RAINFALL RUNOFF INUNDATION ANALYSIS IN BAGO RIVER BASIN

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1. INTRODUCTION

Bago River Basin (BRB) is the most important area in lower Myanmar because of its location in the tropical monsoon climate region, center of transportation network to upper and lower Myanmar and existence of large paddy field land along the Bago River. Flood disasters occur every year in BRB due to increased population density in vulnerable areas, climate change effect and rapid deforestation in the catchment area. Flood control with structural and non-structural countermeasures should be urgently implemented to prevent and reduce socio economic losses. Flood inundation maps are needed for countermeasures to be developed, and existing structures should be operated and maintained to control the flood peak and reduce the adverse effect of flood. BRB gets torrential rainfall in the upstream area, and riverine floods occur along the river every year. In 1994 and 2011, because of BRB flood events, households were inundated, transportation networks were damaged and blocked, agriculture land and fish ponds were destroyed, and livelihood of local people were affected. After 2011 flood event, Irrigation Department (ID) started three projects of flood-control dam construction in the upstream area and finished them in 2012. More flood control measures should be developed in the near future, and it is important to select an optimum solution for this area for development work to maximize the benefits and minimize the losses from flood events. In this study, the Rainfall-Runoff-Inundation (RRI) model was used for simulation to analyze the effectiveness of existing flood control structures. Design rainfall patterns were created and used in the model simulation, and then inundation maps were developed based on different flood scenarios to support the decision making for future development projects.

2. DESCRIPTION OF STUDY AREA

BRB is situated between Ayeyarwaddy river basin and Sittaung river basin. The river starts from the Bago mountain ranges and flows into the Adman sea near Yangon. The basin lies geographically between 16.72 and 18.44 degrees north latitude, and 95.89 and 96.72 degrees east longitude. The main river is 330 kilometers long and its catchment area is nearly 5000 square kilometers. It is one of the most important and useful river basins in lower Myanmar for hydropower generation, irrigation use, fisheries and navigation. According to the recorded rainfall data from 1967 to 1995, the annual average rainfall was 3250 mm at the Bago station, and floods occurred mostly in July and August. In BRB, a hydropower dam and a diversion weir for irrigation use were constructed near Zaungtu village in 1996 and 1998, respectively. The location map of BRB is shown in Figure 1.

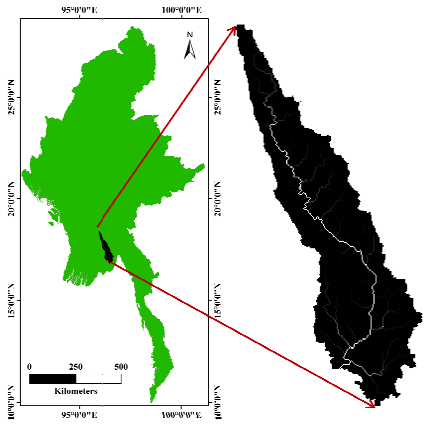

Fig. 1 Location of BRB

3. DATA MATERIALS

Daily rainfall data from 1987 to 2005 collected from two meteorological stations in BRB were used as rainfall input data. Design rainfall patterns were created based on recorded rainfall data by using frequency analysis. Fifteen second arc resolution digital elevation model (DEM) for topography feature, flow direction and flow accumulation data-set supported by HydroSHEDS was used for basin characteristic input data. Arc-GIS and RRI programs were applied to hydrological simulation study, and historical observed hydrographs at the two stations in BRB were used for model calibration and verification. Damage data collected from 2011 flood event were used for damage assessment on flood event. Operation data on hydropower reservoirs in the upstream area were used as boundary conditions in the simulation to represent the actual condition.

4. METHODS

GIS technology was used to create the watershed boundary of the basin, flow direction and flow accumulation data-set and to convert data to RRI input data file format. Original DEM data were modified for input by using an adjustment

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tool in the RRI model to minimize the noise in original DEM. Rainfall data were prepared in RRI input file format, and model parameters were set up based on study area characteristics. Simulated results on hydrographs were calibrated and validated with observed hydrographs by adjusting model parameters and boundary conditions of the river. Inundation maps for BRB were developed based on historical rainfall data with and without considering flood control dams based on several kinds of estimated possible hyetographs calculated from recorded rainfall data by using frequency analysis to compare the effectiveness of flood countermeasures.

5. RESULTS

Inundation maps before and after construction of three flood control dams were produced, and the effectiveness of existing water-related structures in BRB was evaluated. Figure 2 shows the flood inundation map on the 1994 flood and the flood inundation map with the dam scenario completed based on the 1994 flood event. Figure 3 shows the rainfall hyetograph on July 1994. Figure 4 compares observed, simulated and scenario hydrographs. According to the 1994 flood inundation map, the maximum inundation depth is 5 meters, and the inundation depth ranges from 1 to 3 meters in most of the inundation area. The inundation spreads mostly in the Bago district area and agricultural farm land area. The RRI model supports the flood forecasting technology in BRB, and it will be valuable for local flood prevention work.

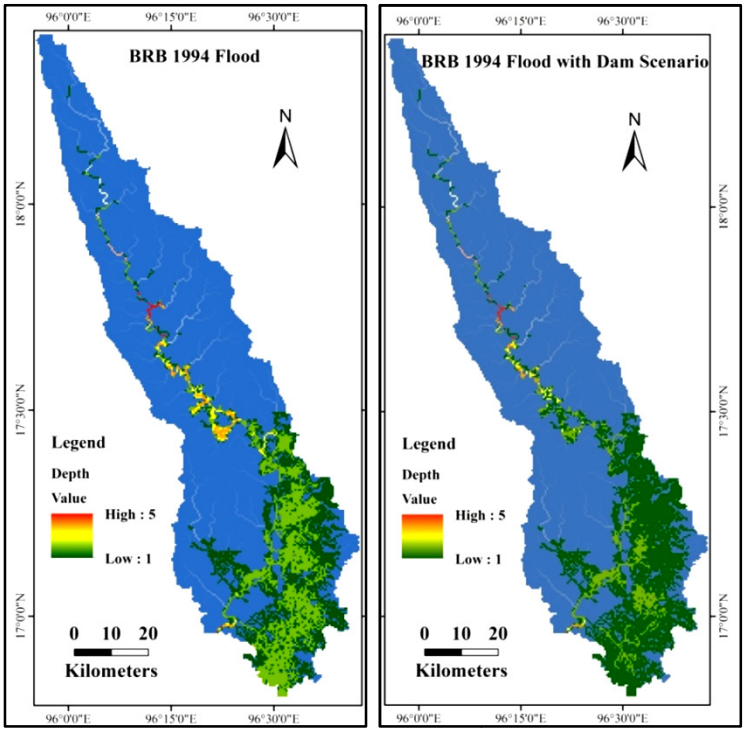

Fig. 2 Flood Inundation Map

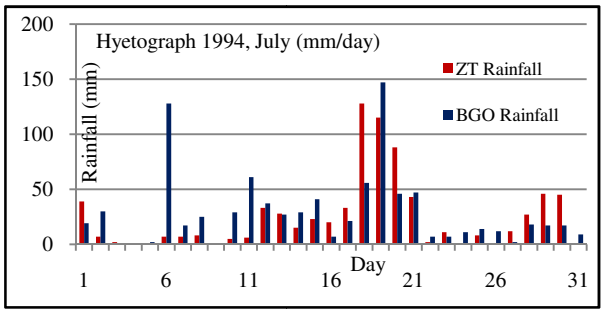

Fig.3 Hyetograph 1994 BRB flood event

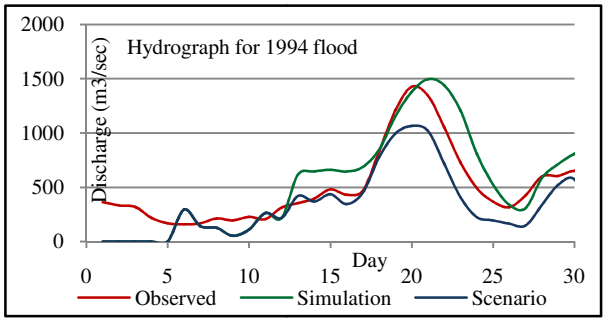

Fig. 4 Observed, simulation and scenario hydrograph

6. DISCUSSION AND CONCLUSION

This study primarily aimed to check the effectiveness of existing flood control structures for a severe flood by using GIS and RRI model simulation and to develop flood inundation maps for BRB. Design hyetograph patterns for 30-year return period and 50-year return period were developed and used in RRI model simulation. Then several kinds of possible flood scenarios were produced, and the location of the most affected area and the type of countermeasures as possible solutions were determined. Flood inundation maps with different return periods can be easily understood by the local community, and it will reduce socio economic losses from flood events. The accuracy of predicted flood inundation maps mainly depends on the model algorithm, the resolution of input DEM, and the quality of recorded rainfall data and boundary condition data. To achieve a higher accuracy for flood inundation maps, more rain gauge stations should be installed in the basin and hourly data should be collected if possible. Land use and land cover should be consider for further study though they were not in this study. Although the flood inundation maps developed by this study are coarse for detail information, it is useful enough to support planners for decision making. There are many options of countermeasures for flood reduction in BRB, and this study can help choose reasonable solutions for structural and non structural countermeasure projects to be developed in future.

References

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