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Projecting Land Use Changes and Its Impacts on Flooding: An Analysis of Remote Sensing Images of Kalu River Basin in Sri Lanka

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Floods are one of the most common natural disasters worldwide, leading to economic losses and loss of human lives. There are 103 rivers in Sri Lanka and some of these rivers make severe impacts on the natural and built environment during the rainy seasons due to floods. Characteristics of the flood is decided by a combination of factors such as rainfall and land use. Although the Kalu river made significant impacts during flooding, hydrological effects driven by the multi-temporal land use changes on flooding in the river basin is yet to be studied. To fill this research gap, the present study generated land cover maps of 1995, 2014 and 2019 using Maximum Likelihood Algorithm of Supervised Classification, and subsequently a Land Change Modeler (LCM)-Markov was implemented to predict the land use of 2019. The model was validated with three-map comparison which consists of two components of agreement and three components of disagreement. Overall accuracy of the validated model was good with a value of 77%, and it was used to predict the land-use maps of the years 2030, 2050 and 2100. Eventually, an event based hydrological HEC-HMS model was developed to study the impacts of land-use changes on hydrological response and runoff processes of the three major sub-basins (Horana, Ellagawa and Millakanda) of Kalu river basin. The model was calibrated and validated for the flood events occurred in April and May 2008, and May 2003 respectively. Finally, curve number (CN) values were generated for the predicted land use maps of the year 2030, 2050, and 2100. Calculated CN values were then incorporated to the validated HEC-HMS model and impacts of land use on hydrological responses and runoff processes were assessed. The projected results indicated that the natural vegetation areas will continue to decrease from 84.8% of the whole study area in 1995 to 73.7% by the year 2100 followed by an increase in both agricultural (from 14.1% in 1995 to 22.3% in 2100) and urban areas (from 0.8% in 1995 to 3.4% in 2100 respectively). The CN values have also increased with the projected land use. As a result, despite the same rainfall prevailing, the peak discharges will continue to rise in all three major sub-basins with respect to the predicted land use changes. Moreover, according to the predicted run-off simulation using HEC-HMS, Horana (Kalutara) and Ellagawa sub-basins are projected to be more vulnerable in near future. The results of this study can be used as a road map for taking necessary actions to achieve sustainable water resources management in Kalu river basin in future.

Keywords: LCM-Markov (Land Change Modeler-Markov), HEC-HMS, Curve Number, Peak discharge