Development of a framework for an integrated time-varying agrohydrological forecast system for Southern Africa: Initial results for seasonal forecasts

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Abstract

Uncertainty about hydro-climatic conditions in the immediate future (today), as well as the near (up to one week) and more distant futures (up to one season) remains a fundamental problem challenging decision makers in the fields such as water resources, agriculture, and many other water-sensitive sectors in Southern Africa. Currently many institutions, such as the SA Weather Service, provide weather and climate forecasts with lead times ranging from 1 d to one season. However, disconnects exist between the weather/climate forecasts and their links to agrohydrological models, and in the applications of forecast information for targeted agricultural and water-related decision-making. The skills level of the current weather and climate forecasts, and the mismatch in scales between the output from weather/climate models and the spatial scales at which hydrological models are applied, as well as the format of seasonal forecasts in that they cannot be used directly in agrohydrological models, are some of the problems identified in this study and are being addressed. This has necessitated the development of a GIS-based framework in which the 'translation' of weather and climate forecasts into more tangible agrohydrological forecasts such as streamflows, reservoir levels or crop yields is facilitated for all the inter-linked quaternary catchments for enhanced economic, environmental and societal decision making over South Africa in general, and in selected catchments in particular. For monthly and seasonal (i.e. 3-month lead time) forecasts, two methods, viz. the Historical Sequence Method and the Ensemble Re-Ordering Method have been developed to translate the triplet of forecast rainfall probabilities (i.e. above, near and below normal) into daily quantitative values of rainfall for use in hydrological models. The first method was applied together with the daily time step ACRU Model to simulate seasonal flow forecasts in the Mgeni catchment in KwaZulu-Natal, South Africa. In taking account of uncertainty in the seasonal rainfall forecasts through the process of translating these to daily streamflow simulations by the ACRU Model, some skilful initial forecasts of streamflows can be obtained which can assist decision makers to take protective action against the impacts of hydro-climatic variability.

Keywords: GIS-based framework, translation of rainfall forecasts, ACRU Model, streamflow forecasting