Climate Change Impacts towards GW in an irrigation area

RIHN Feedback Seminar

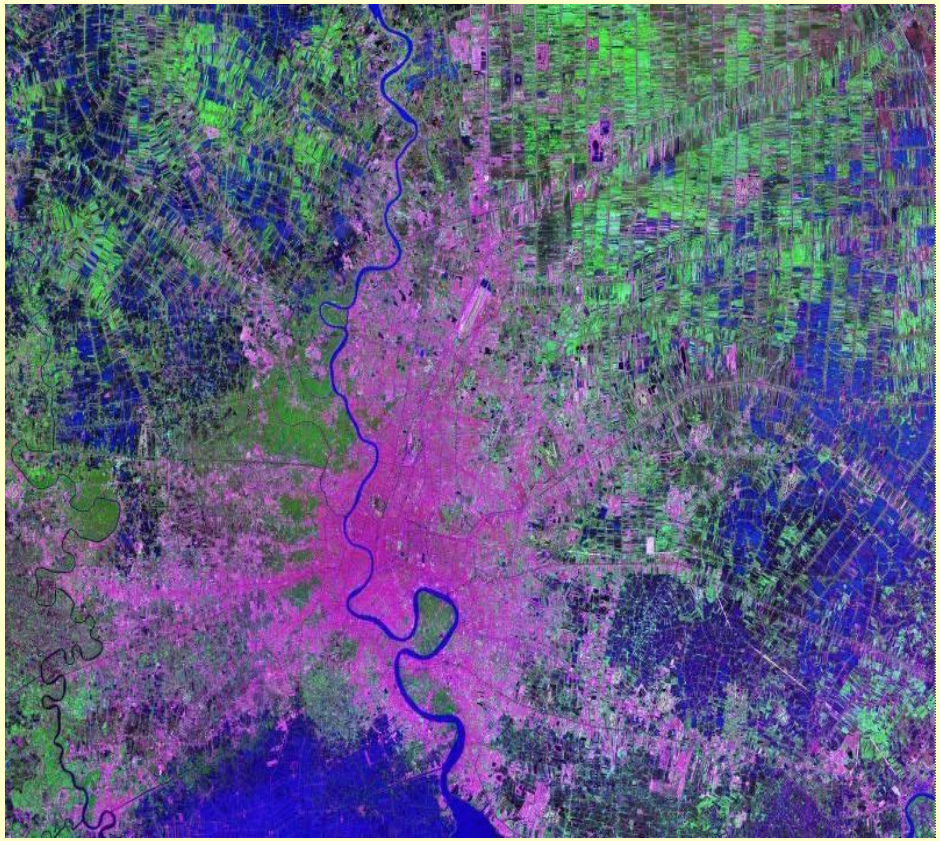
February 28, 2011

Bangkok, Thailand

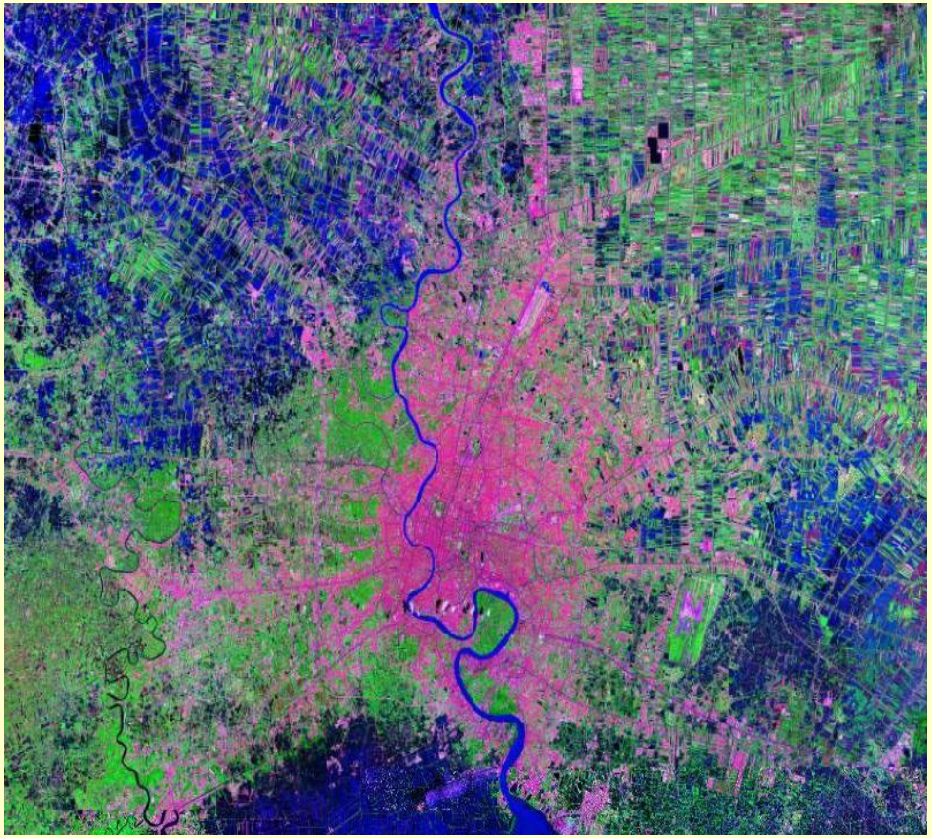
Presentation items

- Introduction
- Water use/GW status
- Climate Change Study
- GW in an irrigation area
- Recommendations
- Future issues

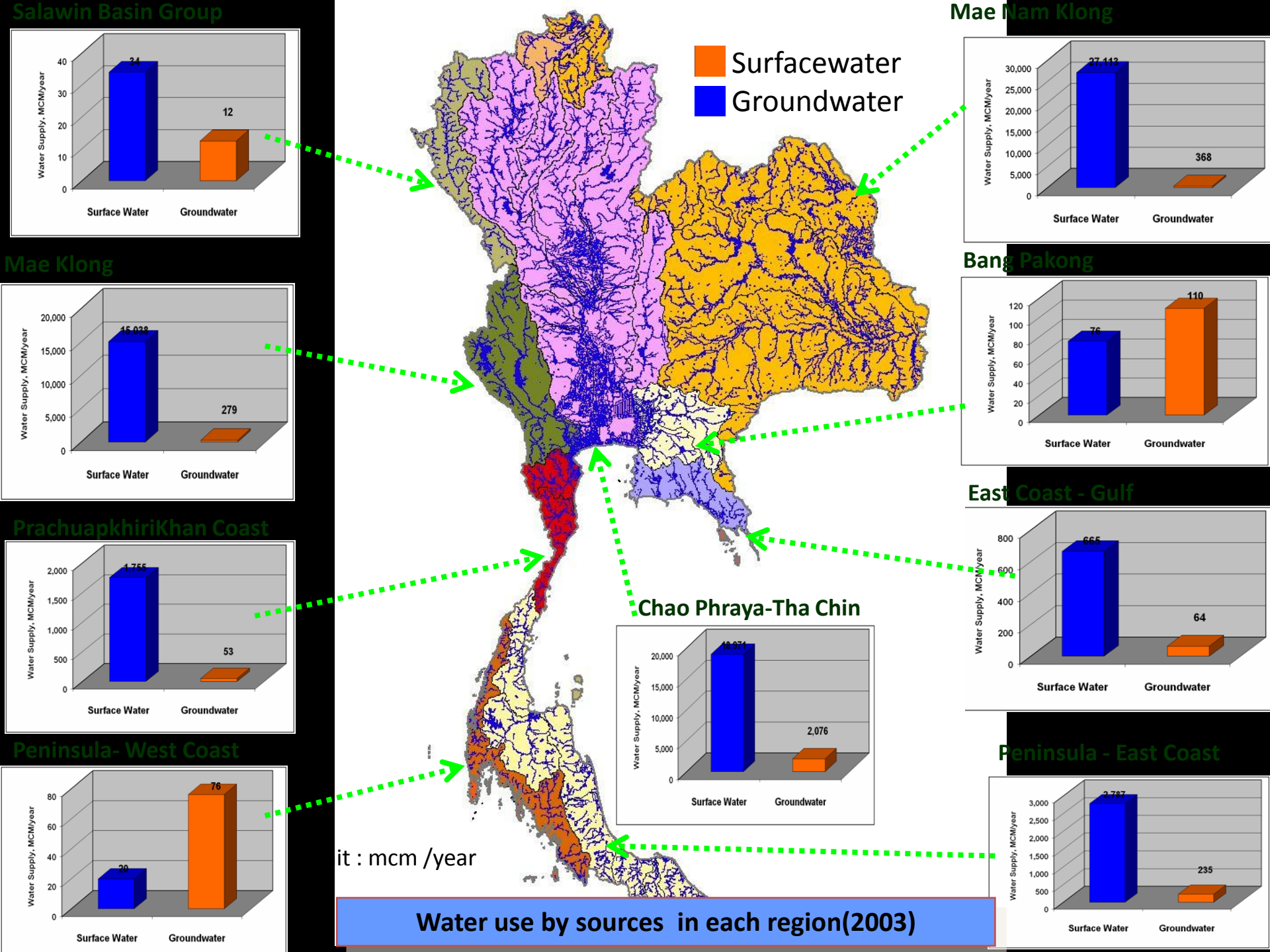
Urbanization from GeoCover better quality , quantity and reliability



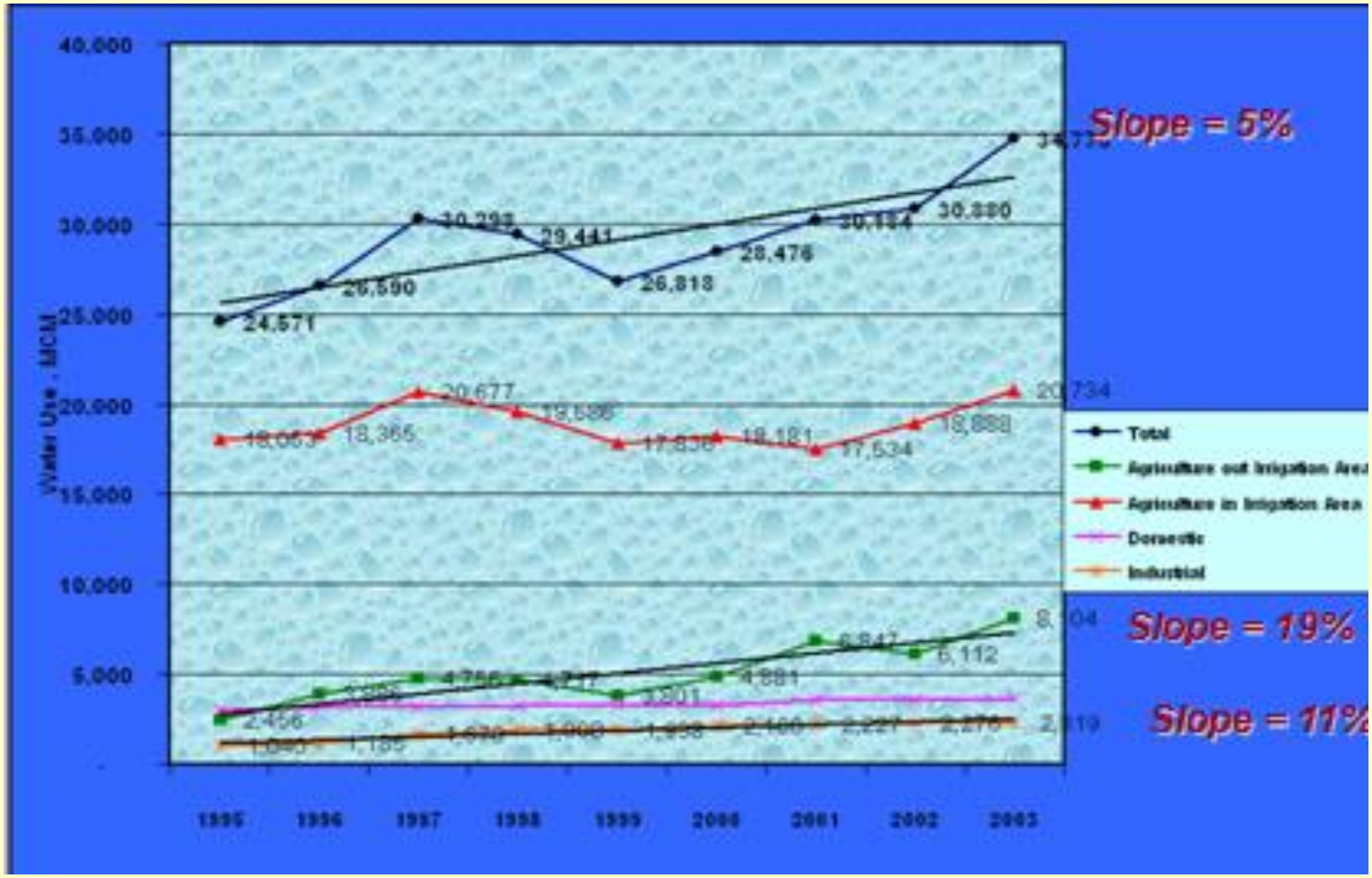
1990



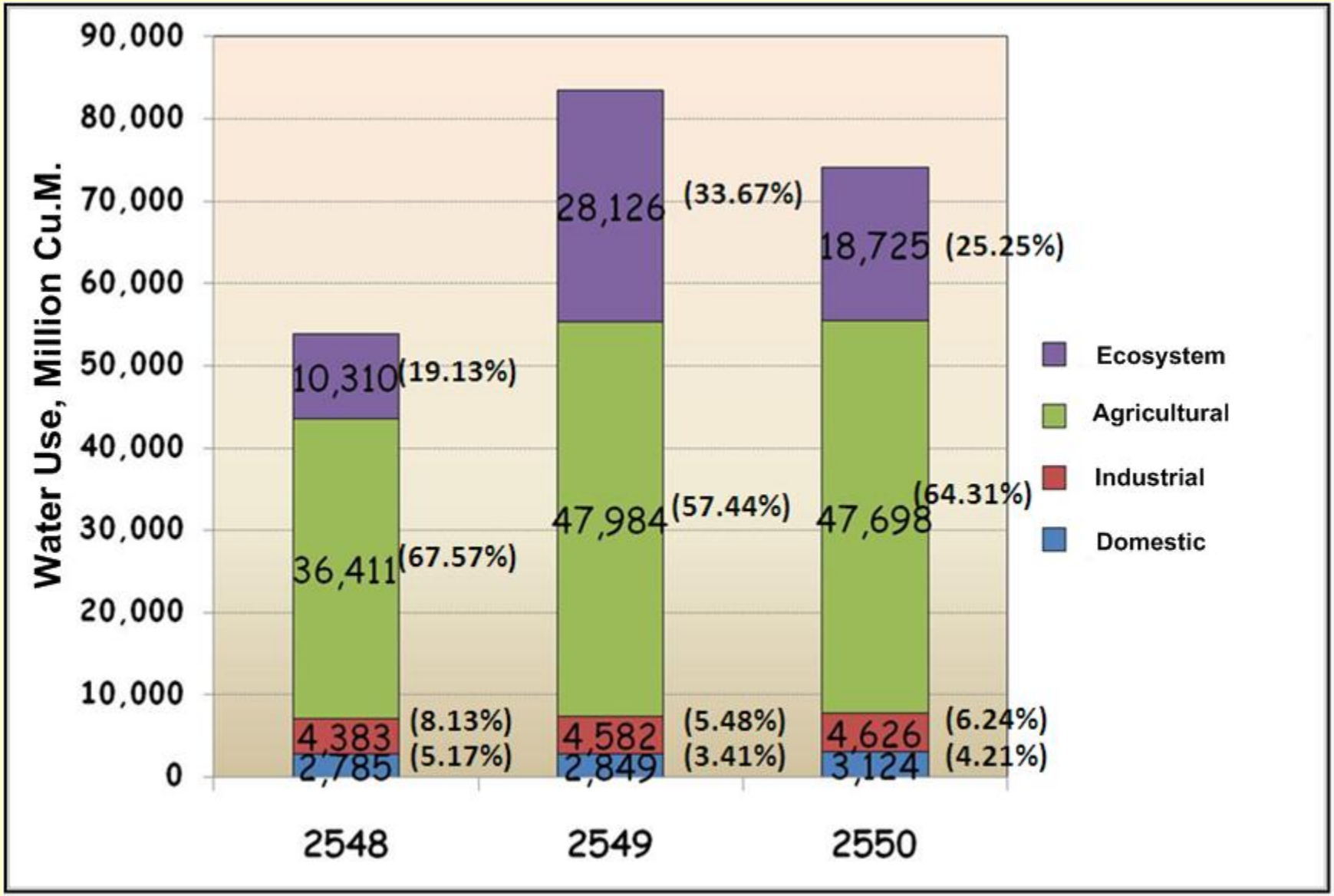
2000


Salawin Basin Group
Water Supply, MCM/year
34
12
Surface Water
Groundwater
Mae Klong
15,038
279
PrachuapkhiriKhan Coast
1,755
53
Peninsula- West Coast
20
76
Surfacewater
Groundwater
Mae Nam Klong
27,113
368
Bang Pakong
76
110
East Coast - Gulf
665
64
Chao Phraya-Tha Chin
18,671
2,076
Peninsula - East Coast
2,787
235
it : mcm /year
Water use by sources in each region(2003)

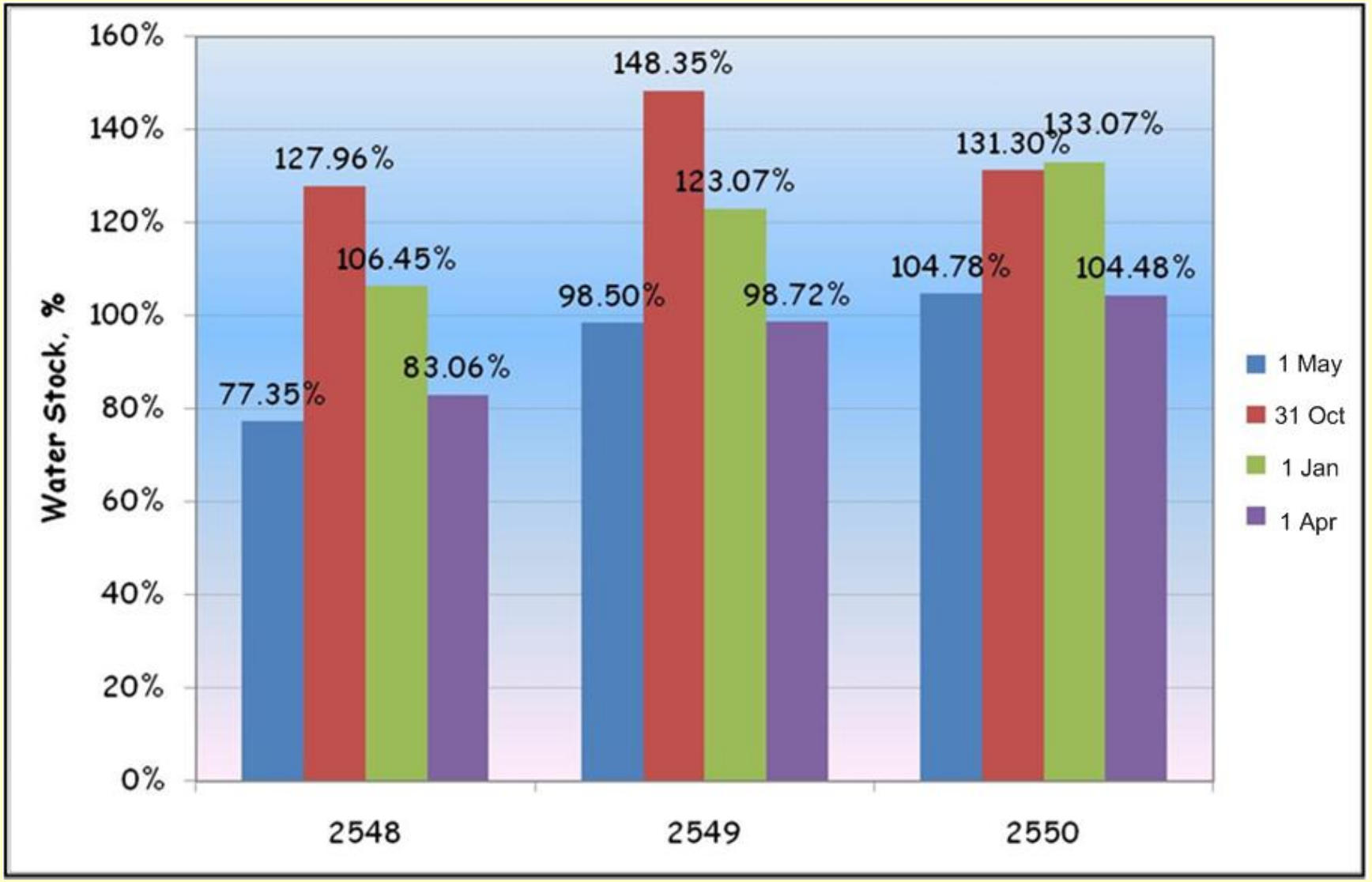
Water use in 1995-2003



Water Use in Thailand

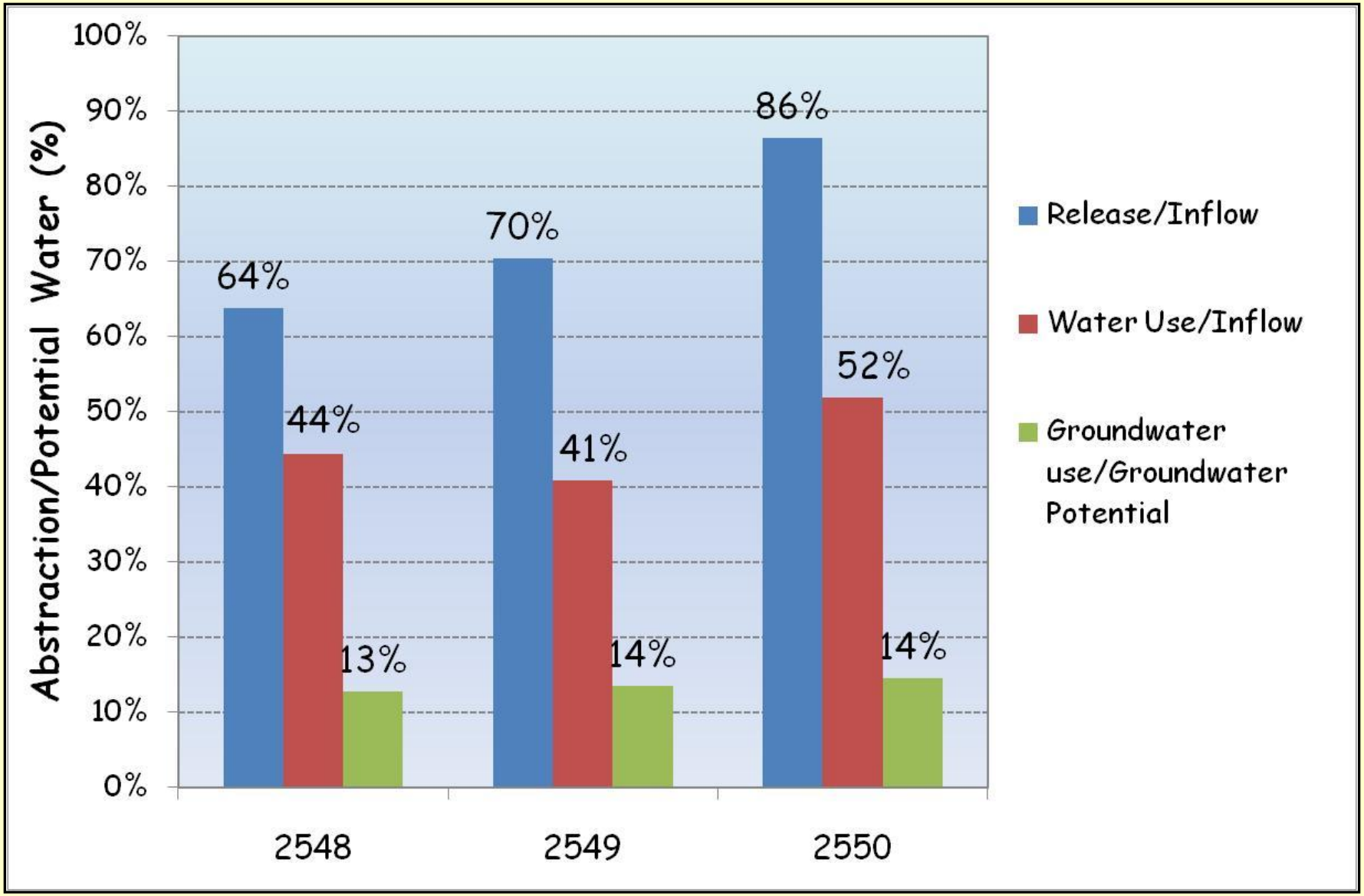


Water Stock*



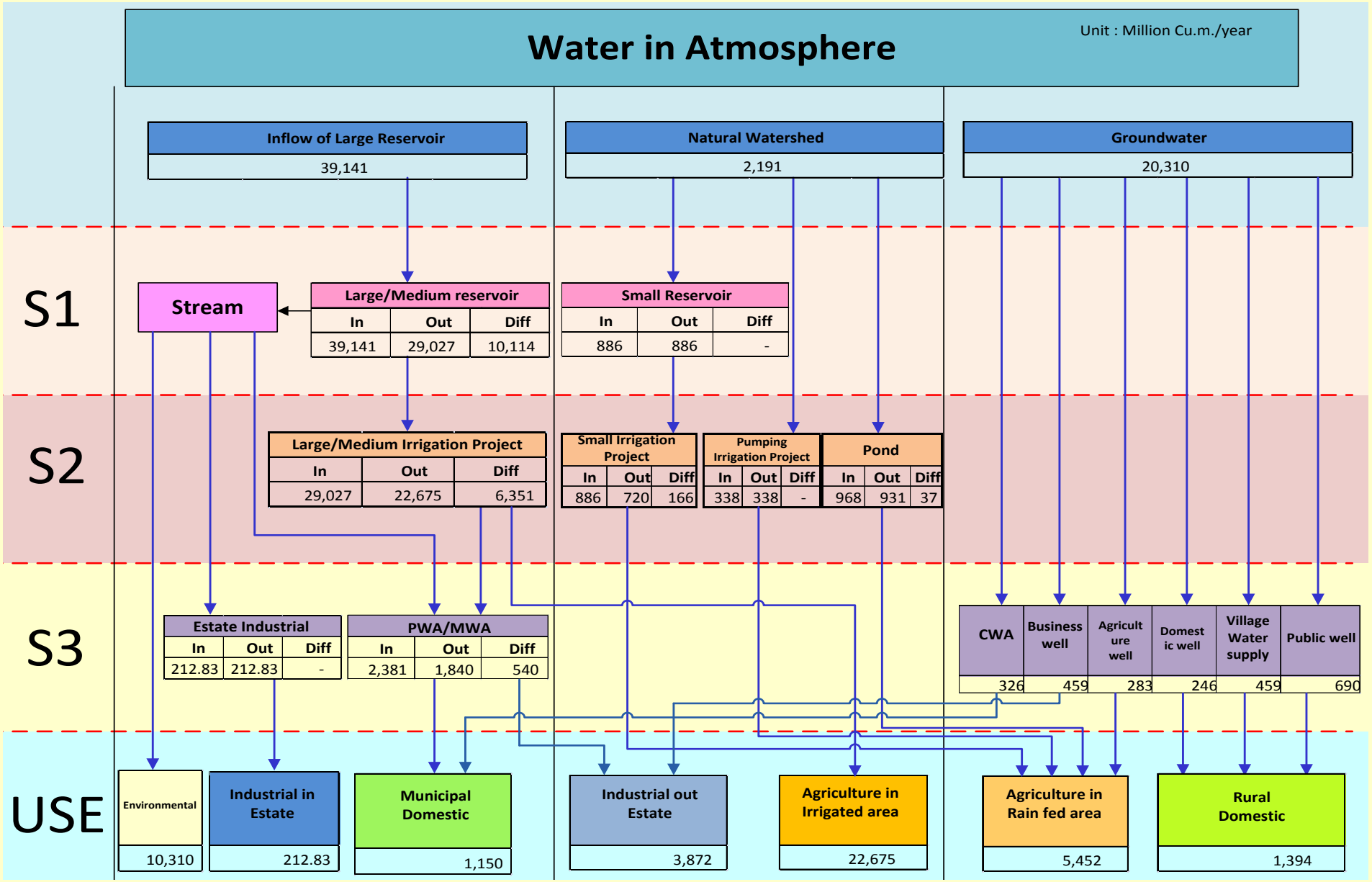
Remarks : data only from large scaled reservoir

Abstraction/Potential Water (%)

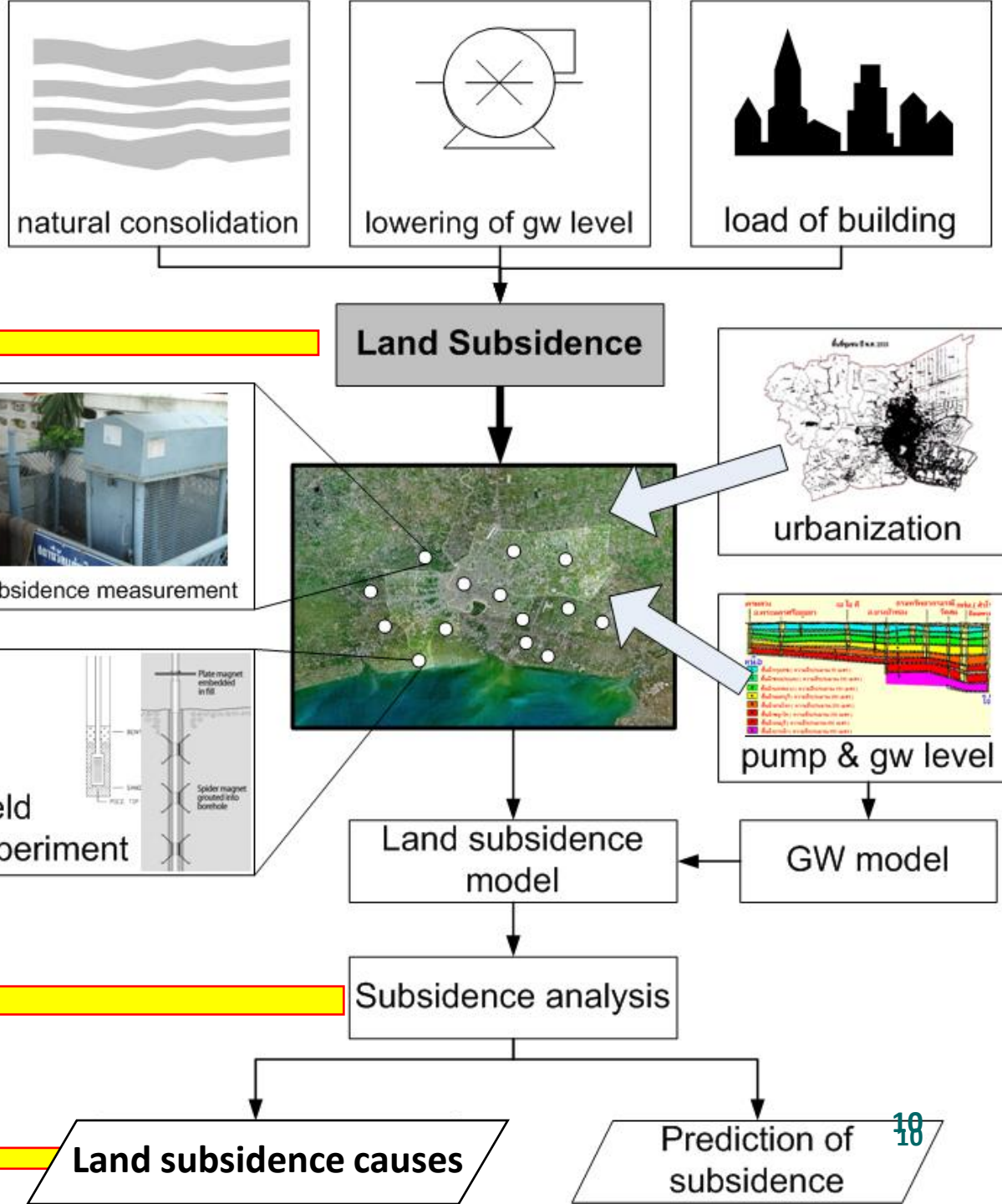


Remarks: data from large scaled reservoir only

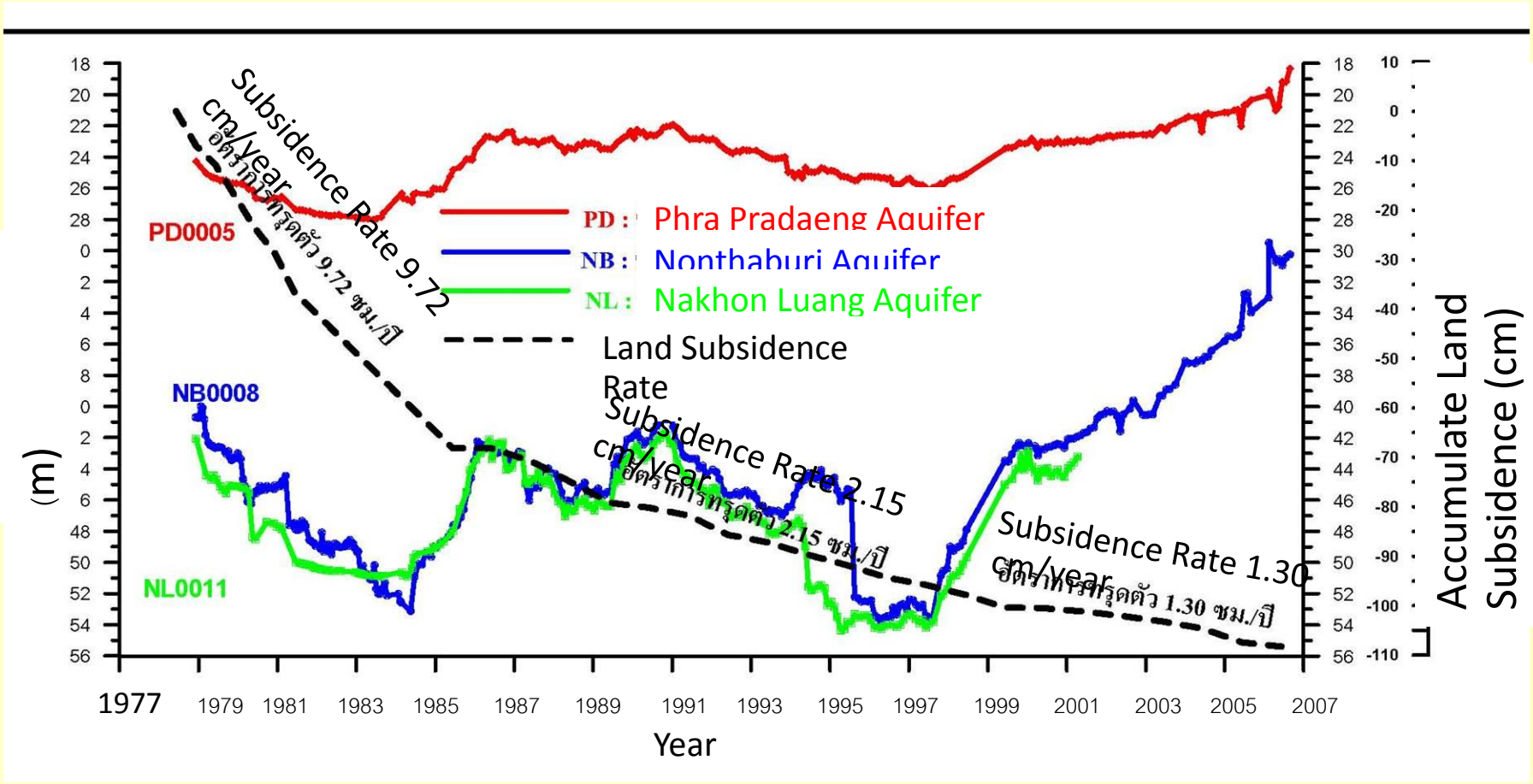
Thai Water Balance



Analysis Concept



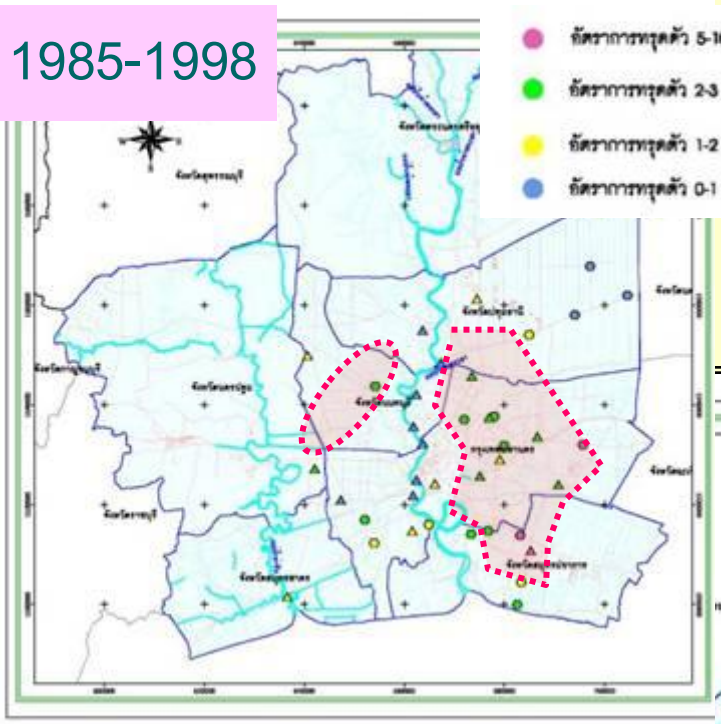
Land subsidence situation in Bangkok Metropolitan Area and its vicinity (Ramkamhang University)



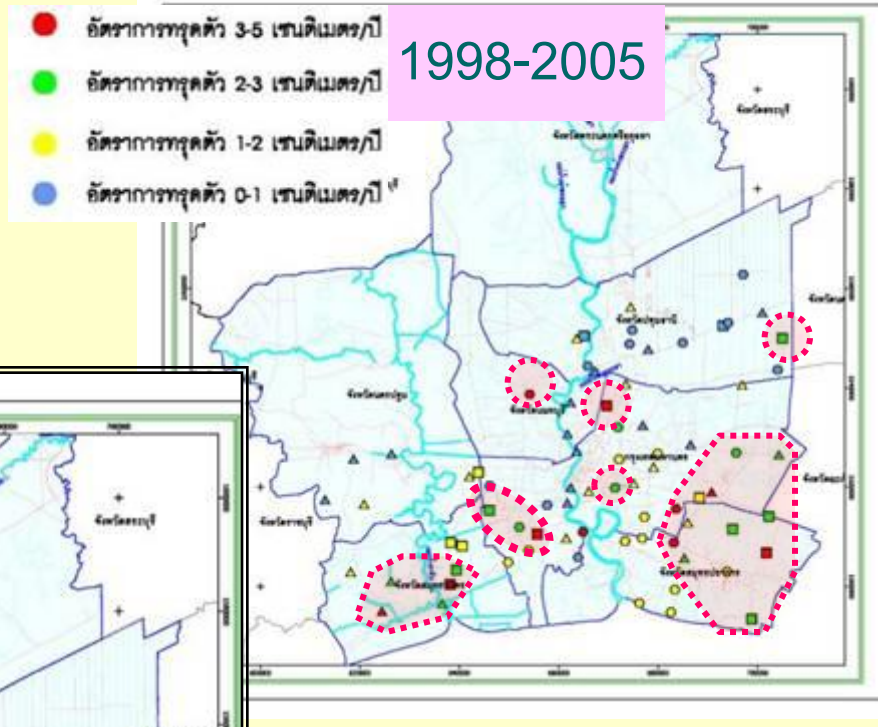
Source : Land subsidence situation in Bangkok metropolitan area and its vicinity , Bureau of Groundwater Conservation and Restoration (2006)

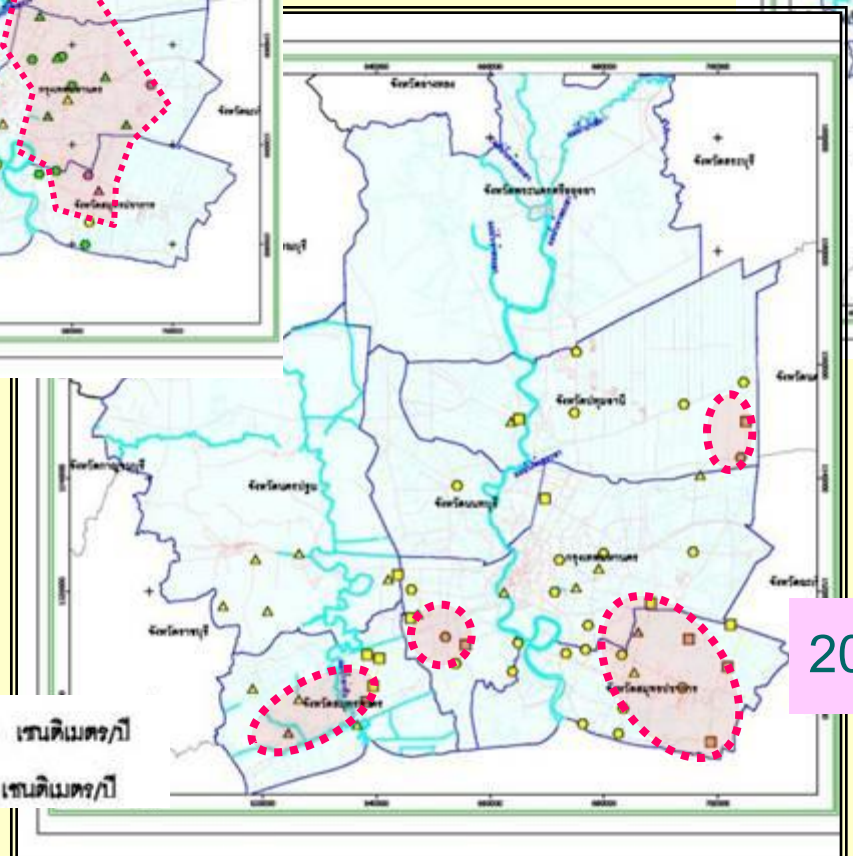
Historical land subsidence

1985-1998



1998-2005





2006-2007

Subsidence rate > 2 cm./year

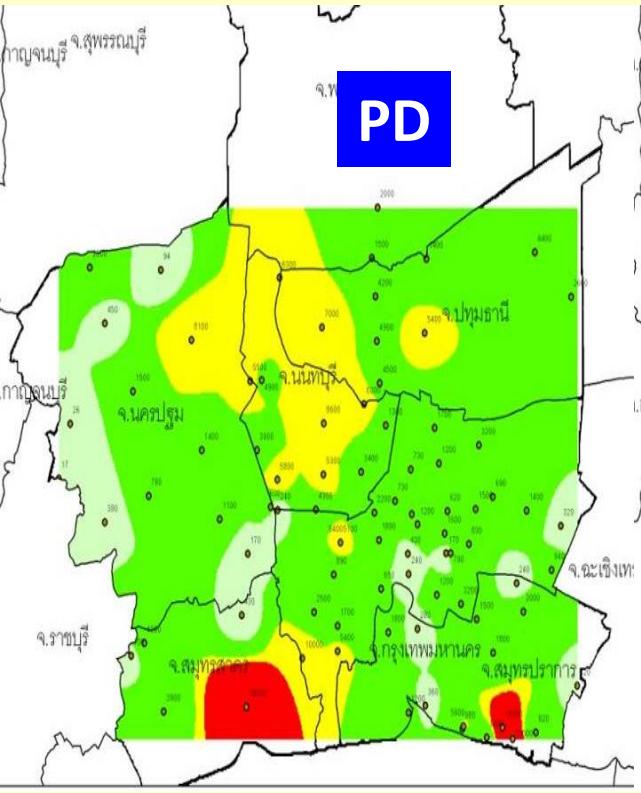
(Conservation B, 2007)

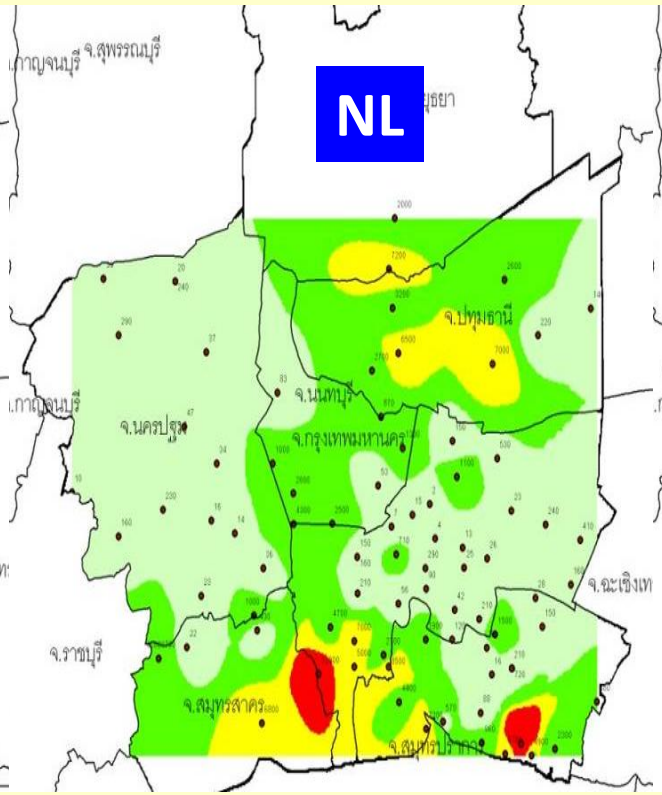
Groundwater Quality (Salinity)

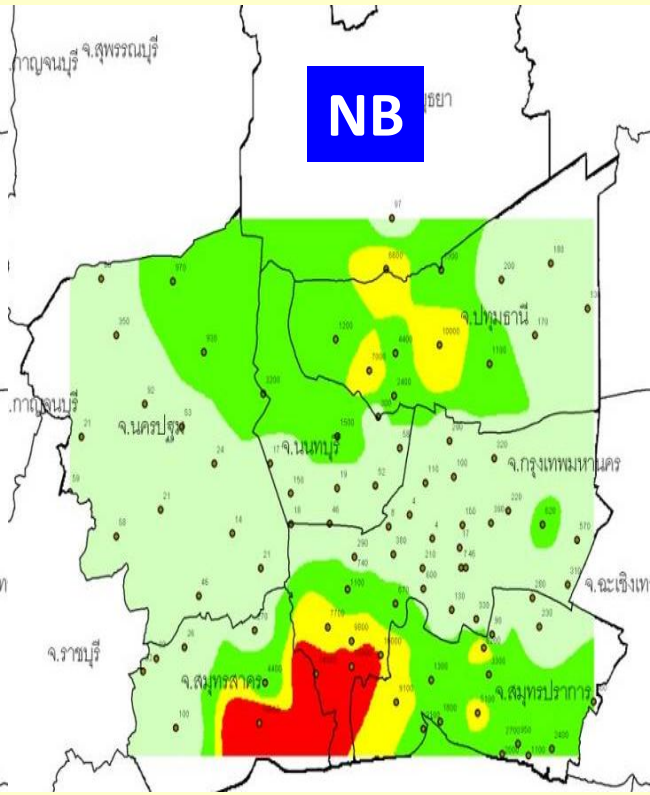
Chlorine (ppm)

0 - 600	5,000 - 10,000
600 - 5,000	> 10,000

2006 (96 **obs. wells**)



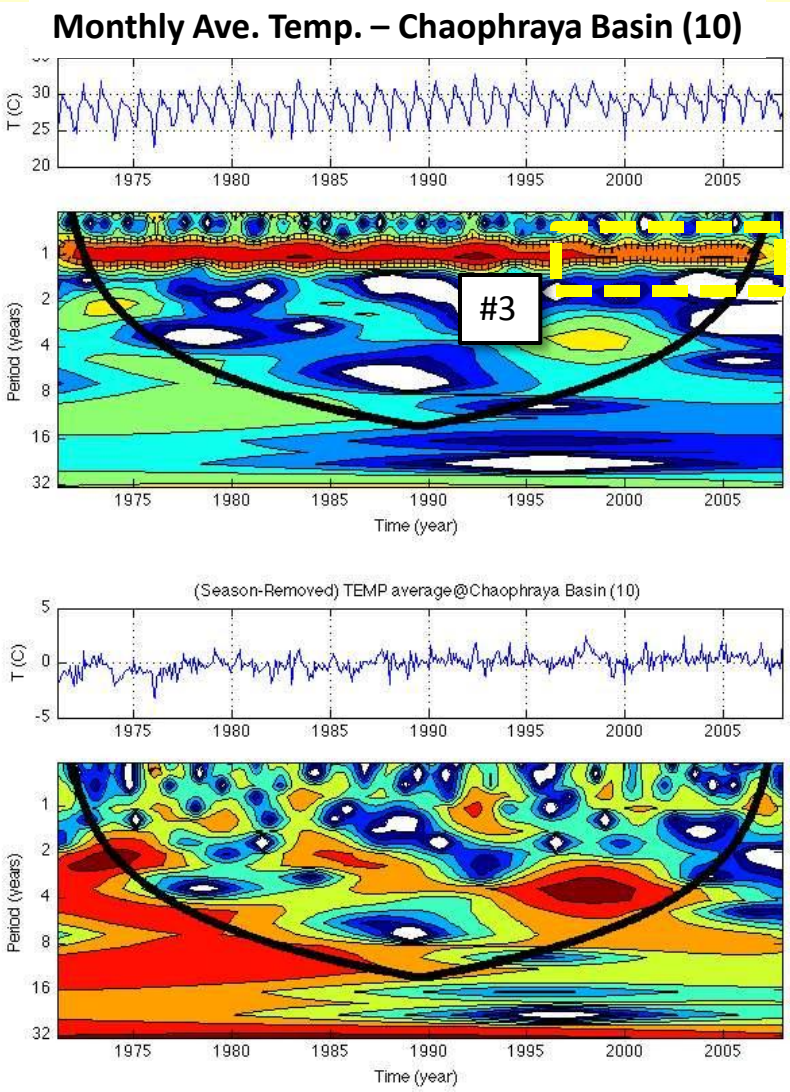




Climate Change Study

Cycle pattern, trend, monthly pattern

Wavelet Pattern of Ave. Temp.



General patterns from national, basin, and station time series.

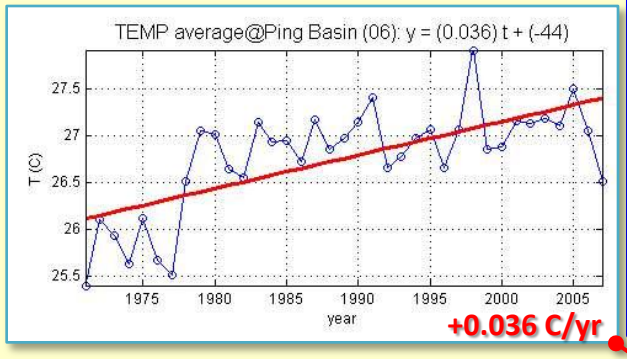
1) Pattern at return period of ~4 years after the year 1995.

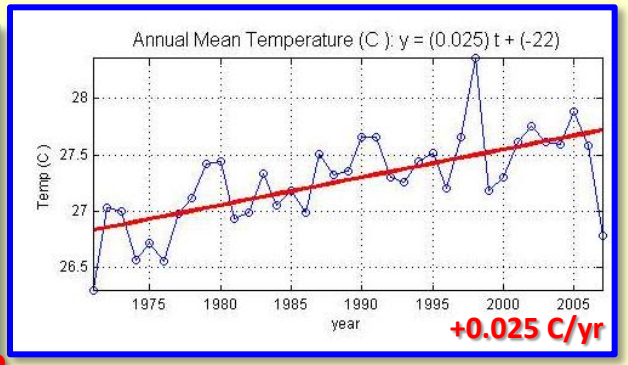
2) Pattern at return period of ~8 years after the year 1985.

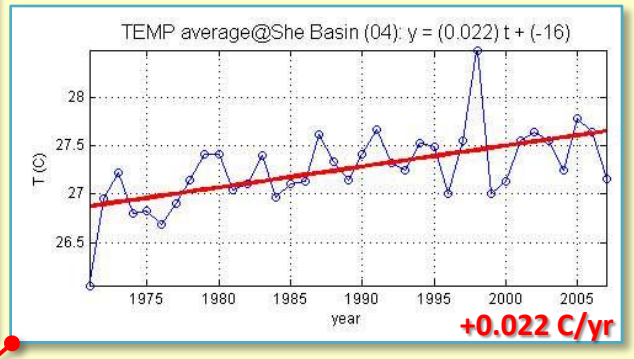
Other general patterns from basin and station time series.

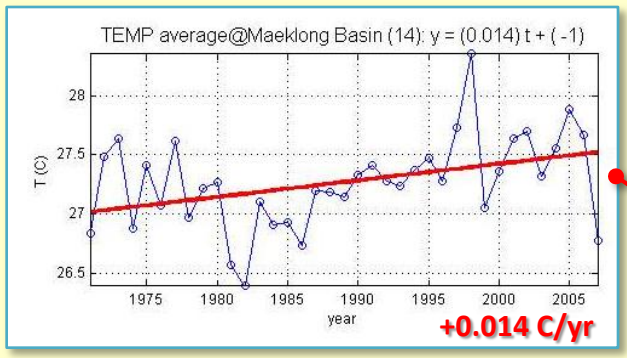
3) Fading of annual or seasonal cycle (period of 1 year) after the year 1995

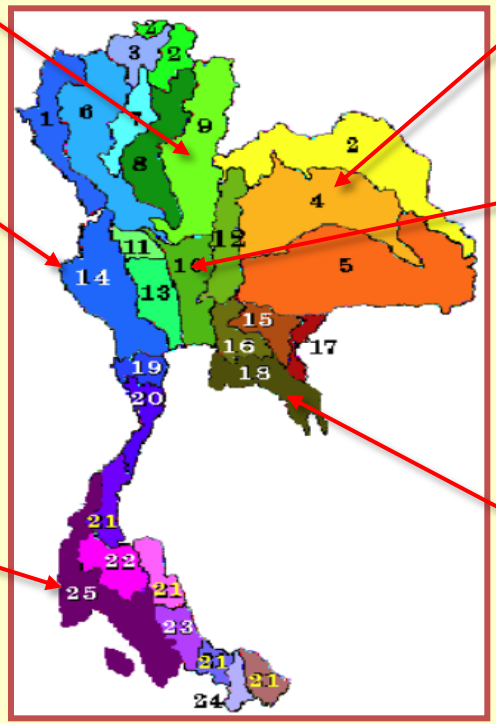
Annual Temperature Trend

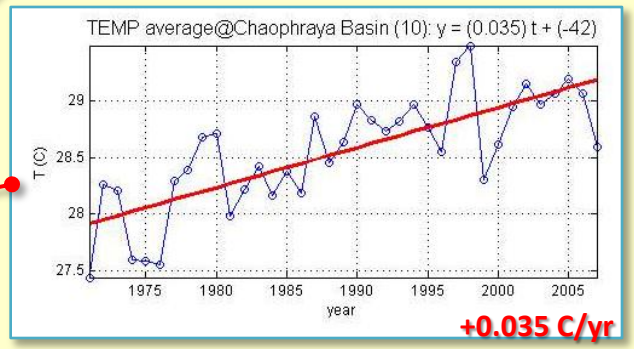


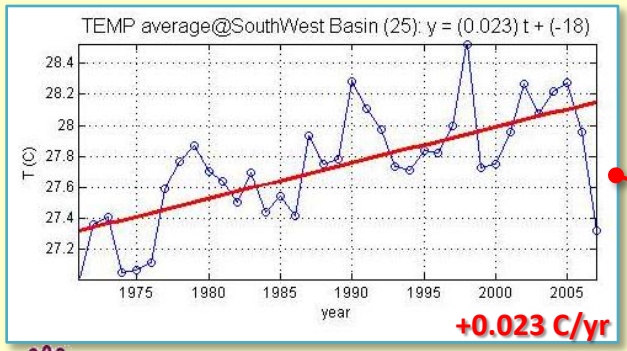


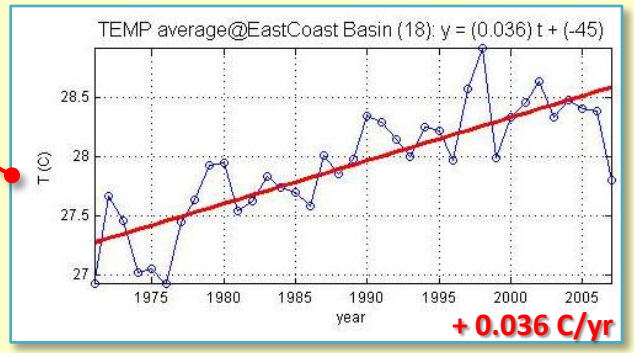




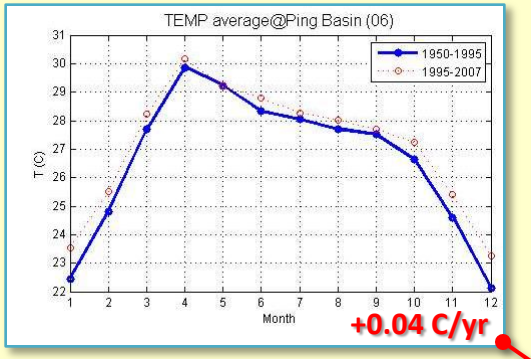


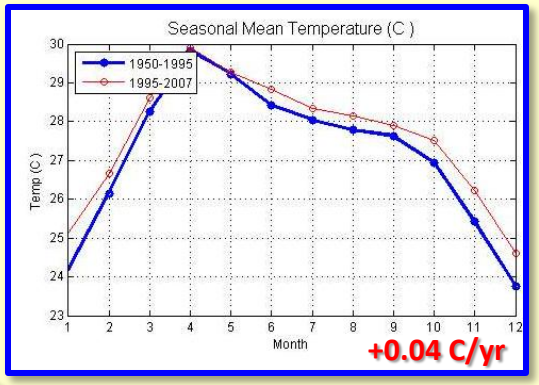


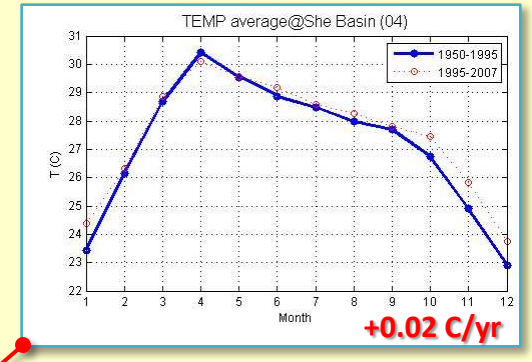


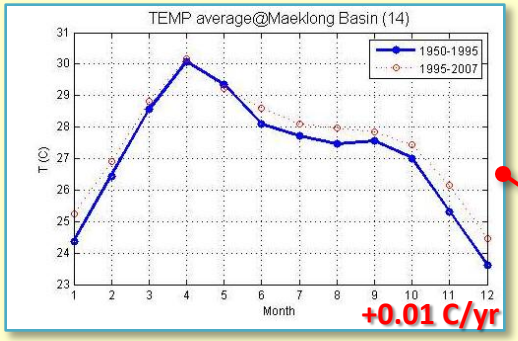


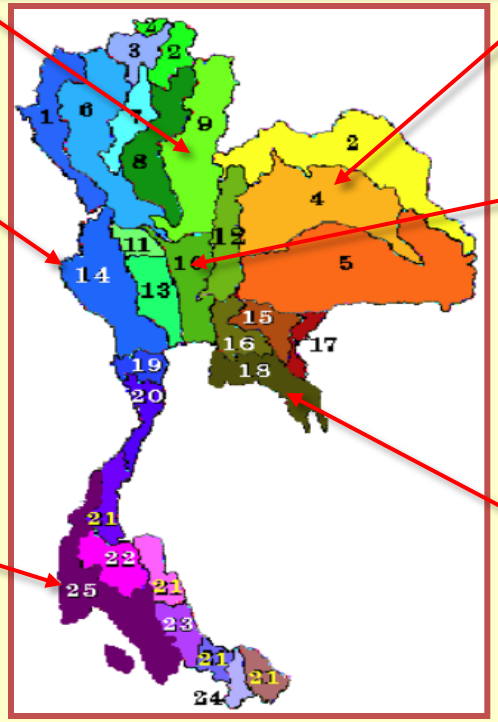
Seasonal Temp. (1950-1995 vs. 1995 – 2007)

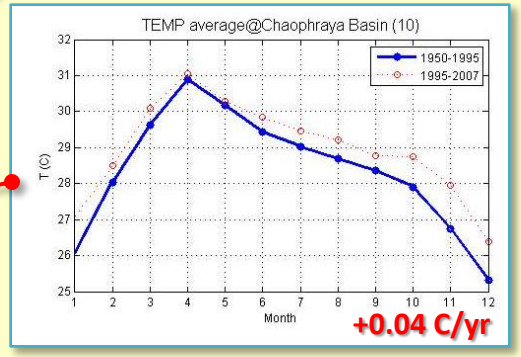


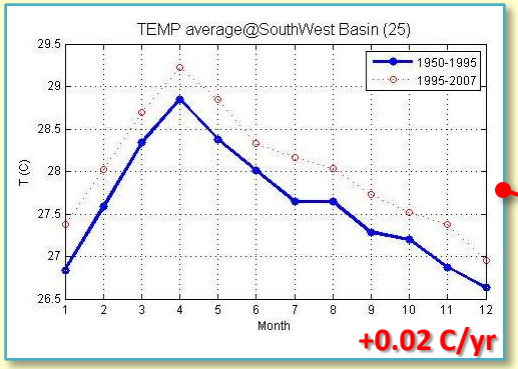


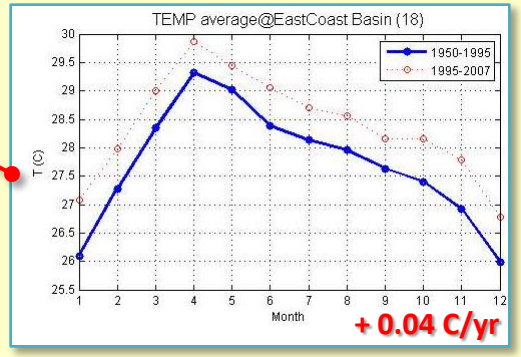




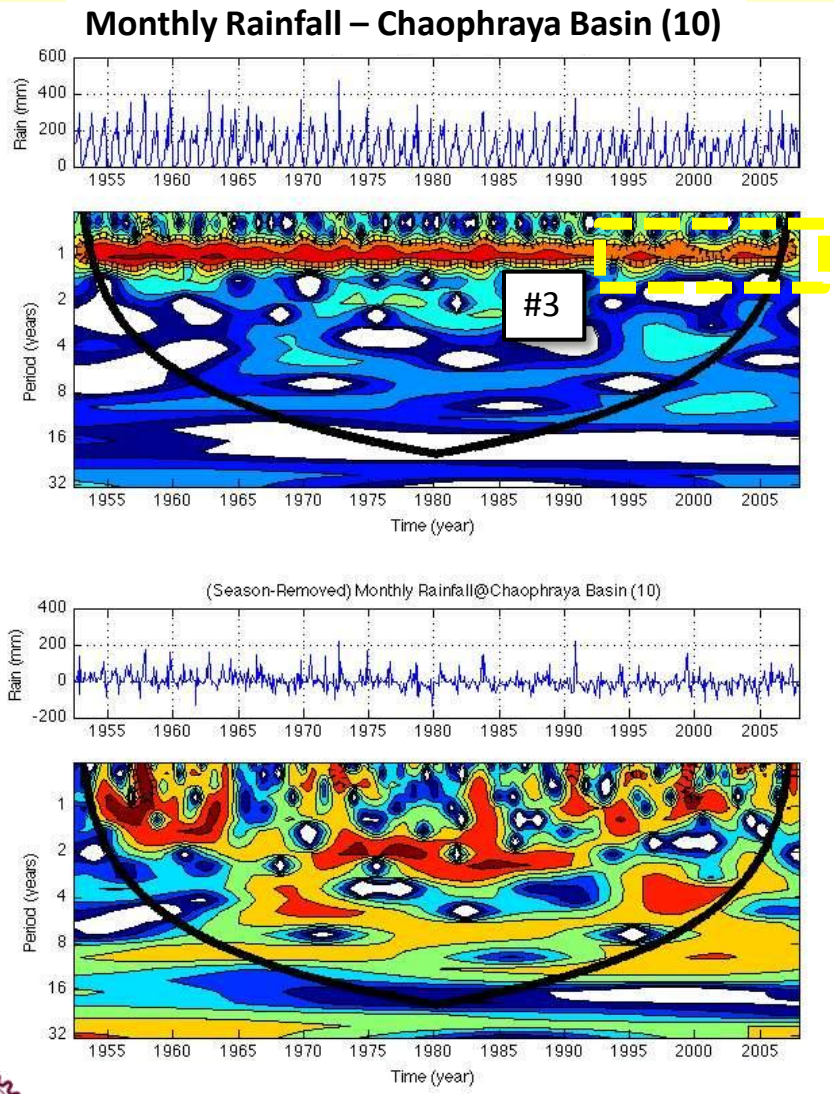








Wavelet Pattern of Rainfall



General patterns from national, basin, and station time series.

*) Pattern from period of 6 years in 1960 to 1.5 years in 2000

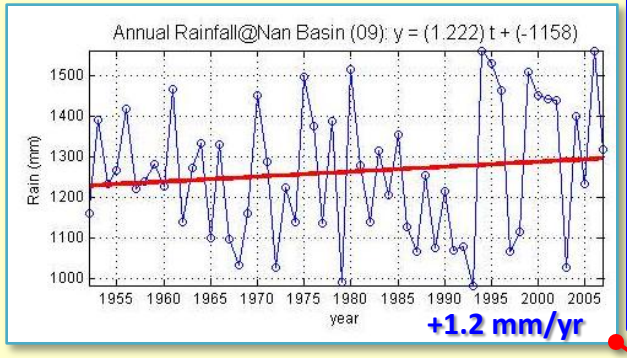
1) Pattern at return period of ~6 years after the year 1990.

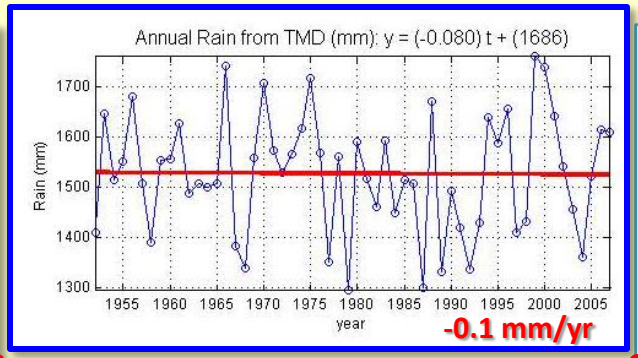
2) Pattern at return period of ~10 years after the year 1975.

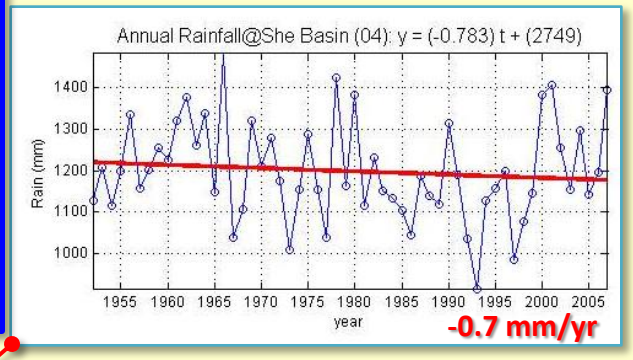
Other general patterns from basin and station time series.

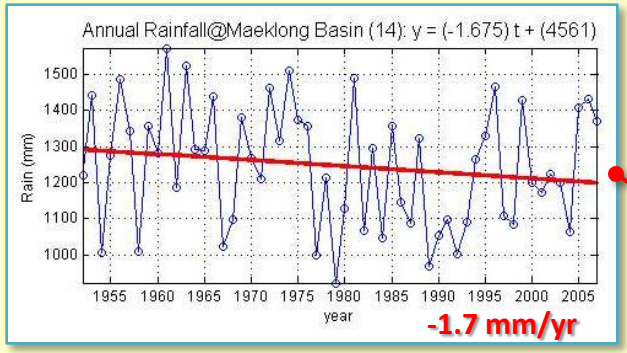
3) Fading of annual or seasonal cycle (period of 1 year) after the year 1995

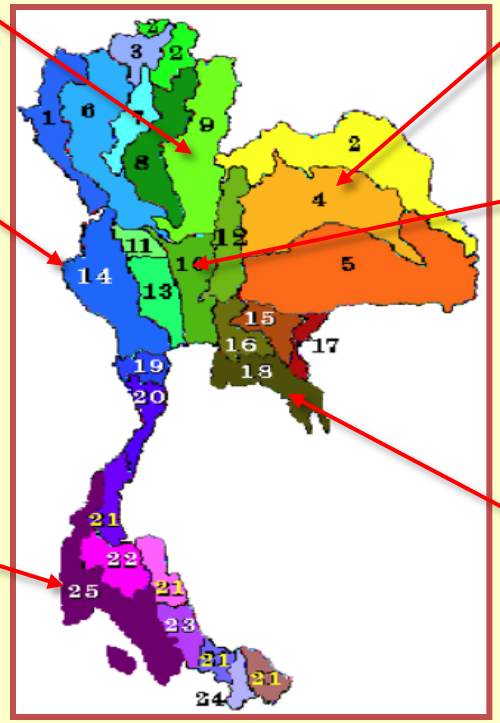
Annual Rainfall Trend

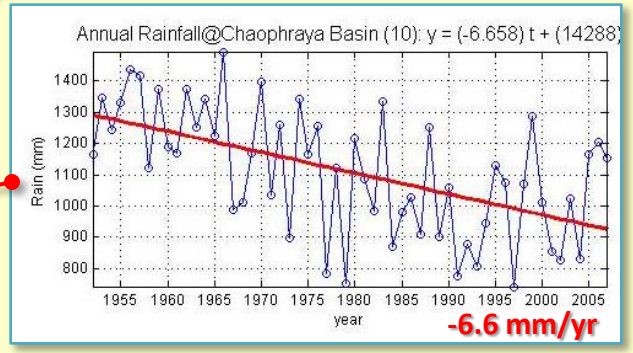


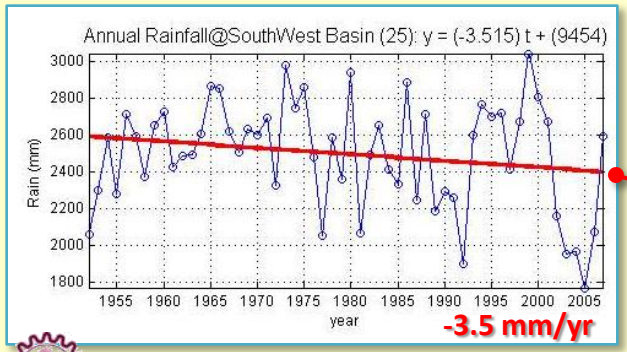


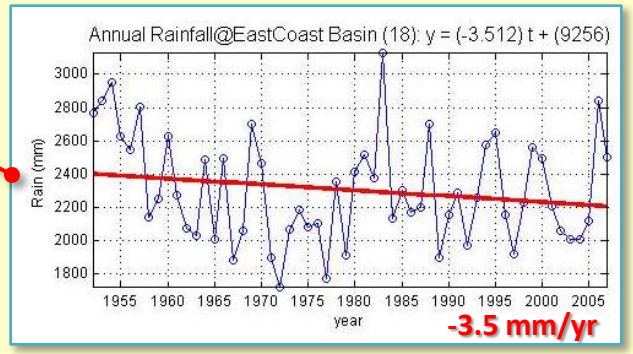




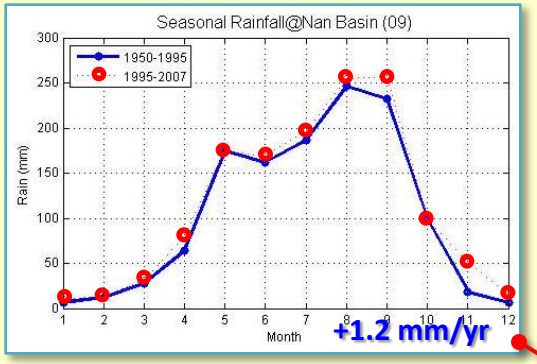


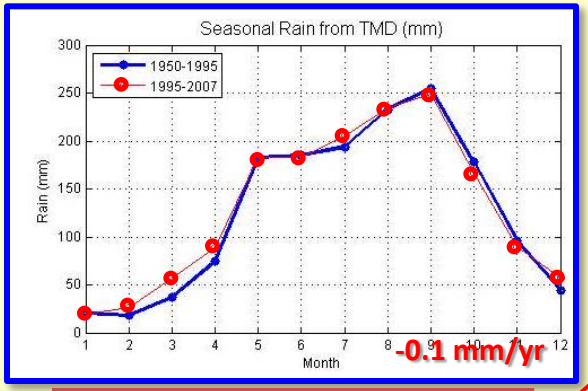


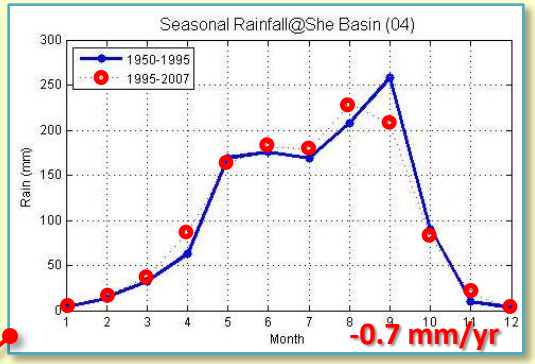


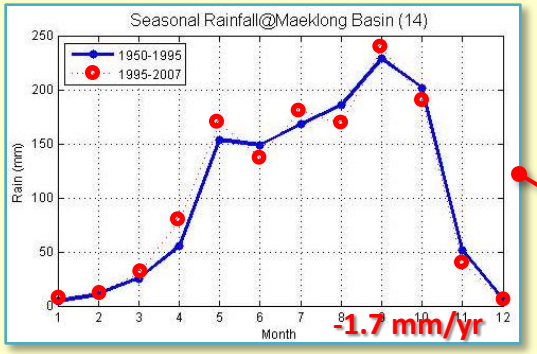


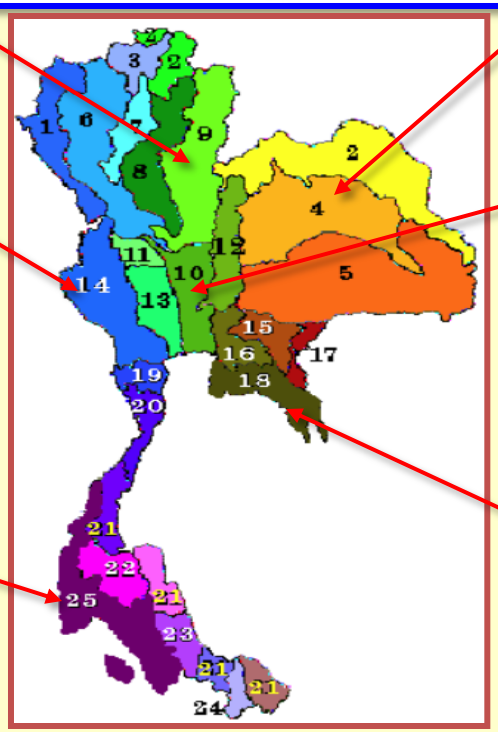
Seasonal Rainfall (1950-1995 vs. 1995 – 2007)

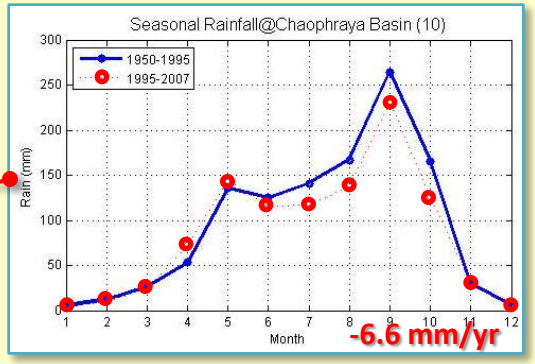


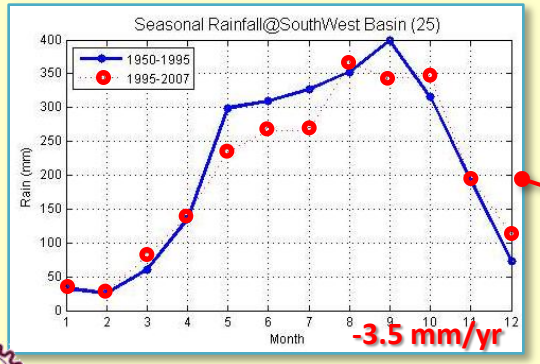


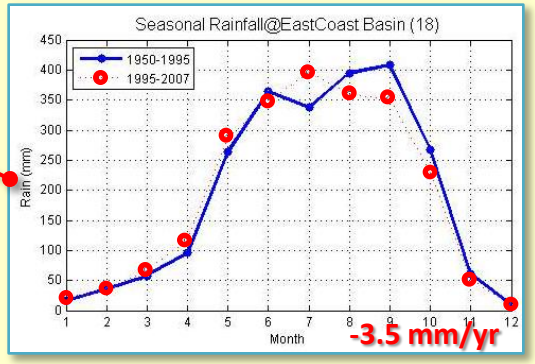




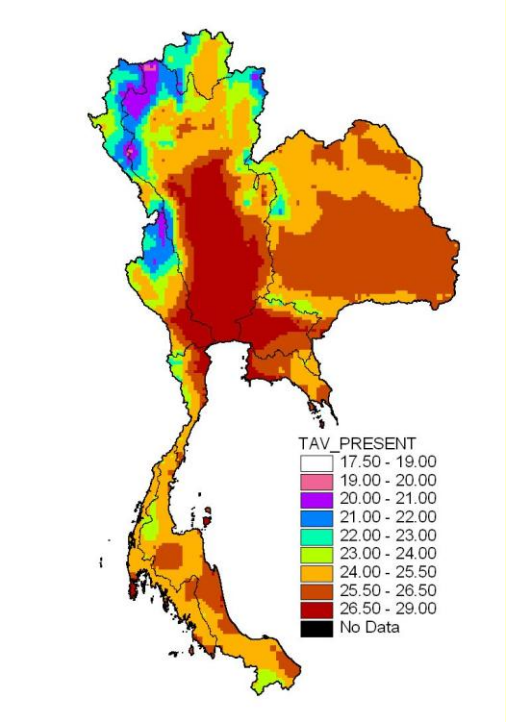




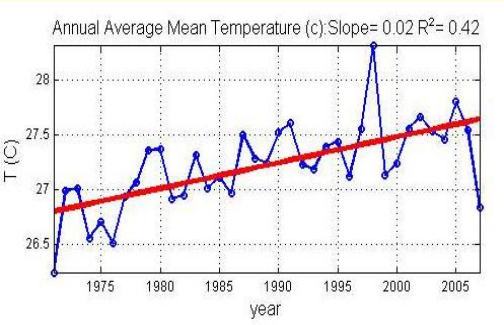


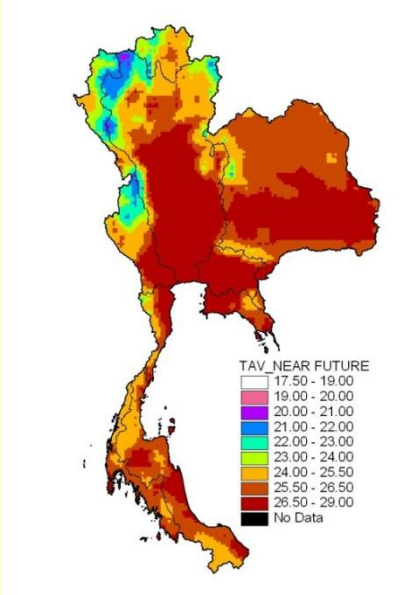


MRI GCM (Japan)

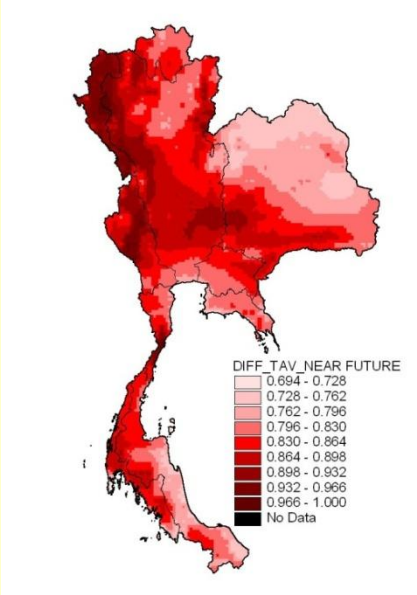


Present Average Temperature

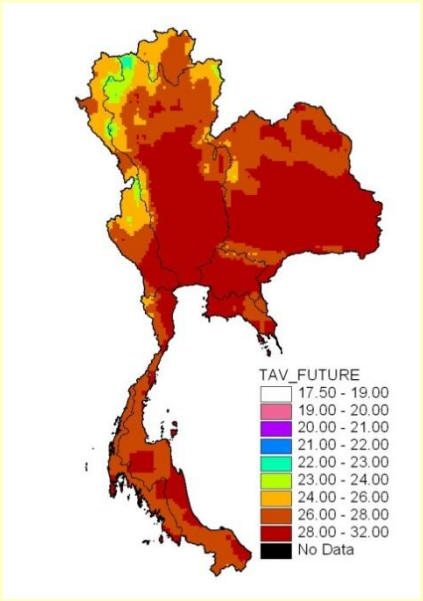




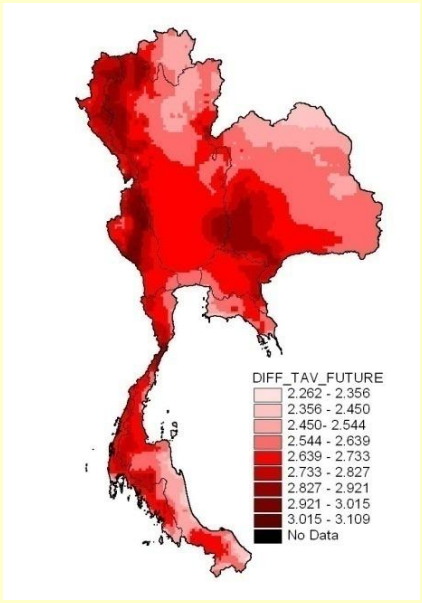
Near Future (2015-2039)



Difference

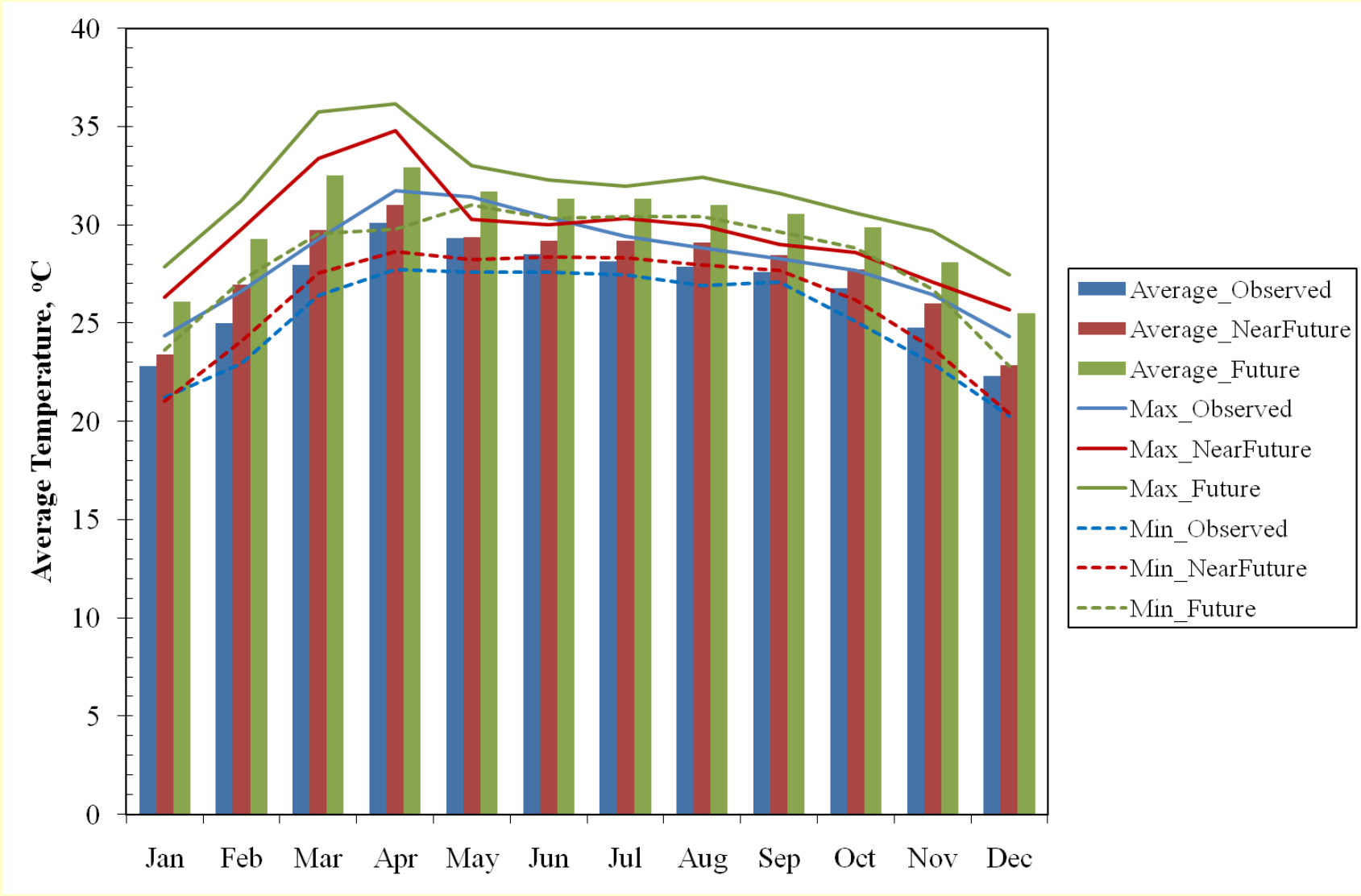


Future (2075-2099)

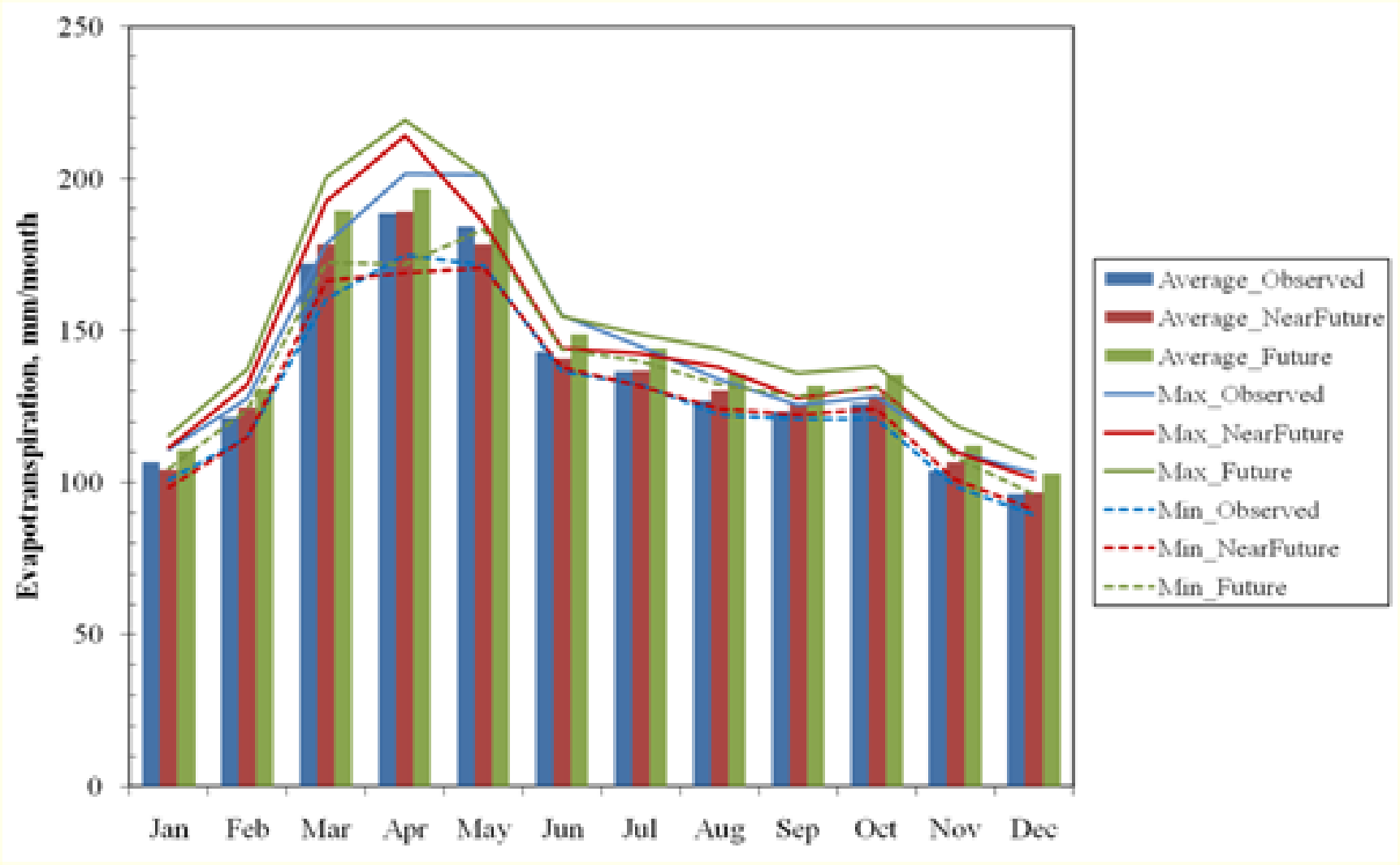


Difference

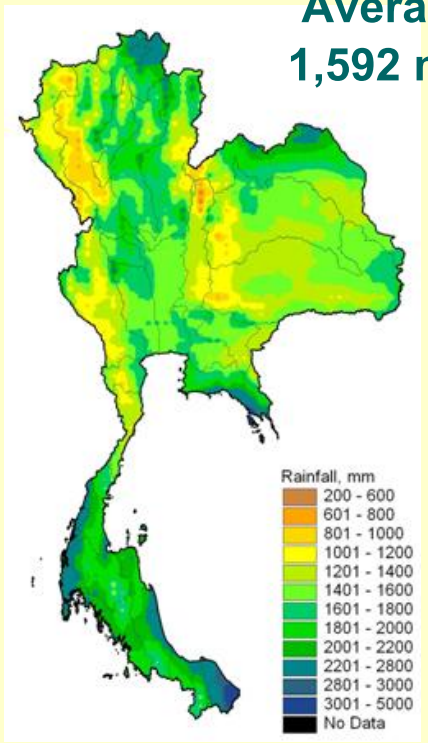
Comparison of Monthly Observed and Downscaled Near-Future and Far-Future temperature



Comparison of Monthly Observed and Downscaled Near-Future and Far-Future Evapotranspiration

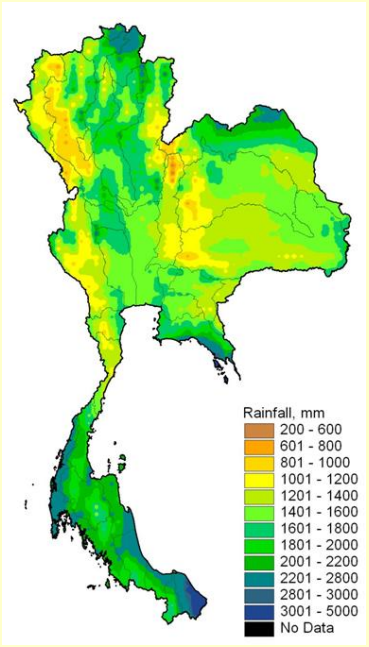


MRI GCM (Japan)



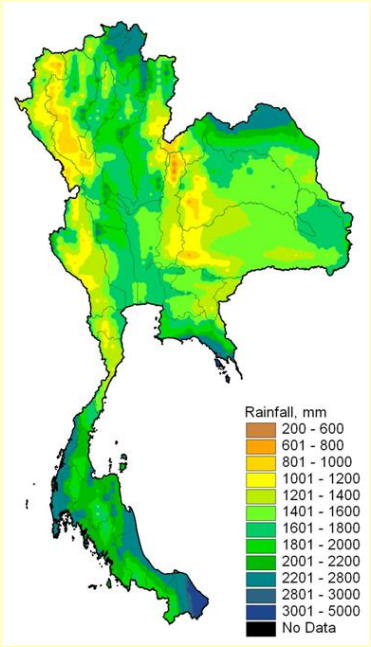
Average 1,592 mm

Present (1979-2006)



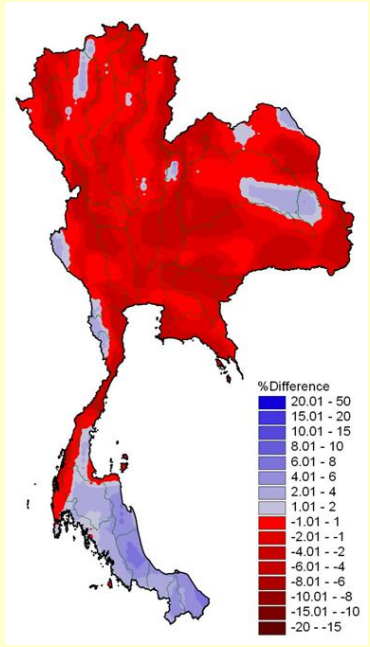
Average 1,584 mm

Near Future (2015-2039)



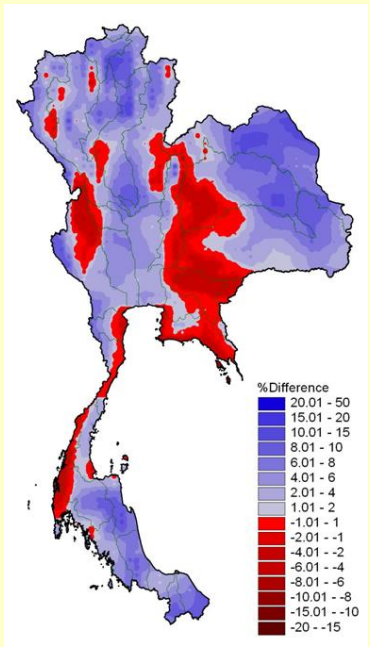
Average 1,651 mm

Future (2075-2099)



%Difference -0.62%

%Difference Near Future



%Difference 3.68%

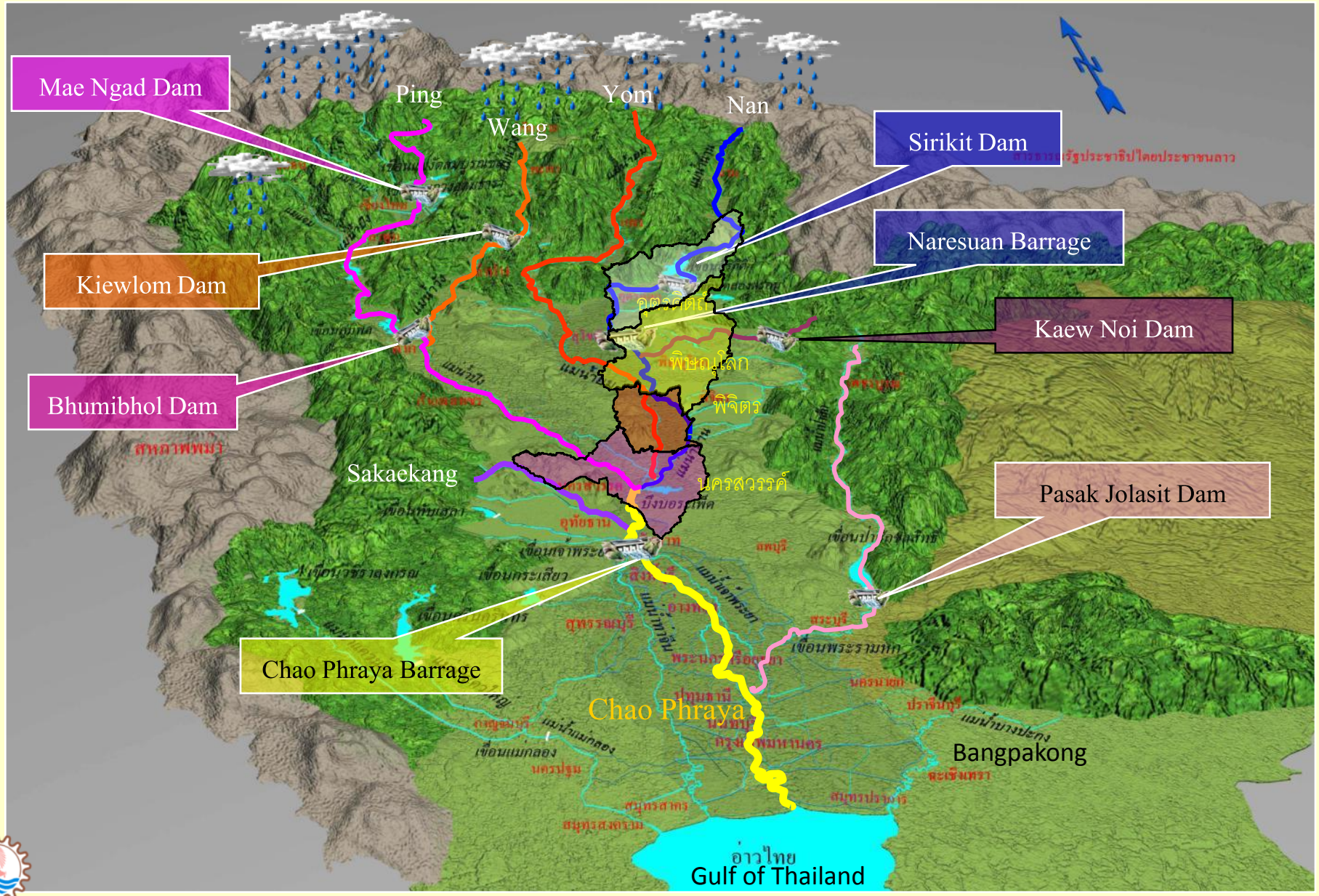
%Difference Future

Impact on Irrigation Project

- Plaichumphol Irrigation Project
  is located in Phitsanulok Province
  about 300 km North of BKK
  cover area of 211,476 rai (34,000 ha).
- The Project receives water from
  Sirikit Dam and also use shallow
  GW as a supplementary during dry season
  and dry year.

Scope of Responsible Areas

Dams and Rivers



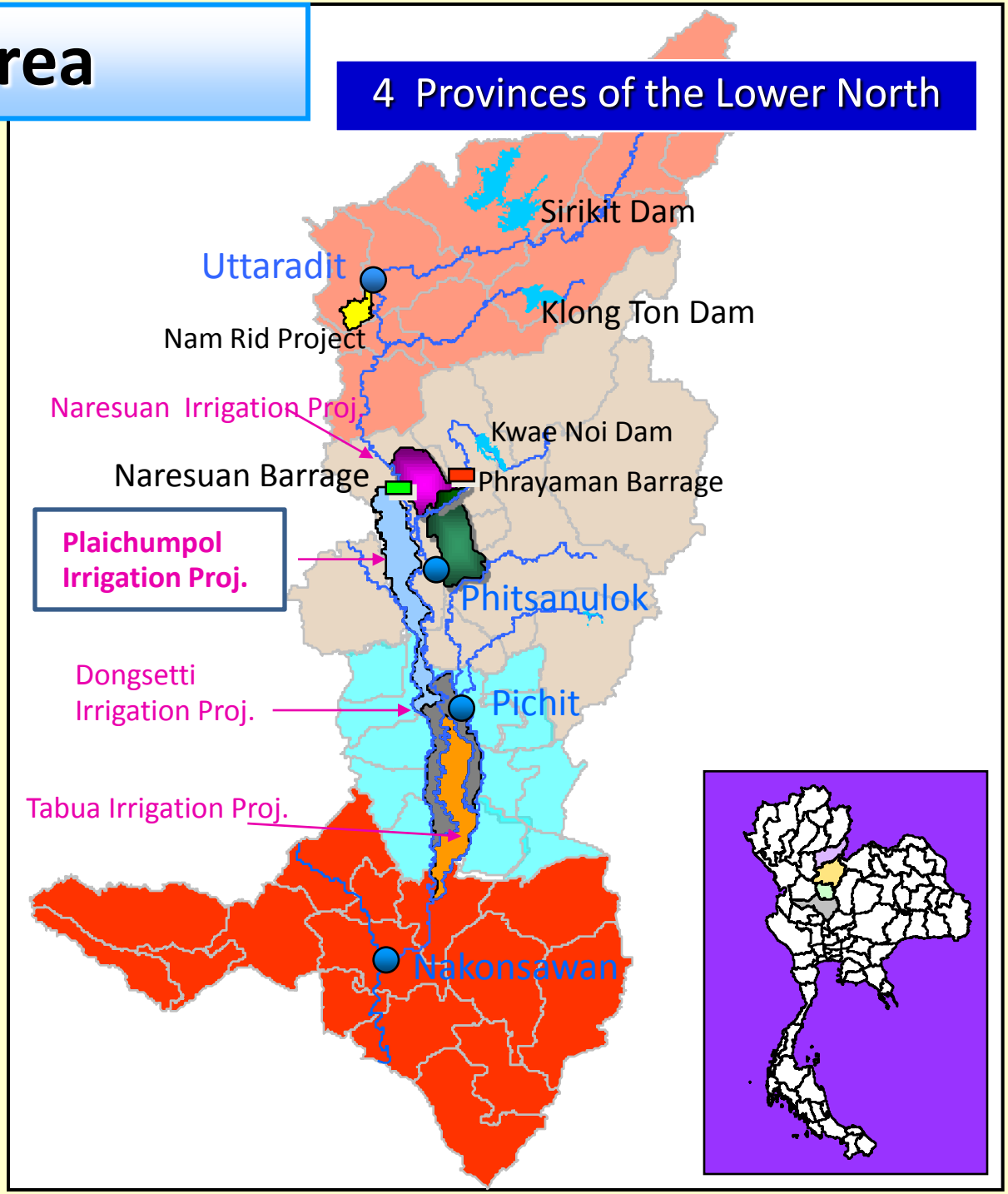
RID RIO 4 Area

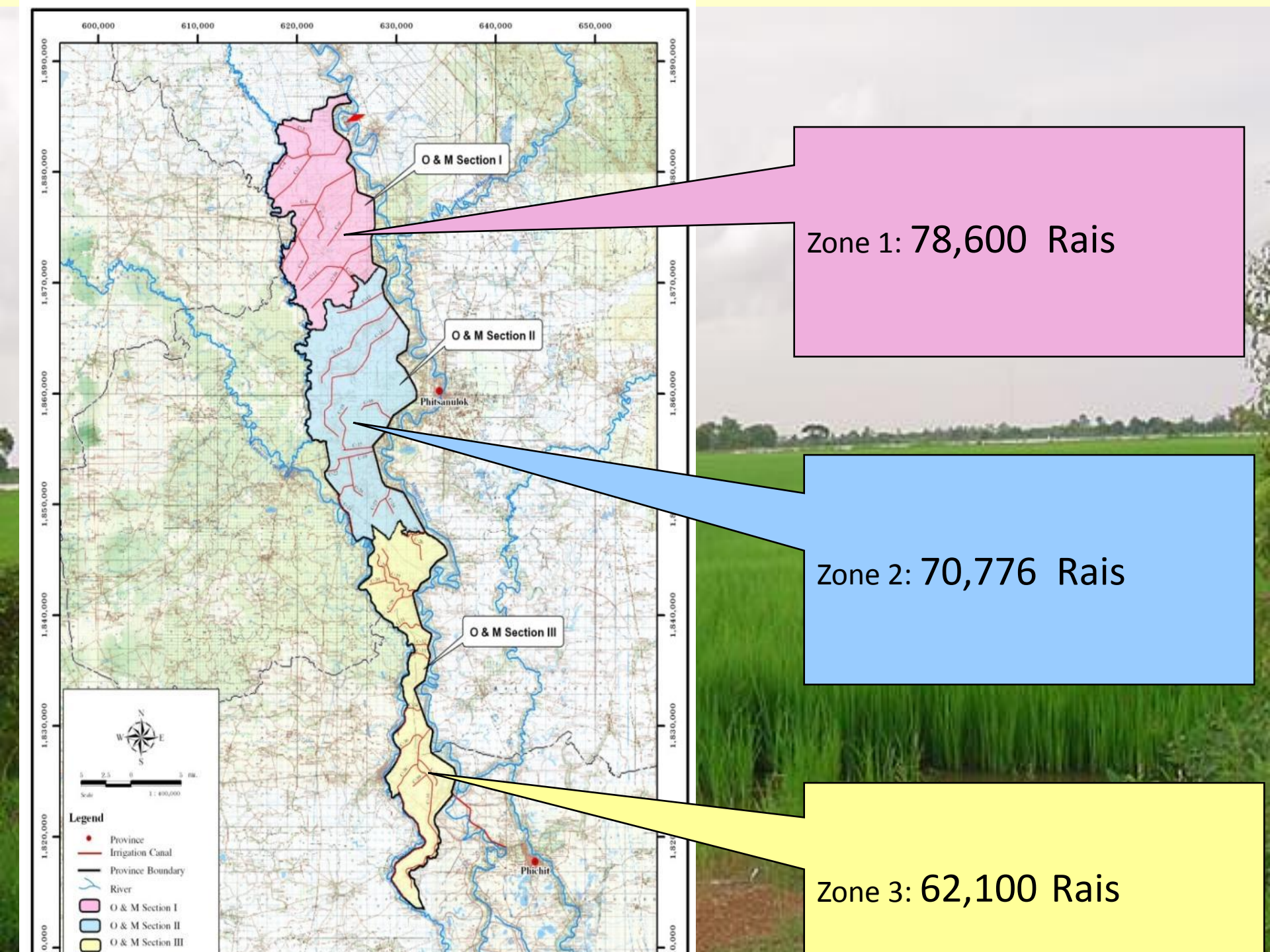
Total 12 Projects

- 4 Provincial Irrigation Proj.
- 5 O & M Projects
- 2 Construction Projects
- 1 Ditch & Dike Projects

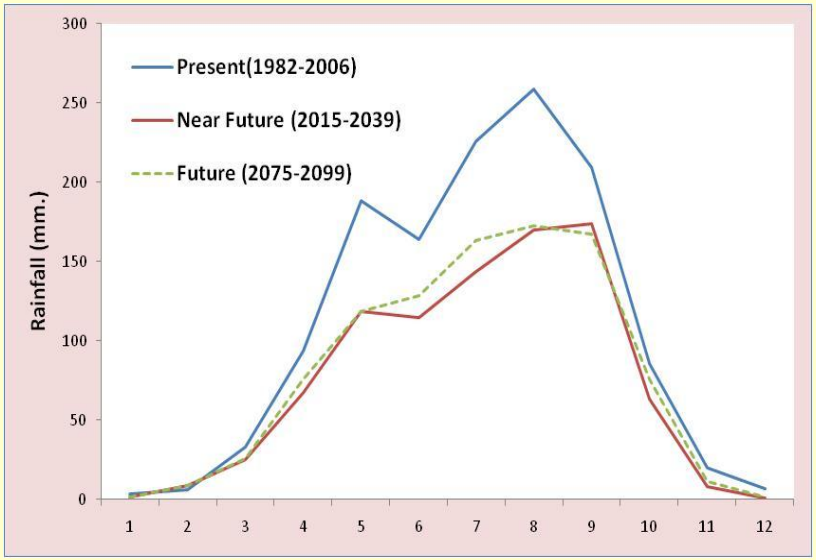
Manpower

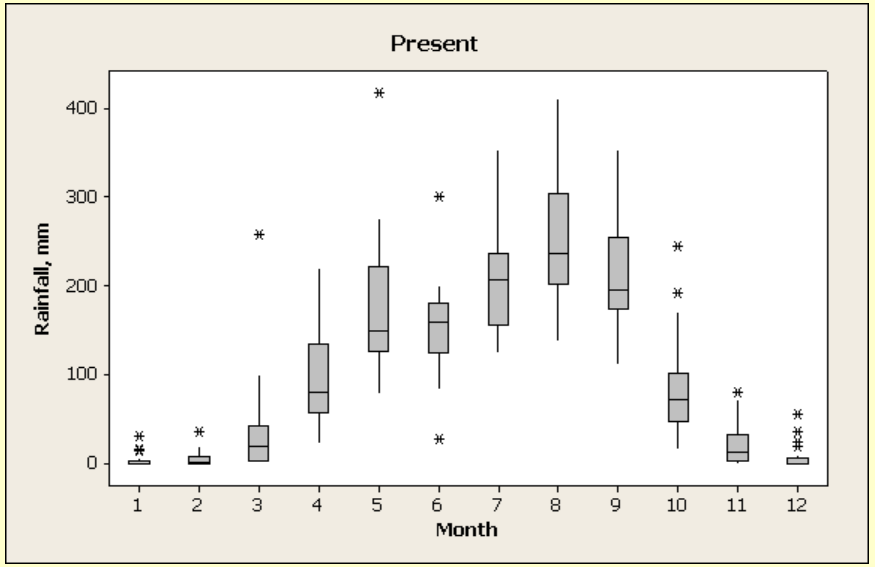
- Ofiicers 243
- Permanent Employees 1,195

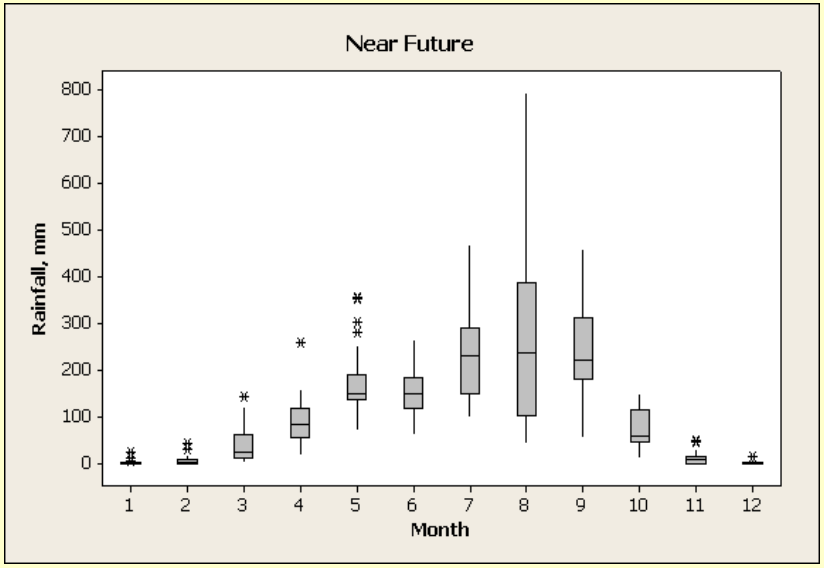


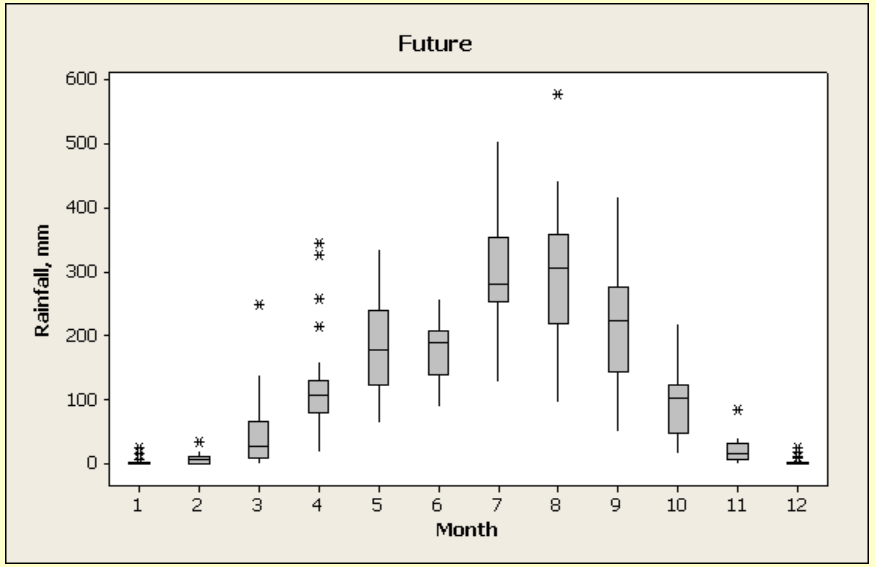

600,000
610,000
620,000
630,000
640,000
650,000
1,890,000
1,880,000
1,870,000
1,860,000
1,850,000
1,840,000
1,830,000
1,820,000
O & M Section I
O & M Section II
O & M Section III
Phitsanulok
Phichit
N
W
E
S
Legend
Province
Irrigation Canal
Province Boundary
River
O & M Section I
O & M Section II
O & M Section III
Zone 1: 78,600 Rais
Zone 2: 70,776 Rais
Zone 3: 62,100 Rais

Rainfall over Sirikit Dam

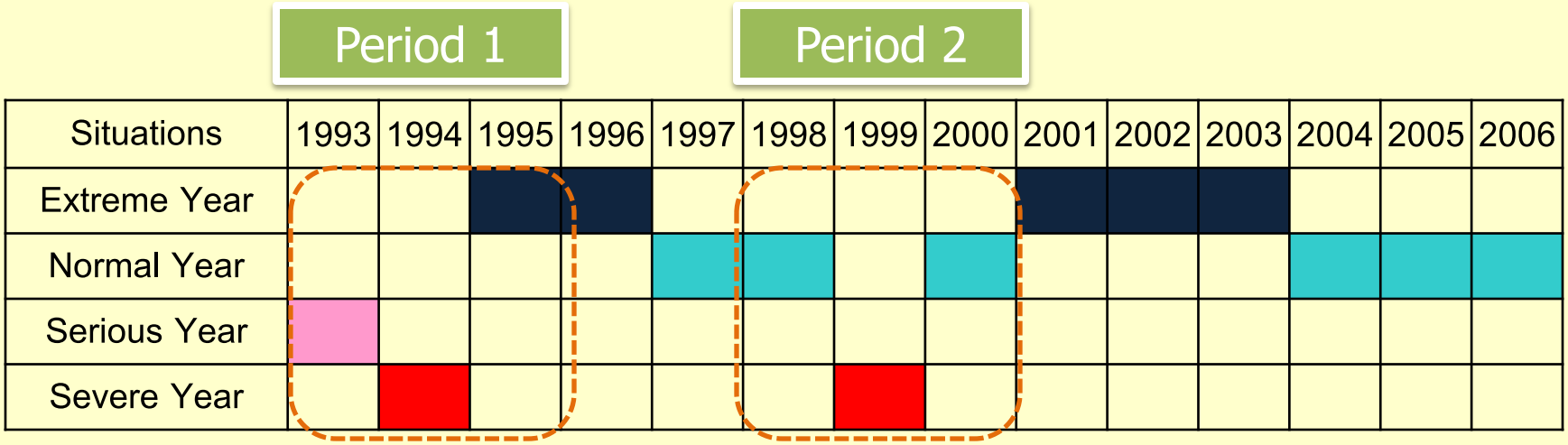








Selected Years for Comparison



	Existing			Near Future			Future		
Period 1	1993	1994	1995	2034	2035	2036	2081	2082	2083
Period 2	1998	1999	2000	2037	2038	2039	2087	2088	2089

Impacts towards GW system

Pumping, water level, storage

Water deficit and groundwater in case of fixed inflow and area

			Water Deficits (MCM.)		Ground Water	
			MCM		M^3/season	
			Wet Season	Dry Season	Wet Season	Dry Season
Period 1	Existing	1993	656.67	126.50	-59.10	101.20
		1994	656.67	126.00	59.10	126.00
		1995	294.44	127.42	26.50	39.50
	Near Future	2034	-21.22%	0.00%	-21.22%	0.00%
		2035	-27.50%	0.00%	-27.50%	0.00%
		2036	40.80%	0.00%	-37.42%	0.00%
	Future	2080	-18.68%	0.00%	-18.68%	0.00%
		2081	-25.63%	0.00%	-25.63%	0.00%
		2082	46.06%	0.00%	46.06%	0.00%
Period 2	Existing	1999	656.67	126.72	59.10	84.90
		2000	656.67	126.50	59.10	126.50
		2001	656.67	126.72	59.10	84.90
	Near Future	2037	-38.39%	-147.91%	-38.39%	-28.50%
		2038	-49.49%	0.00%	-49.49%	0.00%
		2039	-49.98%	0.00%	-49.98%	0.00%
	Future	2087	-34.94%	-149.99%	-34.94%	-30.51%
		2088	-48.18%	0.00%	-48.18%	0.00%
		2089	-46.88%	0.00%	-46.88%	0.00%

Results of water level in extreme cases

Zone 1		Ground Water Level		Climate Change		Climate Change	
		Existing		Near Future		Future	
		Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
Period 1	1993	35.63	35.03	0.50%	0.00%	0.81%	0.00%
	1994	35.97	34.89	1.93%	0.75%	2.12%	4.12%
	1995	36.26	34.79	2.54%	5.38%	0.24%	5.50%
Period 2	1999	36.07	35.35	0.59%	0.00%	0.48%	0.00%
	2000	36.79	35.07	2.28%	4.10%	1.62%	4.07%
	2001	36.47	33.93	2.57%	8.84%	3.02%	8.60%

Analysis results-1

Parameters		Present		Near Future			Far Future		
		average	P90	average	P90	Trend	average	P90	Trend
Temperature (C)	annual	28.2	28.6	29.2	29.8	↗	31.4	31.7	↗
Rain (mm.)	annual	1,193.3	1,504.4	1,187.3	1,201.0	↘	1,309.3	1,314.8	↗
	wet	1,069.4	1,364.2	945.8	1,203.1	↘	1,054.0	1,128.5	↘
	dry	123.5	129.7	241.5	265.2	↗	255.4	276.5	↗
Water Demand(1) (MCM)	annual	697.2	729.5	792.1	830.9	↗	753.0	845.5	↗
	wet	652.3	695.4	646.7	735.5	↘	620.0	689.8	↘
	dry	44.9	68.2	145.4	165.3	↗	133.0	154.4	↗
Water Demand (2) (MCM)	annual	697.2	729.5	741.4	821.3	↗	700.4	844.9	↗
	wet	652.3	695.4	559.7	587.1	↘	530.1	598.6	↘
	dry	44.9	68.2	181.7	220.1	↗	170.3	216.8	↗

Analysis results-2

Parameters		Present		Near Future			Far Future		
		average	P90	average	P90	Trend	average	P90	Trend
Recharge rate (mm)	annual	109.5	137.6	103.6	113.1	↘	115.1	123.7	↗
	wet	101.7	127.2	89.0	96.3	↘	99.2	106.1	↘
	dry	7.9	12.6	14.6	19.1	↗	15.9	21.9	↗
pumping (1) (MCM)	annual	52.4	68.42	56.1	64.1	↗	50.8	72.7	↘
	wet	41.7	57.24	36.9	53.1	↘	33.1	48.6	↘
	dry	13.7	26.41	19.2	24.8	↗	17.7	30.7	↗
pumping (2) (MCM)	annual	52.4	68.42	55.3	75.4	↗	59.1	82.1	↗
	wet	41.7	57.24	31.8	45.3	↘	28.5	39.5	↘
	dry	13.7	26.41	23.5	35.3	↗	30.6	40.5	↗

Analysis results-3

Parameters		Present		Near Future			Far Future		
		average	P90	average	P90	Trend	average	P90	Trend
GW Level (1) (m MSL)	annual	34.04	36.07	33.77	35.81	↘	34.62	36.67	↗
	wet	34.28	36.38	34.59	36.69	↗	34.64	36.72	↗
	dry	34.25	36.22	33.68	36.15	↘	34.59	36.60	↗
GW Level (2) (m MSL)	annual	34.19	36.27	33.79	36.07	↘	34.35	36.31	↗
	wet	34.28	36.41	34.53	36.66	↗	34.46	36.48	↗
	dry	34.25	36.31	33.73	36.12	↘	34.42	36.33	↗
Storage Change (MCM/month)	annual	-2.27	2.60	-2.87	2.91	↘	-0.59	0.23	↗
	wet	-0.59	4.65	-0.51	-0.04	↗	-0.48	-0.08	↗
	dry	-3.95	-0.12	-4.12	-1.25	↘	-0.79	0.05	↗

Recommendations from the study

- Adjust the rule curve of dam/reservoir in accordance with water year in which future water deficit could be reduced.
- Adjust the cropping calendar by moving forward for about 2 weeks in order to reduce water deficit -5% for rainy season and increase 30% in dry season.
- Provide farmers with knowledge on self-adaptation techniques

Conclusions

- Under climate change, rainfall and pattern will change
- more water use due to the temperature and water demand increase due to socio-economical growth
- Less rain in the near future period induced more on GW use esp. in serious year
- Need more GW resource development /conservation and more proper and efficient management including demand side management

Future issues

- Impacts towards recharge mechanism
- Groundwater and reforestation
- Impacts on Groundwater contamination

List of projects done

- *1996-1997* Groundwater Rehabitation Study funded by Department of Public Works
- *2000-2002* Groundwater Potential and Demand Study for GW Management in the Northern Part of Lower Central Plain funded by the Thailand Research Fund
- *2003-2004* Groundwater Monitoring in the north of Lower Central Plain and the development of Groundwater Data Linkage System
- *2004-2005* The Assessment of Pasak Jolasid Dam Project (Effectiveness of Surface Water Management and Impacts on Groundwater)
- *2007* The Risk Assessment of the Contamination in Groundwater Resource in Klangdong District, Pakchong, Nakornrachasima Province, funded by Department of 0Groundwater Resource.
- *2008-2009* Analysis of Land Subsidence in Bangkok Metropolitan and its Vicinity Area
- *2008-2009* The Master Plan for Groundwater Resources and Environment Development and Conservation (2009 – 2012)
- *2010* Impact of Climate Change on Irrigation System and Adaptation Measures
- *2010-2011* Comparative Studies on Development Strategies to adapt for the Nature Disasters due to Climatic Change in Thailand
- *2010-2012* A study of the risk assessment of the population in the area of industrial pollution in Rayong.

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- Sucharit K. et. al., 2006, Water Use Situation, Chulalongkorn University. Technical Report (in Thai).
- DGR, 2008, Impact Evaluation of GW Conservation Fee in the Bangkok and its vicinity area, Final Report (in Thai).
- DGR, 2008, Master Plan for GW Resources and Environment Conservation, Final Report (in Thai).
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- Sucharit K. 2010, Climate Change Impacts towards Irrigation and Groundwater System : Plaichumphol Case Study, Technical Report ISBN 978-616-551-250-3, (in Thai).

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- JIID, 2010, Impact Study on Irrigation Systems and Adaptation Measures (Plaichumphol Irrigation Project-case study), Final Report.
- NESDB (2010) National Account to consider cost on Resources and Environment, Final Report (in Thai).
- Winai C. and Sucharit K. 2010 Climate Change Impact on Water Resources Management in East Coast Basin Thailand, Proc 2nd Regional Conference on Global Environment, Ho Chi Min City, Vietnam, Mar 8-9.
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- JIID, 2011, Impact Study on Irrigation Systems and Adaptation Measures (Wang Bua Irrigation Project-case study), Final Report.

Website

www.watercu.eng.chula.ac.th

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