

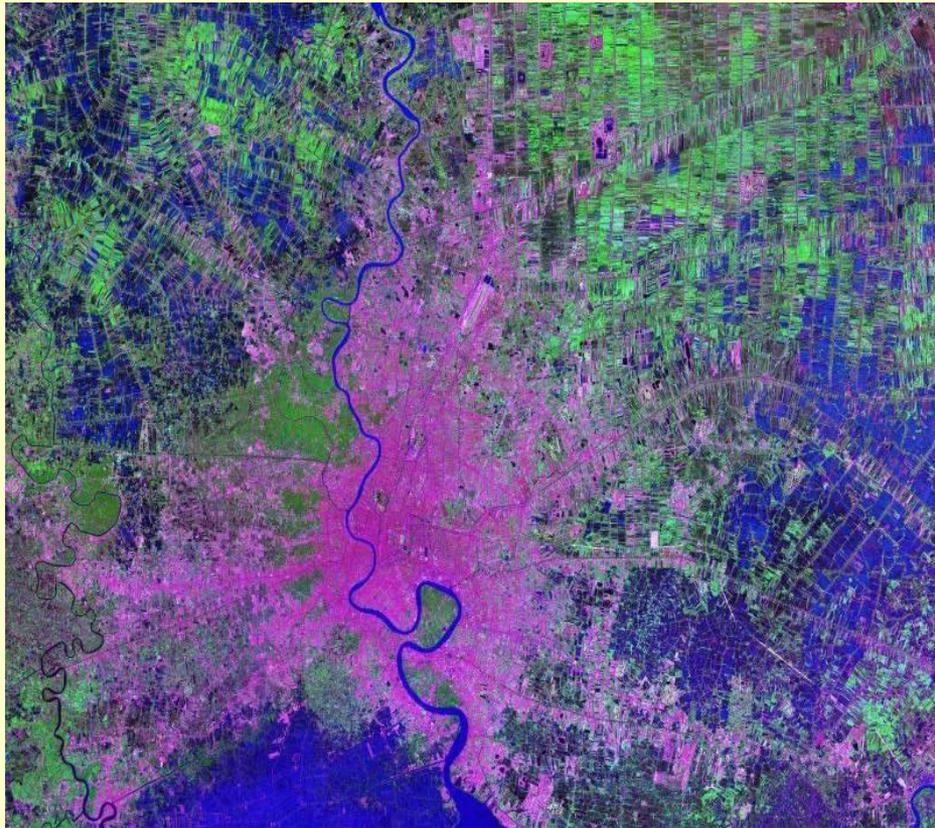
Climate Change Impacts towards GW in an irrigation area

RIHN Feedback Seminar
February 28, 2011
Bangkok, Thailand

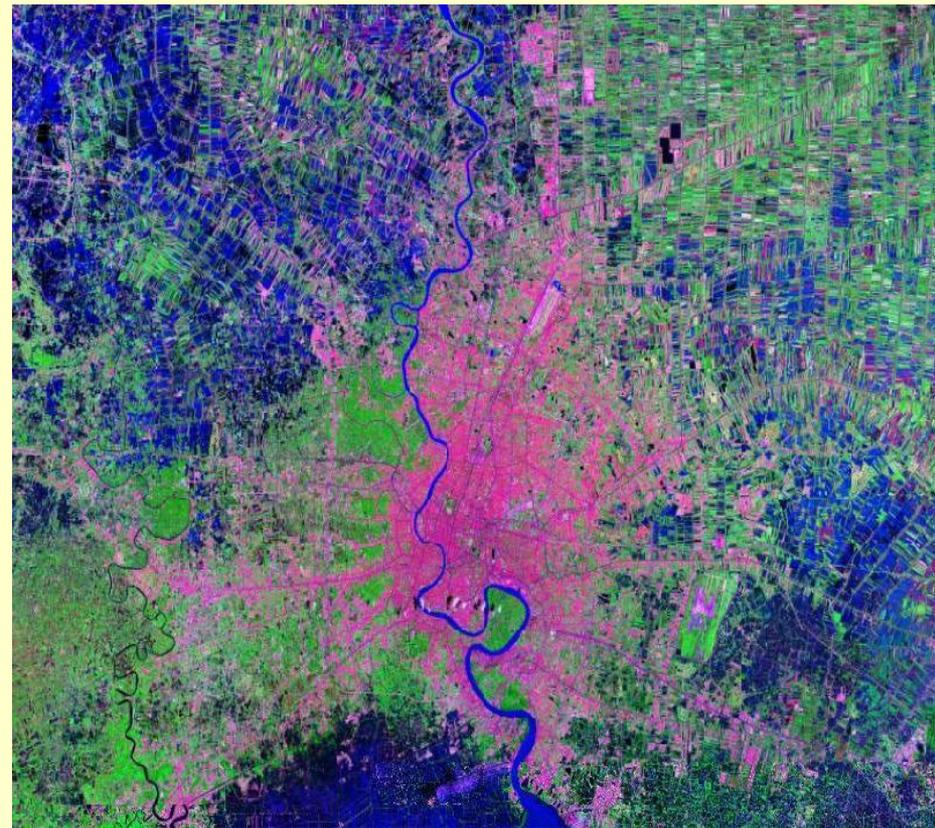
Presentation items

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

Urbanization from GeoCover better quality , quantity and reliability

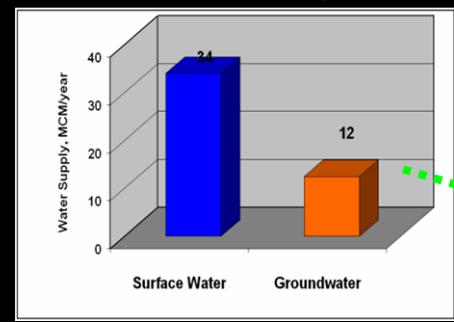


1990

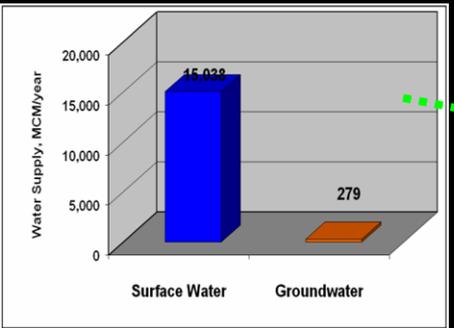


2000

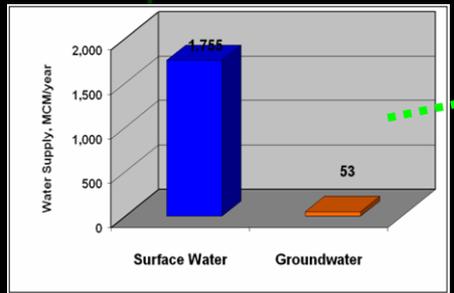
Salawin Basin Group



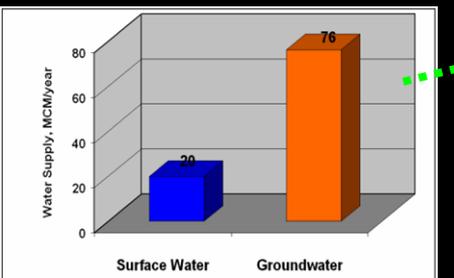
Mae Klong



PrachuapkhiriKhan Coast

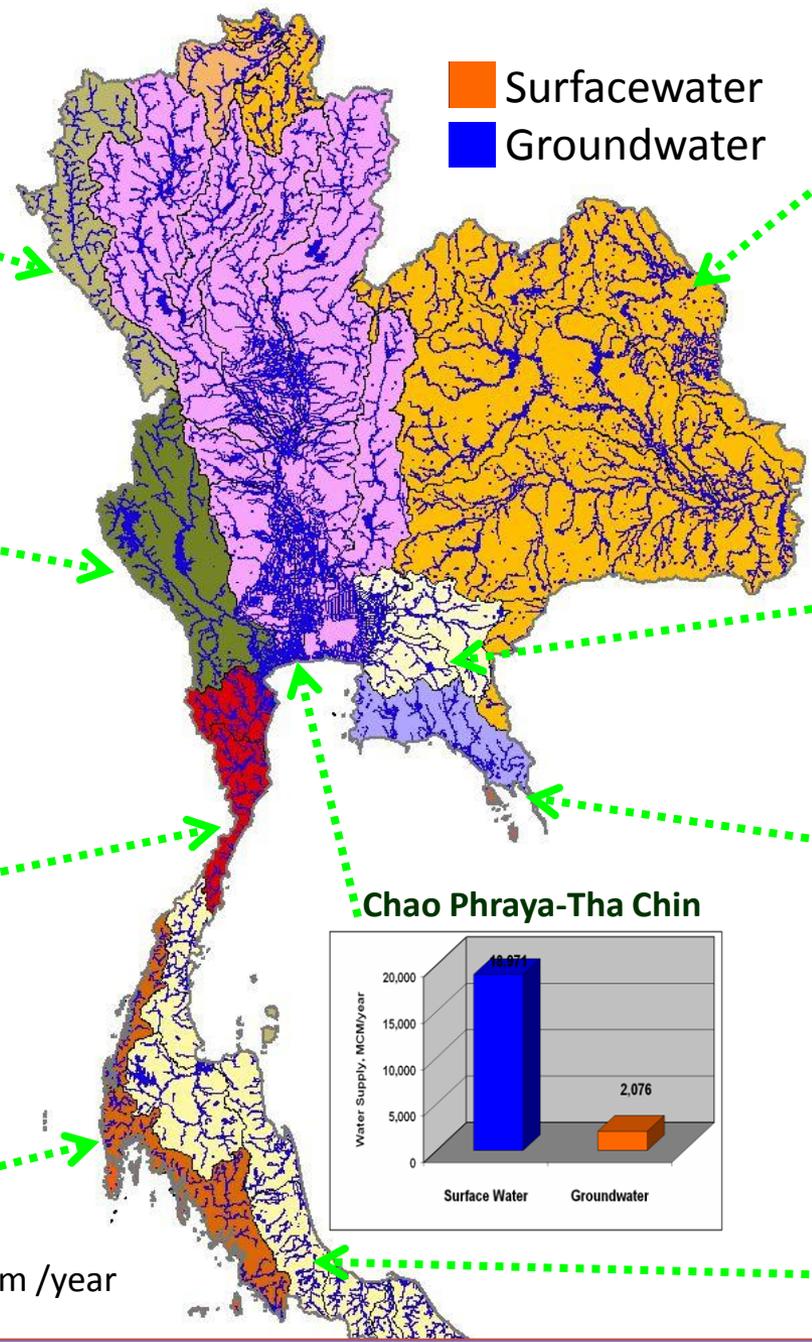


Peninsula- West Coast

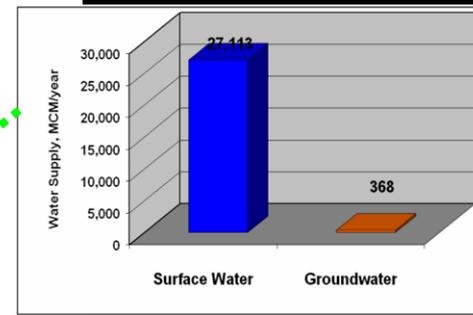


Unit : mcm /year

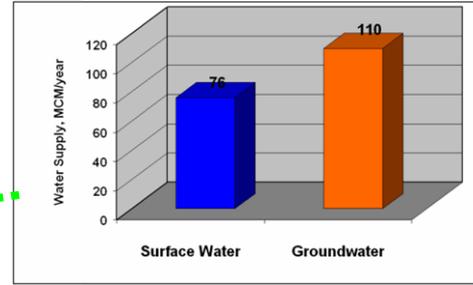
Water use by sources in each region(2003)



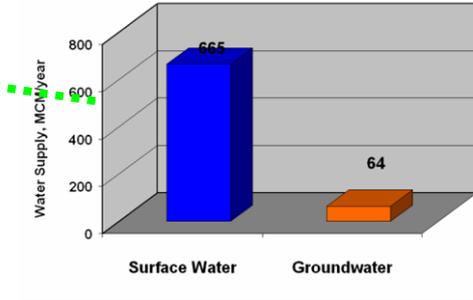
Mae Nam Klong



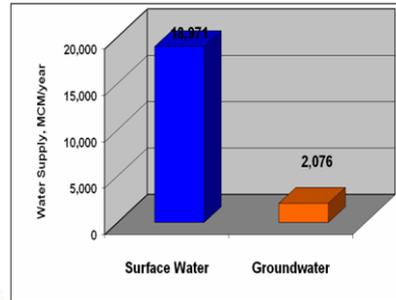
Bang Pakong



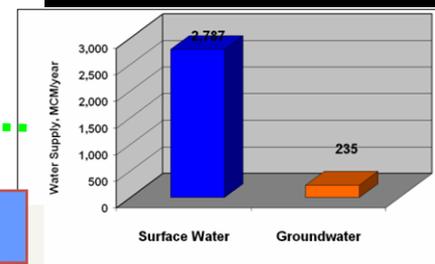
East Coast - Gulf



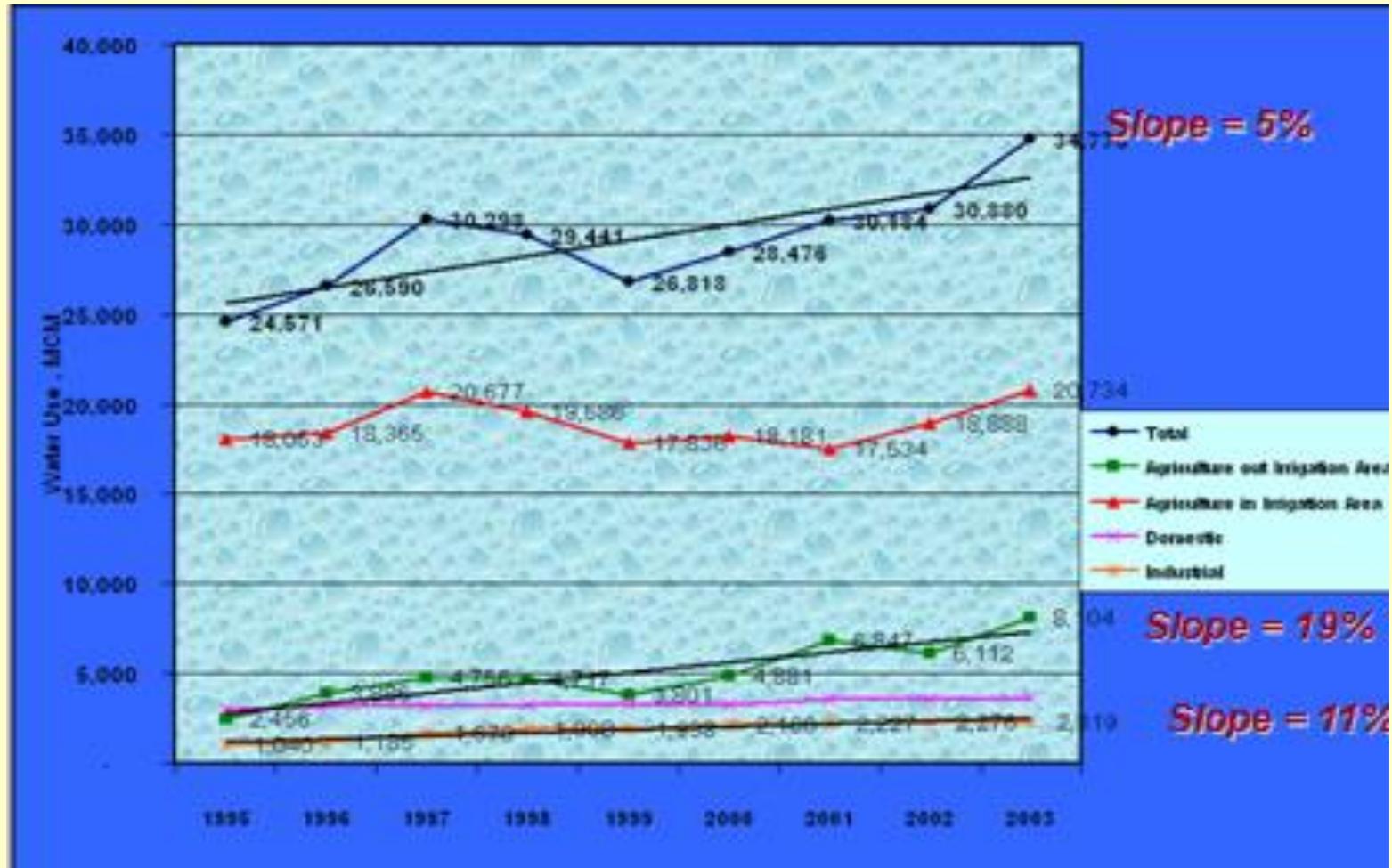
Chao Phraya-Tha Chin



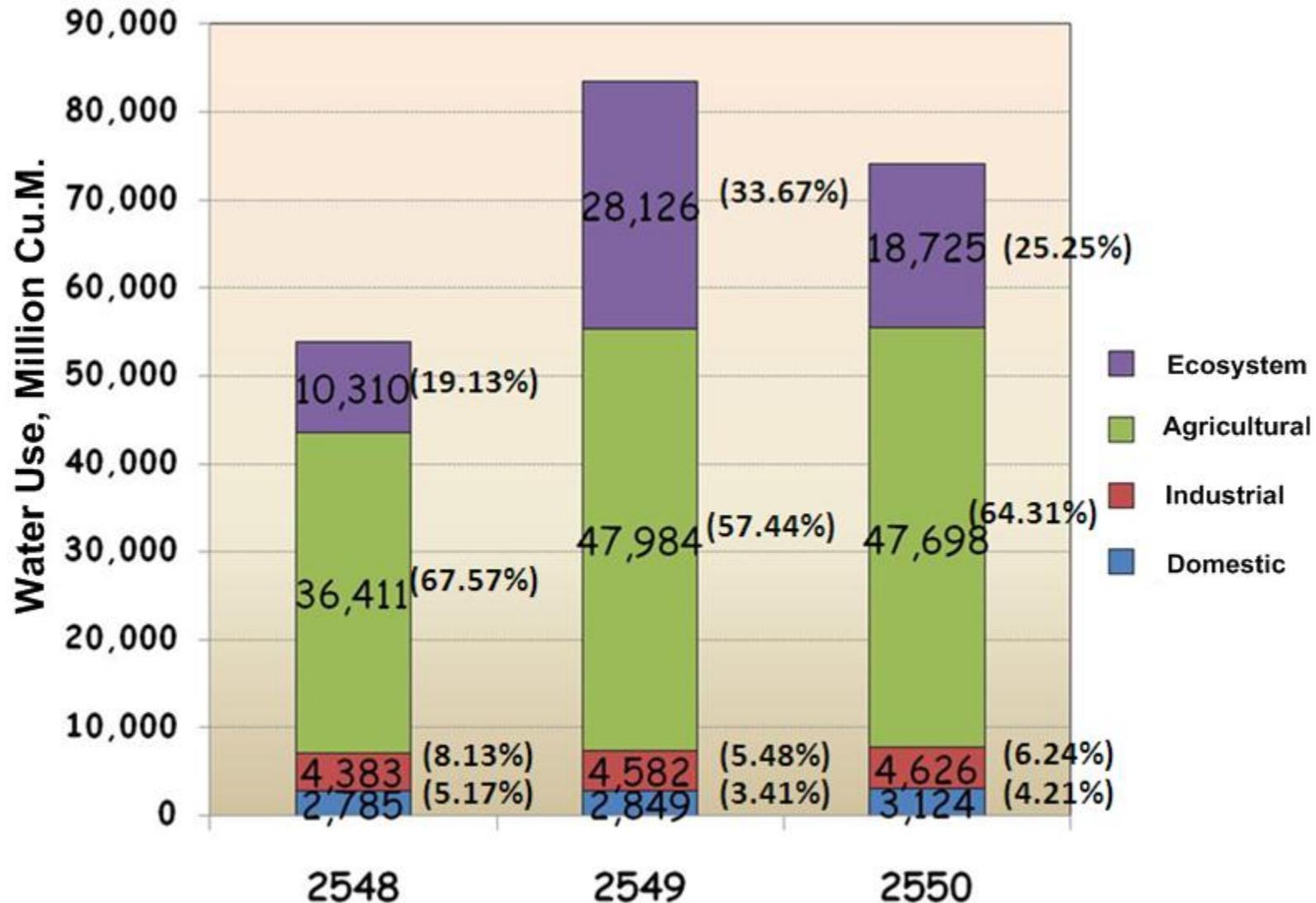
Peninsula - East Coast



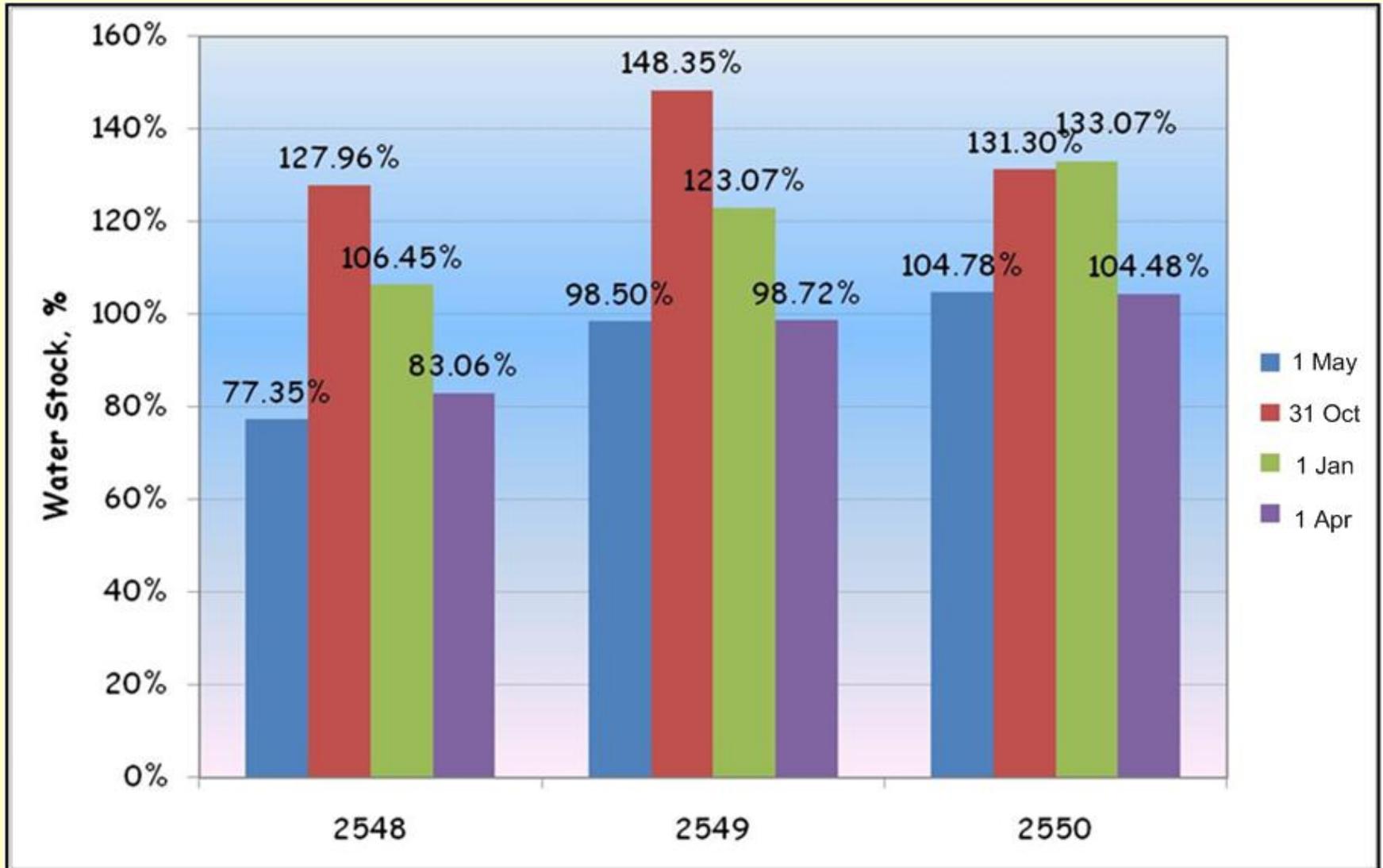
Water use in 1995-2003



Water Use in Thailand

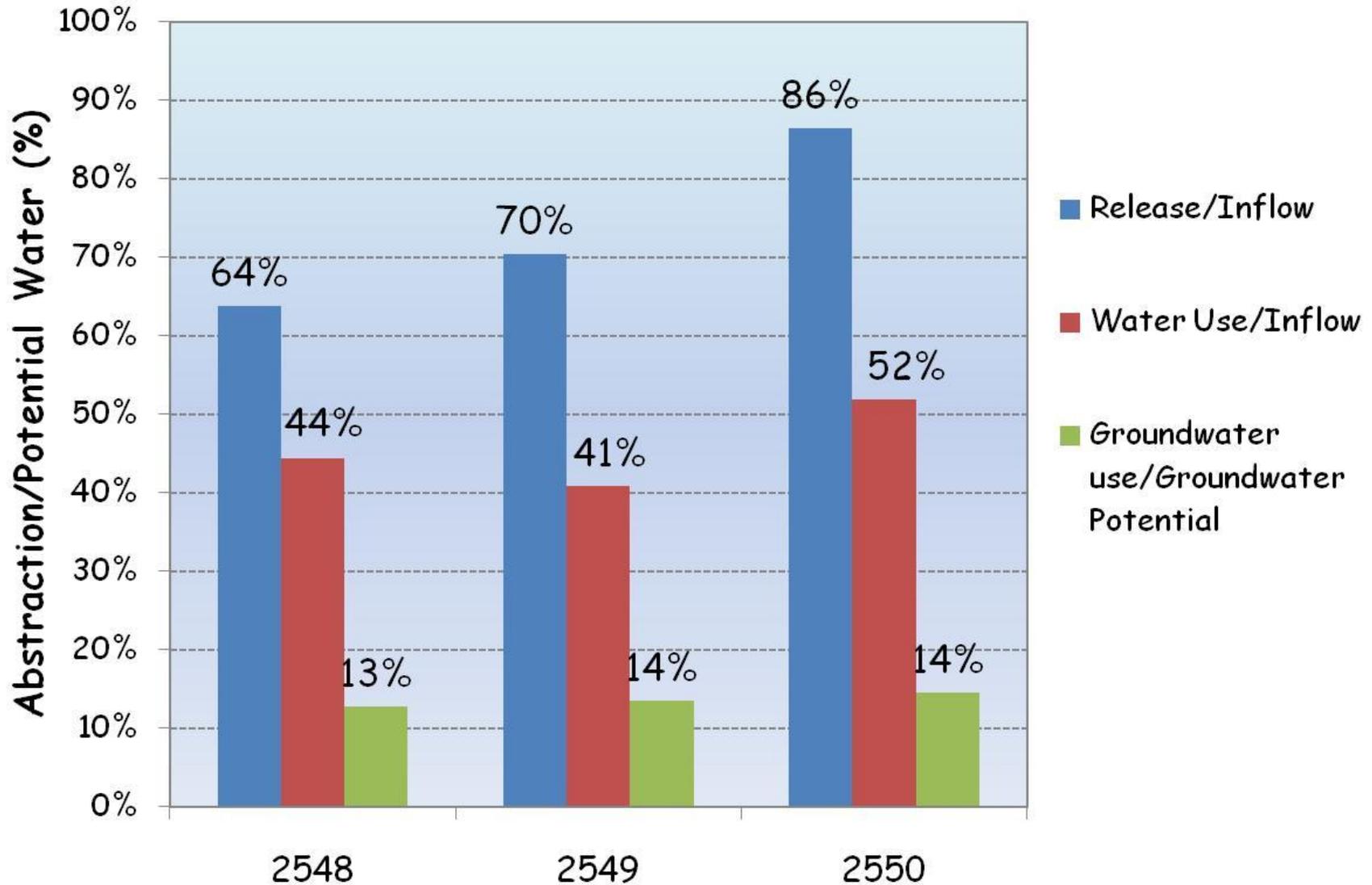


Water Stock*



Remarks : data only from large scaled reservoir

Abstraction/Potential Water (%)



Remarks: data from large scaled reservoir only

Thai Water Balance

Water in Atmosphere

Unit : Million Cu.m./year

S1

S2

S3

USE

Inflow of Large Reservoir	
39,141	

Natural Watershed	
2,191	

Groundwater	
20,310	

Stream	

Large/Medium reservoir		
In	Out	Diff
39,141	29,027	10,114

Small Reservoir		
In	Out	Diff
886	886	-

Large/Medium Irrigation Project		
In	Out	Diff
29,027	22,675	6,351

Small Irrigation Project		
In	Out	Diff
886	720	166

Pumping Irrigation Project		
In	Out	Diff
338	338	-

Pond		
In	Out	Diff
968	931	37

Estate Industrial		
In	Out	Diff
212.83	212.83	-

PWA/MWA		
In	Out	Diff
2,381	1,840	540

CWA	Business well	Agriculture well	Domestic well	Village Water supply	Public well
326	459	283	246	459	690

Environmental	
10,310	

Industrial in Estate	
212.83	

Municipal Domestic	
1,150	

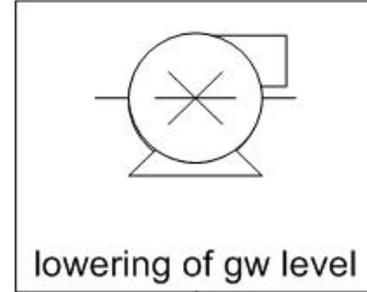
Industrial out Estate	
3,872	

Agriculture in Irrigated area	
22,675	

Agriculture in Rain fed area	
5,452	

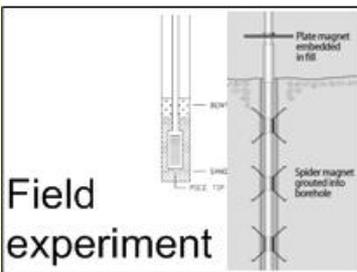
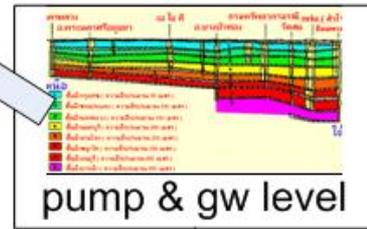
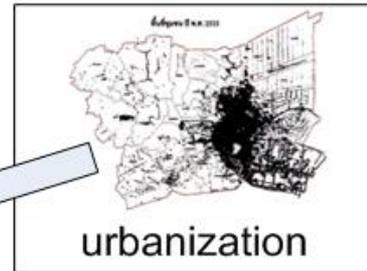
Rural Domestic	
1,394	

Analysis Concept



subsidence situation

Land Subsidence



Land subsidence model

GW model

subsidence causes

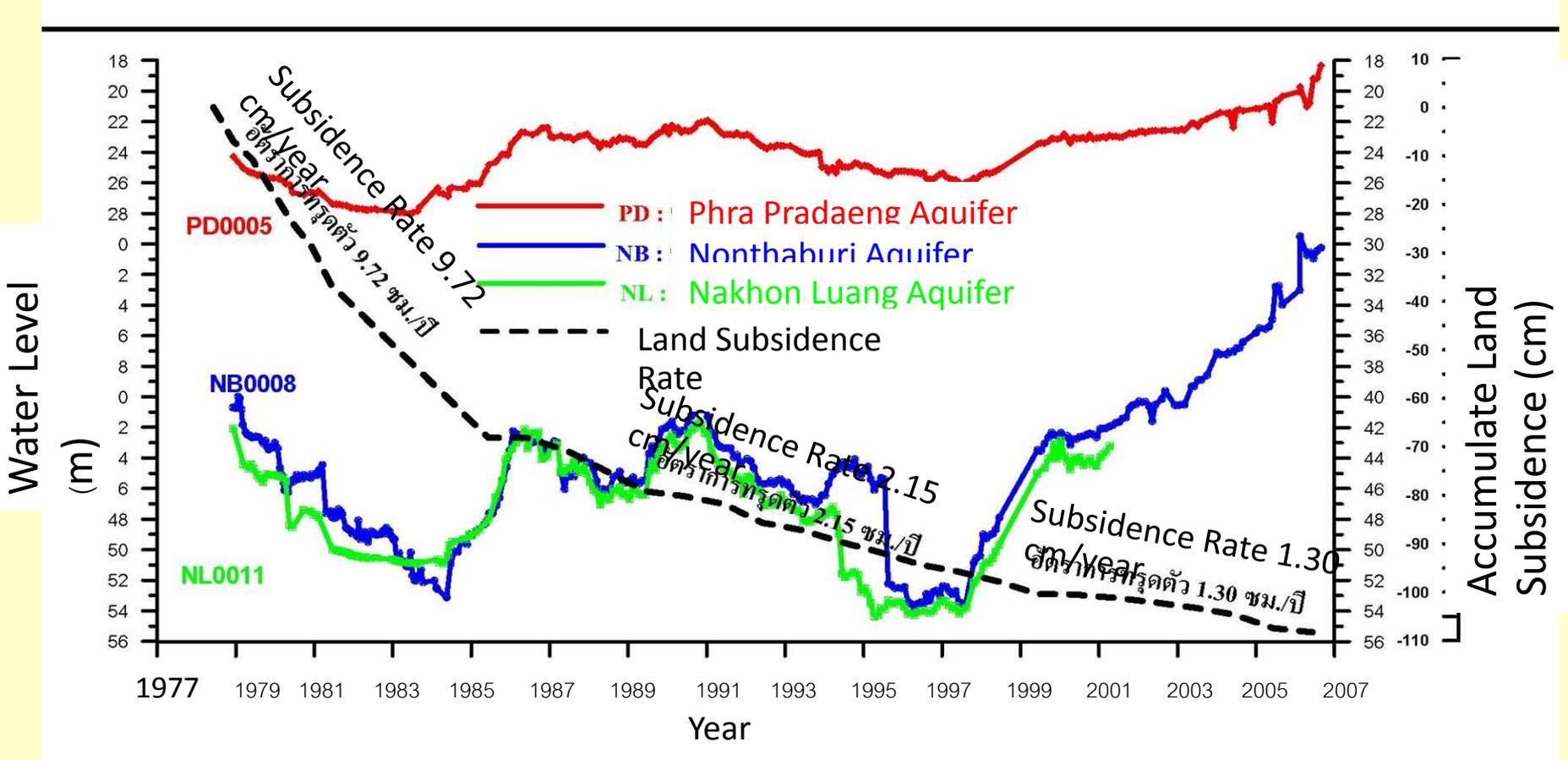
Subsidence analysis

countermeasures

Land subsidence causes

Prediction of subsidence

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



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

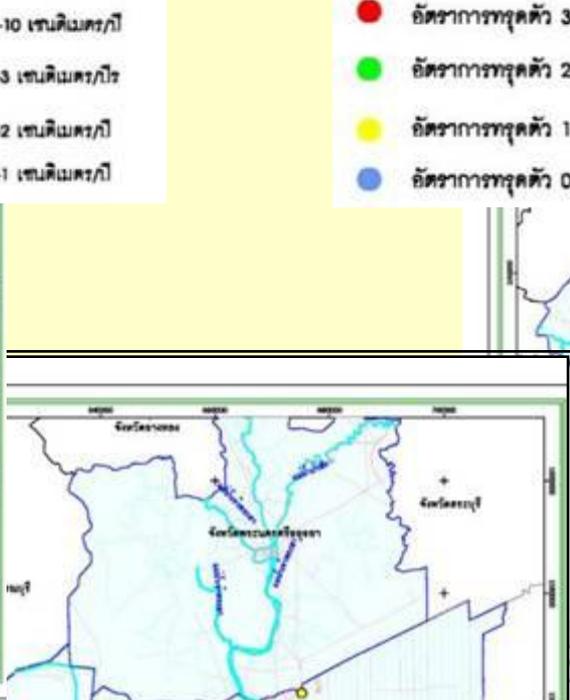
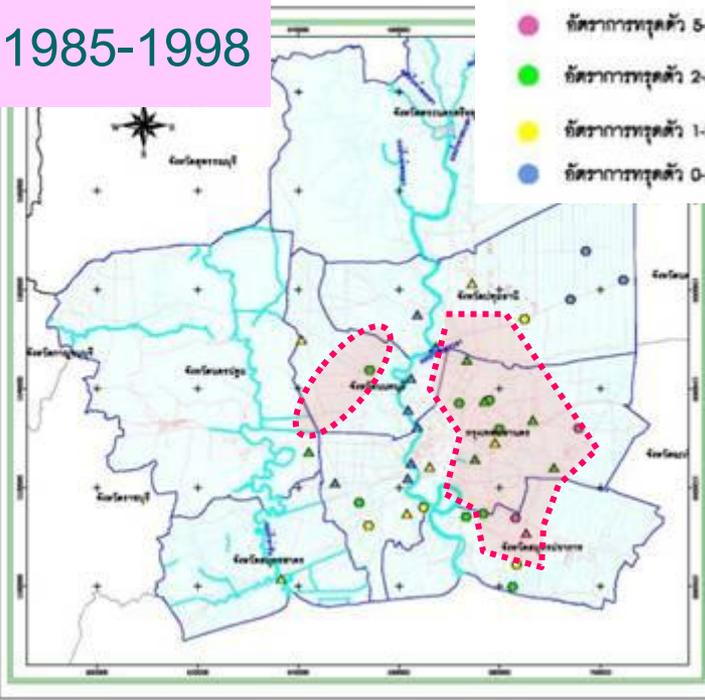
Historical land subsidence

1985-1998

- อัตราการทรุดตัว 5-10 เซนติเมตร/ปี
- อัตราการทรุดตัว 2-3 เซนติเมตร/ปี
- อัตราการทรุดตัว 1-2 เซนติเมตร/ปี
- อัตราการทรุดตัว 0-1 เซนติเมตร/ปี

1998-2005

- อัตราการทรุดตัว 3-5 เซนติเมตร/ปี
- อัตราการทรุดตัว 2-3 เซนติเมตร/ปี
- อัตราการทรุดตัว 1-2 เซนติเมตร/ปี
- อัตราการทรุดตัว 0-1 เซนติเมตร/ปี



● Subsidence rate > 2 cm./year

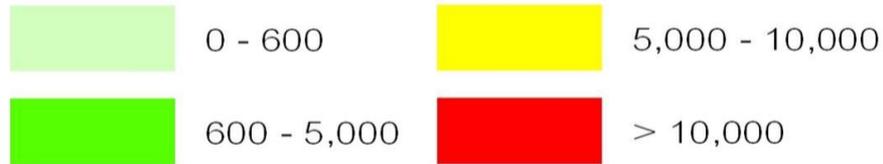
2006-2007

- ขนาดการทรุดตัวประมาณ 2-3 เซนติเมตร/ปี
- ขนาดการทรุดตัวประมาณ 0-2 เซนติเมตร/ปี

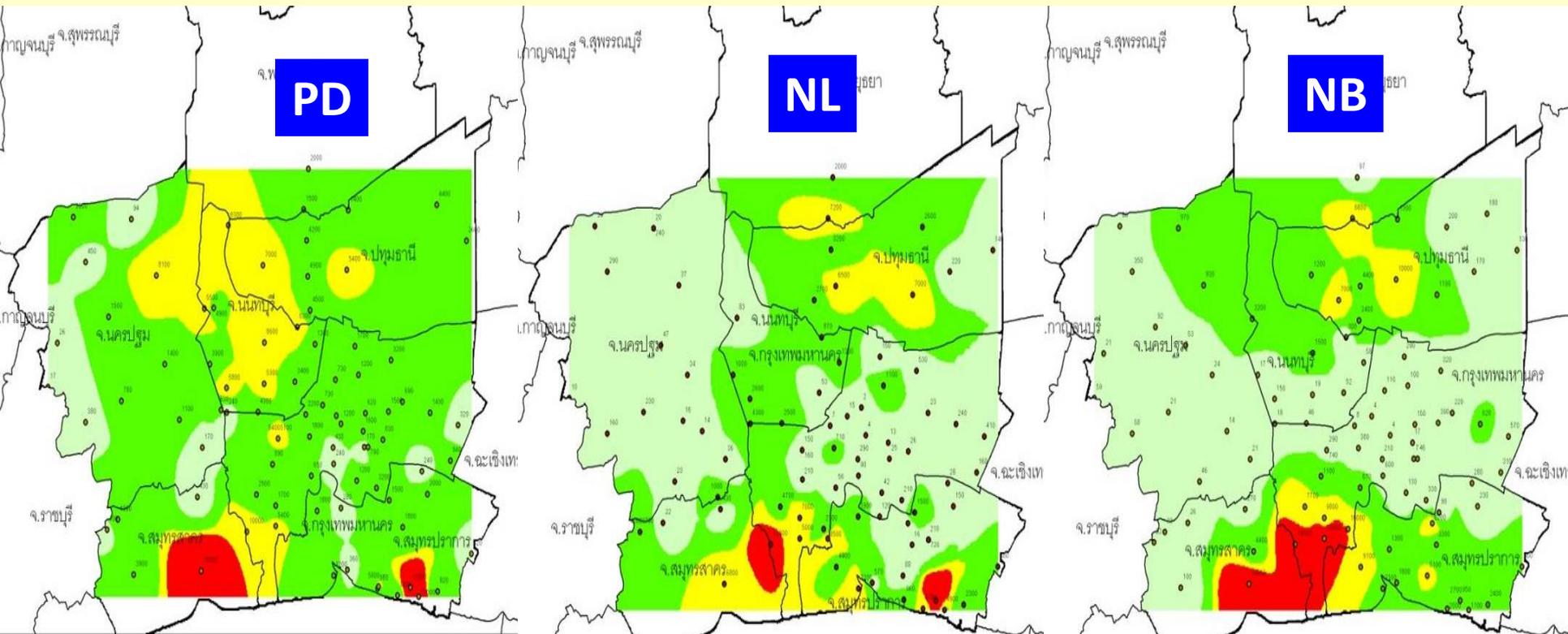
(Conservation B, 2007)

Groundwater Quality (Salinity)

Chlorine (ppm)



2006 (96 obs. wells)

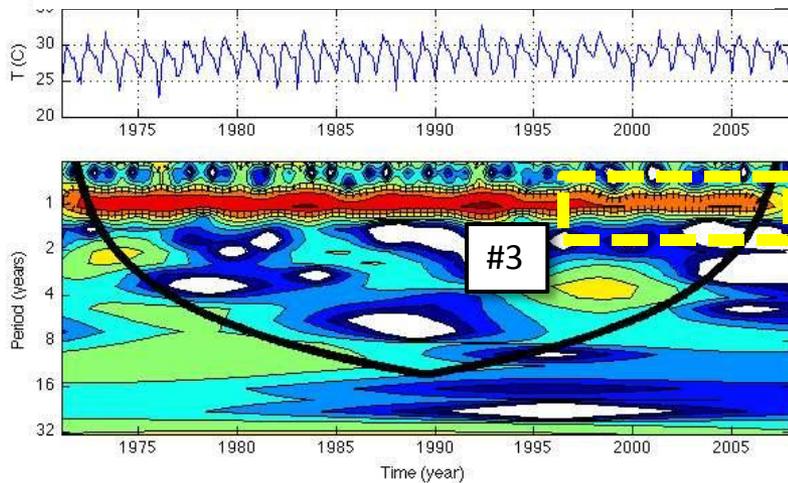


Climate Change Study

Cycle pattern, trend, monthly pattern

Wavelet Pattern of Ave. Temp.

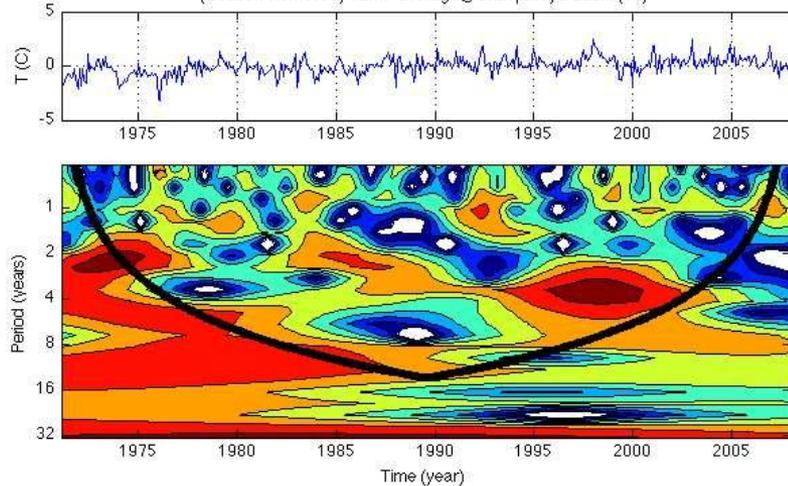
Monthly Ave. Temp. – Chaophraya Basin (10)



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.

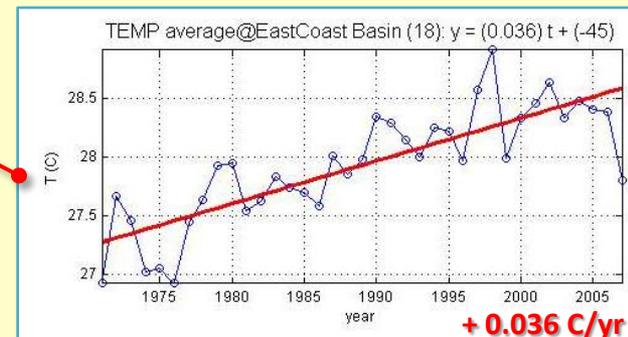
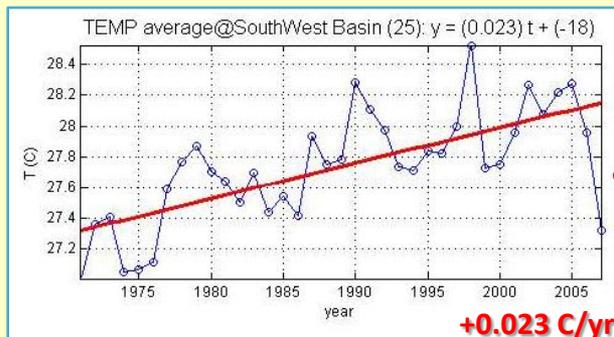
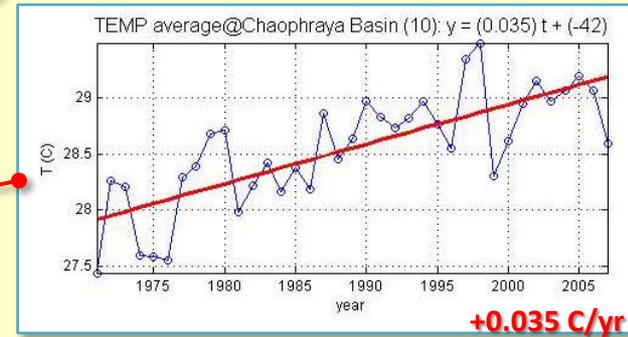
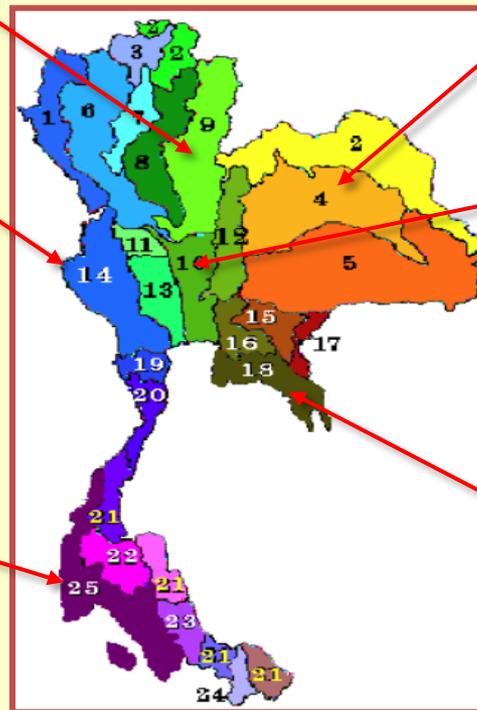
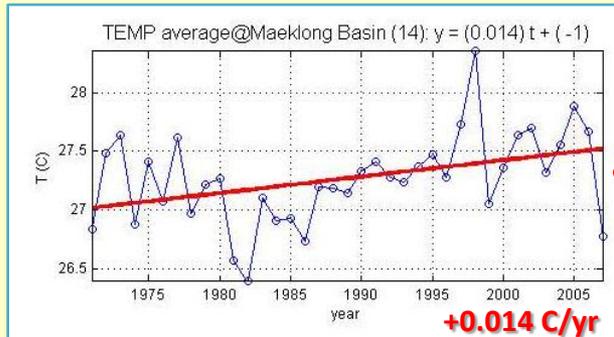
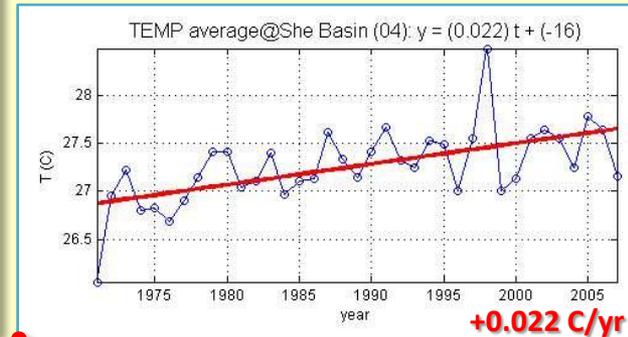
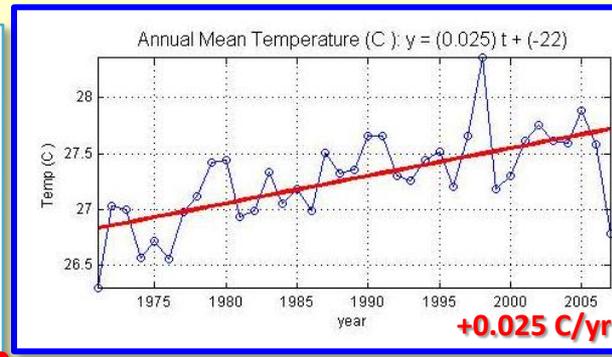
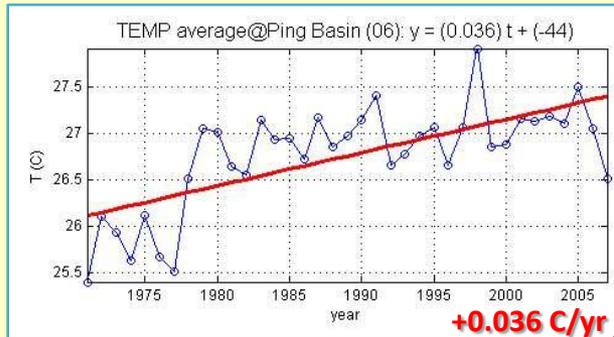
(Season-Removed) TEMP average@Chaophraya Basin (10)



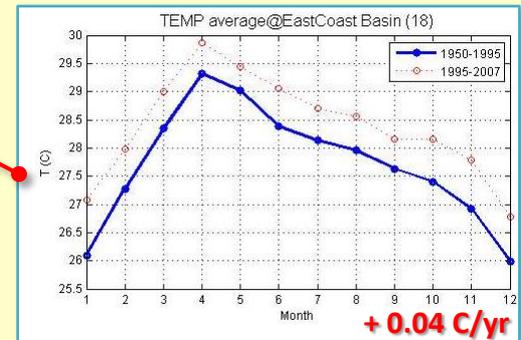
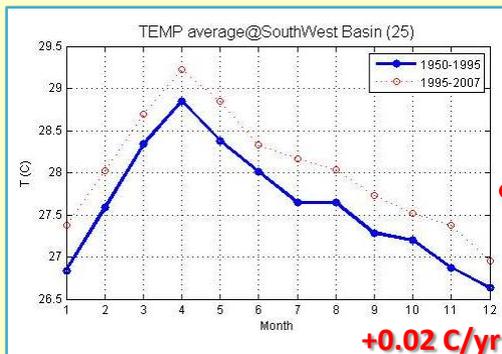
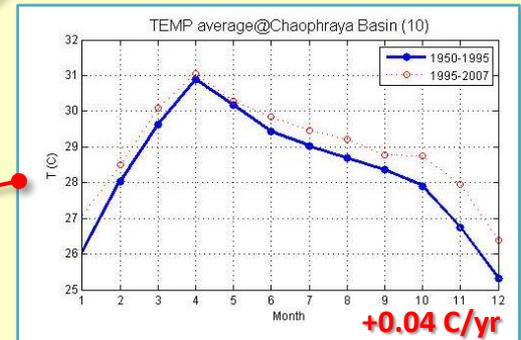
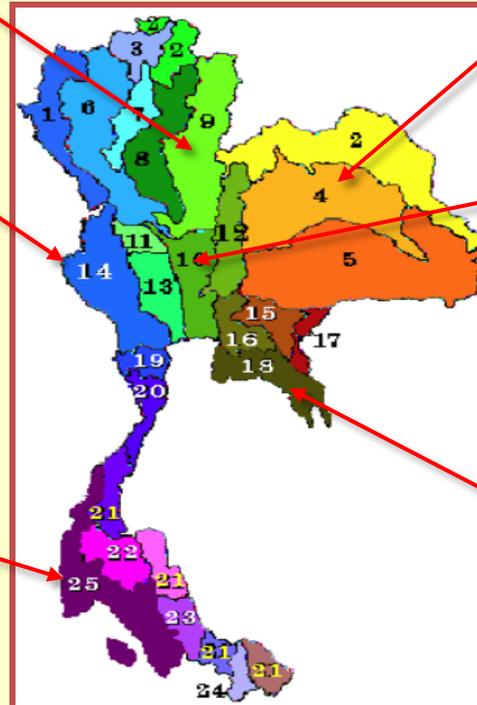
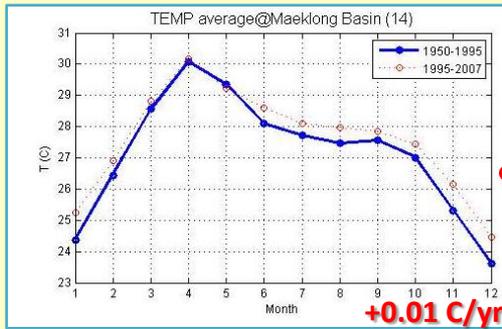
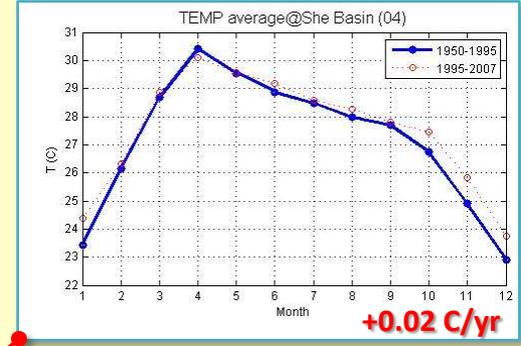
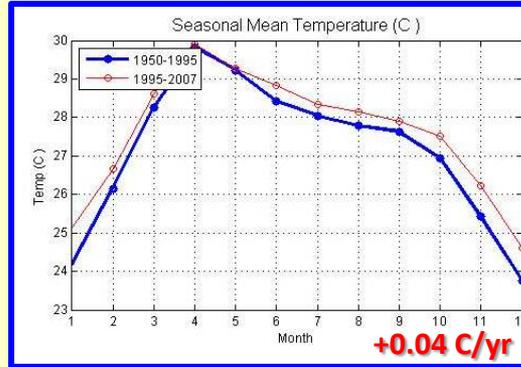
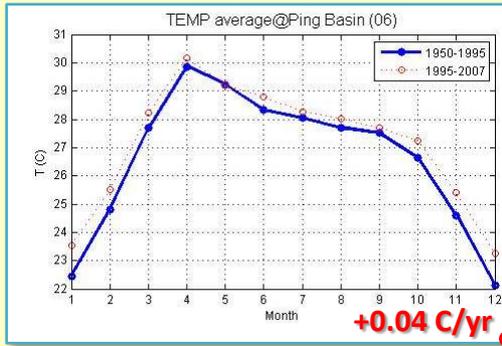
Other general patterns from basin and station time series.

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

Annual Temperature Trend

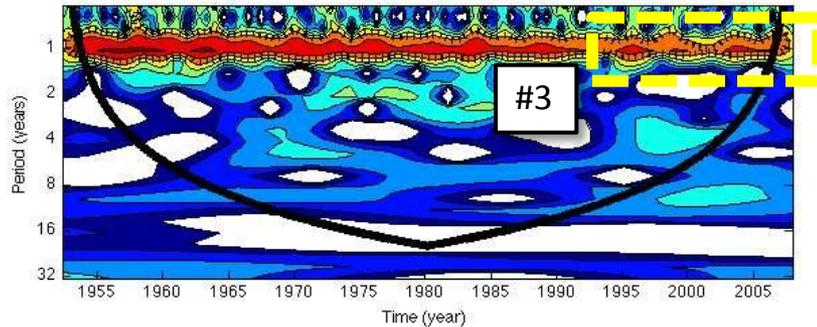
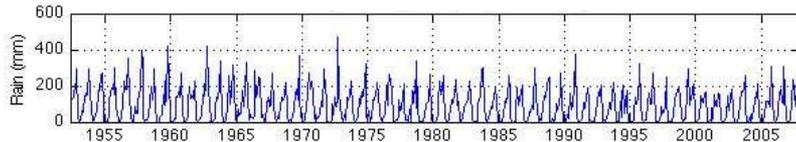


Seasonal Temp. (1950-1995 vs. 1995 – 2007)

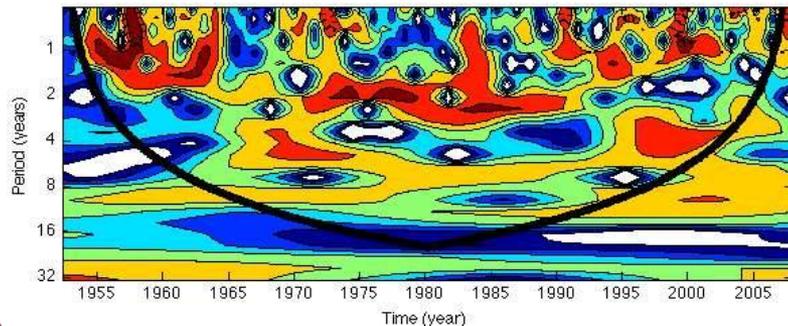
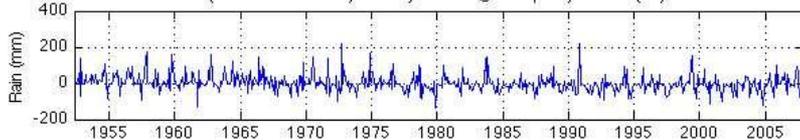


Wavelet Pattern of Rainfall

Monthly Rainfall – Chaophraya Basin (10)



(Season-Removed) Monthly Rainfall@Chaophraya Basin (10)



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

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

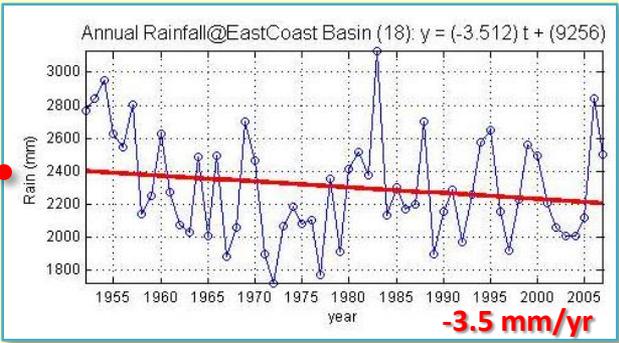
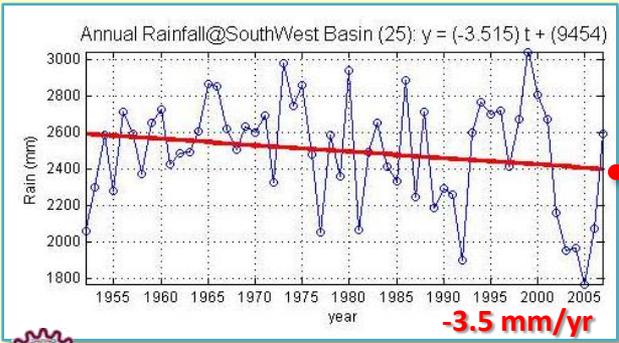
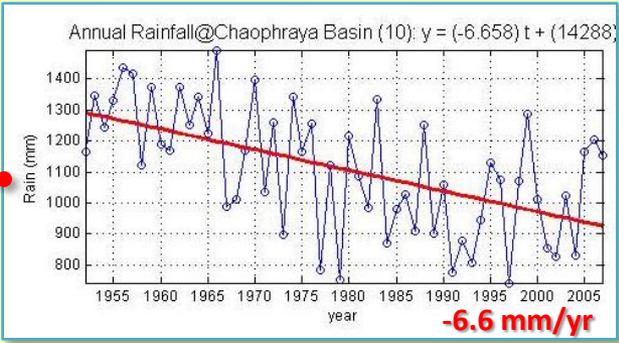
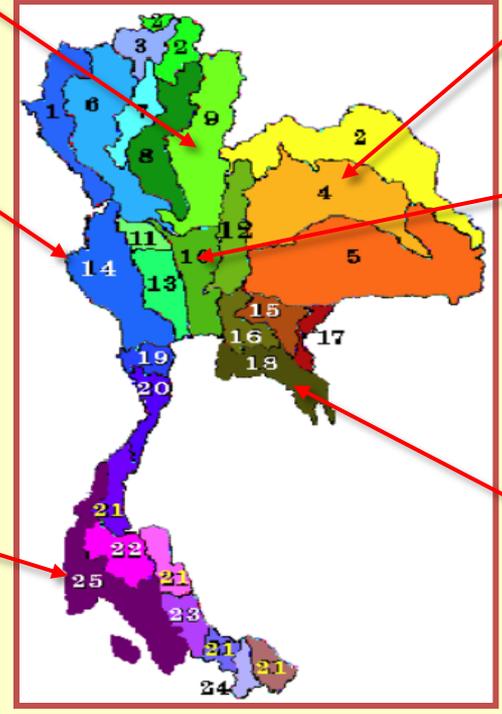
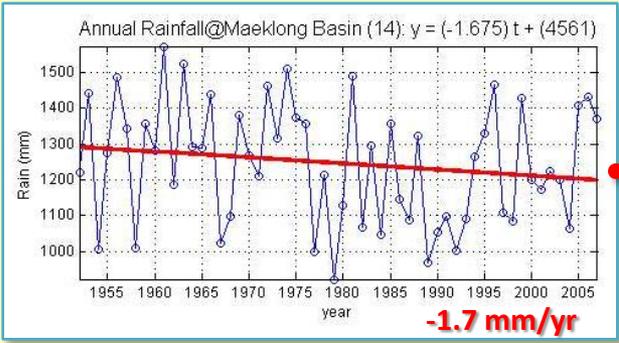
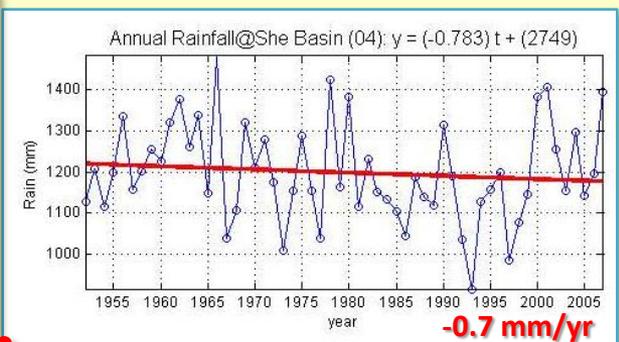
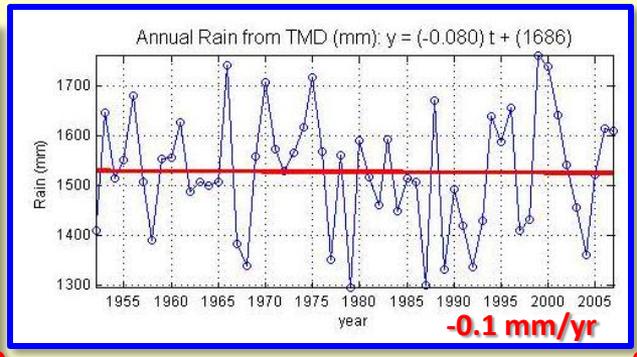
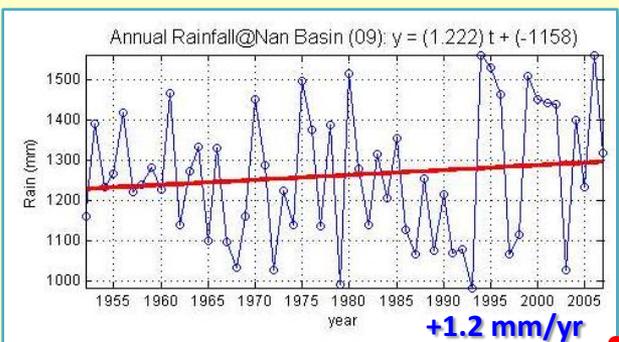
1) Pattern at return period of ~ 6 years after the year 1990.

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

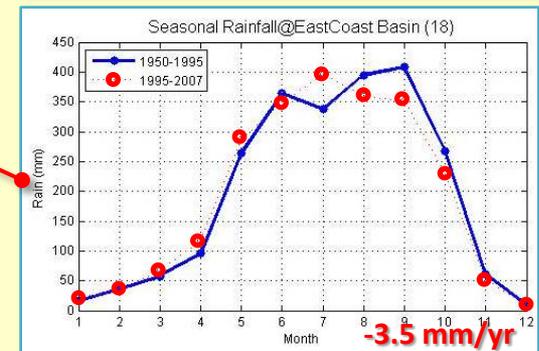
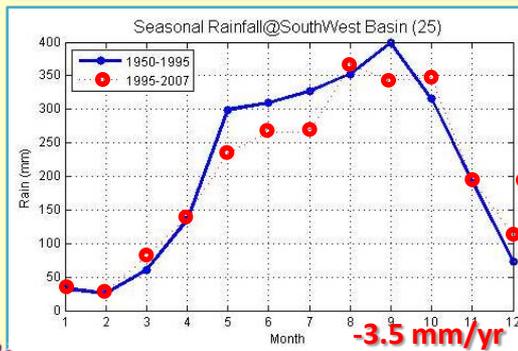
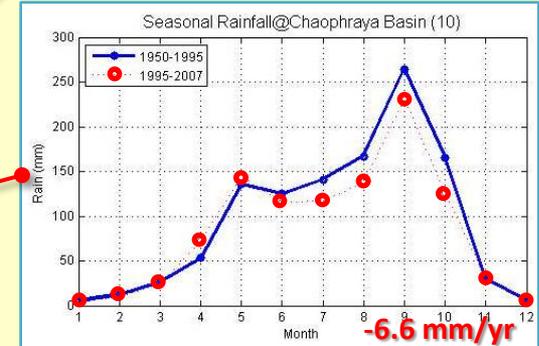
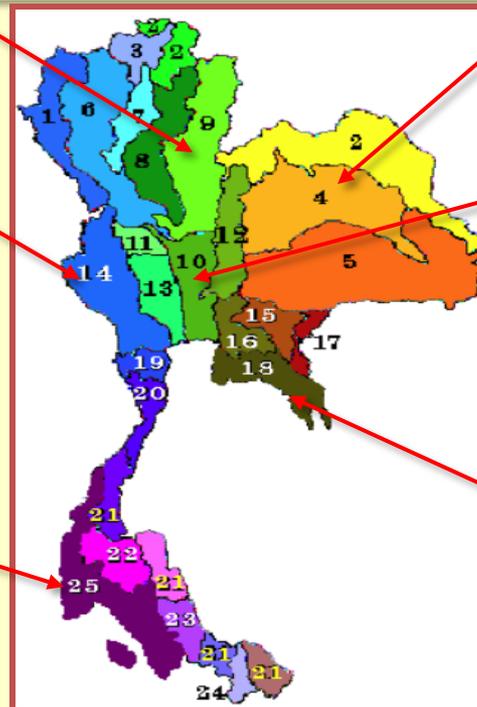
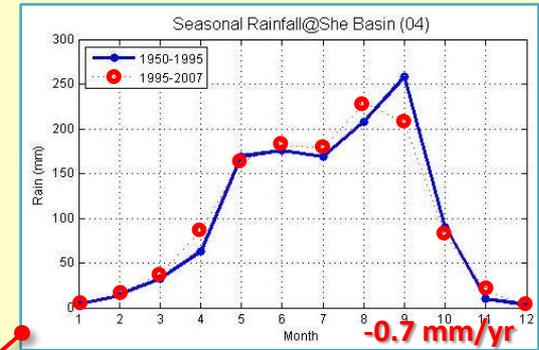
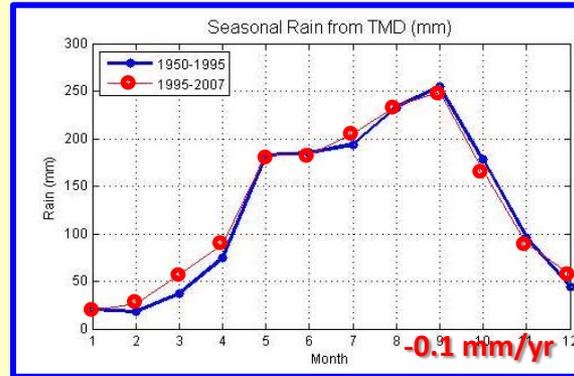
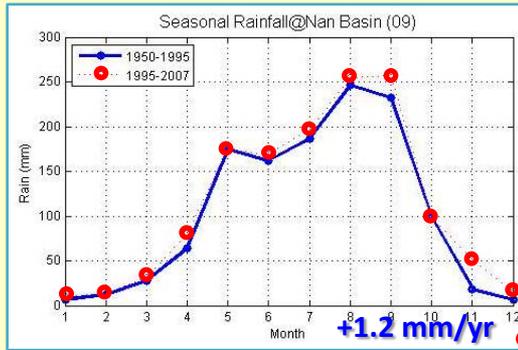
Other general patterns from basin and station time series.

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

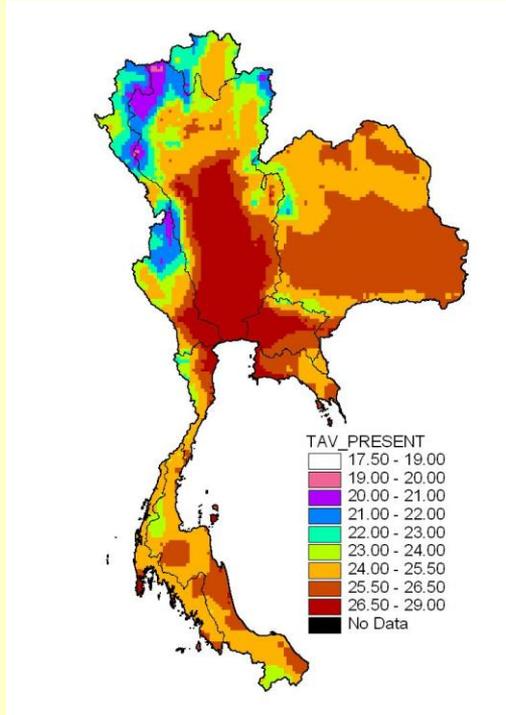
Annual Rainfall Trend



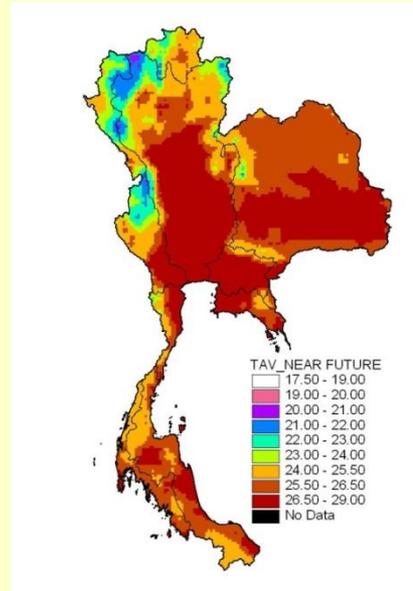
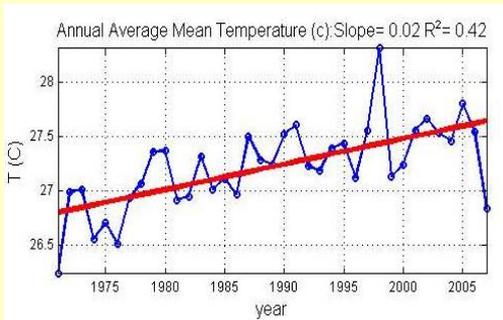
Seasonal Rainfall (1950-1995 vs. 1995 – 2007)



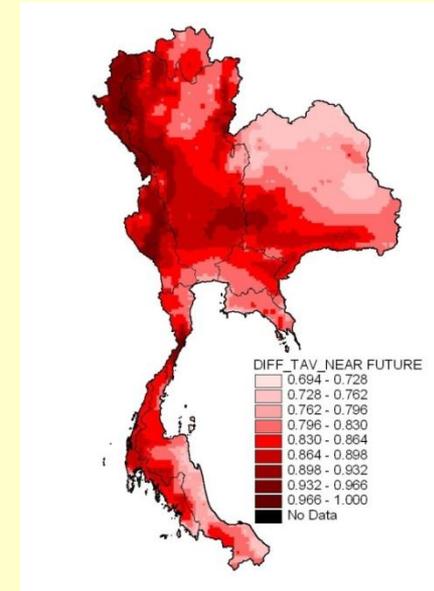
MRI GCM (Japan)



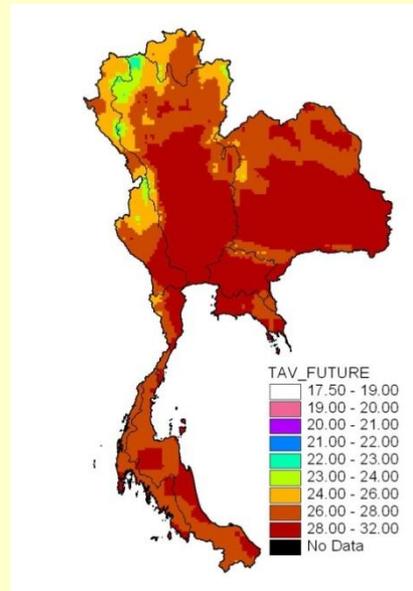
Present Average Temperature



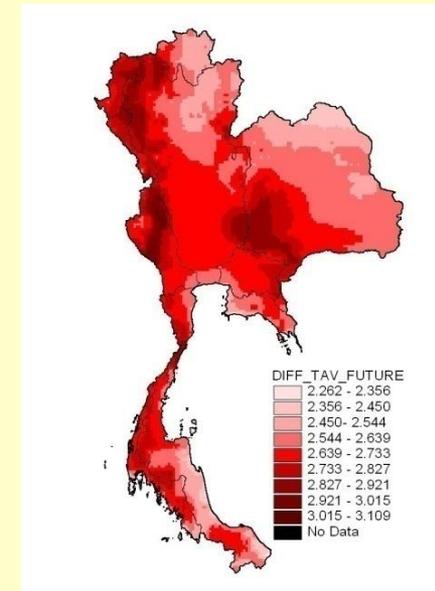
Near Future (2015-2039)



Difference

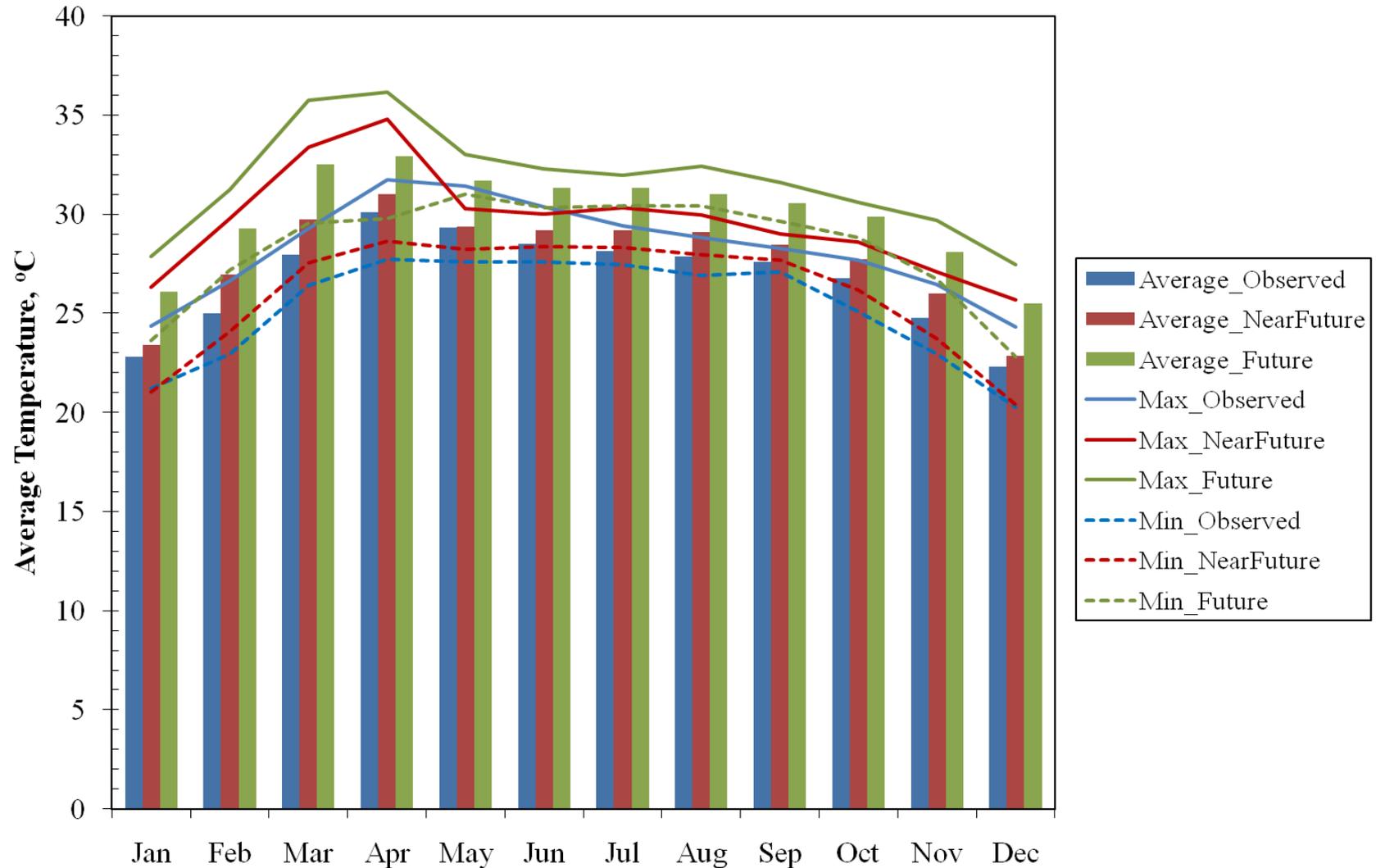


Future (2075-2099)

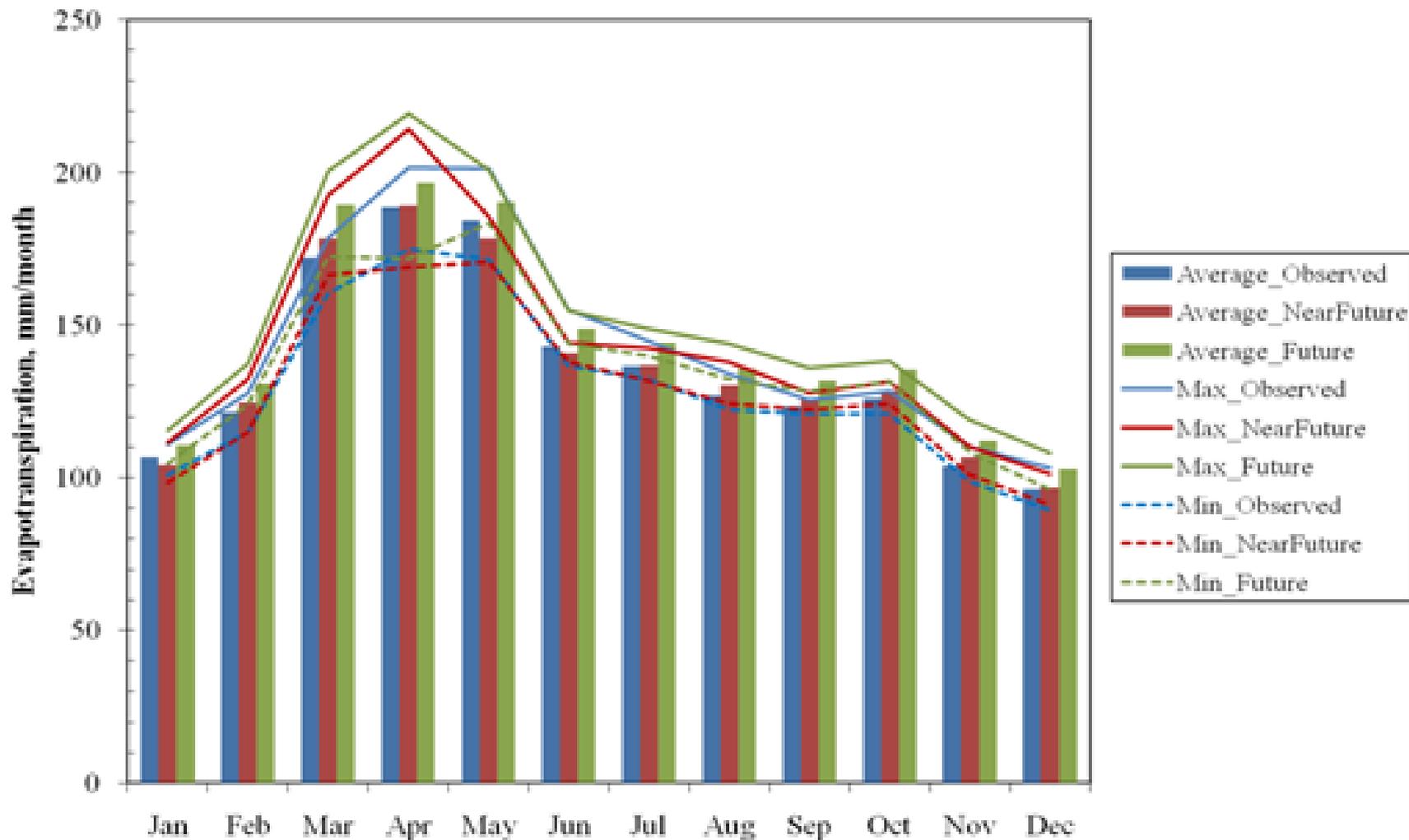


Difference 21

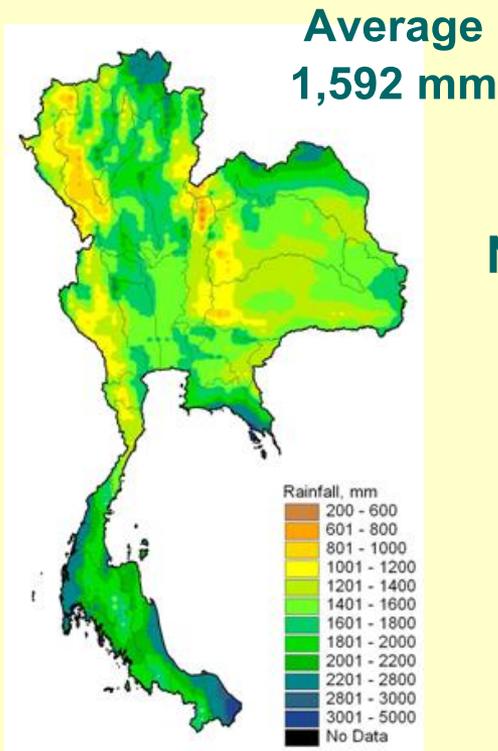
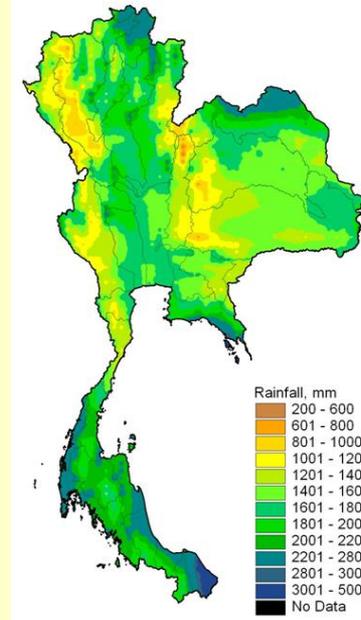
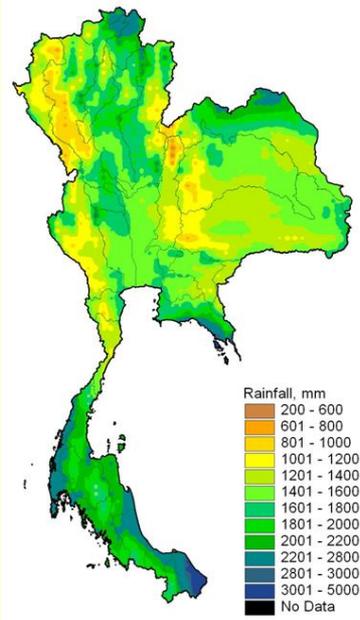
Comparison of Monthly Observed and Downscaled Near-Future and Far-Future temperature



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

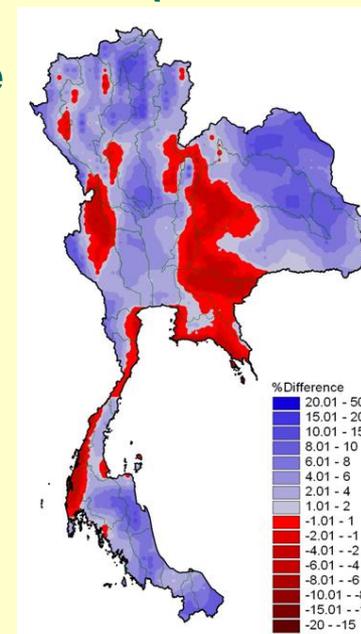
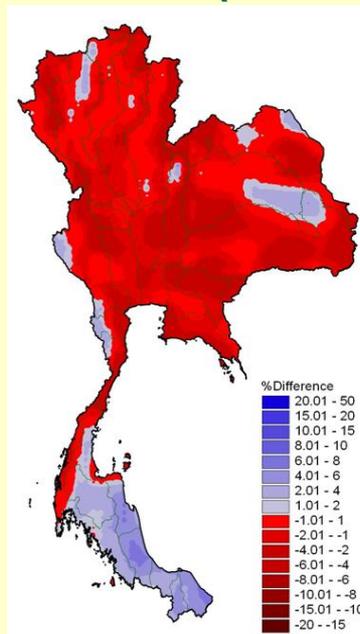


MRI GCM (Japan)



Near Future (2015-2039)

Future (2075-2099)



Present (1979-2006)

%Difference Near Future

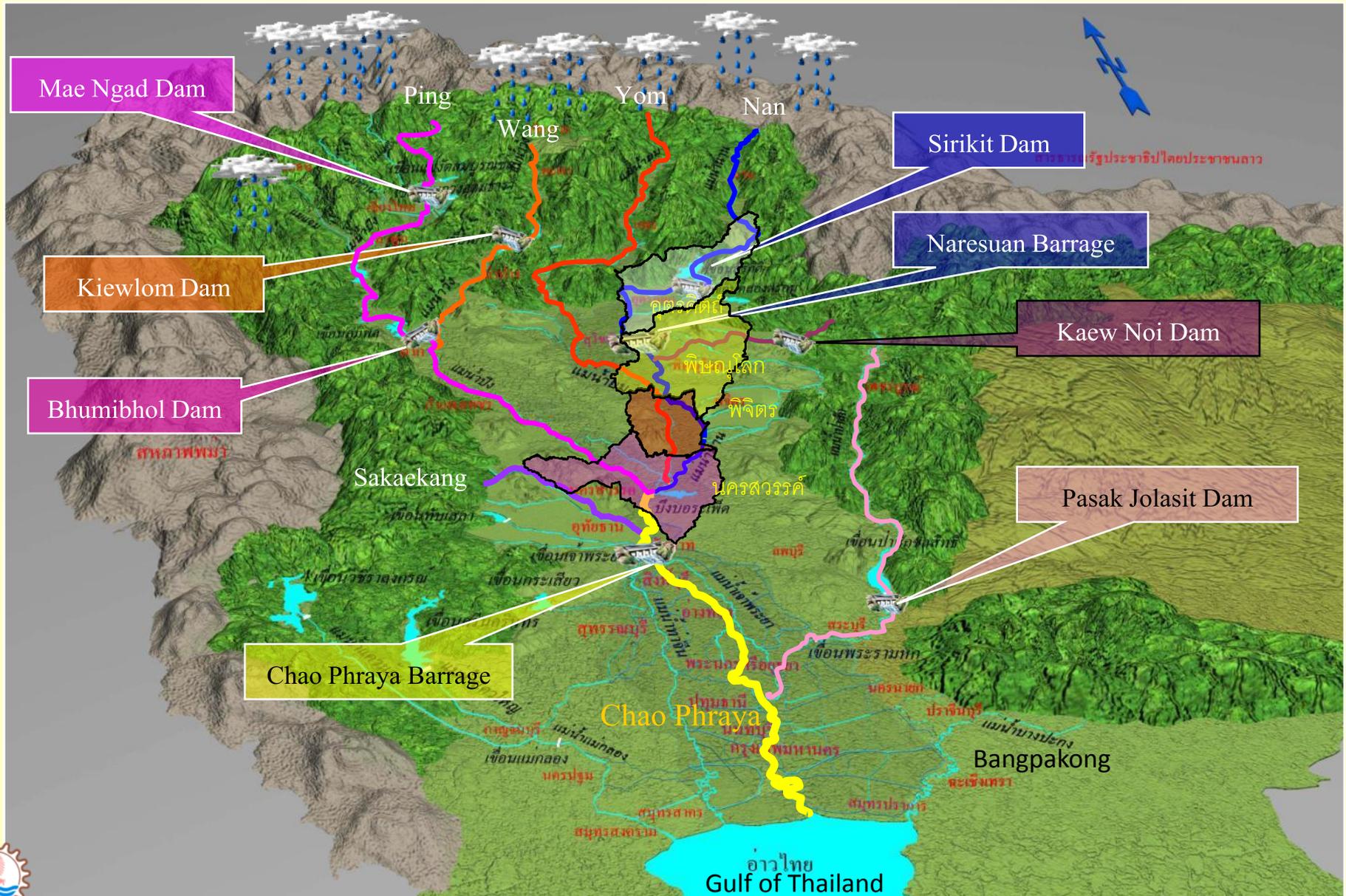
%Difference Future

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

4 Provinces of the Lower North

Total 12 Projects

4 Provincial Irrigation Proj.

5 O & M Projects

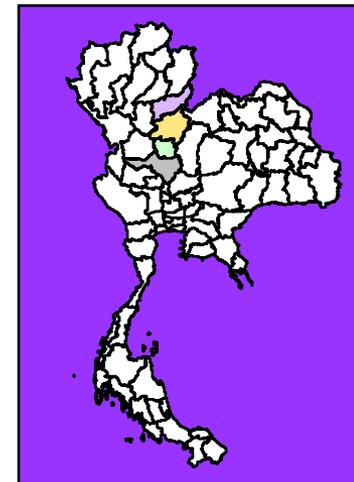
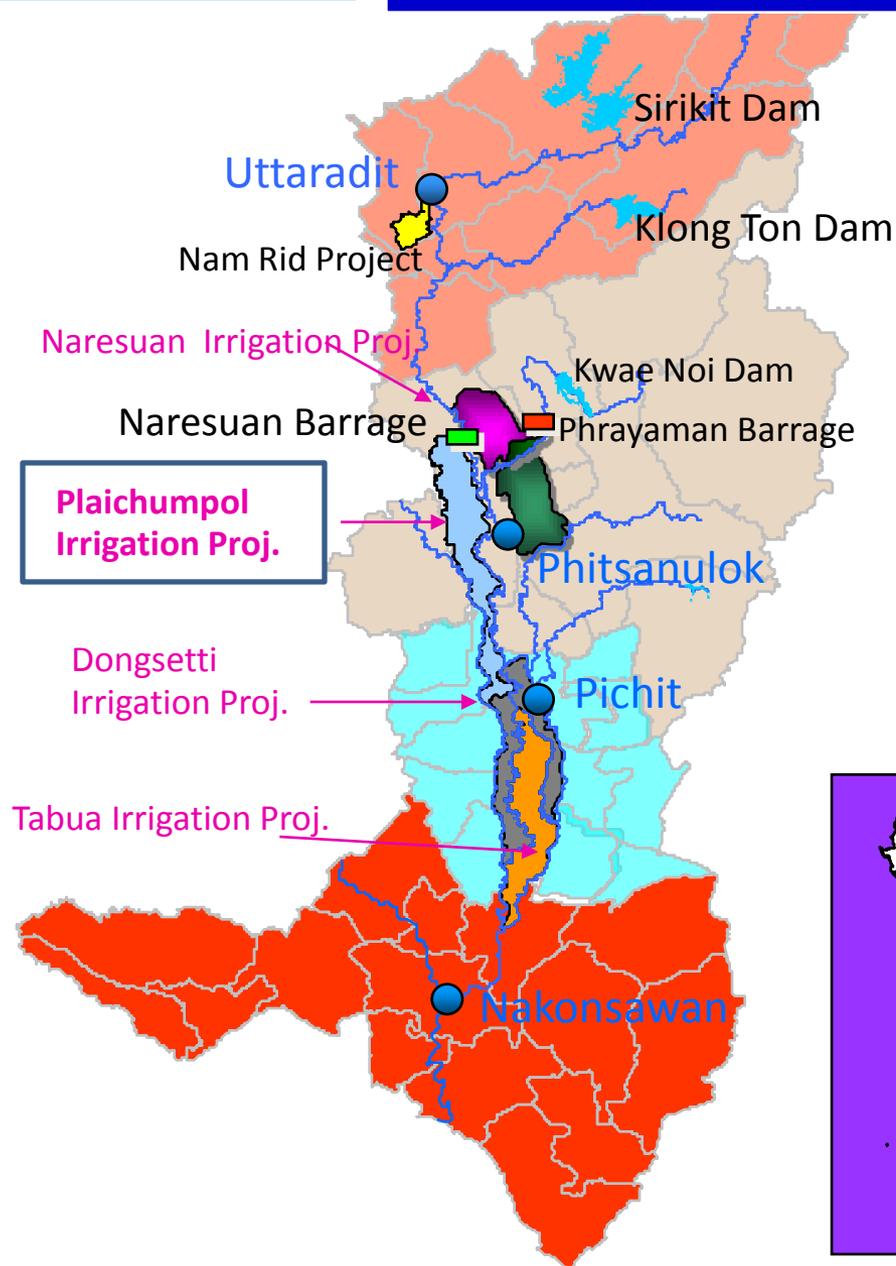
2 Construction Projects

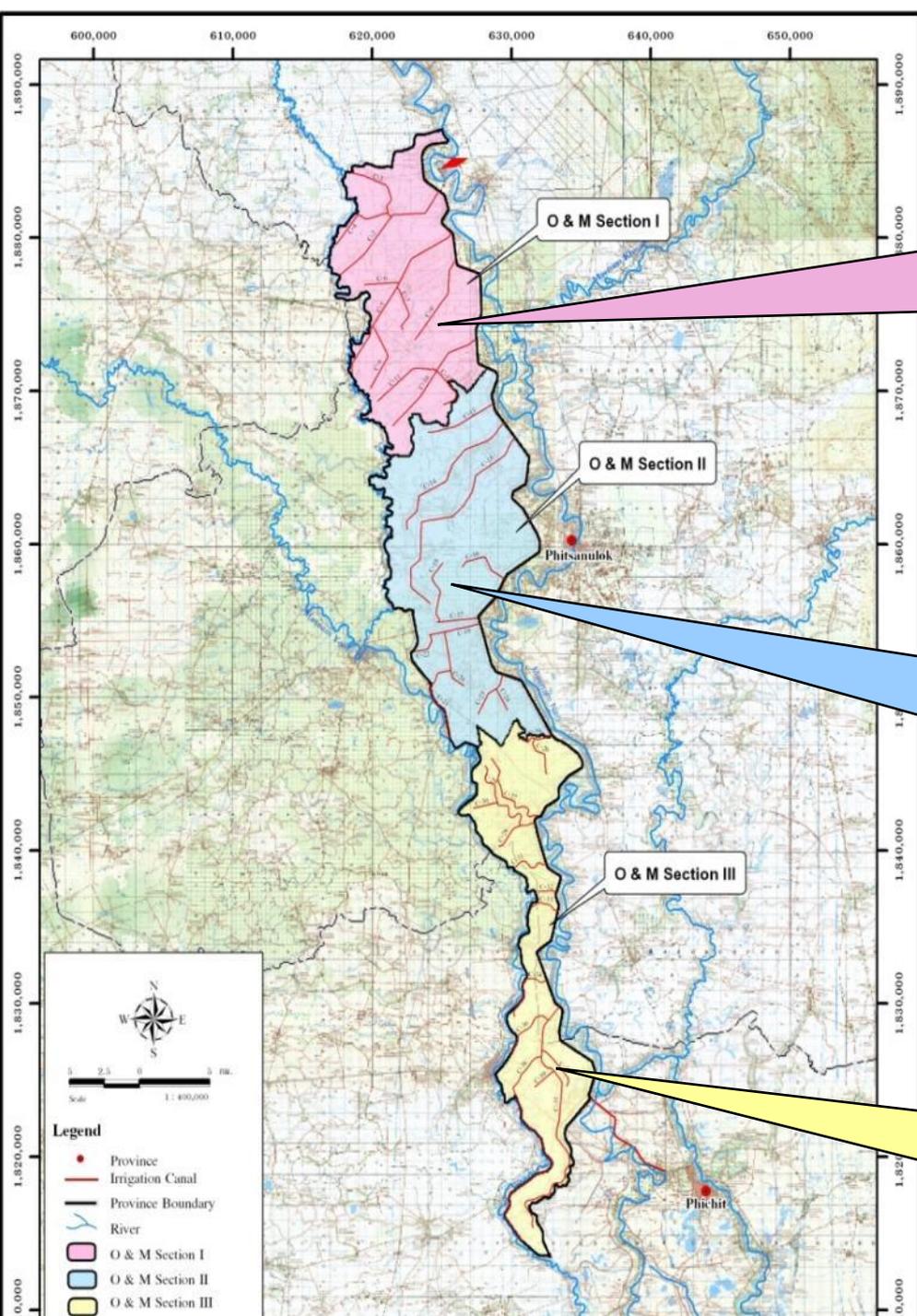
1 Ditch & Dike Projects

Manpower

- Officers 243

- Permanent Employees 1,195



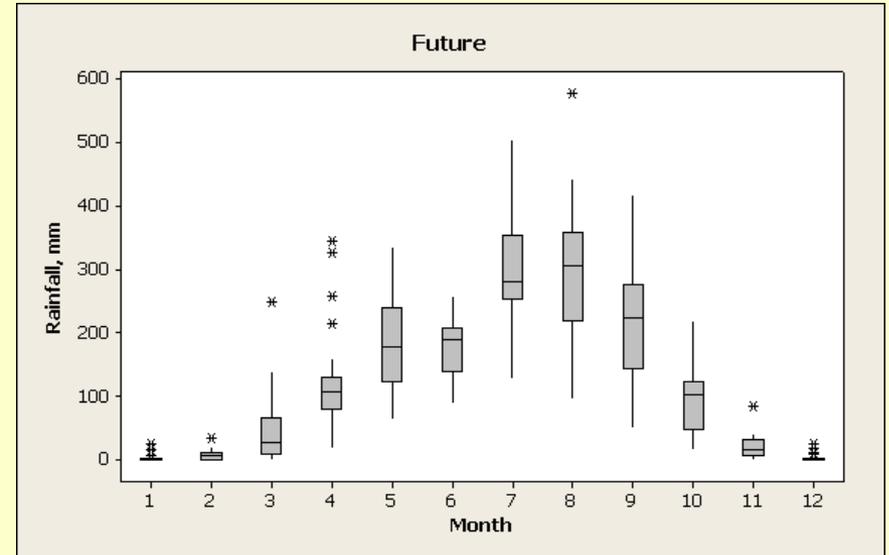
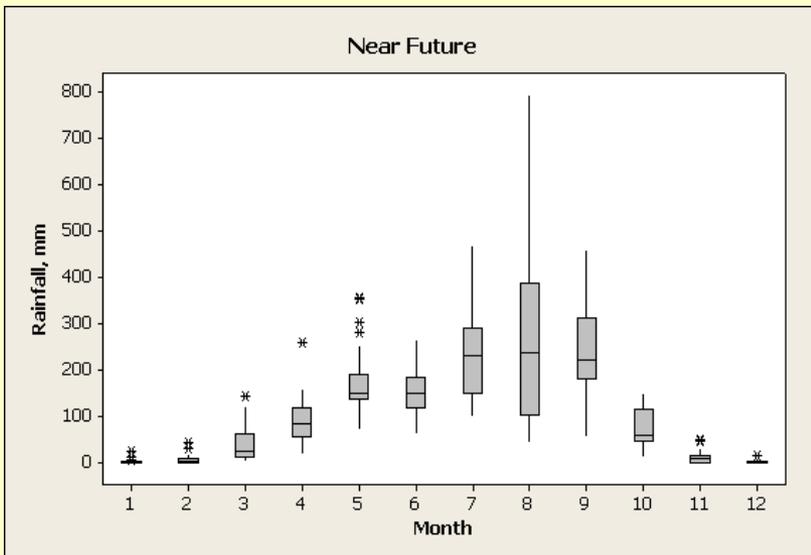
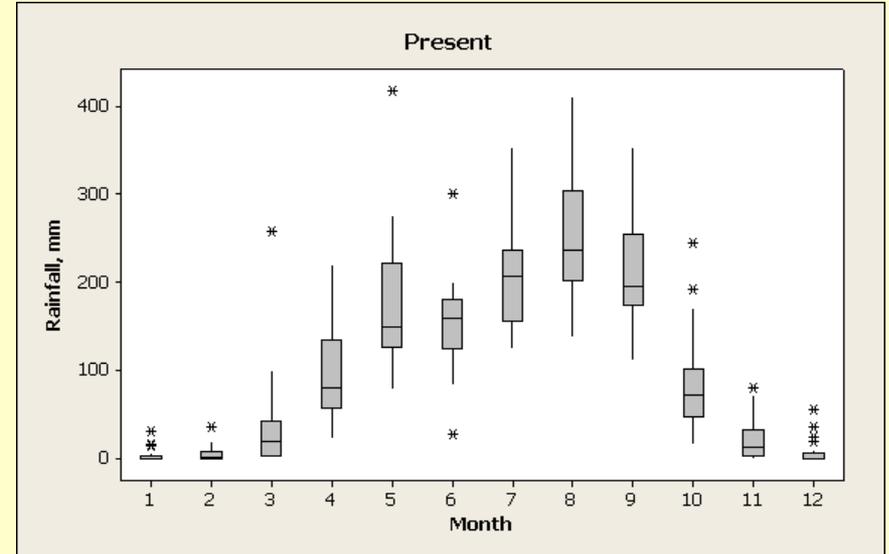
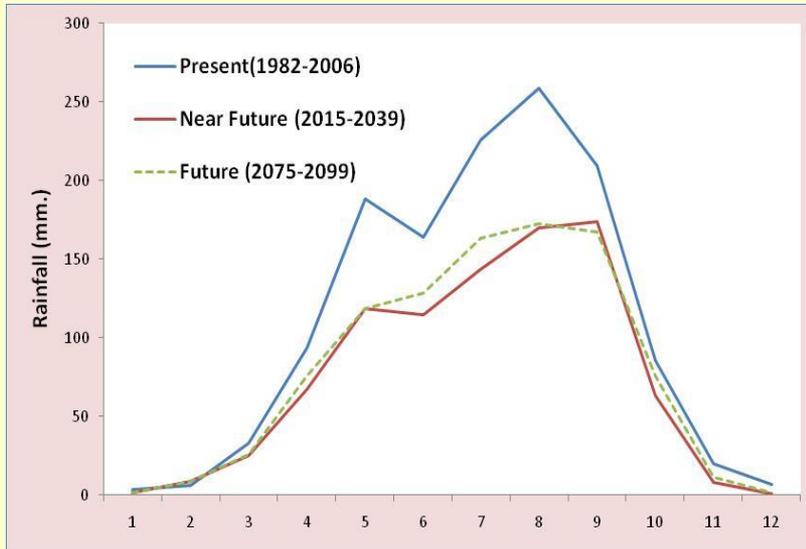


Zone 1: 78,600 Rais

Zone 2: 70,776 Rais

Zone 3: 62,100 Rais

Rainfall over Sirikit Dam



Selected Years for Comparison

Period 1

Period 2

Situations	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Extreme Year														
Normal Year														
Serious Year														
Severe Year														

	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 Rehabilitation 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 Groundwater 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. 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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- **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.**

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Conflict resolution and community role in the Changing Regional Global Climate Scenarios - Case of Drought Crisis Management in Eugene, Japan

Masahiko MIYAZAKI
Kaoru ENOJI

19 October 2006

Conflict Resolution and Community Role in the Changing Regional-Global Climate Scenarios - Case of Drought Crisis Management

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Background

The rapid development of urban areas following the government's economic and social development plans has caused unprecedented problems in several communities in Thailand, including Bangkok. Among the frequently-found difficulties are the lack of water for general usage and consumption, the imbalanced water allocation for the residential and agricultural areas, the mass usage of underground water which leads to the land collapse, the frequent floods and failure in water drainage system, as well as the ineffective waste water management. These obstacles not only cause inconvenience for parties involved, but also bring about environmental problems in the areas.

Problem Solutions

Many relevant governmental agencies have been working on solving the water-related problems caused by rapid expansions in the