Efficiency of MRC Flash Flood Guidance System (MRCFFGS) for Northeastern Thailand: Case Study of Tropical Strom Impact in 2019-2020

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ABSTRACT

Flash flood is a globally drastic natural disaster. Hence, the World Meteorological Organization (WMO) arranges cooperation to develop a tool for flash flood forecasting in each WMO region which is Flash Flood Guidance System (FFGS). In Thailand, FFGS is implemented under a collaboration with the Mekong River Committee and it is called MRCFFGS. This system uses a hydrological model to calculate the capacity of water restoration inland before triggering flash floods in a small river basin. The study of MRCFFGS in Thailand shows that in the Northeast region affected by three tropical cyclones, KAJIKI, PODUL, and SINLAKU, it is found the statistic skill score callings as the following: The probability of detection (POD) is 0.14, and false alarm ratio (FAR) is 0.3. It is not a good score for prediction especially POD. After adjusting the FFG value by half, the result shows that POD is 0.50 and FAR is 0.36. While adapting the FFG value by one-third, the result reveals that POD is 0.50 and FAR is 0.42. In this study, it can be concluded that adjusting the FFG value by half shows the best result. It is suitable for flood simulation and prompt response to rainfall.

1. INTRODUCTION

Flash flood is one of the most dangerous natural disasters. In a year, at least 5000 people lost their lives and many people lost their properties, it is 85% of casualties of the flood came from the flash flood. Flash flood occurs in a short time and small particular area, unlike overbank flow which occurs in the large area in the basin. It is hard to predict this event precisely, flash flood warning is also uncertain and not in a time when it takes place, the main reason for damage to life and properties. The two main factors that trigger flash flood events are 1. rainfall and 2. the soil moisture properties, therefore, a flash flood is varying from place to place and depending on the micro-scale of weather in one another region (WMO,2020)

The flash flood guidance system is supported by World Meteorological Organization, Hydrological Research Center, National Oceanic and Atmospheric Administration, and United States Agency for International Development. The mission of this system is to contribute to forecasting flash flood events for meteorologists and relate agents in each member country and regional area and enhancing flash flood warning for the overall area of the globe but separate responsibility by zone such as country. To launch flash flood warning issued, because of its flash in time and small of the region, some flash flood cases are miss and the information from FFGs show only heavy rainfall and soil moister saturation in area, meteorological and hydrological expertise is required to deal with flash flood warning issue inclusive with high-resolution weather station network and 24-7 monitoring (WMO, 2016)

FFGS use satellite-based rainfall with bias correction and put it into a physically-based hydrological model to explain flash flood event (WMO, 2007). Comparing observed rainfall with forecast rainfall and project to a characteristic of the basin in a specific time, the result of flash flood shows the difference value between soil capacity in basin and rainfall event. The flash flood guidance depends on basin drainage character which portrays by rainfall and evapotranspiration (Mutic et al., 2020)

FFGS that cover Thailand area is operated under MRCFFGS, system development in term of Mekong river basin view, the members country are Thailand Laos Cambodia and Vietnam. When it is applied to use in Thailand performance verification is necessary. The flood event in the past is used as ground truth for FFGs to improve efficiency.

FFGS case study in Thailand done Patsinghasanee et al. (2018), verified accuracy in the southern part of Thailand between 28 November 2007 and 4 December 2007- northeast monsoon period. The FFGS portrayed less rainfall significantly and recommended adding value by correcting soil moisture and rainfall.

This study aims to correct the product of FFGS by comparing it with ground truth. From flash flood operation finds that FFG rarely launch issue in flood warning which congenial with the study of Patsinghasanee et al. (2018) so bias correct as a result of the system are needed cause we cannot correct in process of the system.

2. METHODOLOGY

2.1 Study area

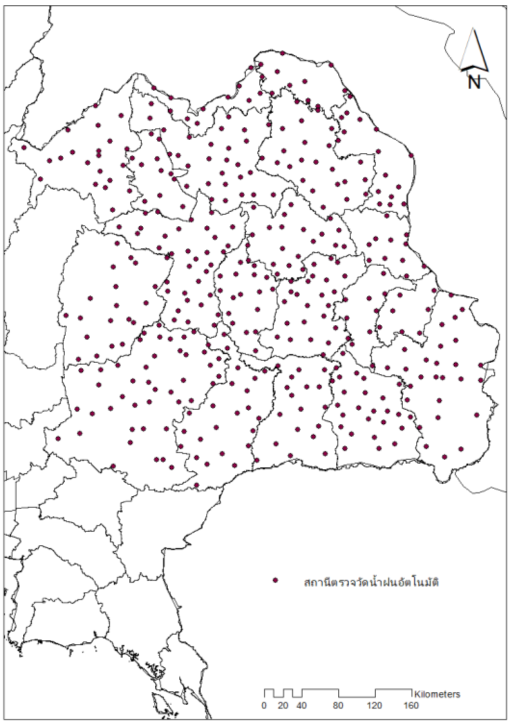

Figure 1. Rain Gauge Network in the study area

The Northeast part of Thailand was selected as a study. The picture1 shows automatic rain gauge network in this area (Figure 1)

2.2 Data collection

1. FFG data from MRCFFG center, located at Phnom Penh Cambodia, a two-period as following: 1. 28 August 2019 to 6 September 2019 and 2. 2 August 2020 to 5 August 2020. The data display the potential of a flash flood occurring by rainfall and soil capacity in the next six hours periodic calculation at 0000 0600 1200 1800 UTC.

2. TMD automatic rain network (403 stations) same period as 2.2.1 for comparing with FFGS record in ASCII file size is 1.4Mb per year

3. Report of flood in Thailand from Department of Disaster Prevention and Mitigation (DDMP) and Media news

2.2 Methods

1. Write Program computer script to download data from MRCFFGS and connect to TMD rainfall database for verification FFGs

2. Develop a script to transform format FFG from polygon of the small basin to grid cell of FFG and transform point rainfall to areal rainfall as grid cell of rainfall. The two grids are the exactly same size.

3. Comparing two types of data as mention earlier for two cases that have an influent of monsoon (2019 and 2020).

4. Bias correction for FFGs

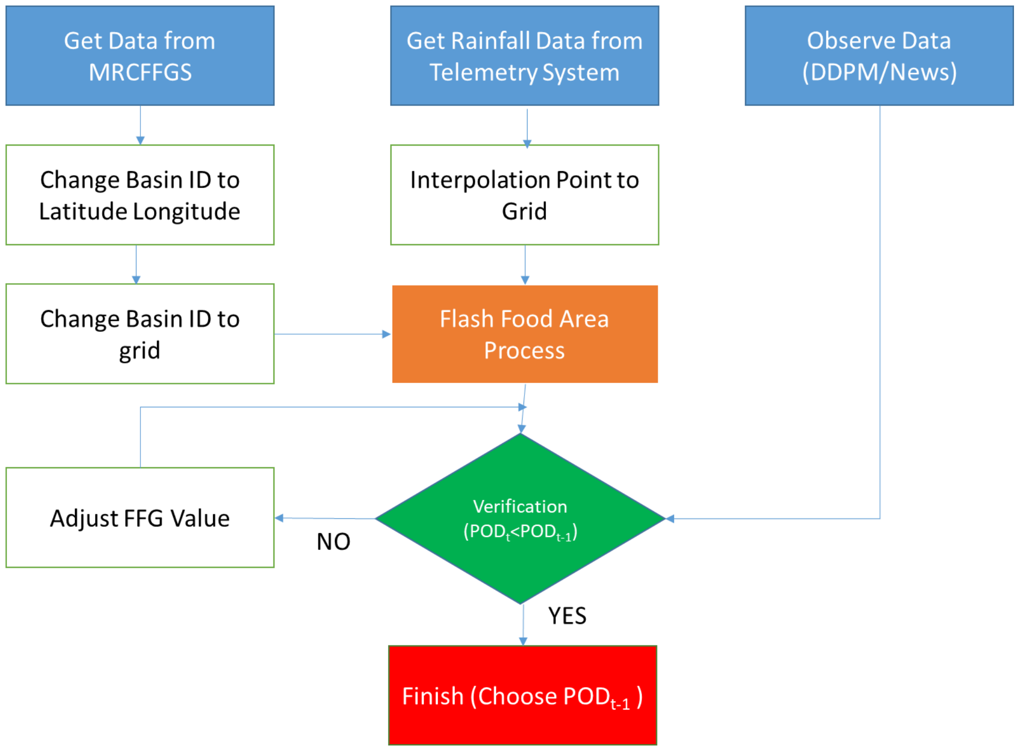

Figure 2. Flow chart of FFGs enhancing in Thailand (northeast part)

3. RESULT AND DISCUSSION

When comparing the value of FFG from the model with observation rainfall and flood event from the DDPM report. The result can show in Figure 3 that a separate category of adjustment technique and Tropical Cyclone case study. Unadjusted FFG has an area which smaller than decreased value of FFG. When more decrease FFG value, the flood area is wider. So, the verification technique is very necessary for the best adjustment value finding for flash flood forecasting.

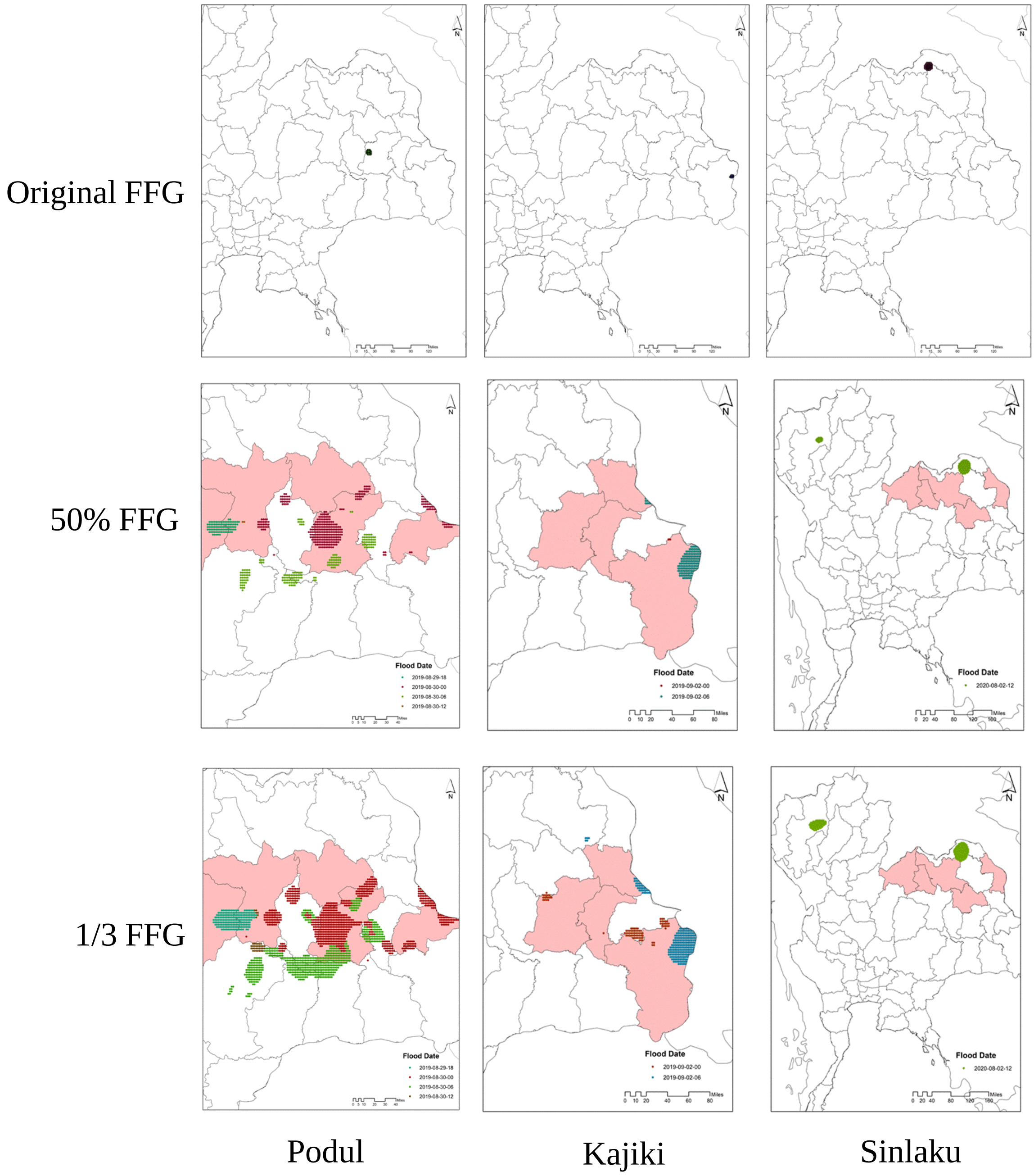

Figure 3. Comparison of FFG value and adjustment for three cases

Statistical verification showed that without a correction POD of FFG was 0.14 after being corrected by reduced FFG value by half and as one third, POD was up to 0.50, mean performance improved. In terms of FAR, FFG score as 0.33, after adjusted FFG by half, the value of FAR has more error score as 0.36 and adjusted as one third shown much more error (0.42) as the following table 1.

Table 1. Verification of FFG

FFG Value	POD	FAR
FFG (original)	0.14	0.33
50% FFG	0.50	0.36
1/3 FFG	0.50	0.42

FFGS, WMO supported system, in Thailand on the operation this system operating with numerical weather prediction by TMD (TMD-HPC) mostly miss flash flood event issue. This reason drives TMD to solve the missing issue and without authorizing to correct the system in the process, we tried to correcting and adjust the result as output by bias correction.

Tropical cyclone cases in this region were selected to fulfill the prediction. Because of the lack of efficiency to estimate rainfall from stratus clouds, vertical forming clouds are the best selection. The result is still poor as POD score 0.14, the event is correct only two provinces of 14 provinces congenial with the operation of FFG in Thailand

Two types of reducing rainfall are designed, 50% FFG and one-third FFG, to prove appropriate of the northeast of Thailand. POD scores are 0.5 in both cases but FAR scores are poorer in both cases especially in one-third score reduce to 0.42. 50%FFG is suitable for this area.

Too much soil capacity that FFG gives to this region is the main factor that FFG not triggering flash flood to launch warning issue. To solve this problem, the tropical cyclone case selected to play a vital to reduce the uncertainty of satellite-based rainfall which is the main trigger for MRCFFG, no adequate rainfall station, and radar-based rainfall.

Without bias corrections, POD score is less than 20 percent but the FAR score is high, the miss of situation has the disadvantage to warn flash flood issues which is the main purpose of the system. After adjusting FFG, scarify with more error but obtain POD is worth to be as the precaution principle and reduce the error with supervising by mereological expertise who work in this field for a long time.

Bias corrections in this study are suitable only for the northeast of Thailand Area with ITCZ and monsoon, when applied in another region the forecaster must study in a particular area before launce warning issue from this FFGS

4. REFERENCES

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