Geophysical Research Abstracts
Vol. 17, EGU2015-6711, 2015
EGU General Assembly 2015

Investigation of land use effects on Nash model parameters

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Flood forecasting is of great importance in hydrologic planning, hydraulic structure design, water resources management and sustainable designs like flood control and management. Nash's instantaneous unit hydrograph is frequently used for simulating hydrological response in natural watersheds. Urban hydrology is gaining more attention due to population increases and associated construction escalation. Rapid development of urban areas affects the hydrologic processes of watersheds by decreasing soil permeability, flood base flow, lag time and increase in flood volume, peak runoff rates and flood frequency. In this study the influence of urbanization on the significant parameters of the Nash model have been investigated. These parameters were calculated using three popular methods (i.e. moment, root mean square error and random sampling data generation), in a small watershed consisting of one natural sub-watershed which drains into a residentially developed sub-watershed in the city of Sierra Vista, Arizona. The results indicated that for all three methods, the lag time, which is product of Nash parameters "K" and "n", in the natural sub-watershed is greater than the developed one. This logically implies more storage and/or attenuation in the natural sub-watershed. The median K and n parameters derived from the three methods using calibration events were tested via a set of verification events. The results indicated that all the three method have acceptable accuracy in hydrograph simulation. The CDF curves and histograms of the parameters clearly show the difference of the Nash parameter values between the natural and developed sub-watersheds. Some specific upper and lower percentile values of the median of the generated parameters (i.e. 10, 20 and 30 %) were analyzed to future investigates the derived parameters. The model was sensitive to variations in the value of the uncertain K and n parameter. Changes in n are smaller than K in both sub-watersheds indicating the Nash model is more sensitive to the K. In addition, there is a wider range in parameter values in urban sub-watershed than the natural one in which the efficiency has an acceptable value. It might be due to less uncertainty in urban watersheds where runoff to rainfall ratios are much larger than in the natural sub-watershed. The uncertainty in rainfall observations (noise) is therefore a much smaller percentage of the runoff (signal).