Annual & seasonal water yields at basin outlet
  - Spatial variation within basin
- Effect of landuse change on annual & seasonal yields

Model performance at basin outlet (P.14)

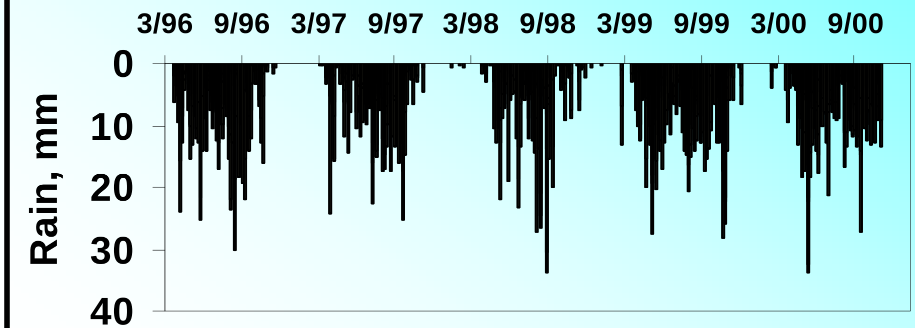
Calibration



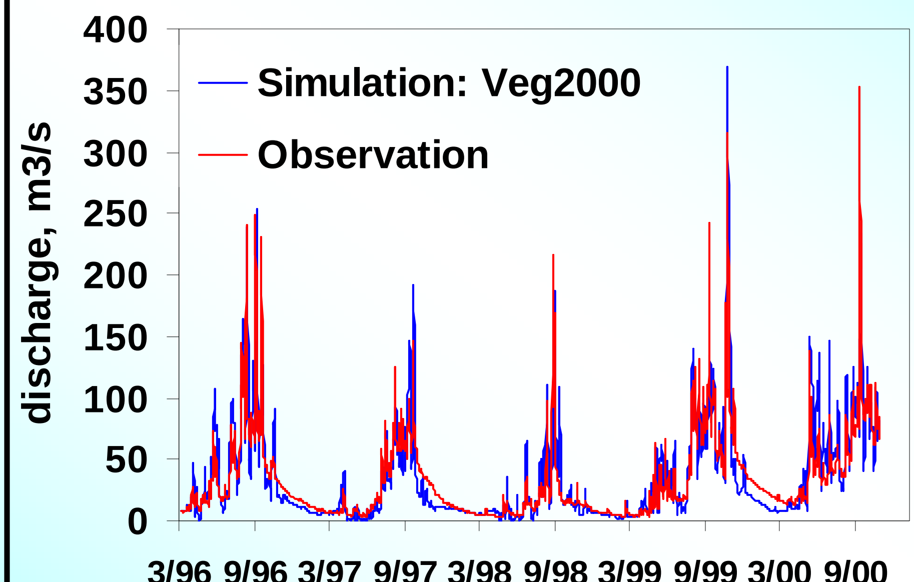
Model efficiency = 0.79
Bias = -9%



Validation



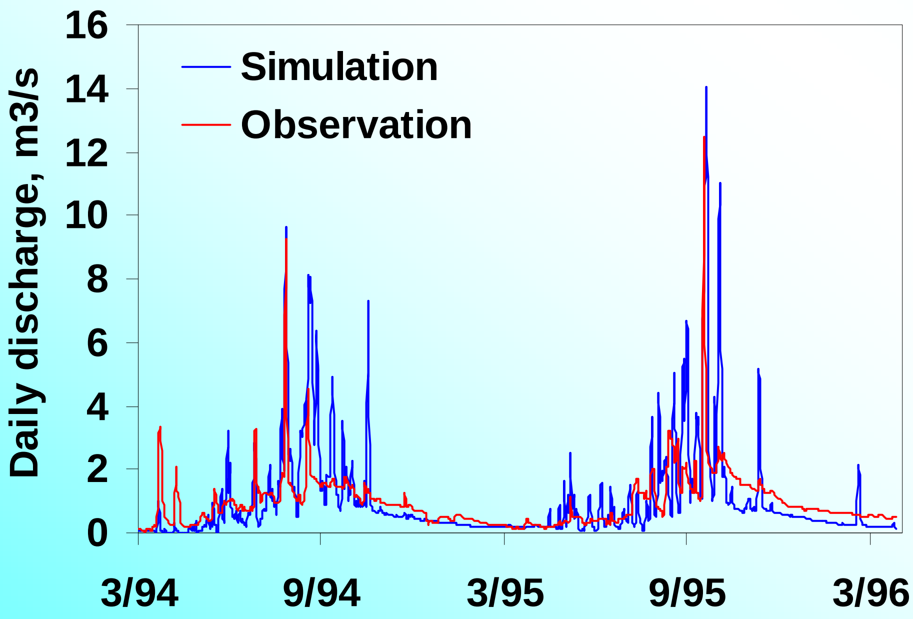
Model efficiency = 0.74
Bias = 2%



Model performance at Mae Mu

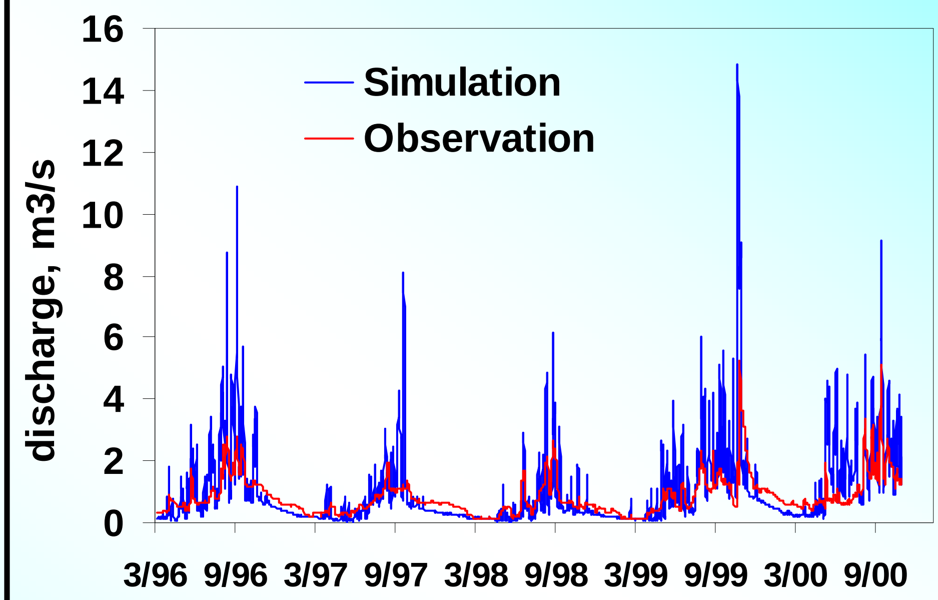
Calibration

Model efficiency = 0.15
Bias = 7%



Validation

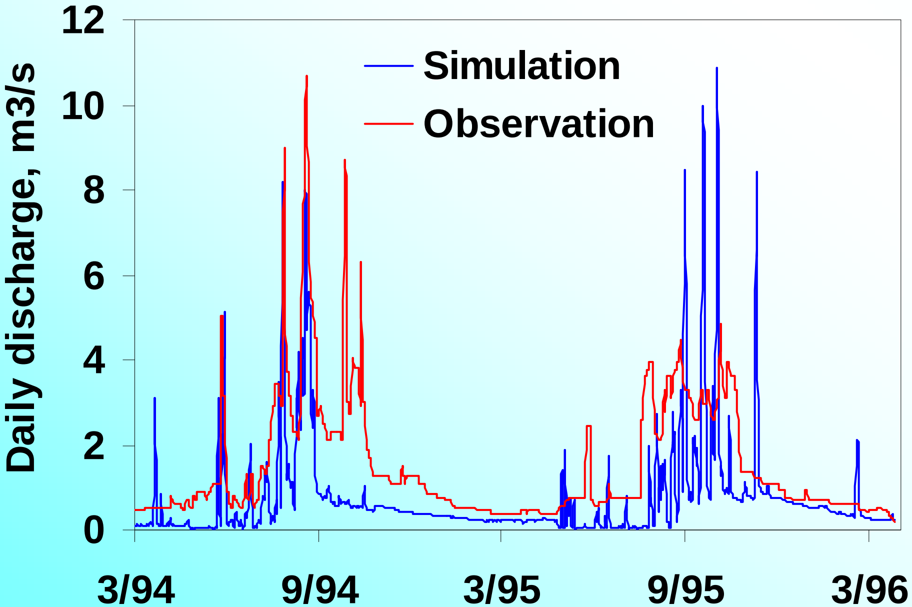
Model efficiency = -0.9
Bias = 24%



Model performance at Mae Suk

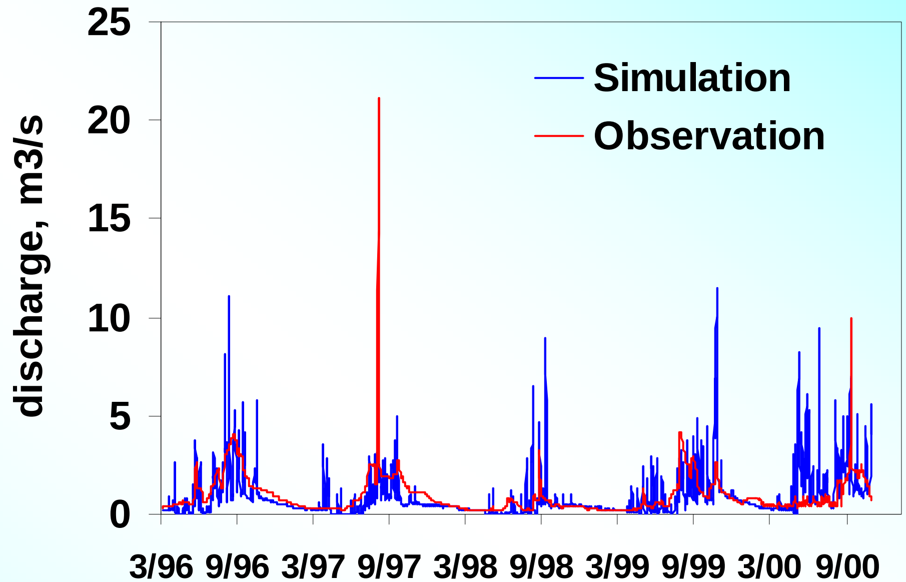
Calibration

Model efficiency = 0.43
Bias = -50%



Validation

Model efficiency = -2
Bias = -5%

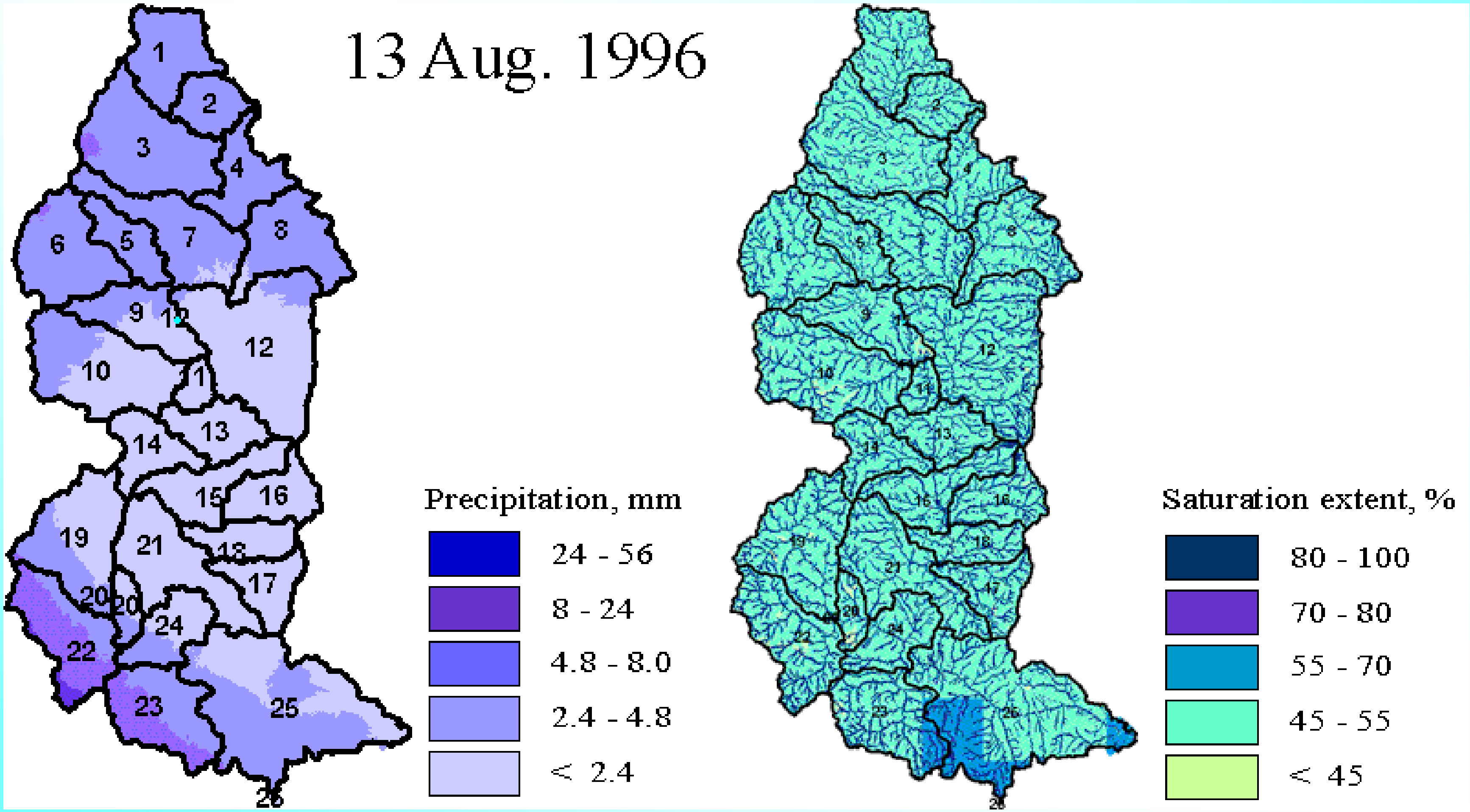


Hydrologic dynamics under current condition

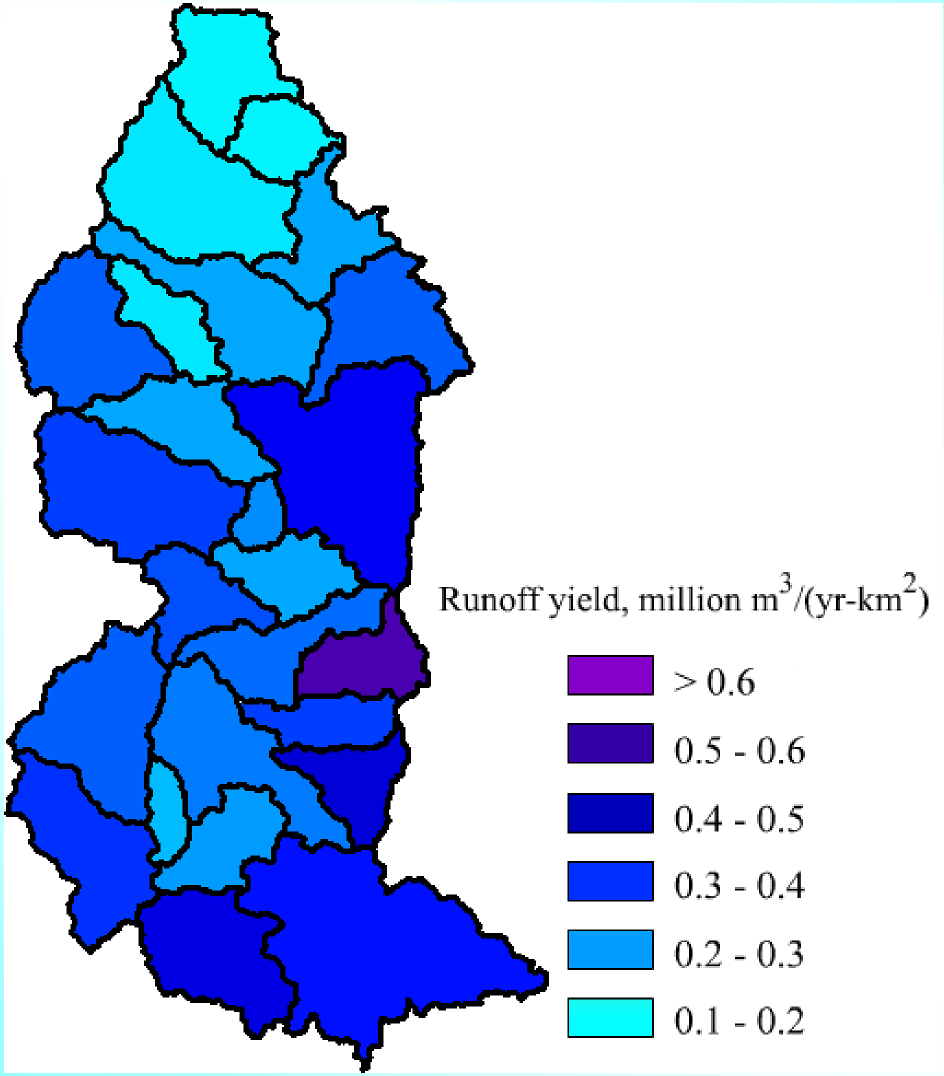
Landcover scenarios		Average hydrologic components (1997 – 2000)				
		Annual yield (Mm^3/yr)	High flow, $Mm^3/month$	Low flow, $Mm^3/month$	ET, mm	Runoff ratio
Observed		987	121	48	750 , 1230	0.19
Veg 2000	Regulated	997	132	39	1016	0.19
	Unregulated	1129	143	50	981	0.21

Wet-season flow = ~70% annual flow

Example rainfall distribution & soil saturation extent maps from 13 – 26 August 1996



ศักยภาพการให้น้ำท่ารายปีเฉลี่ยต่อพื้นที่
ปีน้ำ 1996 - 1999



Results: effect of landuse change

Potential ranges of basin hydrology

Landcover scenarios		Average hydrologic components (1997 – 2000)				
		Annual yield (Mm3/yr)	High flow, Mm3/month	Low flow, Mm^3/month	ET, mm	Runoff ratio
Observed		987	121	48	750 , 1230	0.19
Veg 2000	Regulated	997	132	39	1016	0.19
	Unregulated	1129	143	50	981	0.21
Scenario I (no crops)	Unregulated	1100	140	48	988	0.21
Scenario II	Regulated	915	124	32	1042	0.17
	Unregulated	1154	144	52	975	0.22
Scenario III	Regulated	984	131	37	1020	0.19
	Unregulated	1161	145	52	973	0.22
Scenario IV	Regulated	902	123	32	1045	0.17
	Unregulated	1142	143	52	978	0.22

Potential ranges of basin hydrology

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	Unregulated	1129	143	50	981	0.21
Scenario I	Unregulated	1100	[illegible]40	48	[illegible]	0.21
Scenario II	Regulated	915	124	32	1042	0.17
	Unregulated	1154	144	52	975	0.22
Scenario III	Regulated	984	131	37	1020	0.19
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-9%

-16%

Potential ranges of basin hydrology

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-1%

-3%

Potential ranges of basin hydrology

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Scenario II	Regulated	915	124	32	1042	0.17
	Unregulated	1154	144	52	975	0.22
Scenario III	Regulated	984	**same**	37	**same**	0.19
	Unregulated	1161	145	52	973	0.22
Scenario IV	Regulated	902	123	32	1045	0.17
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Potential ranges of basin hydrology

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Scenario III	Regulated	984	131	37	1020	0.19
	Unregulated	1161	[illegible]	52	[illegible]	0.22
Scenario IV	Regulated	902	123	32	1045	0.17
	Unregulated	1142	143	52	978	0.22

9%

14%

Conclusions – Objective I

- Topography is the main controlling factor
- Irrigation diversion affects discharge → irrigated area, crop type, crop water need
- Rainfed upland agriculture did not seem to lower downstream water availability.
- Upland crop expansion may lead to slightly higher yields than lowland-midland crop expansion

Conclusions – Objective II

Physical-based model as water management tool

- Tool in assessing influence of spatial configuration or fragmentation of landcovers
- Indicate local hydrological hazards in basin
- Simulate stream flow in ungauged locations

Acknowledgement

The Royal Irrigation Department

GEWEX Asian Monsoon Experiment-Tropics (GAME-T)

World Agroforestry Center

Mekong River Commission

Puget Sound RegIonal Synthesis Model (PRISM)

SEA/BASINS Program

Thai Meteorological Department

The Land Development Department

The Royal Project Foundation

U.S. National Science Foundation