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Modeling the hydrological impacts of land use/land cover changes in the Andassa watershed, Blue Nile Basin, Ethiopia

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Understanding the hydrological response of a watershed to Land Use/Land Cover (LULC) changes is imperative for water resources management planning. The objective of this study was to analyze the hydrological impacts of LULC changes in the Andassa watershed for a period of 1985-2015 and to predict the LULC change impact on the hydrological status in year 2045. The hybrid land use classification technique for classifying Landsat images (1985, 2000 and 2015); Cellular-Automata Markov (CA-Markov) for prediction of the 2030 and 2045 LULC states; the Soil and Water Assessment Tool (SWAT) for hydrological modeling were employed in the analyses. To isolate the impacts of LULC changes, the LULC maps were used independently while keeping the other SWAT inputs constant. The contribution of each of the LULC classes was examined with the Partial Least Squares Regression (PLSR) model. The results showed that there was a continuous expansion of cultivated land and built-up area and withdrawing of forest, shrub land and grassland during the 1985-2015 periods, which are expected to continue in the 2030 and 2045 periods. The LULC changes, which had occurred during the period of 1985 to 2015, had increased the annual flow (2.2%); wet seasonal flow (4.6%), surface runoff (9.3%) and water yield (2.4%). Conversely, the observed changes had reduced dry season flow (2.8%), lateral flow (5.7%), groundwater flow (7.8%) and ET (0.3%). The 2030 and 2045 LULC states are expected to further increase the annual and wet season flow, surface runoff and water yield and reduce dry season flow, groundwater flow, lateral flow and ET. The change in hydrological components is a direct result of the significant transition from the vegetation to non-vegetation cover in the watershed. This suggests an urgent need to regulate the LULC to maintain the hydrological balance.

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