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Impact of Land Use Change on the Hydrological Processes of a Peri-Urban Tropical Catchment: The Méfou and Mfoundi basins, Yaoundé, Cameroon

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The city of Yaoundé in Cameroon is exposed to a continuous population increase from 60,000 inhabitants in 1960 to more than 2,500,000 nowadays accompanied by a notable urbanization which tripled over the last 30 years. The case of Yaoundé is representative of many African cities. The aim of this work is to analyze and model the hydrological behavior of the peri-urban catchments of the Méfou (425 km^2) englobing the city of Yaoundé, taking into account the evolution of land use during the last four decades. The methodology has two steps: i) analysis of the hydro-meteorological and cartographic data in order to identify the main hydrological processes; ii) the implementation of a spatially distributed modeling approach and a parameterization strategy adapted to the specificities of the site with scarce data and taking into account the temporal evolution of land use. Scarce daily rainfall/runoff data are available on some periods between 1968 and 2014. Land use maps were also available on the study period. The basin altitude ranges between 700 and 1000 m. Annual rainfall ranges between 1550 and 2060 mm. The analysis of rainfall data didn't show any modification of the rainfall regime during the study period. The mean annual runoff coefficient on the Méfou is 36.7% (with a specific discharge of 18.5 $m^3/s/km^2$) and remains practically unchanged during the study period. The Mfoundi tributary (38 km^2) located in the urban zone, has seen the maximum urbanization extension from 8% in 1951 to nearly 28% in 2005, while the forest zone has decreased from 78% to 6%. The direct consequence was an increase of 100 % of annual runoff coefficient (from 36.7% in 1960 to 78% today corresponding to an increase of the specific annual discharge from 18.5 $m^3/s/km^2$ in 1968 to 42.4 $m^3/s/km^2$ today); moreover we observe an increase of 200% of runoff coefficient during the rainy season (September to November). Then, the HEC-HMS spatially distributed hydrological model was used at a daily time step to simulate the impact of land use change evolution on the hydrograph at both the Mfoundi and the Méfou basins. Calibration/validation strategies were undertaken on different periods, 1965-1970, 1971-1974, 1975-1977, 1984-1986, 2005-2006, 2010-2011 and 2012-2013 in order to identify the evolution of model parameters with the evolution of land use change. Results show that the parameter characterizing the soil surface infiltrability is the most sensitive. Moreover, we observe a correlation between the value of the optimized parameter and the area of the urbanized zone. However, the remaining model parameters seem constant during the whole study period. Finally the model was applied to simulate and compare various scenarios of urbanization extension and land use change.