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Predicting the Discharge Rate Contribution of the Binuwang Watershed to the Agos River, Philippines

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In 2004, Typhoon Winnie brought torrential rains which triggered massive landslides and floods which devastated the provinces of Infanta, Real and General Nakar in the Philippines. Winnie inflicted USD 111.14 million worth of damage to crops, livestock and infrastructure and left thousands dead or homeless. The Binuwang River is a sub-tributary of the Agos River, but the extent to which it contributes to flooding has not yet been determined. This study measures the depth of the Binuwang River to estimate the discharge rate contribution of the Binuwang River Watershed to the Agos River using an automatic rain gauge recorder and water level loggers set to record at 5-minute intervals. Flood-generating rainfall events were monitored during the onset of Typhoon Nesat (locally called "Pedring") September 26-27, 2011. The automated rain gauge recorded 227 mm cumulative rainfall over a 6-hour and 41-minute period. It reached a peak rainfall intensity of 17.5 mm per 5-minute interval that generated a discharge height increase of 1.8 m at the monitoring station and a total discharge volume of 99,823 m^3 over a 35-hour duration. An 8.81-hour lag time from the peak rainfall to the peak discharge concentration was recorded.

A PCRaster-based hydrologic model was used to predict the total discharge hydrograph of the Binuwang River Watershed. A Digital Elevation Model (DEM) and soil and land use maps were prepared to parameterize the model. The observed and predicted discharge hydrographs were found to be highly correlated. Among the parameters used to calibrate the model hydrologic output, most sensitive are the infiltration saturation coefficient and Manning's roughness coefficient. An increase in the infiltration saturation coefficient resulted in a decreased discharge height, while an increase of Manning's roughness coefficient lengthened the lag time. The predicted discharge volume and height were used to simulate the impact of reforestation and land conversion to cultivated areas in the watershed. The results showed that by converting the brushland and tree plantation area—which accounts for 78% of the watershed (710 ha)—to cultivated area, the discharge height could increase by 2 m with a total discharge volume of 218,694 m^3 and shorten the lag time by 1.36 hours. On the other hand, implementing a reforestation plan for 38% of the watershed (350 ha) covered by brushland, bareland and grassland areas could substantially lower the discharge height by 1.2 m with a total volume of 20,663 m3 and lengthen the lag time by 8.38 hours.