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Assessing Flood Risk in Prek Thnot River Basin Using AHP and GIS Analysis

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Introduction

Prek Thnot River is one of the larger tributaries of the Lower Mekong River in Cambodia. The majority of the Prek Thnot River Basin is located in Kampong Speu province. This area has been exposed to hazards and disasters, particularly floods (IRD, 2018), where people suffered critical damage from flash floods. The information and analysis of flash floods from reliable sources are plausible in an attempt to reduce the impact of floods (Elkhrachy, 2015). Identifying flood-prone zones is essential for mitigation and prevention measures (Radwan, Alazba, & Mossad). Consequently, flood hazard mapping provides a great deal of information for decision-makers and the community to effective implementation and preparedness.

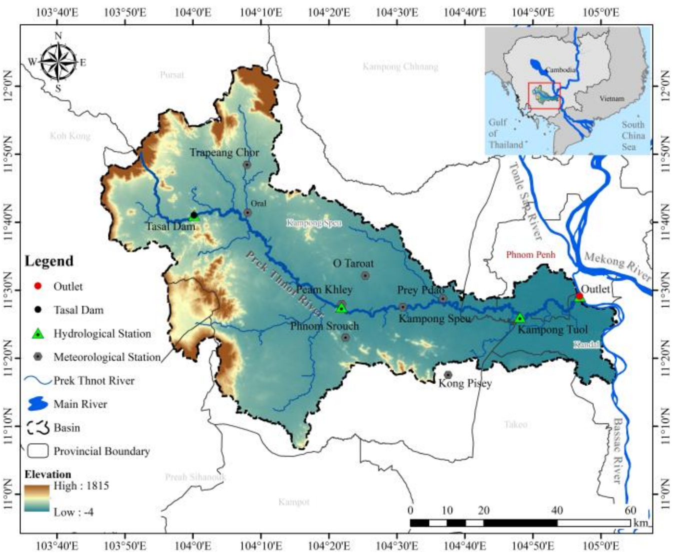

Fig 1. Prek Thnot River Basin

The study on flood hazard mapping is currently sparse in Cambodia, including the basin of the Prek Thnot River. This study aims to determine flood hazard risk levels across the Prek Thnot River Basin (Fig. 1) using coupling AHP-GIS analysis.

Method

The requirement data input in assessing flood hazard risk in Prek Thnot River Basin was rainfall, digital elevation model (DEM), soil types, and land used. The rainfall data were from the Ministry of Water Resources and Meteorology (MOWRAM). The observed data were collected from eight ground observed rainfall stations measured daily time steps for 15 years (1997-2011). The resolution of DEM was 30m × 30m obtained from ASTER-GDEM2. The soil type and land used were obtained from the Mekong River Commission (MRC) with a 250m × 250m resolution.

This study first categorized various factors associated with flood events based on literature reviews and historical records in the basin to define the flood hazard risk for an area. The selected parameters were Rainfall intensity (R), Elevation (E), Slope (Sl), Flow accumulation (F), Drainage density (DD), Distance to rivers (D), Soil types (So), and Land-use (Lu). Using the GIS technique, then, all the selected factors were developed and reclassified. Afterward, the AHP tool was utilized to weigh the parameters (Saaty, 2008). Then, Flood Hazard Index (FHI) multiplied the rated score by the priority weight from the AHP of each parameter. The composite FHI is defined as Eq. 1. However, the "Weighted Overlay" tool of GIS was applied to obtain a flood hazard map. Then, the flood risk hotspot area was classified into five levels, including "Very Low", "Low", "Moderate", "High", and "Very High". Finally, the flood hazard map is compared with flood maps from the satellite to confirm if it is acceptable.

$$FHI = \sum_{i=1}^{n} r_i \cdot w_i \qquad \text{(Eq. 1)}$$

Where r_i: score rating of a parameter, w_i: effective weight of a parameter, n: number of parameters

Result and Discussion

The AHP method weighted eight selected parameters resulting in weights for the criteria based on pairwise comparisons (Table. 1) with a consistency ratio (CR) of 0.9%. Rainfall, elevation, and slope are the most significant parameters that dominate the flood hazard, and the remaining other parameters are also substantial with a lower priority percentage. The flood hazard map was developed utilizing the GIS technique to convert each parameter to raster grid cells and classify it into five risk levels (Fig. 2). As compared to the other satellite flood maps, it was confirmed to be acceptable. The very low, low, moderate, high, and very high hazard levels are covered 695km^2, 1079km^2, 2187km^2, 1263km^2, 311 km^2 of the total area, respectively (Table 2). The high and very high flood hazard levels are found over the downstream and area along the Prek Thnot River, which are in low elevation and gradual slope, and close to the rivers and dam; meanwhile, the other three levels are found over the Northwest, West, and the Southwest of the basin along the boundary, which are located in high elevation and steep slope, particularly mountains.

Table 1. Pairwise comparison for flood hazard and the priorities result from AHP method

Para.	R	E	Sl	DD	D	F	So	Lu
R	**1**	1	1	5	6	3	8	9
E	1	**1**	1	5	6	3	8	9
Sl	1	1	**1**	5	6	3	8	9
DD	0.20	0.20	0.20	**1**	1	0.50	2	3
D	0.17	0.17	0.17	1	**1**	0.33	2	3
F	0.33	0.33	0.33	2	3	**1**	3	4
So	0.13	0.13	0.13	0.50	0.50	0.33	**1**	1
Lu	0.11	0.11	0.11	0.33	0.33	0.25	1	**1**
AHP	**25%**	**25%**	**25%**	**5%**	**5%**	**10%**	**3%**	**2%**

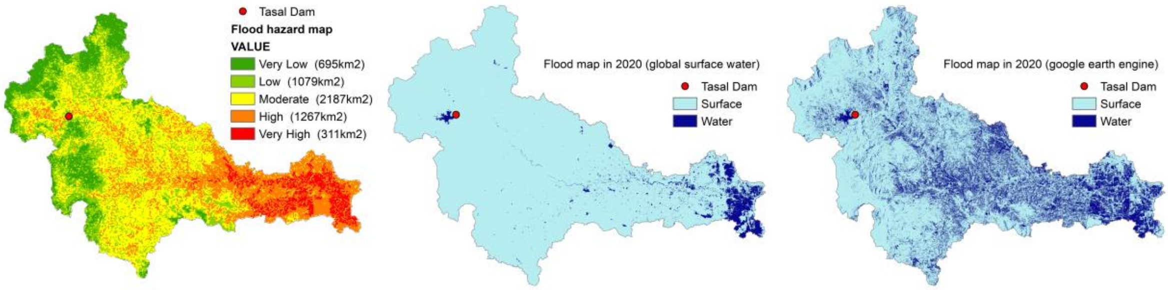

Figure 2. Flood hazard map in Prek Thnot Basin

Conclusion

The coupling AHP-GIS analysis takes the intention of assessing flood risk hazards into account. In conclusion, the results of this study indicated that flood tendency extent at the low-lying area and area near the Prek Thnot River and its reach. These areas are exposed to the risk of flooding. Twelve out of seventeen districts are at a very high risk of flooding, requiring decision-makers to establish appropriate plans for future flood occurrences.

Acknowledgement

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