Verification of the *ACRU* model for forest hydrology applications[#]

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Abstract

Simulation model output must be tested for goodness of fit against observed data before the model can be utilised with confidence for any useful or decision-making purpose. Unless this is the case, a model is unlikely to be accepted by users other than the model developers. With intense competition for Southern Africa's sparse water resources, the potential impacts of afforestation, currently the only named streamflow reduction activity (SFRA) in the National Water Act of 1998, need to be assessed prior to planting.

The *ACRU* model has been used extensively in conjunction with a decision support system to assist the user in preparing input information to simulate water production from afforested areas. Verification of the output of the *ACRU* model is thus of utmost importance if it is to be accepted by the water community at large for use in this type of application.

Values of simulated streamflow were compared with observed streamflow at three locations, one each in KwaZulu-Natal, Mpumulanga and the Northern Province on forested catchments with a range of catchment sizes, forest species and ages of plantation. *ACRU* was found to perform acceptably at most sites. Some problems of temporal distribution of streamflow were, however, found to exist. It is concluded that *ACRU*, when used in conjunction with the decision support system developed to assist in the simulation of forest hydrological impacts, could be a particularly useful tool to resource managers, planners and Catchment Management Agencies in water management areas where afforestation may take place or where its impact has to be assessed.

Introduction

With intense competition for Southern Africa's sparse water resources, the potential impacts of afforestation, currently the only named streamflow reduction activity (SFRA) in the National Water Act of 1998, need to be assessed prior to planting. Increasing afforestation in Southern Africa and concern for its impact on water resources has led to increasing use of models to simulate the impacts of commercial afforestation on downstream water resources. The *ACRU* agrohydrological modelling system has been used extensively in this regard. As a result, a decision support system has been developed for use when simulating hydrological impacts of afforestation with the *ACRU* agrohydrological modelling system. This system simplifies the task of the model user a great deal by providing default values to land cover and soils input variables which may be affected by afforestation of a catchment. The user merely provides information regarding tree species and age and the method of site preparation used. The development of this forest decision support system has been described and discussed elsewhere (Jewitt and Schulze, 1991; Summerton, 1995).

A model such as *ACRU* can only be used with confidence if its output has been verified against observed data sets. The version of the *ACRU* model used in this study can perform such statistical analyses of model performance at both daily and monthly levels of output for a number of variables, including streamflow, which is used in the verification of output from forested catchments. The equations and objective functions used in *ACRU* have been explained and discussed in detail by Smithers and Schulze (1995).

Verification of output from *ACRU* for forested catchments was undertaken with the aim of determining whether the *ACRU* model can be used with confidence to simulate streamflow from catchments afforested with different species and at different stages of growth using different site preparation techniques. In the light of South Africa's new National Water Act, it is the water yield of an area that is of utmost importance to the water resources planner acting for the local catchment management agency (CMA), thus statistics of monthly totals of daily simulated streamflows are presented in this paper.

The *ACRU* agrohydrological modelling system

The *ACRU* agrohydrological modelling system has been developed in the Department of Agricultural Engineering (now the School of Bioresources Engineering and Environmental Hydrology) at the University of Natal. The *ACRU* model is described by the developers as a multi-purpose and multi-level integrated physical conceptual model that can simulate streamflow, total evaporation, and land cover/management and abstraction impacts on water resources at a daily time step.

Model documentation was first published in 1984 (Schulze, 1984) and updated in 1989 (Schulze, 1989). The latest public domain version of the model is *ACRU327* and updated documentation has been published (Schulze, 1995). Model input parameters are contained in a menu file. Input to the menu is controlled by a "menubuilder" program where the user enters parameter or catchment related values or uses defaults provided. In the case of simulations of forest hydrology, this function is performed by the ACRU forest decision support system.

The *ACRU* model revolves around multi-layer soil water budgeting. Runoff is generated as stormflow dependent upon the magnitude of daily rainfall in relation to dynamic soil water budgeting. Components of the soil water budget are integrated with modules in the *ACRU* system to simulate many other catchment components including irrigation requirements and sediment yield.

Spatial variation of rainfall, soils and land cover is facilitated

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