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Simulation of land use configuration impacts on stream flow characteristics of a tropical catchment

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While most studies assessing the effects of land use change on hydrological processes have focused on the impact of changes in the relative occurrence of different land use types, less attention has been paid to the impacts of changes in spatial land use configuration (e.g. shape and connectivity of land use types). The impacts of the spatial land use configuration on water resources, however, is relevant when selecting a particular land use management strategy, for instance either small-scattered or large-clustered forest planting and harvesting strategies.

This study aims to assess the impacts of different spatial configurations of specific forms of land use, like forest and settlements, on stream flow characteristics in the Samin catchment (278 km2) in Indonesia. The land use distribution of the study catchment in the period 1982-2013 was reconstructed based on satellite images and used to estimate land use pattern characteristics for the years 1982, 1994, 2000, 2006 and 2013. A validated hydrological model was employed using the land use distributions for the mentioned years as inputs and a correlation analysis was done to identify relations between changes in land use pattern characteristics and simulated streamflow characteristics. Furthermore, a future land use scenario analysis was carried out to assess the sensitivity of streamflow characteristics to different future land use patterns. In this scenario analysis, the governmental land use planning of the study area was used as a baseline condition, where the spatial configuration was changed while the percentages of different land use types remained constant. The results of these analyses can be used to explore potential hydrological impacts of alternative land use planning strategies.

The model simulations show that changes in the percentages of different land use types and the physical connectivity between patches of similar land use types are the dominant drivers for changes in streamflow characteristics, namely the ratio of surface runoff to streamflow and the ratio of dry-season to wet-season streamflow. When the relative occurrence of different land use types is fixed but the physical connectivity of patches is changed, the results indicate that an increase in the settlement connectivity can result in an increase in the ratio of surface runoff to streamflow and a decrease in the ratio of dry-season to wet-season streamflow, and vice versa, while changes in the forest connectivity have less impact on streamflow characteristics. The results suggest that land use pattern management can be an important component in water management.

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