Riverflow Modelling in Two Large River Basins: the Parana (Subtropical) and the Niger (Tropical).

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Water balance models of varying degrees of complexity have been widely used for a number of hydrological applications. Here we apply a simple conceptual water balance first developed by Thornthwaite (1948) and later Thornthwaite and Mather (1955) in a distributed manner to model riverflow in two very large river systems, the Parana river in South America and the Niger river in west Africa. The approach utilises global data sets of rainfall, potential evaporation and soil available water capacity at 0.5 degree latitude and longitude resolution. The rainfall and PE data sets have been augmented with additional station data from regional sources to provide dense spatial coverage over much of the river basins. River flow data for tributaries ranging in size from 631 km2 to 67,600 km2 for the period 1931-1990 (Parana) and 1951-1990 (Niger) are used to calibrate and validate the model.

The results show varying degrees of model performance during both the calibration and validation procedure. Time series of rainfall and PE were used to reconstruct river flows for the whole river basins back to 1901. These were compared with measurements dating back to 1901 and 1907 for the Parana and the Niger, respectively. There was reasonable agreement between modelled and observed river flows and the prolonged changes in river flow regimes that have occurred since the 1970s (Table 1) are unprecedented in the instrumental records. The analysis highlights some interesting issues pertaining to the development and application of water balance models.

* Varying levels of model performance in different catchments, ranging from acceptable to poor.

* Sensitivity of model performance and parameter values to input data sets, particularly the method chosen to estimate PE. Average annual PE for the period 1961-1990 over each river basin is 552 mm (1666 mm) with a Penman Monteith PE function and 1261 mm (3477 mm) with a standard reference crop Penman function for the Parana and Niger, respectively. Best model results were obtained with the standard reference crop Penman function.

* Both rivers exhibit prolonged large fluctuations in their flow characteristic (volume and timing) before and after the early 1970s which are associated with changes in rainfall, runoff ratios and possibly changes in land use and land cover although these are unquantified. This raises difficulties in defining periods for model calibration and validation and the stability of parameter values during periods where changes in catchment characteristics and runoff processes are taking place.

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