ASSESSMENT OF LAND COVER CHANGES OF MARIKINA WATERSHED, PHILIPPINES TO RIVER RUNOFF AND FLOODING

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Abstract

Land cover in Marikina Watershed has been changing in the past years and have influenced the hydrological parameters in the area especially the runoff of Marikina River. Land cover data of 2009 and 2018 were used in determining the effect of land cover changes on peak discharge and timing of runoff. A Typhoon Ketsana scenario-based hydrologic and hydraulic models were generated with HEC-HMS and HEC-RAS. Flood model results showed increases in both peak discharge (500 m^3/s) and volume of flood (40 mm). Modelled peak discharge for land cover of 2018 happened 15 minutes earlier than in 2009. Flood extent in the downstream areas also increased by an estimated of 7 km^2. The increase in areas converted to built-up raised the risk of flooding downstream. Forest cover should be protected to mitigate flooding and flood modelling is recommended as a potential early warning system and tool in disaster risk planning.

Keywords: flood model, HEC-HMS, HEC-RAS, land cover change, watershed management

Introduction and Methods

In September 2009, Marikina River overflowed during Typhoon Ketsana (Ondoy) and caused floods (NOAH, 2009). From 2009 to 2018, 33.27 km^2 of the watershed was urbanized leading to 4.5% impervious surface increase.

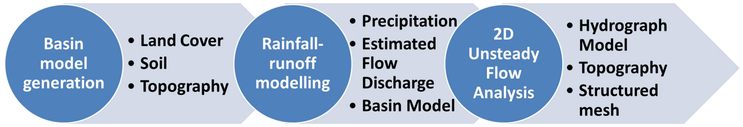

Figure 1. Methodology.

Figure 1 shows the data needed and the modelling methods. Precipitation and estimated flow are used as scenario constants.

Results

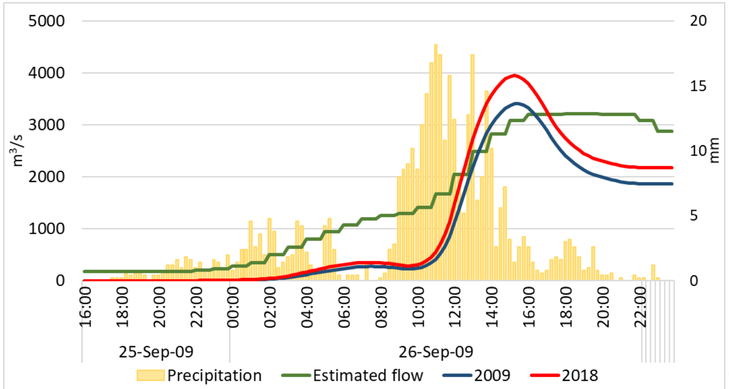

Figure 2: Hydrograph models of 2009 and 2018.

The resulted peak discharge and flow volume of 2018 model (3,951.1 m^3/s; 242.74mm) is higher and 15 minutes earlier than the result for 2009 (3,414.9 m^3/s; 205.76mm) (Figure 2).

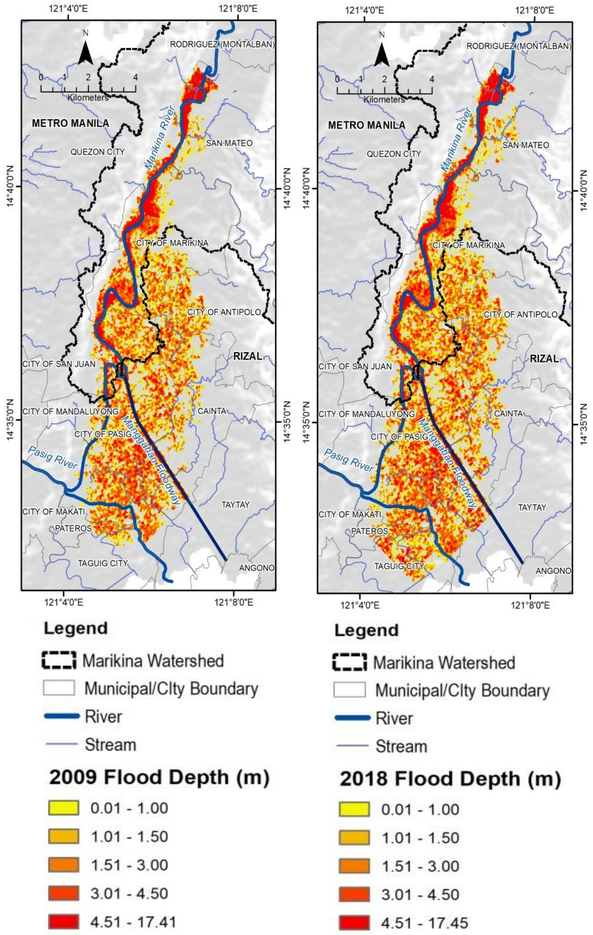

Figure 3. Flood model maps.

- The flood models covered 36.20 km^2 for 2009 while 43.03 km^2 for 2018 (Figure 3).
- The highest flood level was raised to 17.45m, 0.04mm higher than 2009 model.
- Largest deepening would happen upstream, along the riverbanks and some downstream areas.
- The model maps were overlain to Marikina 5-, 25- and 100- Year Flood Hazard Maps and they overlapped inside the flooded area. They were also in accordance with the flood reports during Typhoon Ketsana.

Conclusions

- The changes in land cover resulted to same discharge pattern but is higher and 15 minutes earlier than 2009. The 4-hour time difference between the peak rainfall and peak discharge (lag time) can be utilized for evacuation. Inundation map in the downstream areas also increased by 7 km^2.
- For policy, it is recommended that land cover change be considered in flood mitigation and disaster risk planning.
- Vegetal cover should be increased by allocating green spaces in land use plans.
- Hydrologic and hydraulic modelling are effective tools for assessing the extent of damage caused by flooding.
- Future scenarios can also be studied using downscaled climate projections on projected land cover.

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