TA-102S

Managing Flash Flood and Drought in Rainfed Agriculture – The Context of Water Crisis Management in Thailand

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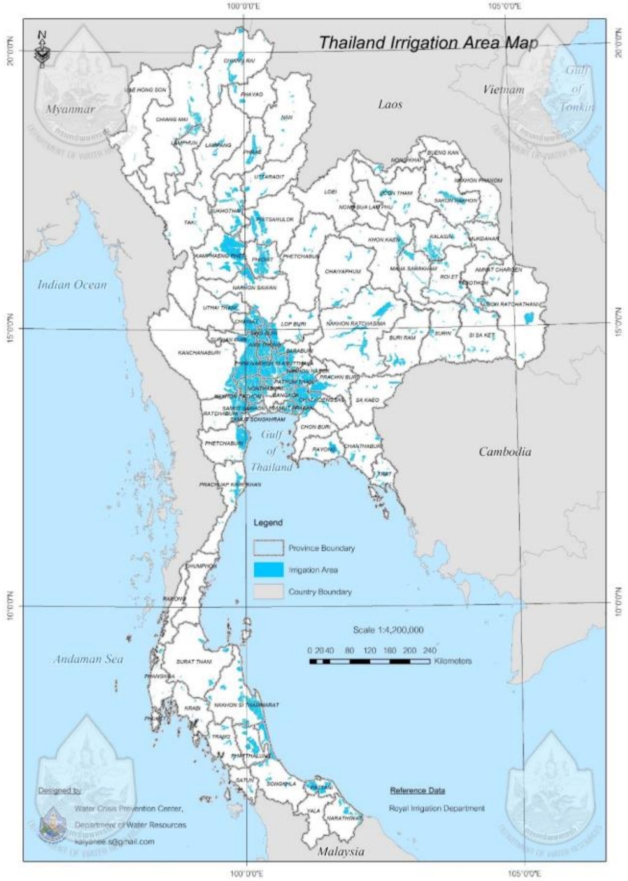
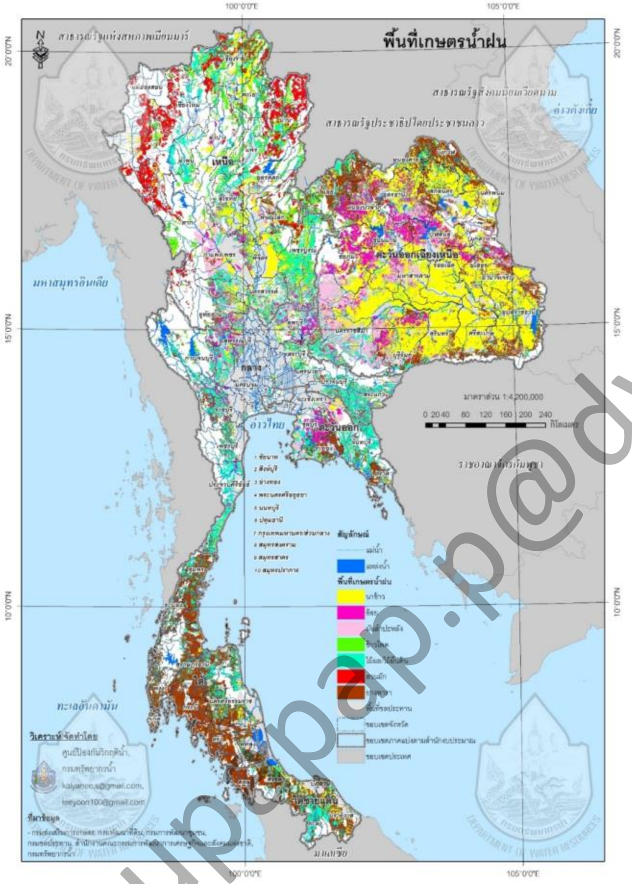
Introduction: What is rainfed agriculture? & Why rainfed agriculture is important?

Irrigation Agriculture:



Rainfed Agriculture:

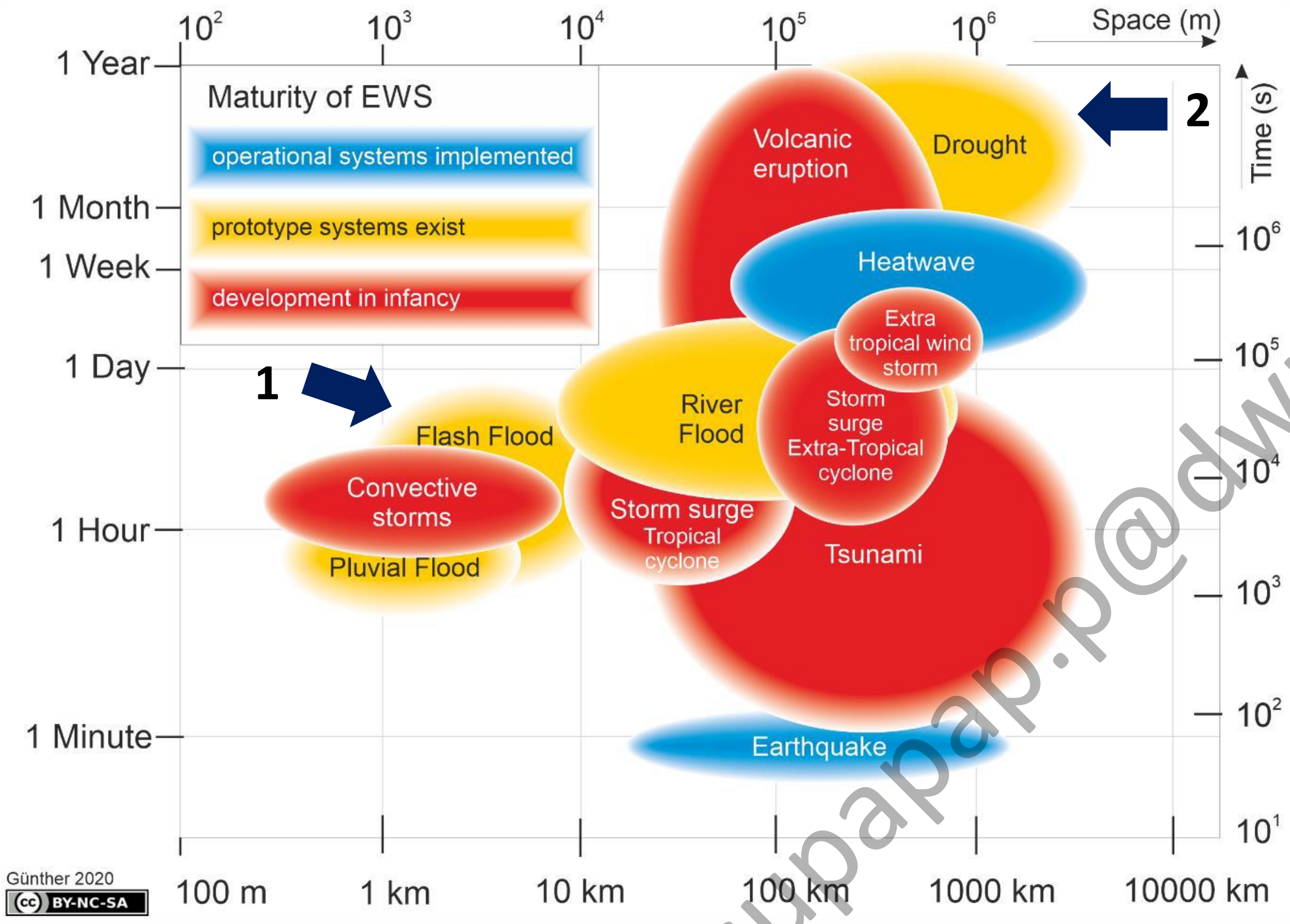


(*Wani SP et al, 2009 & S. Patsinghasanee et al, 2019*)

- ❑ Rainfed agriculture is varied by regionals and climate conditions, but it mostly contributes food for poor communities in developing countries.
- ❑ Rainfed agriculture has traditionally been managed at the field-scale.
- ❑ Supplemental irrigation systems (100 – 10,000 m^3) are affordable for small-scale farmers.

Irrigation Agriculture 52,400 km^2 (22 %)	Rainfed Agriculture 187,200 km^2 (78 %)
❑ Water supply by large and medium reservoirs.	❑ Water supply by small reservoirs and waterbodies.
❑ Managed by irrigation systems and structures.	❑ Inadequate of irrigation systems and structures.
❑ Low risk in water shortage.	❑ High risk in water shortage.

Objectives:



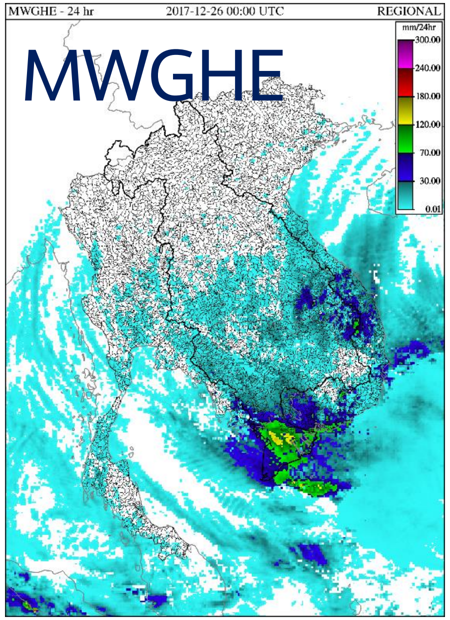
(Merz et al, 2020)

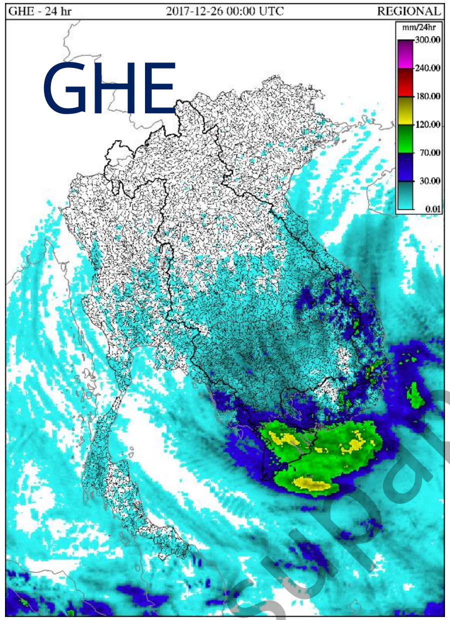
- ❑ **Flash flood warning and forecasting systems.**
- ❑ **Seasonal drought forecasting system.**
- ❑ **Water crisis prevention & mitigation plans.**

(1) Flash Flood Warning Systems: Flash Flood Guidance System (FFGS)

MRC: Flash Flood Guidance System

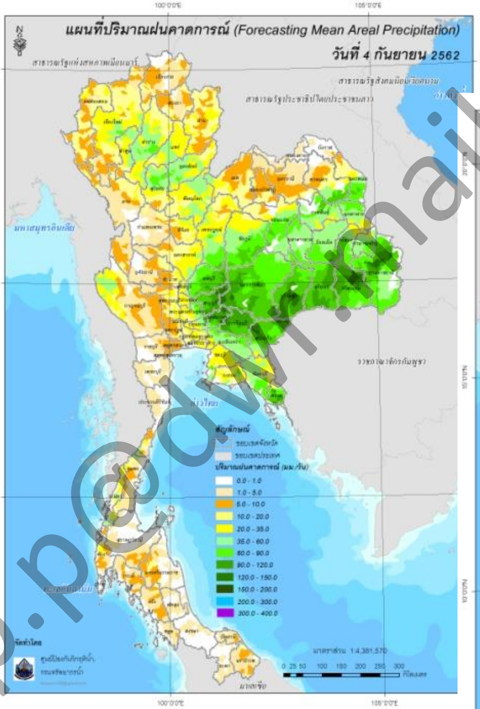
Developers:
- World Meteorological Organization
- Hydrologic Research Center (USA)
- Mekong River Commission



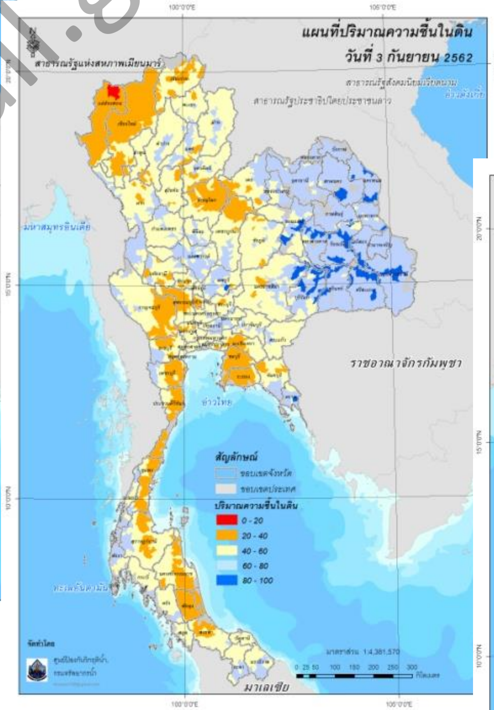


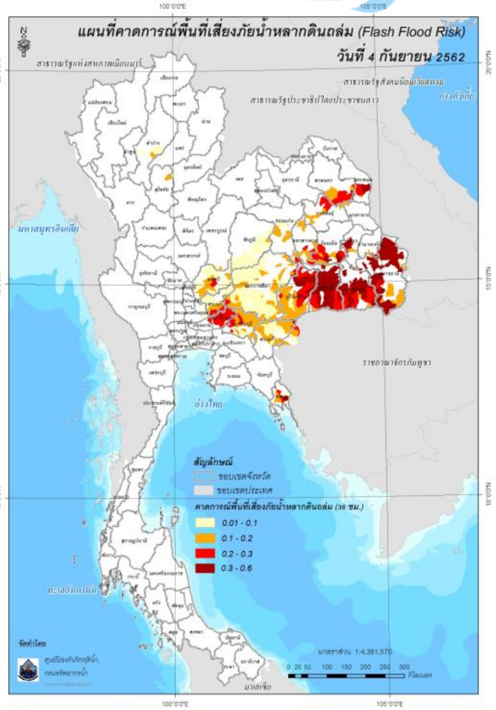
Global Hydro-Estimator

Forecasting Mean Areal Precipitation (1-24 hrs.)



Soil Moisture Content

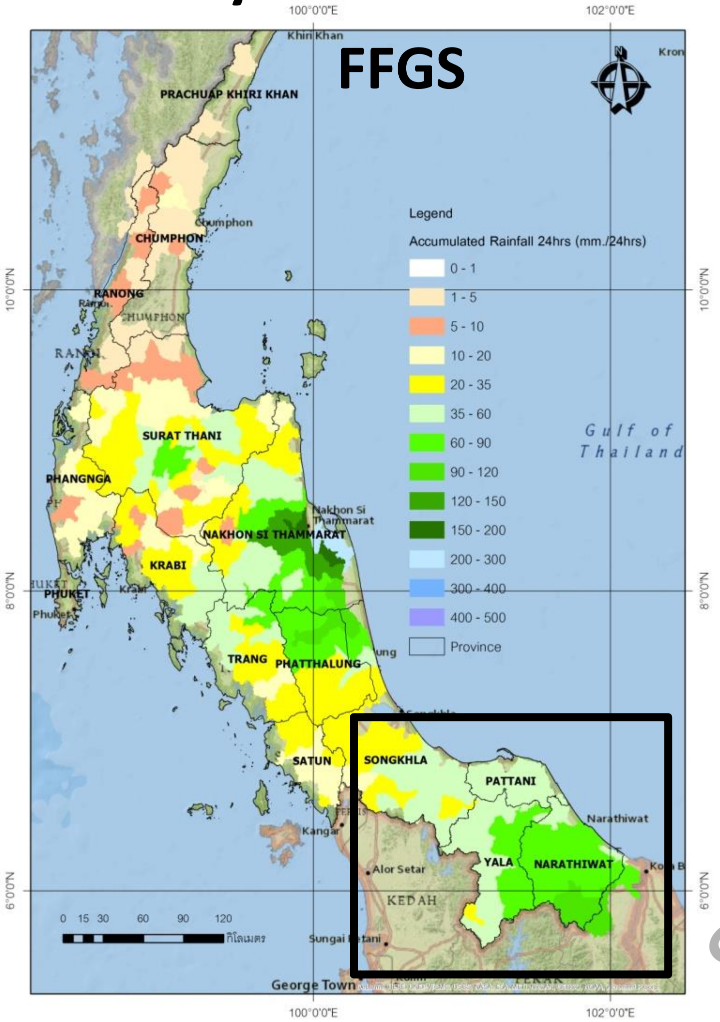


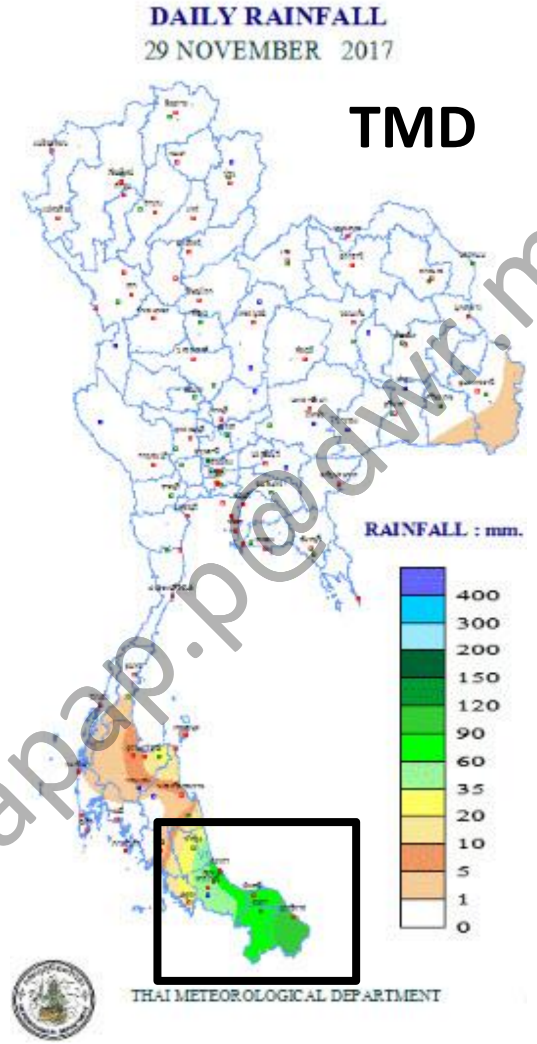


Flash Flood Risk Area (3/6/24 hrs.)

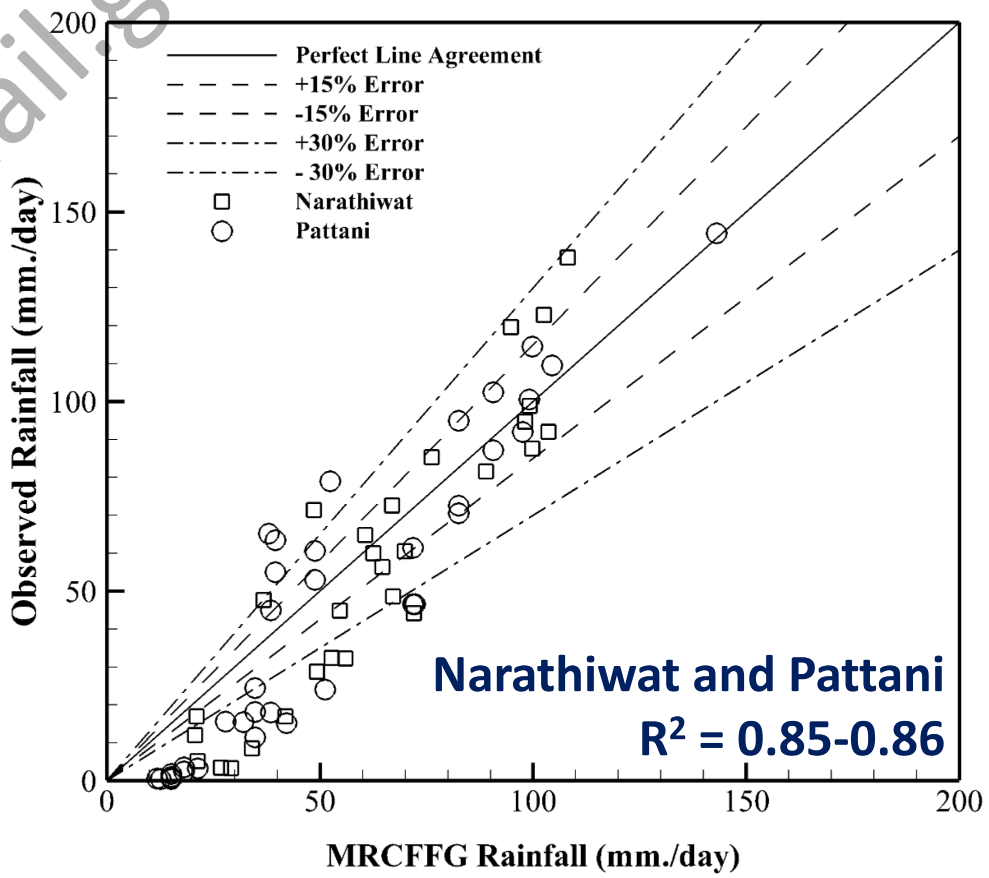
(1) Flash Flood Warning Systems: Existing Works

Case study from 28 Nov to 4 Dec 2017



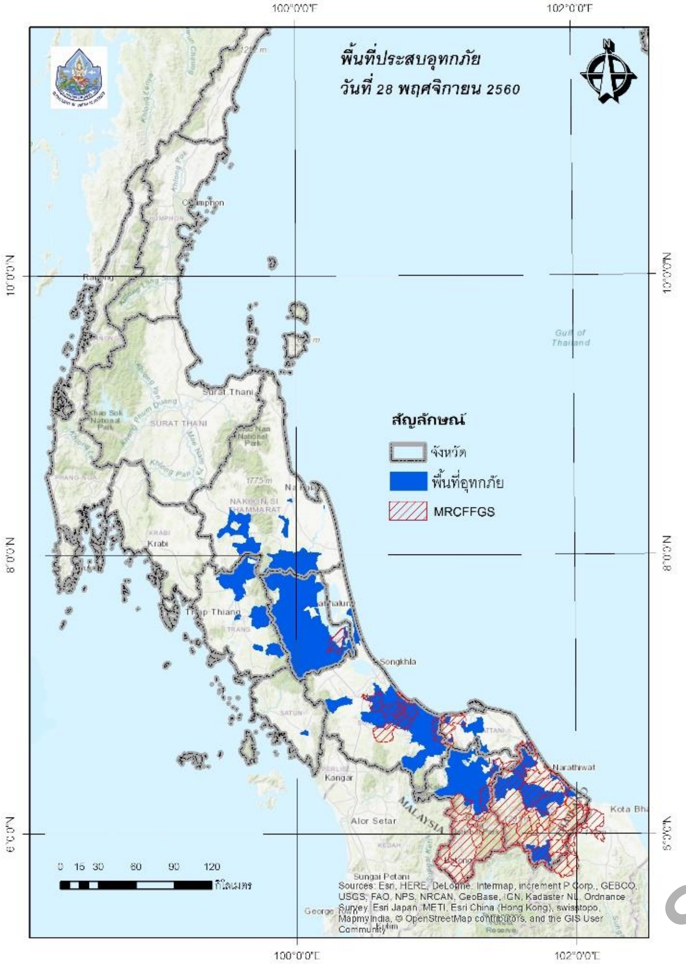


Obs. Data Vs Mean Areal Precipitation

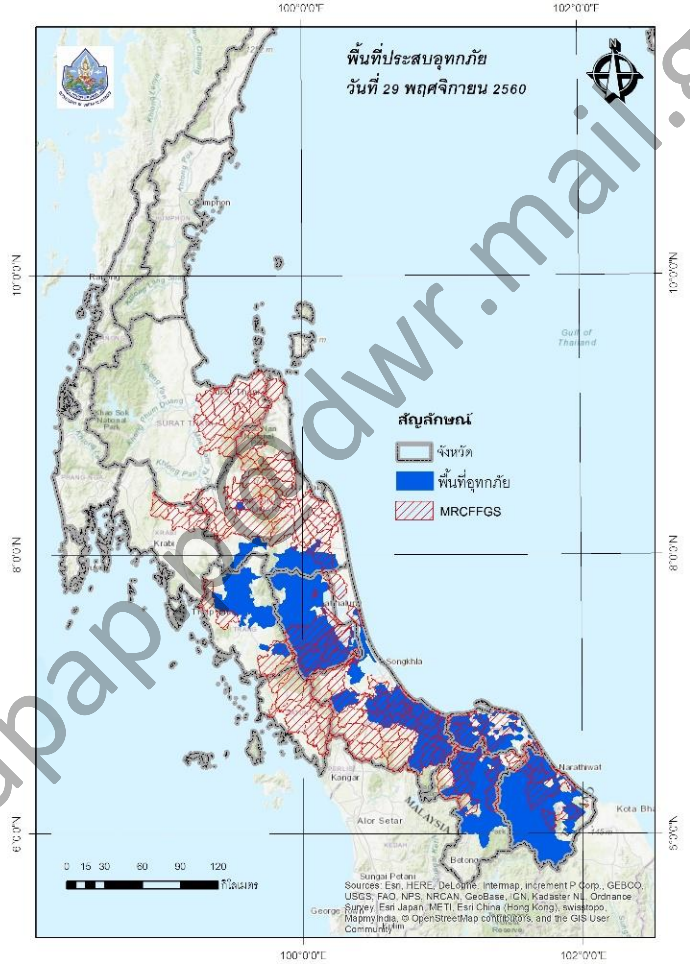


(1) Flash Flood Warning Systems: Existing Works

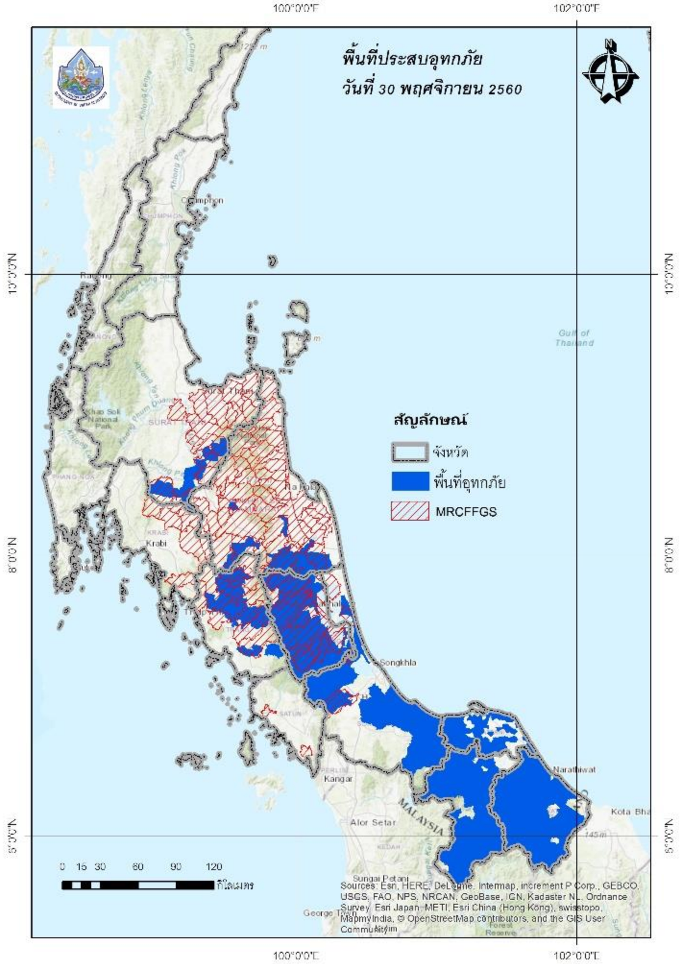
28 Nov 2017



29 Nov 2017

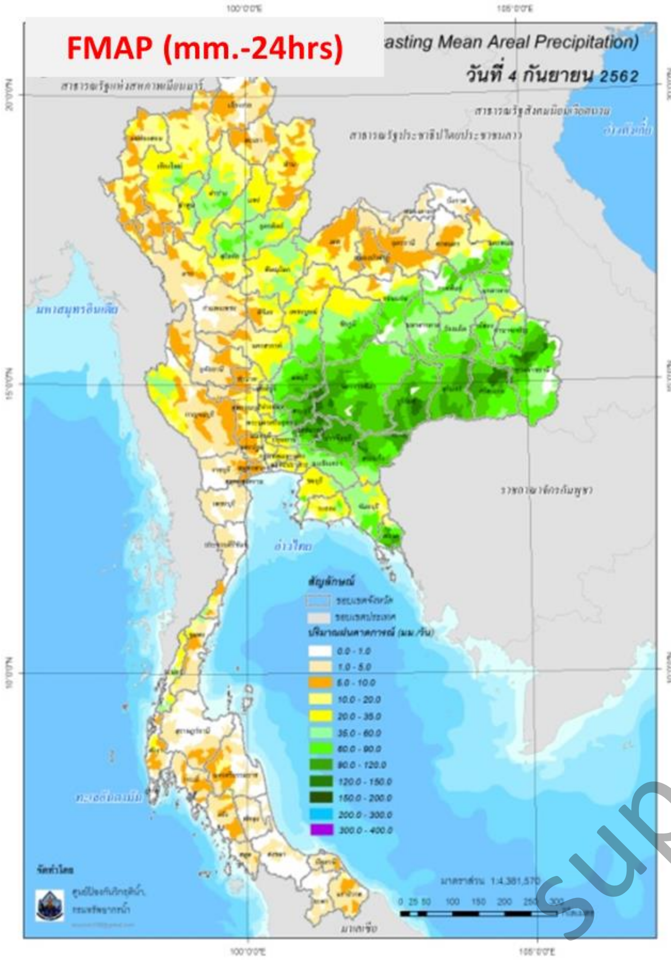


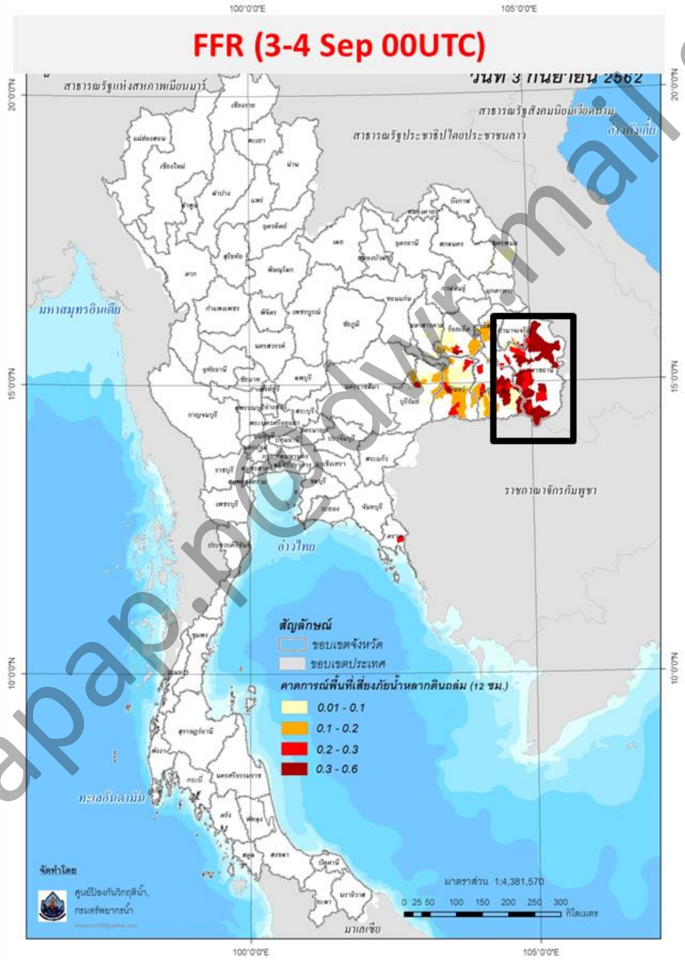
30 Nov 2017

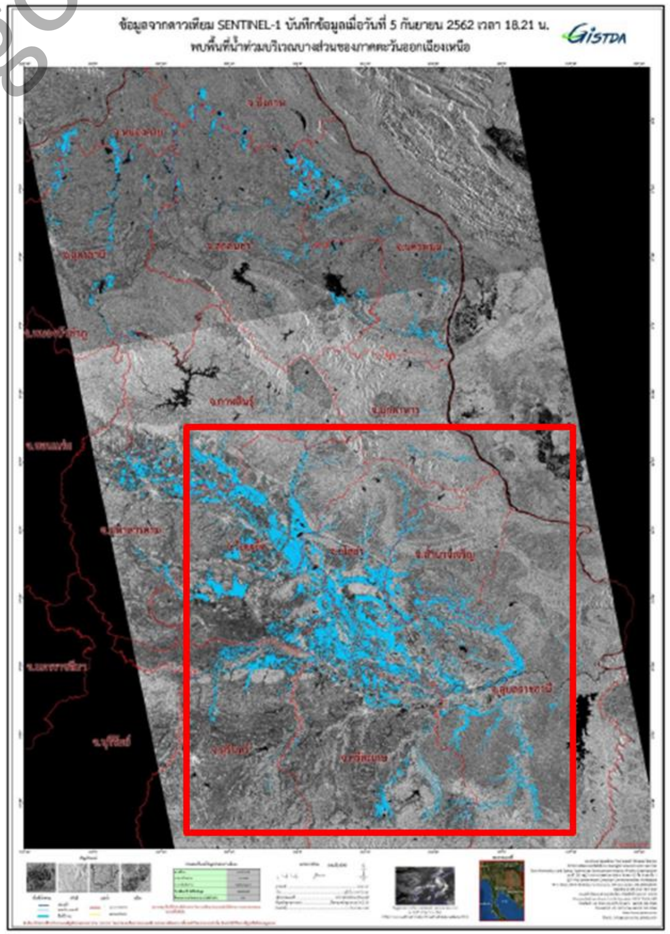


(1) Flash Flood Warning Systems: Existing Works

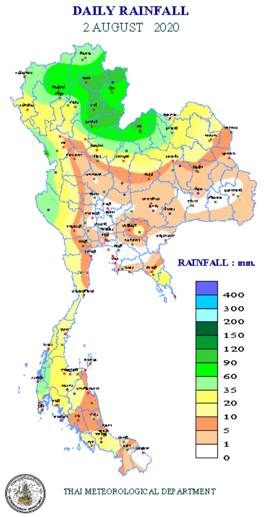
Case study: Tropical Storm Podul & Kajiki (Sep 2019)

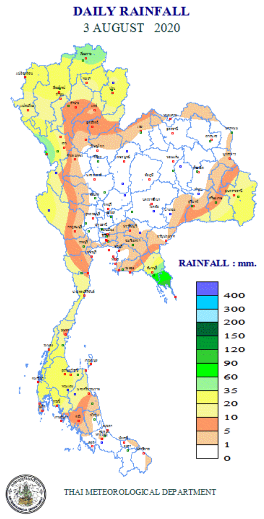


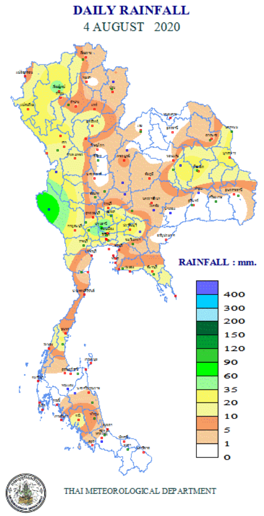


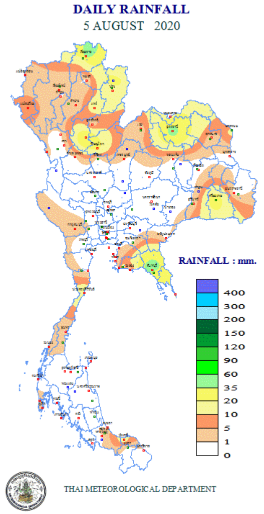


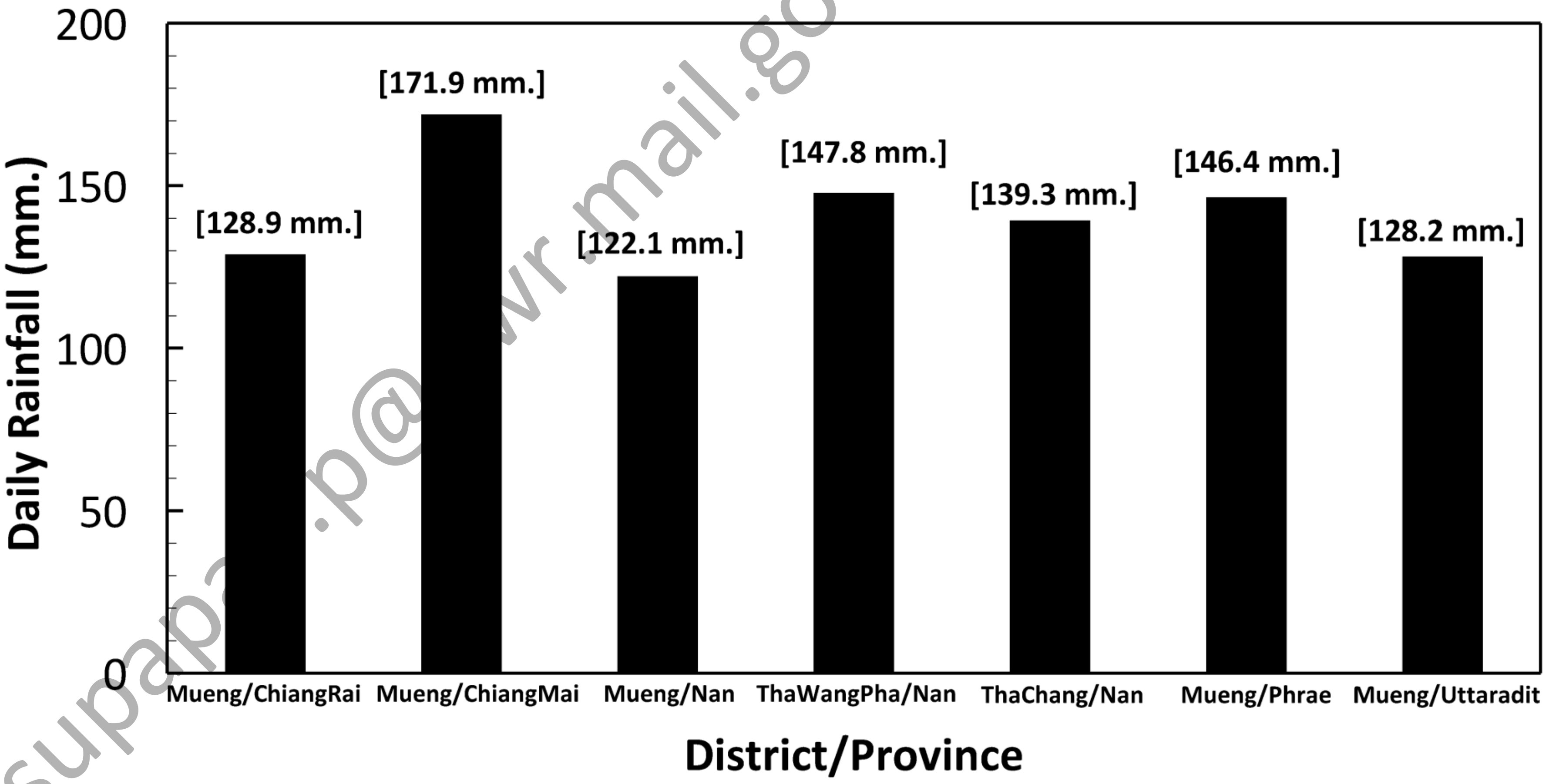
(1) Flash Flood Warning Systems: SINLAKU (August 2-5, 2020)



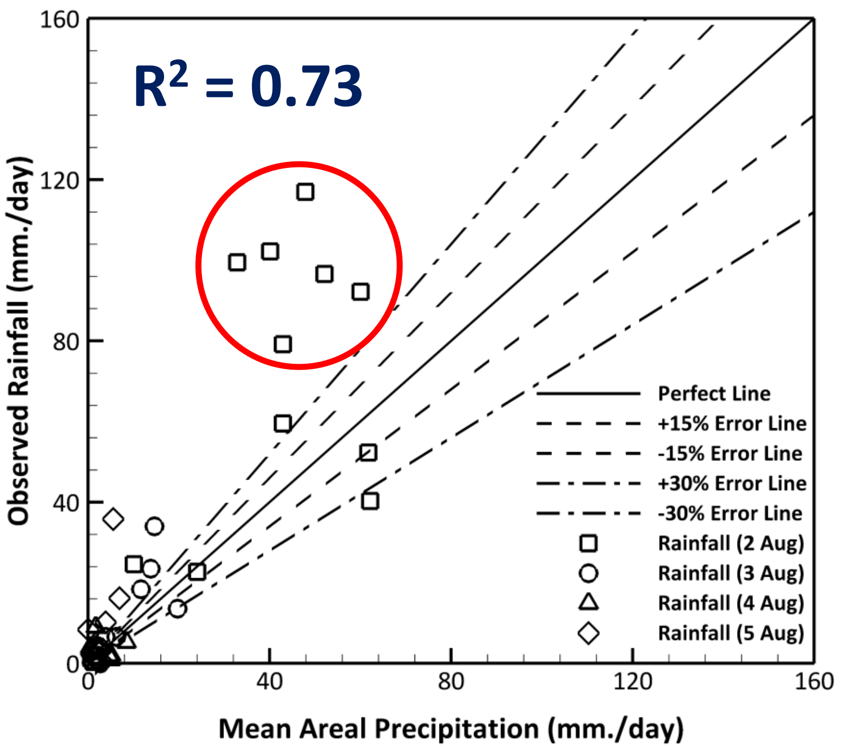




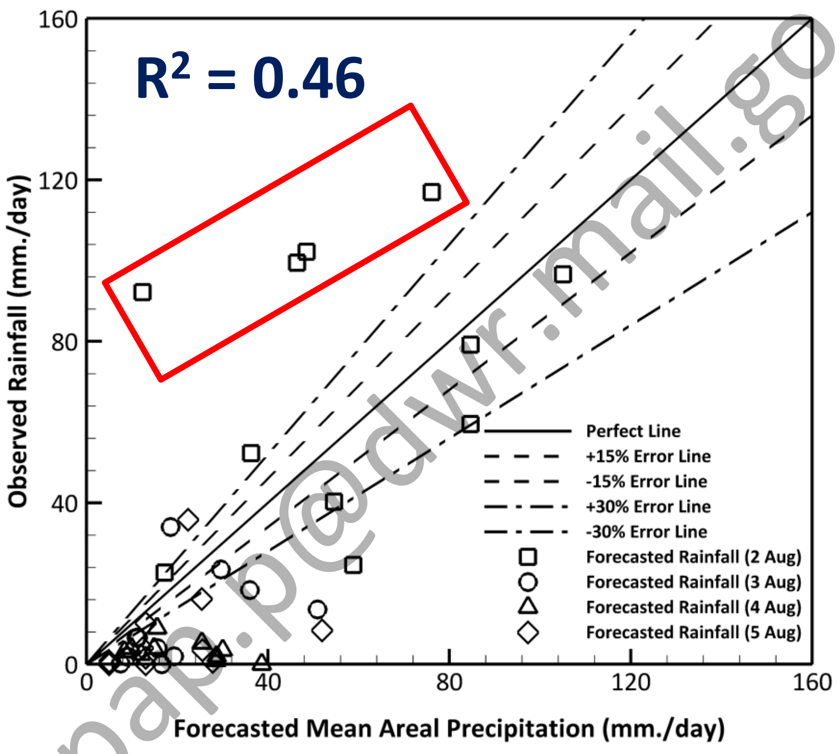




(1) Flash Flood Warning Systems: SINLAKU (MAP & FMAP)



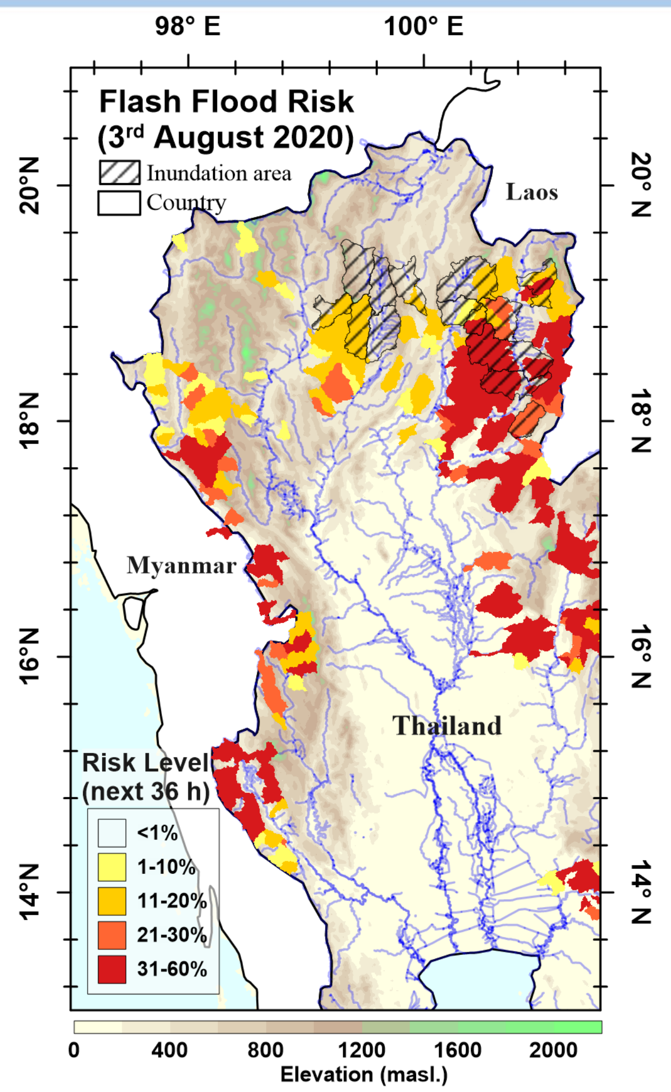
Comparison results between MAP & Observed data.



Comparison results between FMAP & Observed data.

- The daily MAP & FMAP estimations were significantly underestimated in study areas.
- The local forecasting rainfall systems, radar stations, and forecaster abilities are essential to consider with the products for making a good decision.

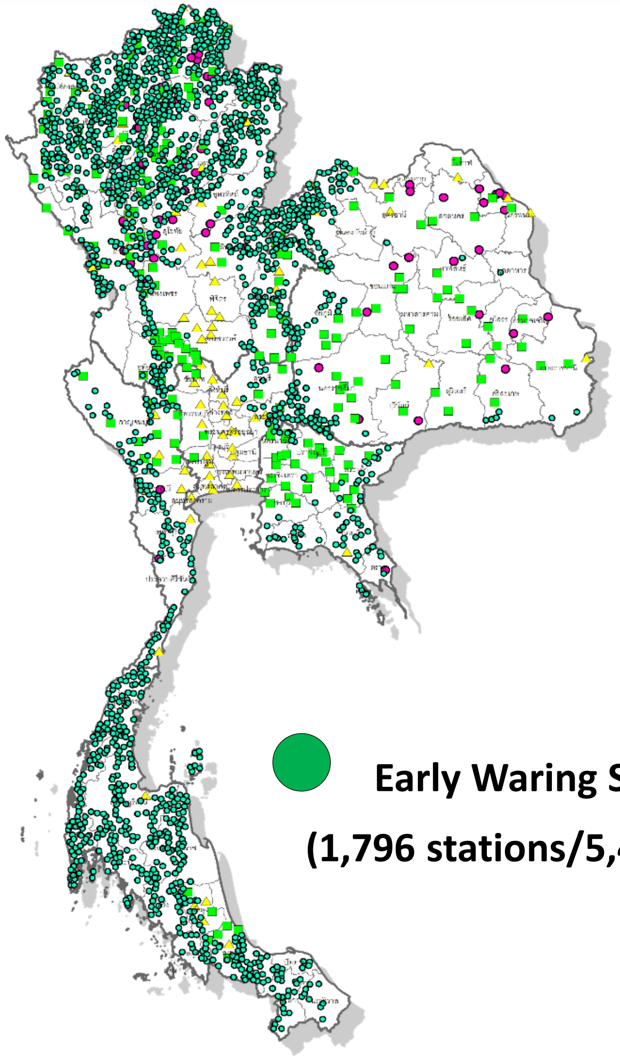
(1) Flash Flood Warning Systems: SINLAKU (Flash Flood Risk, FFR)



- The comparison results between FFR and inundation areas are illustrated in good agreement.
- The FFGS needs to highlight the uncertainty characterization of forecasting products due to uncertainties in the qualitative forecasting rainfall.
- The forecasters are required to consider the in-situ stations (e.g., rainfall and water level) for implementing the FFGS.

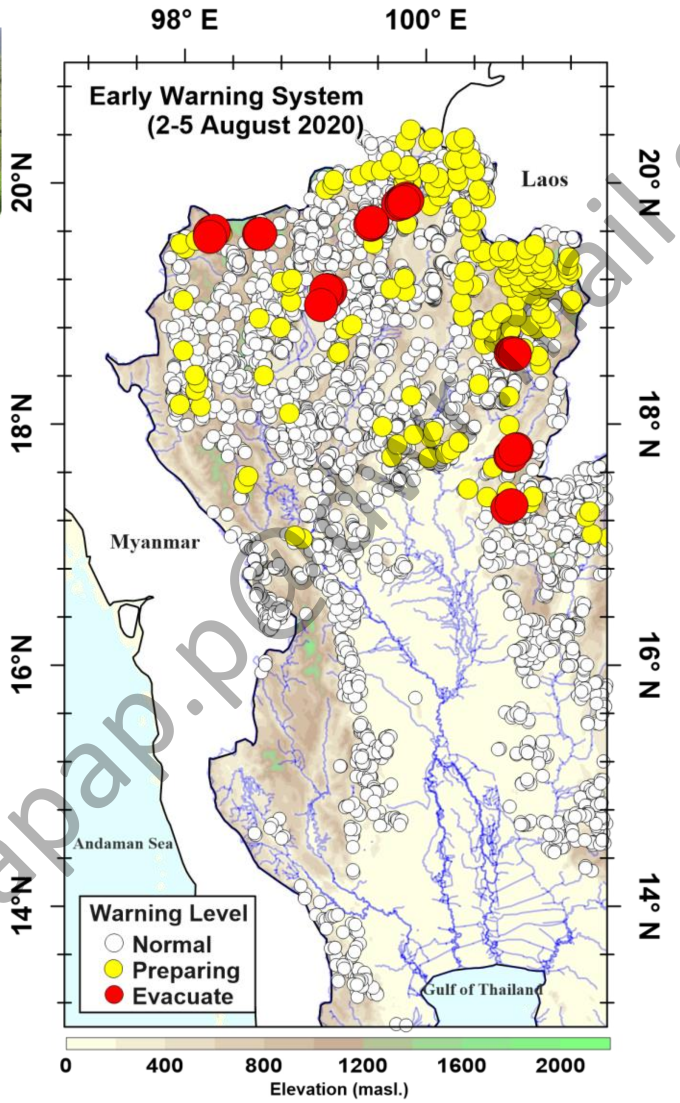
The inundation areas did not specify the actual type of flooding (e.g., flash flood, riverine flood, and debris flow).

(1) Flash Flood Warning Systems: Early Warning System



Early Waring System

(1,796 stations/5,482 villages)



Warning Level	Times	Villages
Normal	94	298
Preparing	86	279
Evacuate	8	29
Total	188	606

- The evacuation warning (red alert) was issued 8 times in 6 provinces (Nan, Chaing Mai, Chaing Rai, Uttaradit, Phisanulok, and Mae Hong Son).
- Coupled Flash Flood Warning System by the forecasting system and in-situ stations is strongly recommended to clarify the flash flood risk in Northern Thailand.

(2) Drought Forecasting System:

2007 — Drought Risk Area in Provincial Level (76)

2015 — Drought Risk Area in District Level (878)

2019 — Drought Risk Area in Sub-District Level (7,255)

Provincial Level

- Tovichakchaikul, S., Chitprom, P. and Patsinghasanee, S. Annual Report of Thailand Drought Situation and Forecasting 2007, ***Proceeding of the fourth Kasetsart University (Kamphaeng Saen Campus)***
- Patsinghasanee, S. Annual Report of Thailand Drought Situation and Forecasting 2010, ***Proceeding of the third Ministry of Natural Resource and Environment Conference***

District Level

- Laonamsai, J., Patsinghasanee, S., Suwanprasert, K., Pracheepchai, J., and Wangpimool, W. Evaluation of water balance process in dry season for the rainfed areas in Thailand: Case study from 2016 to 2018. ***The 3rd Mekong River Basin International Conference***, April 2-3, 2018, Siem Reap, Cambodia.

Sub-District Level

- Patsinghasanee, S., Pracheepchai, J., Suwanprasert, K., Saprateth, T. and Laonamsai, J. Drought Management for the Rainfed Areas in Thailand: A Case Study of October 2019 to April 2020 Period, ***Srinakharinwirot Engineering Journal***, Vol. 15 No.3, 54-64, 2020.

(2) Drought Forecasting System:

Water Supply

Water Demand

$$WB_{sub} = \sum_{n=1}^{n=7,425} \left((S_{RR} + S_{st} + S_{riv}) - (D_{dom} + D_{eco} + D_{agr} + D_{ind}) \right)$$

01 **Waterbodies (102,112 waterbodies)**

$$S_{st} = \sum_{n=1}^{n=7,425} \left(\frac{S_t}{S_{max}} \times S_n \right)$$

02 **Watercourses (137 stations)**

$$S_{riv} = \sum_{n=1}^{n=137} (0.0036 \times c_{riv} \times Q_n)$$

03 **Forecasting Rainfall (878 districts)**

Domestic (120 l/person/day)

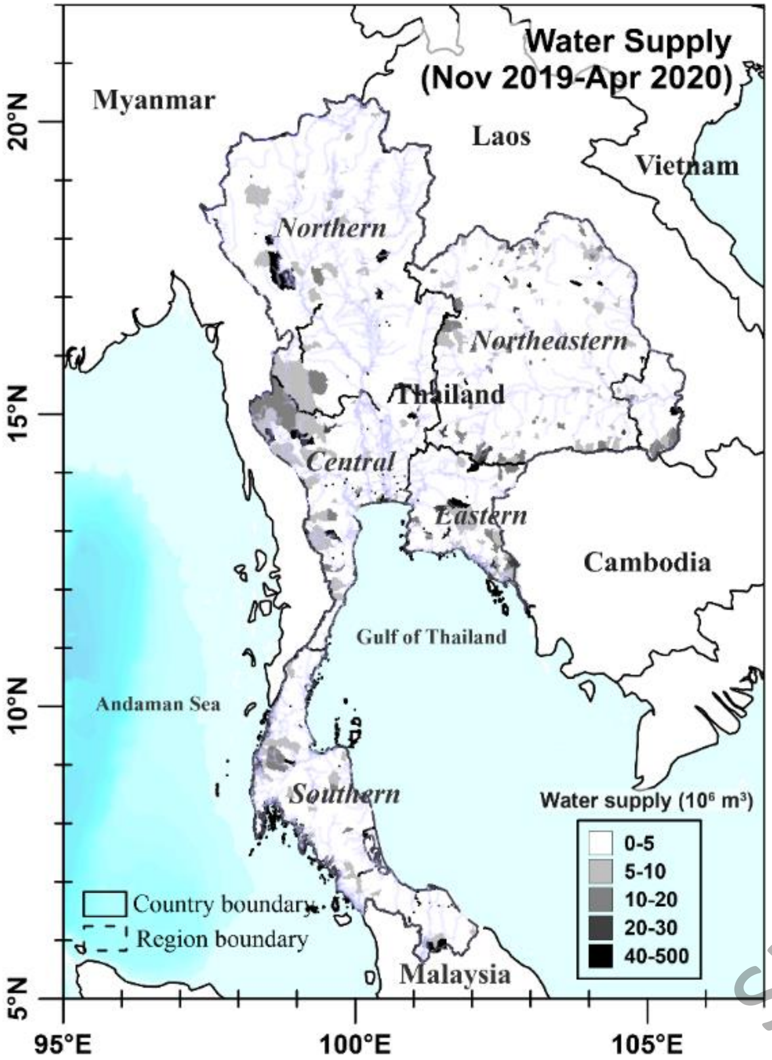
Ecology

Agriculture (Rice/Corn/Sugarcane /Maize/Vegetable)

Industry

Para Rubber

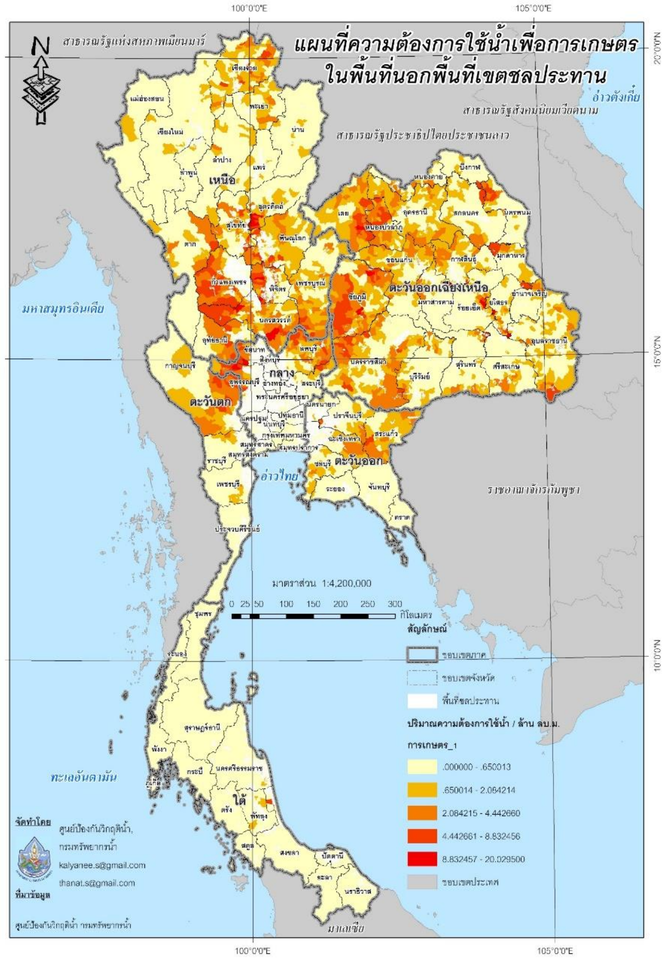
(2) Drought Forecasting System: Water Supply



Regional	Supply-side (Oct 2019 – Apr 2020) (million m^3)			
	RR Model	Watercourse	Waterbody	Total
North	143	512	935	1,590
Northeast	183	806	4,421	5,410
Central	65	441	1,002	1,508
East	41	117	730	888
West	42	260	588	890
South	178	230	1,072	1,480
Total	652 (5.5%)	2,366 (20%)	8,748 (74.5%)	11,766

(3) Drought Forecasting System: Water Demand

Demand-side



Agriculture Sector (Rice/Cassava/Sugarcane/Maize)

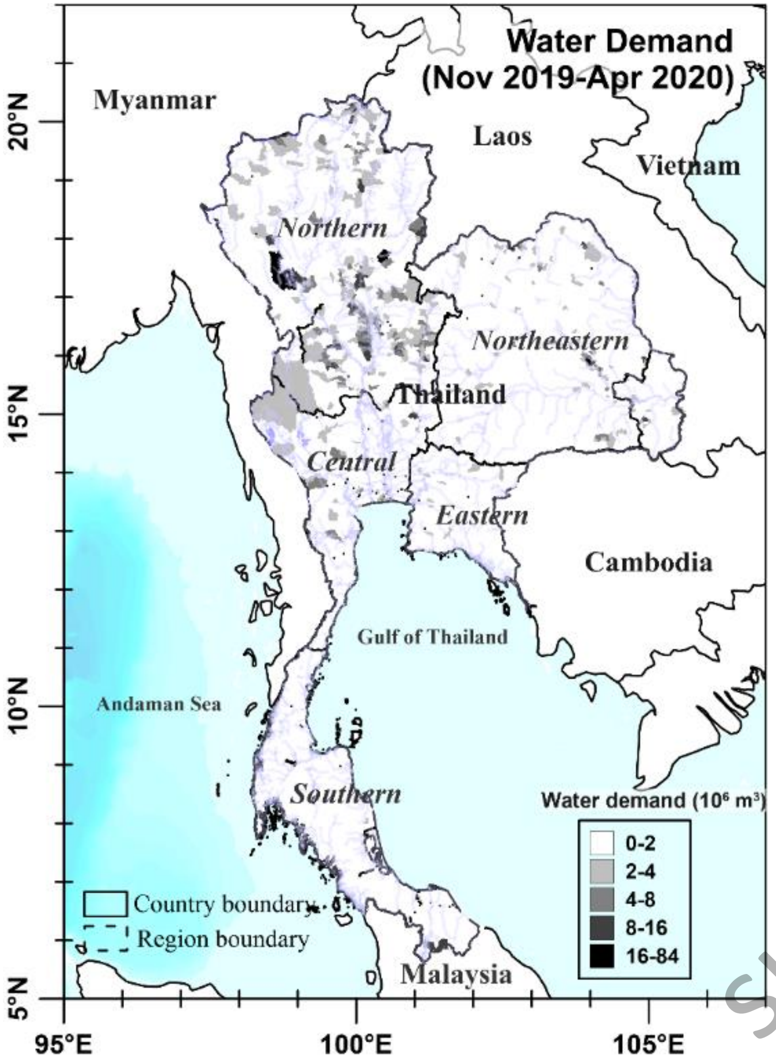
- Paddy field 35,560 km^2 (Department of Agricultural Extension)
- Maize 1,370 km^2 (Department of Agricultural Extension)
- Sugarcane 4,590 km^2 (GISTDA)
- Cassava 2,560 km^2 (GISTDA)

Plant	Date	Water use (m^3/rai)
Paddy field	100	1,101-1,172
Maize	100	550-594
Sugarcane	300	1,503-1,656
Cassava	125	715-773

(Remark: 625 rai = 1 km^2)

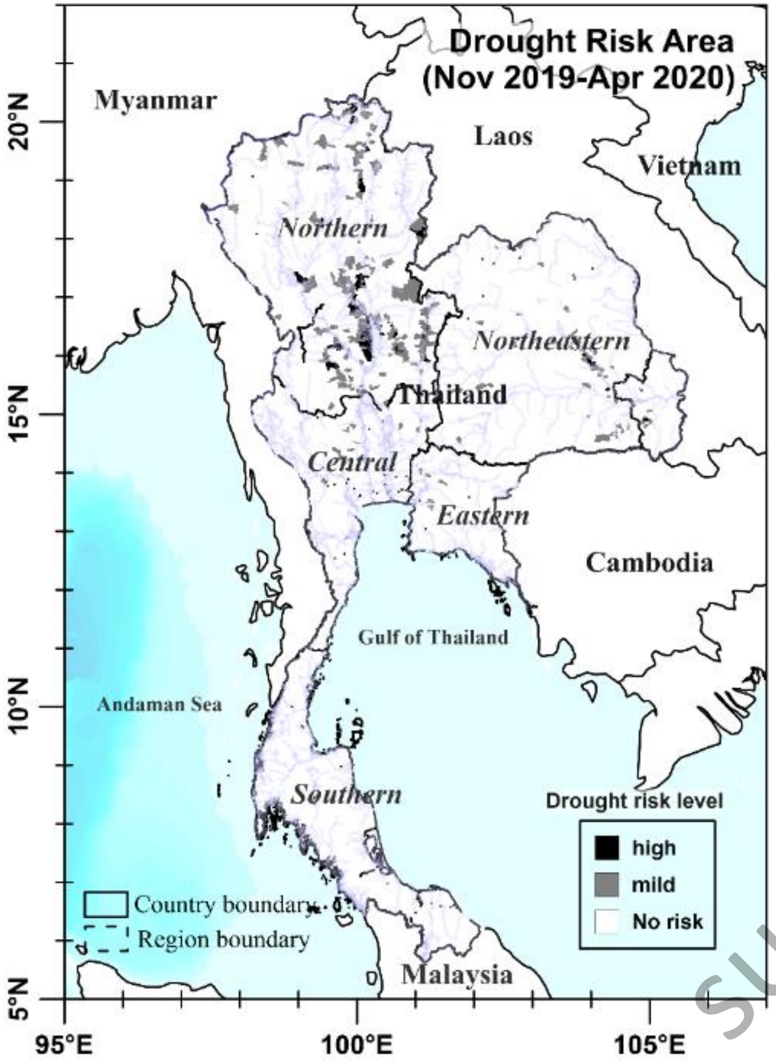
GISTDA: The Geo-Informatics and Space Technology Development Agency

(2) Drought Forecasting System: Water Demand



Regional	Demand-side (Oct 2019 – Apr 2020) (million m^3)				
	Agr	Dom	Ind	Eco	Total
North	1,860	134	30	193	2,217
Northeast	2,491	332	60	167	3,050
Central	942	222	204	145	1,513
East	202	61	57	54	374
West	150	28	32	189	399
South	47	150	18	189	404
Total	5,692 (71%)	927 (12%)	401 (5%)	937 (12%)	7,957

(2) Drought Forecasting System: Water Balance



Drought Risk Area

(Water Deficit > 1 million m^3 in sub-district)

57 provinces 305 districts

984 sub-districts

Department of Disaster Prevention and Mitigation Report on 14 April 2020: Water deficit areas from 17 October 2019 to 14 April 2020 are in **24 provinces 145 districts 782 sub-districts**

702 sub-districts were in the same between forecasting results and existing report (71%).

(3) Water Crisis Prevention & Mitigation Plan: Conclusions

Rainfed Agriculture:

1 Rainfed agriculture plays and will dominant role in providing foods, generating incomes, and ensuring water security in developing countries.

Flash Flood Warning System:

2 The FFGS needs to highlight the uncertainty characterization of forecasting products due to uncertainties in the qualitative forecasting rainfall.

3 Coupled system of FFGS and EWS was clearly effective for implementing the actual situation in study areas.

Drought Forecasting System:

4 Drought risk areas forecasted by water balance technique were in a good agreement with reported drought areas.

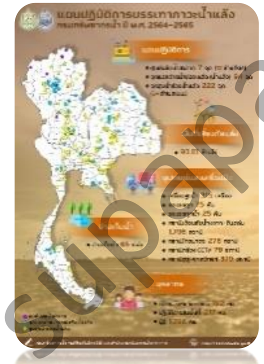
(3) Water Crisis Prevention & Mitigation Plan:

Water Crisis Prevention and Mitigation:

5 Before disaster, DWR provided the water resources information, and prevention and mitigation plans to national agencies and local authorities.

6 During disaster, DWR has established Ad-hoc center in the headquarter and regional offices for emergency management.

7 Post disaster, DWR rehabilitated and reconstructed the damaged infrastructures.



กรมทรัพยากรน้ำ
DEPARTMENT OF WATER RESOURCES

กระทรวงทรัพยากรธรรมชาติและสิ่งแวดล้อม

Thank You