Abstract

Drought is acritical stochastic natural disaster that adversely affects water resources, ecosystems and people. Drought is a condition characterized by scarcity of precipitation and/or water quantity that negatively affects the global, regional and local land-scales. At both global and regional scales, drought frequency and severity have been increasing leading to direct and indirect decline in water resources. For instance, increase in drought severity and frequency in the upper Tana River basin, Kenya, water resources systems quantity and quality have been adversely affected. Timely detection and forecasting of drought is crucial in planning and management of water resources. The main objective of this research was to formulate the most appropriate models for assessment and forecasting of drought using Indices and Artificial Neural Networks (ANNs) for the basin. Hydro-meteorlogical data for the period 1970-2010 at sixteen hydrometric stations was used to test the performance of the indices in forecasting of the future drought at 1, 3, 6, 9, 12, 18 and 24-months lead times, by constructing ANN models with different time delays. Drought conditions at monthly temporal resolution were evaluated using selected drought indices. The occurrence of drought was investigated using non-parametric Man-kendall trend test. Spatial distribution of drought severity was determined using Kriging interpolation techinique. In addition, a standard Nonlinear-Integrated Drought Index (NDI), for drought forecasting in the basin was developed using hydro-meteoroogical data for the river basin. The performance of the drought forecasting models at the selected lead times were assessed using Mean Absolute Error (MAE), correlation coefficient (R), Nash-Sutcliffe Efficiency (NSE), Ratio of mean square error (RSR) and modified index of agreement (d1). The results of spaial drought show that the south-eastern parts of the basin are more prone to drought risks than the northwestern areas. The Mann-Kendall trend test indicates an increasing drought trend in the south-eastern and no trend in north-western areas of the basin at both 90 and 95% significant levels. Another output of this research was the development of Surface Water Supply Index (SWSI) function, NDI and characteristic curves defining the return period and the probability of different drought magnitudes based on Drought Indices (DIs). In addition, drought Severity-Duration-Frequency (SDF) curves were developed. The formulated NDI tool can be adopted for a synchronized assessment and forecasting of all the three operational drought types in the basin. The results can be used in assisting water resources managers for timely detection and forecasting of drought conditions in prioritized planning of drought preparedness and early warning systems.