Hydrological Characteristics in Chao Phraya River, Thailand

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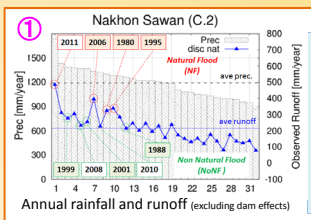
1. Background

Intermittent heavy rain from June 2011 led to massive flooding in the Chao Phraya River basin, Thailand. The World Bank estimates that the total economic damage and losses from the floods stands at 1.425 trillion Baht (45.7 billion US$). These damages have affected not only Thailand but also industries in other countries such as Japan, as has been widely reported in the press. After the massive flooding in 2011, The Thai government intends to revise the master plan (prepared in 1999) for management of the entire river basin.

The Japan International Cooperation Agency (JICA) launched a flood-control project following the massive flooding. The authors join the project through the Integrated Study on Hydro-Meteorological Prediction and Adaptation to Climate Change in Thailand (IMPAC-T) project.

Keyword: Floods, Chao Phraya River, Numerical simulation

2. Scientific questions



① **Natural Flood (NF)**
Increase in rainfall *brings* increase in runoff.
(2011, 2006, 1980, 1995)

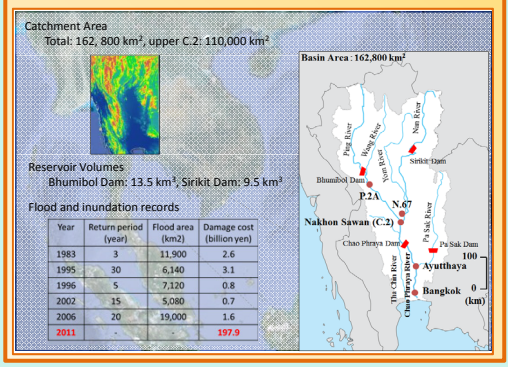
What produces the difference ?

Non Natural Flood (NoNF)
Increase in rainfall *does not result* increase in runoff.
(1999, 2008, 2001, 2010, 1988)

② *Can we capture indications of floods before September?*
Through hydrological modeling and observations

③ *How have runoff characteristics been changed ?*
Land cover change (deforestation), strengthened rainfall, *etc*...

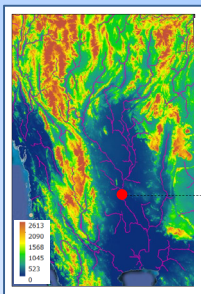
3. Study area: Chao Phraya River Basin

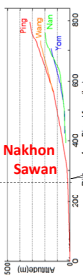


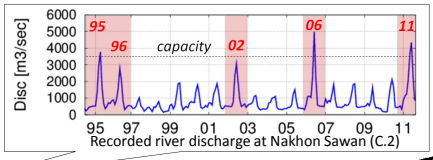
Year	Return period (year)	Flood area (km2)	Damage cost (billion yen)
1983	3	11,900	2.6
1995	30	6,140	3.1
1996	5	7,120	0.8
2002	15	5,080	0.7
2006	20	19,000	1.6
2011	-	-	197.9

4. Results

Geographical Characteristics

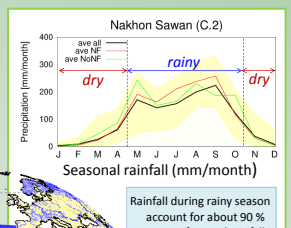




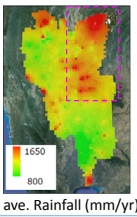


The Ping, Wang, Yom, and Nan Rivers flow down from the northern mountain area and merge at Nakhon Sawan (C.2).
Floods have been caused in the years when river discharge at Nakhon Sawan is beyond 3500 m³per second.

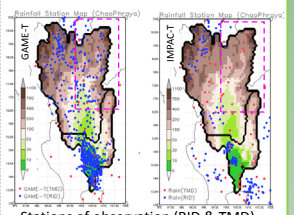
Rainfall observation



Rainfall during rainy season account for about 90 % of annual rainfall In the basin.

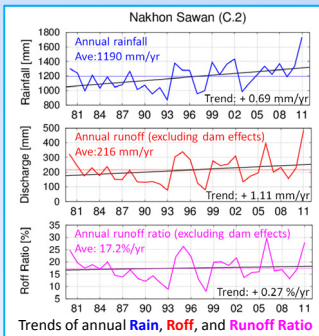


There are more rain in northeast mountain than south lower part via Asia Monsoon.



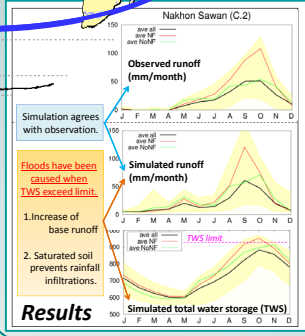
Rainfall-observing stations is not substantial in north east mountain although it have much rainfall in the area.
Adding stations in the area is desire in future.

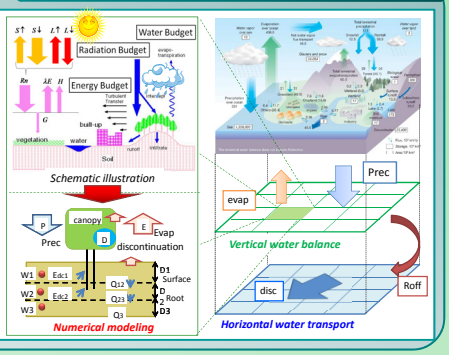
Long-term Trends



Both annual rainfall and runoff show increase trends slightly in this 30 years.
Average annual runoff ratio is 17. 2% , which means more than 80% of rainfall is lost through evapotranspiration in the basin.
Rainy years have large runoff ratios as shown in 1980, 1995, 1996, 2006, and 2011.
Because runoff ratio is very low, small increase in rainfall can result large increase in runoff.
Significant increase trend in runoff ratios have not been captured in this 30 years,
It suggests that land cover changes such as deforestation and urbanization do not have much impact, currently.

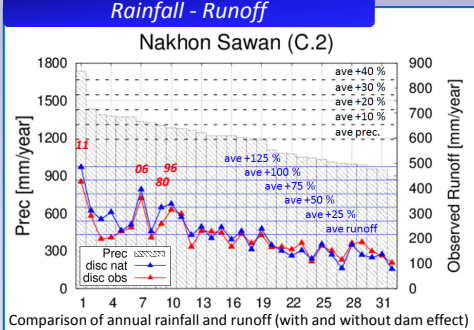
Hydrological Modeling





5. Discussion

Rainfall - Runoff

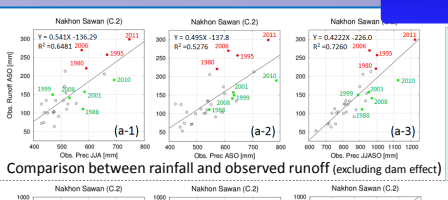


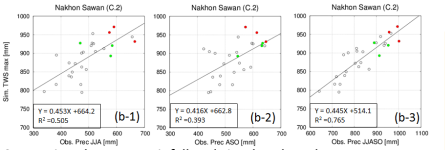
Natural Flood year: 2011
・+43% of average rainfall brought +125% of average runoff, which accounts for about +29 km³.
・Bhumibol (13.5 km³) and Sirikit (9.5 km³) Dams could not prevent floods.

Natural Flood years: 1980, 1996, 2006
・+10% rainfall brought +50-75% runoff

1. No dam's operation may prevent the massive flooding in 2011 perfectly.
2. Small increase in rainfall can results large increase in runoff because of low runoff ratio in the basin.

Rainfall – Runoff & TWS





Determination coefficient
(a-1) 0.6481: between JJA rain and ASO runoff
(a-1) 0.5276: between ASO rain and ASO runoff
(a-3) 0.7260: between JJASO ran and ASO runoff
(b-1) 0.505: between JJA rain and peak TWS
(b-2) 0.393: between ASO rain and peak TWS
(b-3) 0.765: between JJASO rain and peak TWS
JJA: June July August, ASO: August September October

1. Rainfall in meddle rainy season (JJA) is more dominant than that in late rainy season.
2. TWS exceeded its limit in Natural Flood years, because they had much rainfall in JJA. Saturated soil increases not only base runoff, but surface runoff via preventing infiltrations.

6. Conclusion

Summary

1. +43% of average rainfall in 2011 brought +125% of average runoff, which accounts for about +29 km³. No dam's operation may prevent the massive flooding perfectly because increased runoff exceeded the capacity of Bhumibol Dam (13.5 km³) and Sirikit Dams (9.5 km³) .
2. Small increase in rainfall can result large increase in runoff because of low runoff ratio.
3. Rainfall in meddle rainy season (JJA) is more dominant than that in late rainy season. TWS exceeded its limit in Natural Flood years, because they had much rainfall in JJA. Saturated soil increases not only base runoff, but surface runoff via preventing infiltrations.

Acknowledgements

The authors wish to thank RID(Royal Irrigation Department of Thailand), EGAT(Electricity Generating Authority of Thailand), and TMD(Thai Meteorological Department) for providing their valuable data sets. This work has been supported by a research project of the JICA entitled "Integrated Study on Hydro-Meteorological Prediction and Adaptation to Climate change in Thailand (IMPAC-T)" and the Japan Society for the Promotion of Science (JSPS).