Interfacing GIS and hydrological modelling : Mgeni case study+

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Abstract

Although geographical information systems (GISs) enhance hydrologists' ability to access and extract relevant spatial information quickly and efficiently, interfacing GISs and hydrological modelling are essential for meaningful hydrological simulation that transforms geographical information into hydrological knowledge. In this paper the Mgeni catchment is used as a case study to illustrate interfacing between a GIS and a hydrological modelling system for simulation of the catchment's water resources.

Creation of the GIS interfacing processes and an example of a hydrological simulation are presented. A possible future development scenario illustrates the routing of GIS derived spatial information through the interface to obtain a realistic hydrological response from the modelling system. Future requirements for interfacing between GIS and hydrological modelling are discussed.

Introduction

Geographical information has been used in hydrological modelling for many years but recent developments in the capabilities and speed of computer hardware together with appropriate software applications have greatly facilitated the manipulation, processing and display of spatial information using geographical information systems (GISs). While many institutions, universities and state departments in South Africa are collecting data and creating GISs (Conley, 1989), it is not always clear for what purpose and how this information will be used. GISs are very adequate for the transformation of data into information, but it is the transformation of information into knowledge that requires greater attention. Hydrological modelling, which makes use of geographical information, including catchment physiography and climatic data, can be greatly enhanced when coupled to a GIS because of the associated ease of data access and extraction and increased speed and efficiency of data manipulation. The accuracy of hydrological simulation, however, remains limited by the quality of input variables. Consequently the usefulness of a GIS for hydrological modelling is dependent on the accuracy of the original data contained in the GIS and the hydrological variables generated at the GIS/hydrological model interface. In this paper the interfacing between a GIS and a hydrological modelling system for the simulation of the Mgeni catchment's water resources is used to illustrate the progress made towards filling the gap between geographical information and hydrological knowledge.

Simulation of the water resources of the 4 387 km^2 Mgeni catchment is necessary because water from the catchment is presently supplied to 3,6 m people and industry and agriculture producing 20 % of South Africa's Gross National Product. It has been predicted that the population in the area presently supplied could increase to between 9 and 12 m by the year 2025 (Home Glasson Partners, 1989) and that the water resources of the Mgeni catchment will be utilised fully by the year 2005. Concomitant with complete utilisation of the Mgeni's water production, is the envisaged decrease in water quality associated with poor quality return flows from industrial and agricultural wastes, treated sewage effluents and increased informal settlements. Hydrological simulation of water quantity and quality in the Mgeni catchment will enhance the ability of decision-makers to manage effectively the water resources of the Mgeni catchment.

The ACRU agrohydrological modelling system (Schulze, 1989) was chosen to simulate the water resources of the Mgeni catchment and evaluate consequences of possible future development on the catchment's water resources. Geographical information for the entire Mgeni catchment was collected and stored in a GIS. The highly variable physiography and climate of the region necessitated the subdivision of the catchment into 123 subcatchments for hydrological simulation. Since input variables based on the physical features and climate of each subcatchment were required by the ACRU modelling system, the interfacing of the Mgeni catchment GIS with ACRU to generate meaningful inputs from the spatial data formed an important part of the modelling process.

This paper describes the composition of the Mgeni catchment GIS and the processes used to interface the GIS with the ACRU modelling system. Transformation of spatial information into hydrological input variables is illustrated for a selected subcatchment of the Mgeni. A possible future development scenario applied to an area of the Mgeni catchment is used to show how a change in the geographical information is routed through the interface to be realized in a realistic hydrological response from the modelling system. Future requirements for interfacing between GISs and hydrological modelling are outlined with particular reference to the need for simulating water quality aspects of the Mgeni catchment.

Mgeni catchment GIS

Details of the geographical information contained in each layer or coverage for the Mgeni catchment GIS and the sources from which this information was obtained are shown in Table 1. Two commercially available GIS packages in addition to "in-house" software were used to capture, process and store the geographical information. The catchment physiographic information is embodied in the altitude, soils, land-cover, reservoir and river coverages, while the climatic information is contained in the rainfall, temperature and evaporation layers. A distinct

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