JRBM vol 5 Issue 1

A hybrid metric-conceptual (HMC) model for monthly riverflow prediction in the semi-arid Volta Basin of West Africa

By B.A. AMISIGO and NICK VAN DE GIESEN

Data-based mechanistic modelling techniques have been applied to catchment monthly runoff, potential evaporation and rainfall time series to model monthly catchment runoff at selected gauging sites in the Volta Basin of West Africa. The aim of the study was to obtain a modelling framework that not only accounts for the rainfall-runoff non-linearity in the basin and provides acceptable predictions of the monthly catchment runoff for the sub-basins studied, but also reveals the necessary insights for a plausible interpretation of the rainfall-runoff mechanism in the basin. The rainfall-runoff process was considered in two stages - a nonlinear transformation from rainfall to effective rainfall and then a linear transformation from effective rainfall to runoff. First a linear time varying, state dependent parameter (LTV-SDP) transfer function model was applied to the monthly rainfall-runoff calibration series of each sub-basin to determine the form of the rainfall-effective rainfall non-linear transformation. The observed series (runoff or rainfall) that was significantly related to effective rainfall was then identified. Next, the functional form of this relationship was established and used to fit linear time invariant (LTI) transfer function models relating monthly runoff to monthly effective rainfall and potential evaporation. The best estimate of the monthly effective rainfall from the nonlinear modelling was obtained from the product of monthly rainfall and a fractional power of monthly runoff - the runoff acting as surrogate for catchment wetness. Since this form of effective rainfall cannot be used for simulation in validation mode (as the runoff series is unknown then), a non-linear rainfall filter used in the Identification of unit Hydrographs And Component flows from Rainfall, Evaporation and Streamflow data (IHACRES) application was used to model effective rainfall in this mode. The study showed that monthly catchment runoff in the basin can be decomposed into two parallel flows, an instantaneous (within a month) and a slower (with one month delay) flow components. These results suggest that baseflow contribution to streamflow is insignificant in the Volta Basin.