The application of geographic information systems (GIS) in the analysis of nutrient loadings from an agro-rural catchment

S Mtetwa[1]* , S Kusangaya[2] and CF Schutte[1]

[1] *University of Pretoria, Department of Chemical Engineering, Pretoria 0002, Republic of South Africa*

[2] *University of Zimbabwe, Geography Department, PO Box MP 167, Mt Pleasant, Harare, Zimbabwe*

Abstract

A large amount of data is usually generated during environmental monitoring programmes. The data need to be transformed into useful information that can be used for interpretation and analysis of problems. This paper outlines the feasibility of using geographic information system (GIS) techniques in the analysis of catchment nutrient yields with the aim of providing a knowledge base for effective decision-making. In this case the spatial and temporal distributions of the nutrient yields in the catchment were analysed. Interpolation with the GIS packages (*Arc View Version 3.1* and *Arc View Spatial Analyst*) enabled the estimation of yields in areas without actual measurement thereof.

Key words: GIS, nutrient yields, ACRU, pollution loads, spatial distribution.

Introduction

The objective of the project on which this paper is based, is to develop a methodology for managing the water quality in the rural areas of developing semi-arid regions. The water quality problems experienced in these areas are mostly of a diffuse nature and their control is difficult. The major problems in the rural areas include overgrazing, siltation, poor agricultural practices and poor land management, emanating from technological, economical and socio-political problems with numerous stakeholders who have differing goals and perceptions (Fedra, 1984, Ongley, 1998). This paper follows on an earlier paper (Mtetwa and Schutte, 2002) in which details of the Muda catchment, farming practices and pollution loads are given. Here the focus is on the feasibility of using a geographical information system (GIS) in the analysis of water quality data to facilitate decision-making.

GIS can be defined as (ESRI 1996): An organised collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyse, and display all forms of geographically referenced information. GIS technology integrates common database operations such as query and statistical analyses with the unique visualisation and geographic analysis benefits offered by maps and spatial databases. These abilities distinguish GIS from other information systems and make it a valuable tool for explaining events, predicting outcomes, and planning strategies.

* To whom all correspondence should be addressed.
Current address: Zimbabwe National Water Authority, Water Quality Section, PO Box CY 617, Causeway, Harare, Zimbabwe.
☎+263 4 793139; fax: +263 4 793139;
e-mail: mtetwa@utande.co.zw

Received 4 April 2002; accepted in revised form 28 January 2003.

Procedures and analyses

A key parameter required in the development of water quality management methodologies is the nutrient loads emanating from catchment and subcatchments. These loads form the basis of any decisions on the management actions to be taken to preserve water quality. Nutrient loads were derived from the product of the nutrient concentrations and their corresponding discharges as described below.

Water quality

Water quality data are not readily available in developing countries, and a water quality monitoring programme had to be implemented to obtain the required information. A total of 10 sampling sites were established as is shown in Fig. 1. Water quality samples

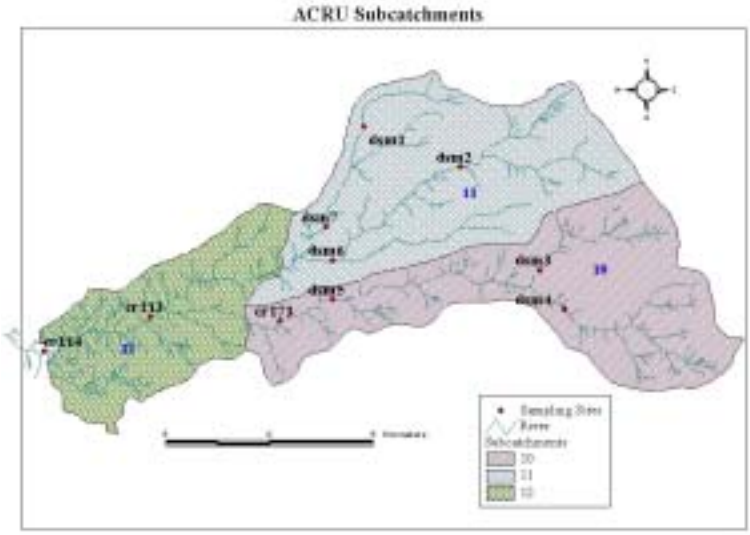

Figure 1
Muda River subcatchments and sampling sites