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Evaluation Performance of Various Precipitation Datasets over Flood Inundation under Climate Change

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1. Introduction

Climate change is a sensitive and debatable topic nowadays since it has been affecting or influencing every sector. The climate change and water resources always link within one another; therefore, the alteration of climate would significantly affect the water resources and hydrological cycle. Numerous records from meteorological stations, satellites, and radar amply demonstrate that global precipitation patterns have changed[1]. Flooding is one of the most frequent disasters in Cambodia that occurs over the years, especially in the research area. Stung Sen River Basin typically faces high risk of damages whenever major floods occur, particularly 2000 and 2011 flood events. Various precipitation datasets are chosen for this study in order to evaluate the flood characteristics.

2. Methodology

Study area

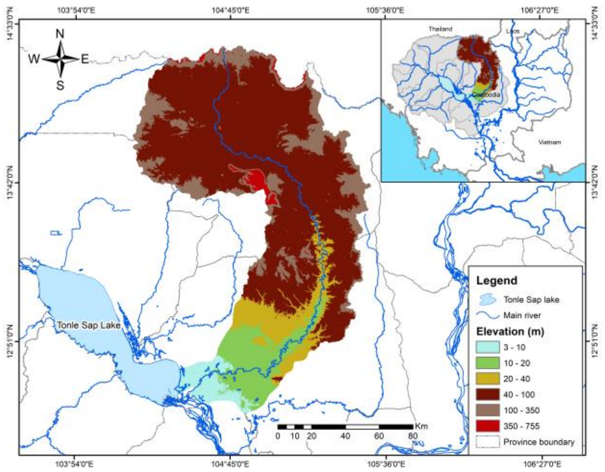

Fig. 1. Stung Sen River Basin location

Stung Sen River Basin is located in the eastern part of Tonle Sap Lake which is known as the biggest tributary among the 11 tributaries. The total catchment area is around 16,000 km^2 with the length of 500 km and 60% of highland area. The climate is dominated by tropical monsoon that covers annual average rainfall of 1,500 mm.

Rainfall-Runoff-Inundation (RRI) model

RRI model is a hydrologic distributed model that is developed to simulate rainfall runoff and flood inundation at once[2]. This distributed model is based on diffusive wave (both 2D and 1D) between the river channel and the slope grid cells has been chosen to apply in many studies to performing flood evaluation. Considering subsurface and vertical infiltration flow, the model will calculate the flow condition based on land use type.

Precipitation datasets

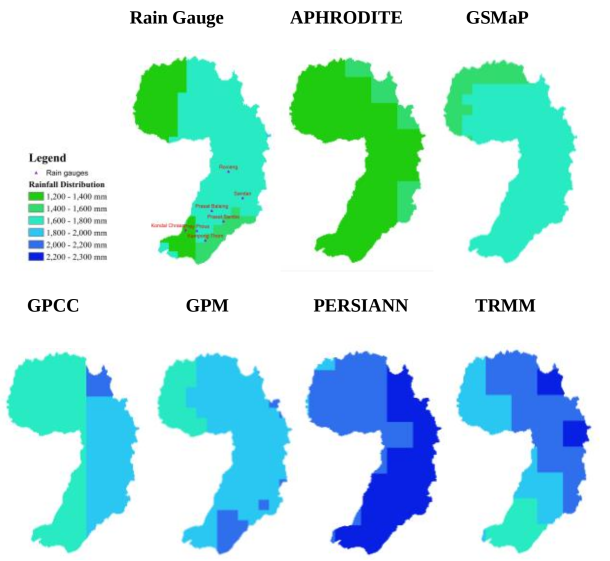

Fig. 2. Rainfall distribution of precipitation datasets

Precipitation is one of the predominant components in the hydrological cycle and in the RRI model which allows to access flood inundation information. The accuracy of the estimated streamflow from the model is totally relied on the validity of the precipitation data input[3]. The observed rainfall are scarce, which are predominantly located in the downstream and no rain gauges available in the upstream of basin, leading as a challenge to predict streamflow and the flood inundation. Therefore, multiple satellite-based products, namely APHRODITE, GSMaP, GPCC, GPM, PERSIANN and TRMM, have the benefit of high temporal resolution and spatial distributions to fill the gap from observational dataset to examine the model performance and to evaluate which one is better and suitable for this study.

3. Results and Discussions

Comparing with observed discharge, TRMM, GPM and GPCC display a good agreement, especially peak flow in rainy season; while APHRODITE, GSMaP, and rain gauge show underestimation. On the other hand, PERSIANN shows over-estimation in rainfall amount. Among all datasets, TRMM shows a better performance for predicting discharge and flood inundation with NSE = 0.74 and R^2 = 0.76.

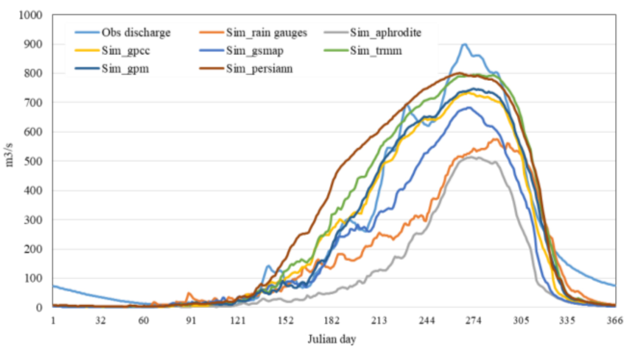

Fig. 3. Comparison of average daily discharge with simulated flow from various rainfall datasets

TRMM is selected to assess the climate change with MRI-AGCM3.2S for present (1979-2003) and future periods (2075-2099). However, the AGCM data contain seasonal bias in the wet season which leads to perform the bias correction. **Fig. 4.** displays the comparison of discharge before and after bias correction. The performance of discharge is improved with NSE from 0.79 to 0.98 and R^2 from 0.97 to 0.98. Moreover, the flow changes before and after bias

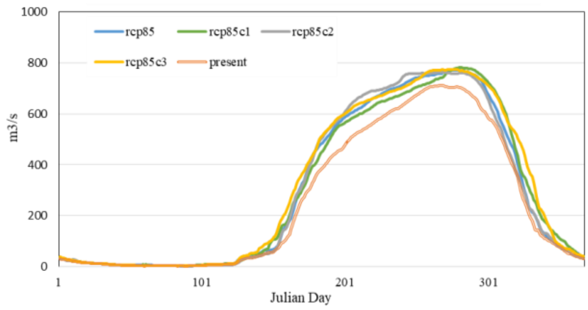

Fig. 4. The comparison of streamflow between Present and Future ACGM3.2S

correction for future climate 21% to 34.4% and 15.11% to 21.74%, respectively. The different flood inundation maps for future period also indicate below.

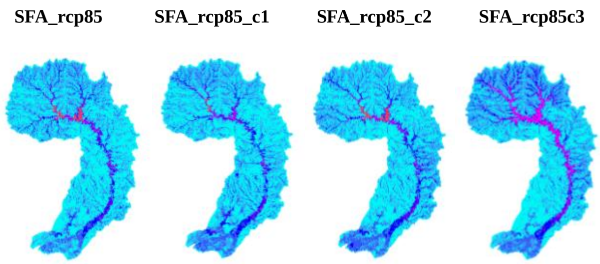

Fig. 5. Peak flood inundation for future period

4. Conclusion

After evaluating the performance of precipitation datasets with the observation data, the results showed that TRMM is the most compatible for this study among other six datasets. Hence, TRMM product would become as a good utilization to hydrological studies, especially flood inundation in this study area.

References

1) IPCC, 2022: *Climate Change 2022*: *Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
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3) Li, X. H., Zhang, Q., & Xu, C. Y. (2012). Suitability of the TRMM satellite rainfalls in driving a distributed hydrological model for water balance computations in Xinjiang catchment, Poyang lake basin. *Journal of Hydrology*, *426*, 28-38.