THA 2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs
23-25 January 2019, Swissôtel Bangkok Ratchada, Thailand

The assessment of climate change impact on extreme flood and drought in Yom and Nan River basin, Thailand

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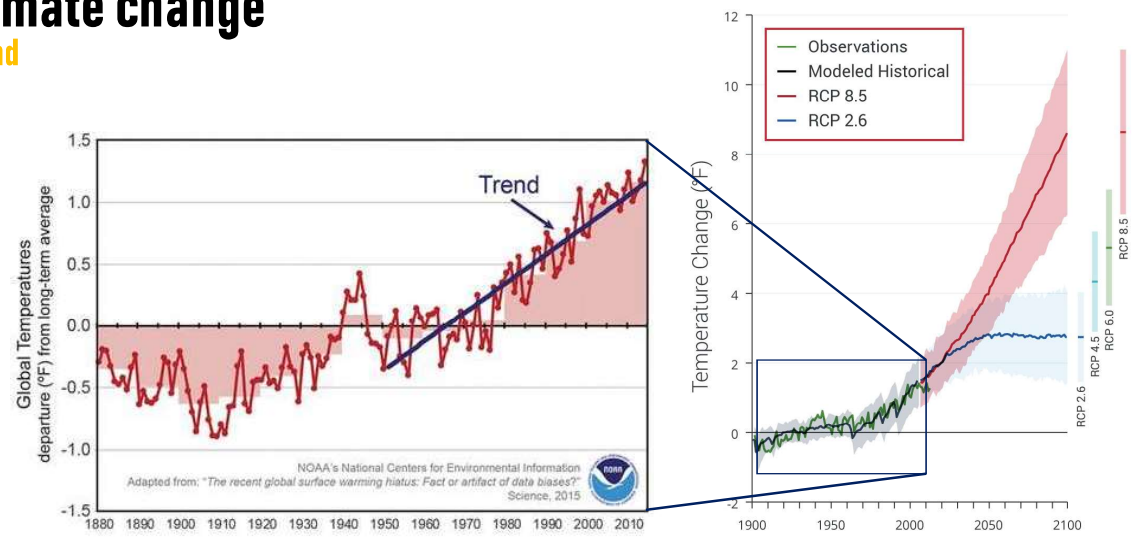
Climate change

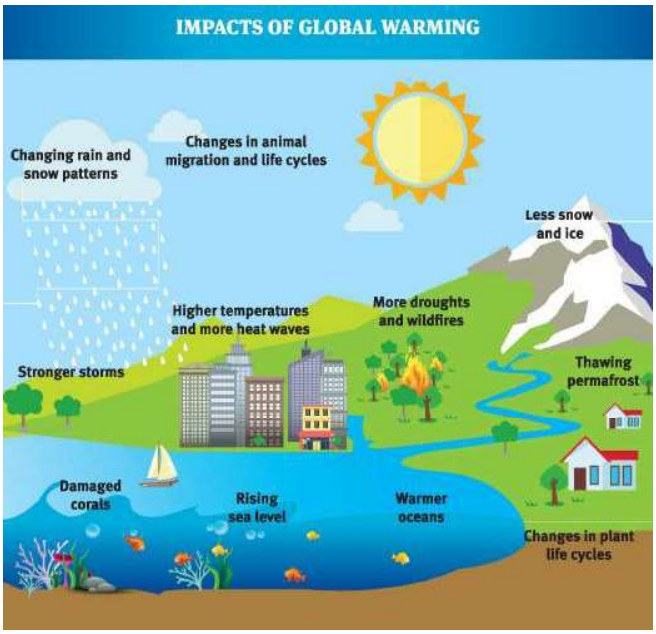
Trend



Ref: https://www.dailykos.com/stories/2015/9/19/1422888/-Climate-Change-Trend-Line-Analysis
http://nca2014.globalchange.gov/report/our-changing-climate/future-climate-change

Climate change

Impact

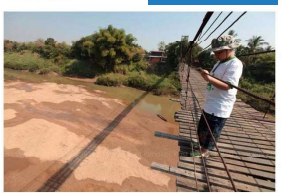


Ref: Panandiker, 2016

INTRODUCTION HYDROLOGICAL MODEL & STUDY AREA GCMs DATA AND BIAS-CORRECTION METHOD RESULT CONCLUSION

Water shortages bite as annual drought sets in

Bangkok Post



THE NATION

Northern Thailand Continues to Battle Severe Floods

Citylife Chiang Mai

CityNews – Parts of Northern Thailand continue to be affected by severe floods following heavy rain at the weekend.

Residents battle floods in Chiang Rai's Paha village. Photo: Natthawat Arm.

The water in the Yom river, which flows through Phrae province, has started overflowing, according to the Hydrology and Water Management Center for the Upper Northern Region.

The Ping there are

Yom River may dry up in 70 days

Nan River basin faces drought crisis threat

Bangkok Post

The Nan River basin is being threatened by a drought crisis as a vast tract of forest in the area has been turned into cash crop plantations, water management experts have warned.

THE NATION

JS100 radio photos

Yom River floods downtown Sukhothai

Sukhothai city centre braces for flooding

Massive runoff also likely in Phitsanulok

Bangkok Post

Floods along the Kwae River system have driven out residents and resort operators as the Vajiralongkorn Dam has already reached more than 90% of capacity. (Post Today photo)

PM off on flood trip on Monday

Storms, run-off batter North, South provinces

Bangkok Post

Prime Minister Yingluck Shinawatra will next week kick off her tip to inspect the progress of flood prevention projects in eight rovinces.

nfirous tracks – A railway official inspects a damaged section of railway tracks in tambon Huay Rai of mae sOwnChai district after forest run-off, triggered by heavy rain, washed away the soil under the tracks. Train rvices to the North were temporarily suspended yesterday. THAWEESAK SUKKHASEM

Officials yesterday inspect the 100-metre-long section of road that subsided in Ban Huai Fong Moo 6 in Nan

Flood crisis in Nan as storms hit North

THE NATION

70% of city swamped as river rises fast to 2011 levels; locals missing in Nan and Phayao.

200mm of rain floods Nan

THE NATION

Heavy downpours over 200mm flooded the northern province of Nan's Santisuk, Pua and Bo Klua districts on Friday, while other districts, especially Tha Wangpha and Mae Jarim, were warned to brace for floods as more than 90mm of rain was expected.

OBJECTIVE

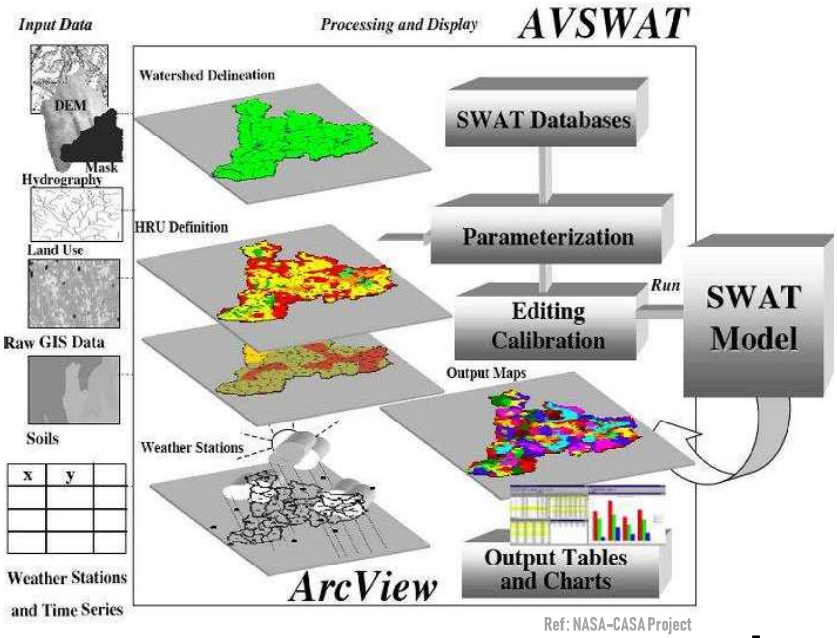
- To assess the future rainfall and temperature using climate model result and bias correction
- To apply the Hydrological Model with a climate data from Climate Model for runoff assessment
- To assess the probability of extreme flood and drought in Yom and Nan River basins by considering on change of river runoff due to the climate change

HYDROLOGICAL MODEL

Soil & Water Assessment Tool

Soil & Water Assessment Tool SWAT

By
United States Department of Agricultural Research Service (USDA-ARS)

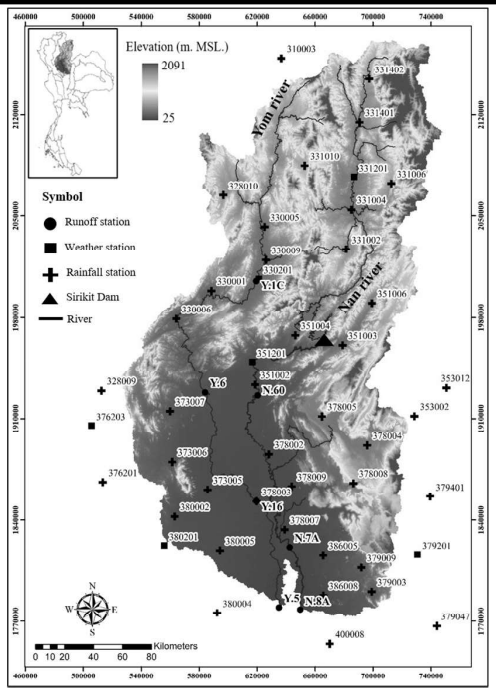


Ref: NASA-CASA Project

STUDY AREA

Yom and Nan River basins

	Yom	Nan
	24,046.89 sq.km	34,682.04 sq.km
	Doi Khun Yuam in Phayao	Luang Prabang Mountains
	1,260.4 mm.	1,287.4 mm.
	Agriculture	Agriculture
	-	Sirikit Dam



GCMs data

National Institute for Environmental Studies,Japan

Predicted precipitation and temperature data

List of CMIP5 GCMs used (Climatology lab, 2018)

Model	Institution
MIROC5	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies and Japan Agency for Marine-Earth Science and Technology
HadGEM2-ES	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)
CNRM-CM5	Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique
MPI-ESM-MR	Max Planck Institute for Meteorology Earth System Model MR.
bcc-csm1-1-m	Beijing Climate Center(BCC),China Meteorological Administration,China
CSIRO-Mk3-6-0	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence
GFDL-ESM2M	Geophysical Fluid Dynamics Laboratory, National Oceanic and Atmospheric Administration (NOAA)
IPSL-CM5A-MR	Institut Pierre-Simon Laplace
MRI-CGCM3	Meteorological Research Institute
NorESM1-M	Norwegian Earth System Model, Norwegian Climate Centre

BIAS-CORRECTION

Shifting and Scaling method

Temperature :

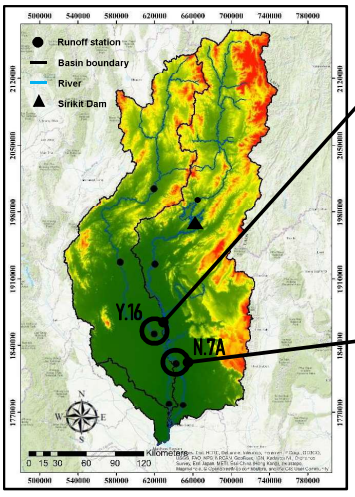
$$T_{y,m,d}^{bias-cor.} = T_{y,m,d}^{obs} + (\overline{T}_{future,m}^{org} - \overline{T}_{reference,m}^{org})$$

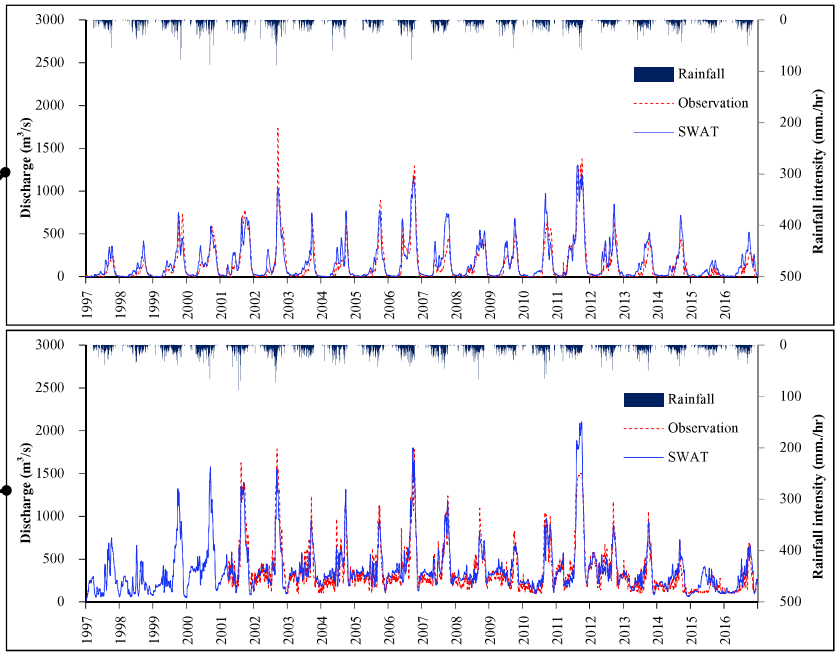
Precipitation :

$$P_{y,m,d}^{bias-cor.} = P_{y,m,d}^{obs} \times (\overline{P}_{future,m}^{org} \div \overline{P}_{reference,m}^{org})$$

RESULT

SWAT Model Calibration





RESULT

SWAT Model Calibration

Nash-Sutcliffe model Efficiency (NSE)

> 0.75

Root-Mean-Square Error (RMSE)

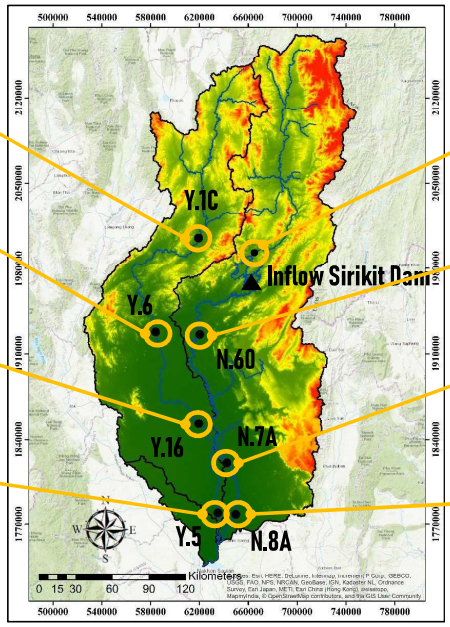
< 20% of average discharge

NSE	RMSE (m^3/s)
0.820	53.871

NSE	RMSE (m^3/s)
0.809	82.905

NSE	RMSE (m^3/s)
0.908	68.335

NSE	RMSE (m^3/s)
0.873	96.313



NSE	RMSE (m^3/s)
0.802	117.187

NSE	RMSE (m^3/s)
0.759	83.618

NSE	RMSE (m^3/s)
0.858	108.613

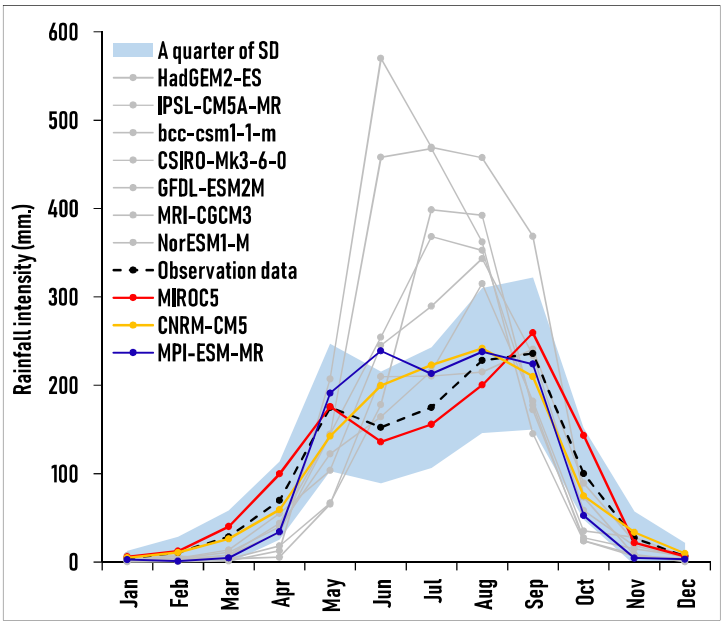
NSE	RMSE (m^3/s)
0.878	106.773

RESULT

GCMs Selection

GCMs model	NSE	RMSE (mm)
MIROC5	0.93	19.17
HadGEM2-ES	0.69	42.50
CNRM-CM5	0.90	24.61
MPI-ESM-MR	0.86	28.40
IPSL-CM5A-MR	0.71	41.36
bcc-csm1-1-m	-2.03	133.69
CSIRO-Mk3-6-0	-3.77	167.71
GFDL-ESM2M	-0.06	79.08
MRI-CGCM3	-0.44	92.29
NorESM1-M	0.40	59.45

Considering on monthly rainfall intensity



RESULT

GCMs Selection

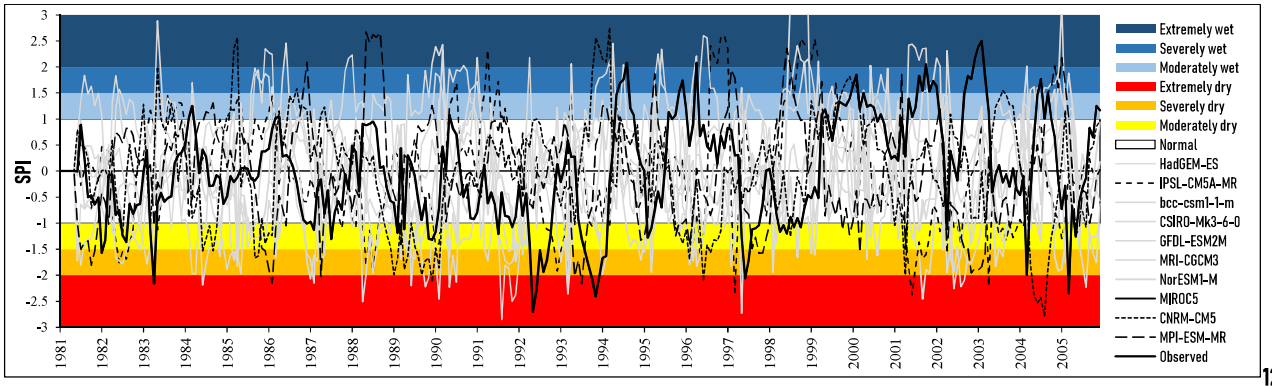
Considering on Standardized Precipitation Index

"6 months is effective to represent the precipitation over distinct seasons and related with unusual stream flows and reservoir levels" (World Meteorological Organization, 2012)

The classification of SPI and SRI

Higher than 2.0	Extremely wet
1.5 -1.99	Very wet
1.0 -1.49	Moderately wet
-0.99 -0.99	Near normal
-1.0 - -1.49	Moderately dry
-1.5 – 1.99	Very dry
Less than -2.0	Extremely dry

SPI from observe rainfall in Yom and Nan River basins 1981-2005



RESULT

GCMs Selection

Considering on Standardized Precipitation Index

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Number of extreme flood and drought event of observation and GCMs

	Very Wet	Extremely Wet	Very Dry	Extremely Dry
Obs	3	4	3	5
MIROC	3	4	2	5
HadGEM	7	3	5	4
CNRM	3	3	3	5
MPI	4	4	5	5
IPSL	2	3	3	5
bcc	2	6	6	3
CSIRO	3	7	8	3
GFDL	3	5	9	2
MRI	5	4	8	3
NorESM	2	4	5	7

RESULT

Impact of climate change assessment

Reference period : 1981-2005

Future Scenarios
Representative Concentration Pathway (RCP)
2.6 & 8.5

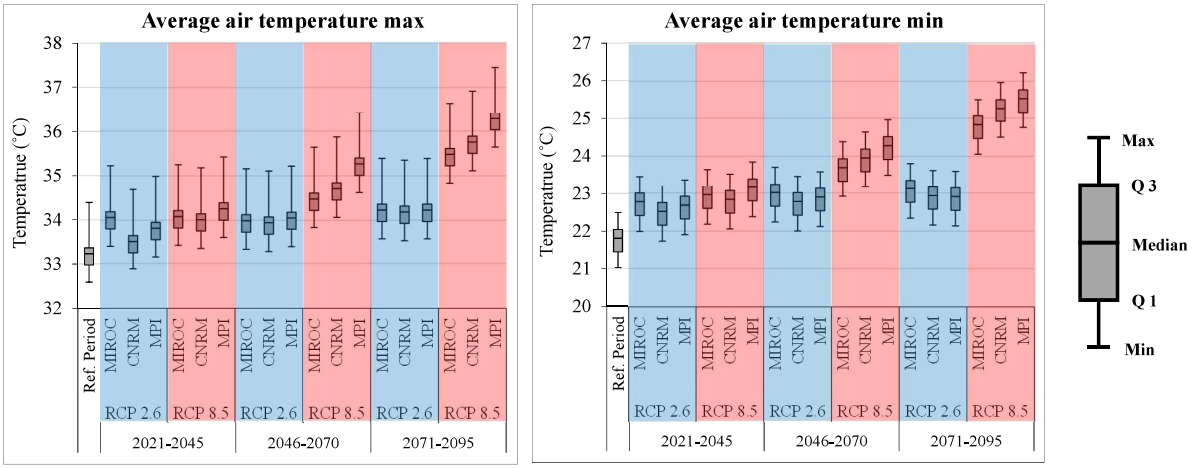
Near future : 2021-2045

Intermediate future : 2046-2070

Far future : 2071-2095

RESULT

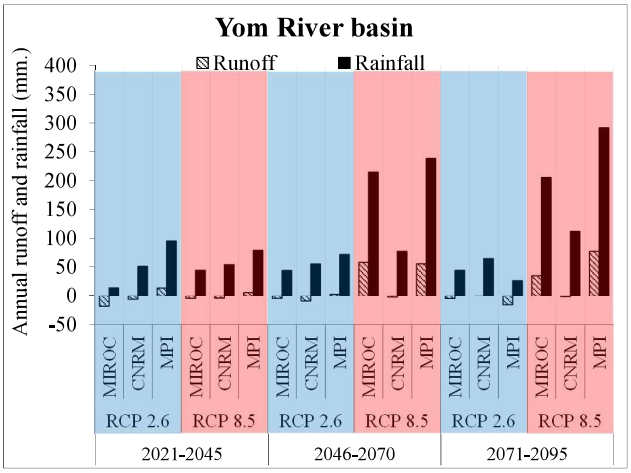
Impact of climate change assessment

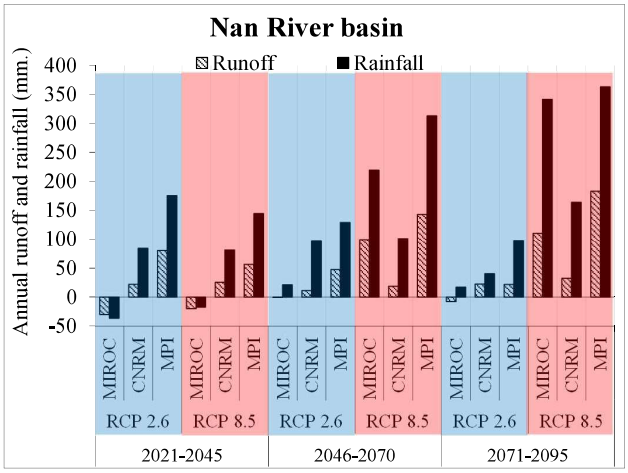


Box plot of average air temperature max and min of Yom and Nan River in reference period, near, intermediate and far future under scenario RCP 2.6 and 8.5

RESULT

Impact of climate change assessment

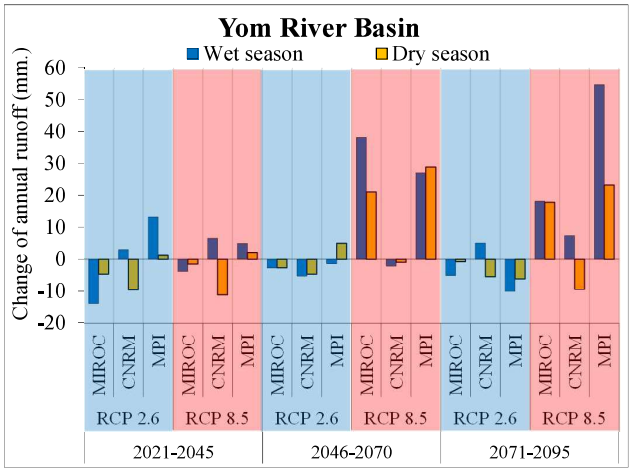


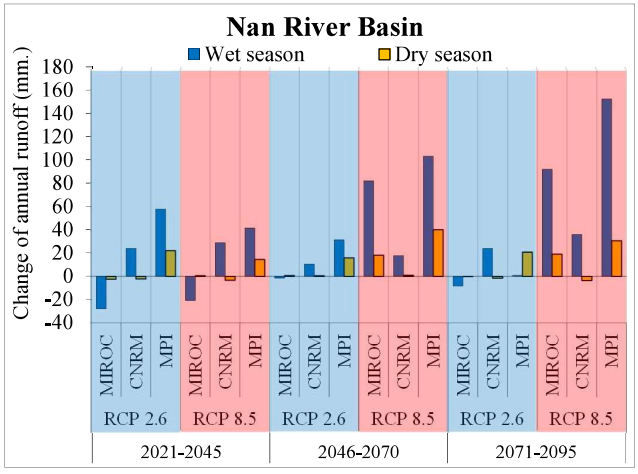


Annual runoff and rainfall change in reference period, near, intermediate and far future under scenario RCP 2.6 and 8.5

RESULT

Extreme flood and drought analysis

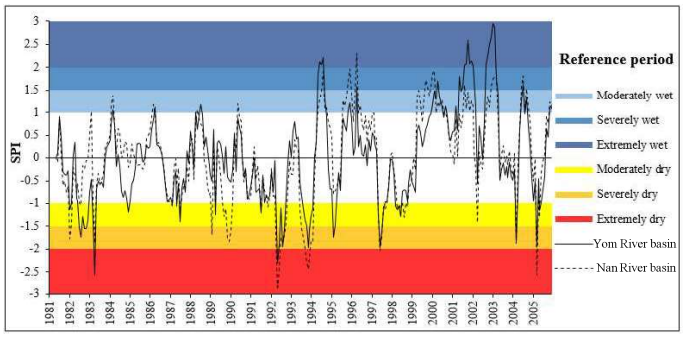


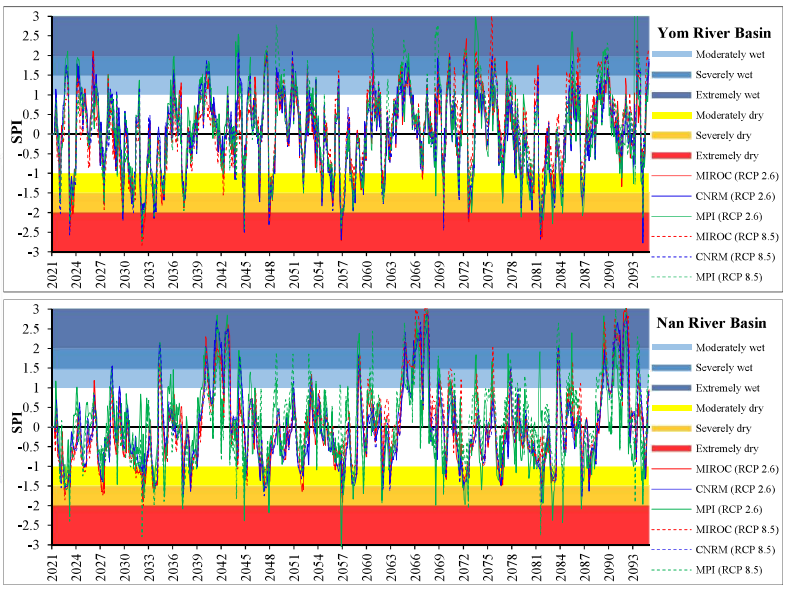


The runoff change during wet and dry season in reference period, near, intermediate and far future under scenario RCP 2.6 and 8.5

RESULT

Extreme flood and drought analysis



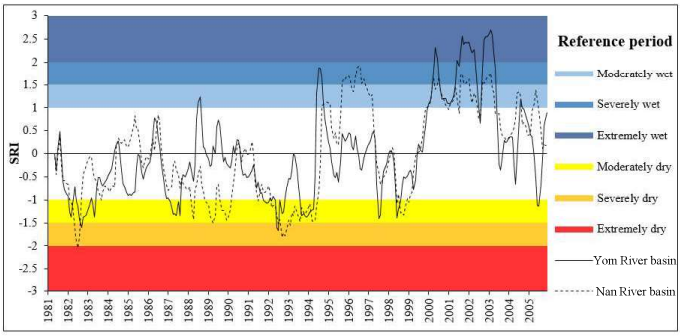


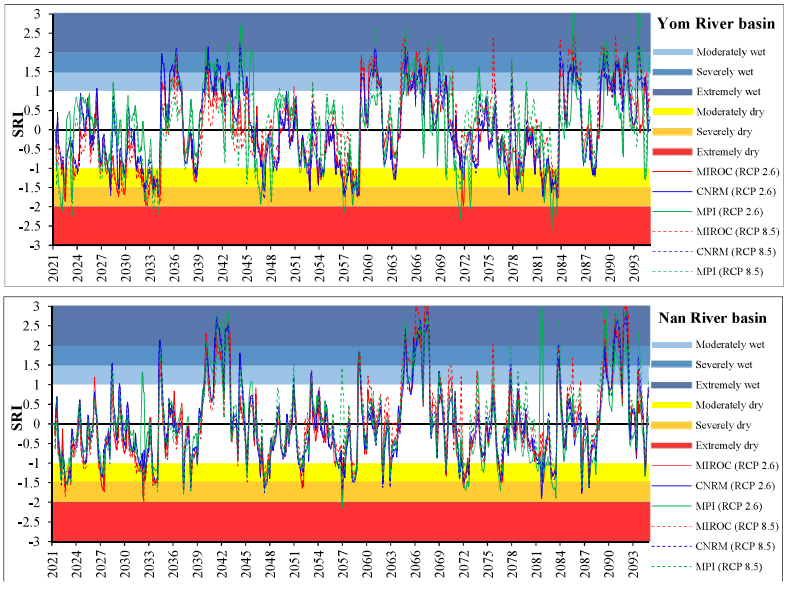
The Standardized Precipitation Index (SPI) of reference and predicting period under scenario RCP 2.6 and 8.5

INTRODUCTION HYDROLOGICAL MODEL & STUDY AREA GCMs DATA AND BIAS-CORRECTION METHOD RESULT CONCLUSION

RESULT

Extreme flood and drought analysis





The Standardized Runoff Index (SRI) of reference and predicting period under scenario RCP 2.6 and 8.5

CONCLUSION

Average air temperature

Annual rainfall

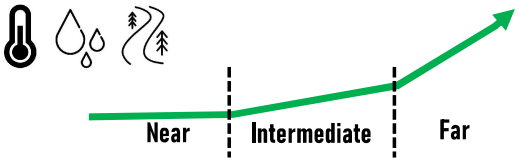
Annual runoff

RCP 2.6

slow and fluctuated increasing trend

No trend

RCP 8.5



significant rising trend during immediate and far future

CONCLUSION

Extreme flood

Extreme drought

RCP 2.6

remain constant in almost area

slight upward trend in some period at upper Yom River basin and Lower Nan River basin

RCP 8.5

significant upward trend since immediate future onward in both Yom and Nan River basins

slightly upward trend in near future, decrease at immediate future and increase again in far future

CONCLUSION

The Shifting and Scaling method, used for bias-correction, removed only the mean annual/monthly biases. The biases for over/under-estimation of the interannual/diurnal range might still exist in Extreme event analysis. This mean that the possibility of extreme flood and drought in the future are more likely to occur than analyze.

ACKNOWLEDMENT

ADAP-T
Advancing Co-Design of Integrated Strategies with Adaptation to Climate Change in Thailand
METEOROLOGICAL DEPARTMENT
ROYAL IRRIGATION DEPARTMENT
National Institute for Environmental Studies,Japan

THANKS!

Any questions?
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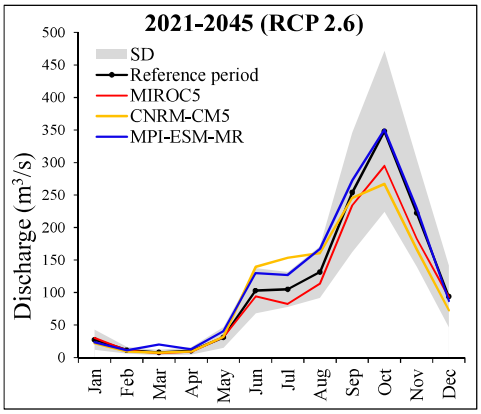
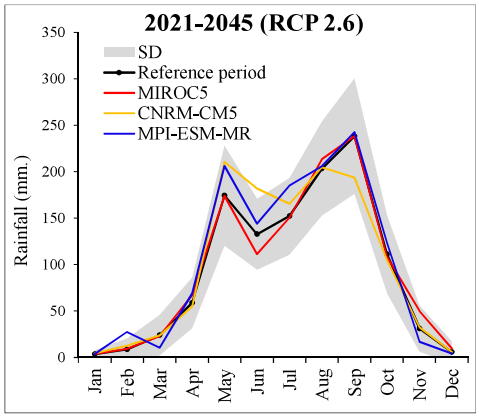
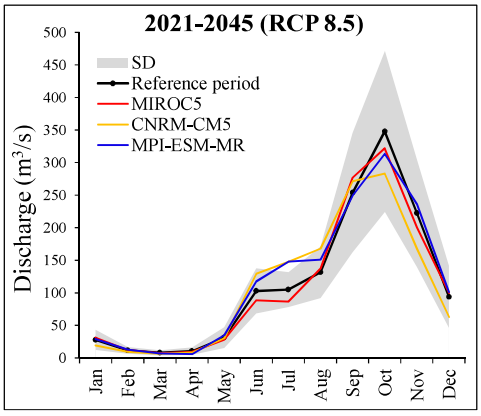
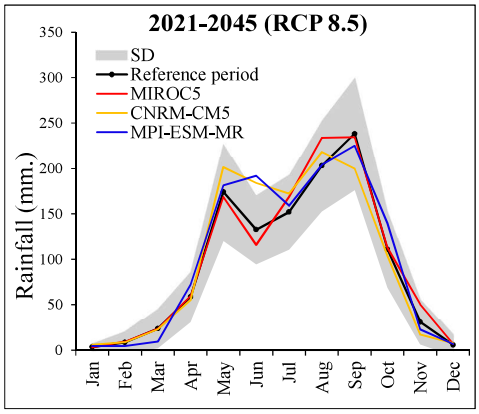
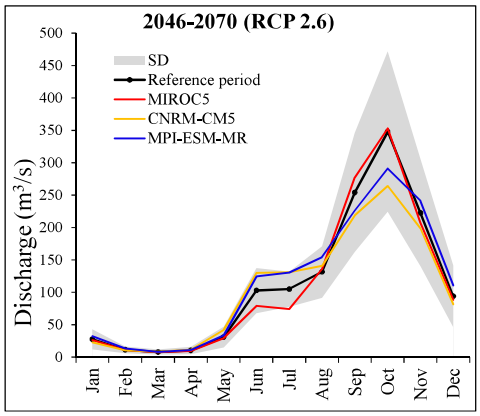
Chanchai_Petchpongpan@outlook.co.th

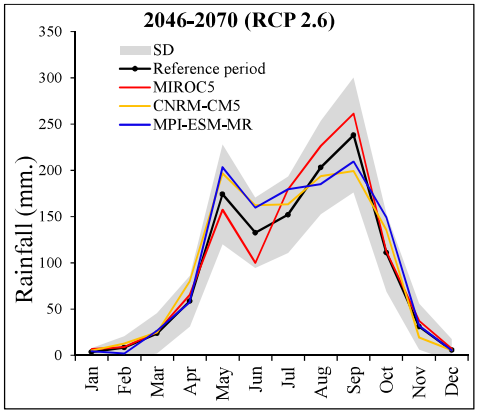


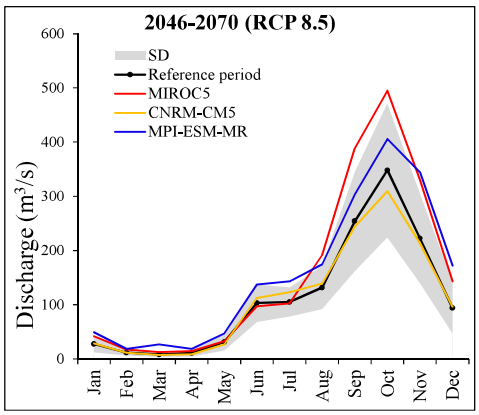


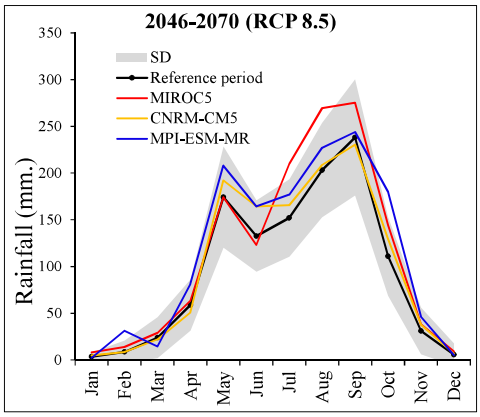





2046-2070 (RCP 2.6)
SD
Reference period
MIROC5
CNRM-CM5
MPI-ESM-MR
Discharge (m3/s)
0
50
100
150
200
250
300
350
400
450
500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


2046-2070 (RCP 2.6)
SD
Reference period
MIROC5
CNRM-CM5
MPI-ESM-MR
Rainfall (mm.)
0
50
100
150
200
250
300
350
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


2046-2070 (RCP 8.5)
SD
Reference period
MIROC5
CNRM-CM5
MPI-ESM-MR
Discharge (m3/s)
0
100
200
300
400
500
600
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


2046-2070 (RCP 8.5)
SD
Reference period
MIROC5
CNRM-CM5
MPI-ESM-MR
Rainfall (mm.)
0
50
100
150
200
250
300
350
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec