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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Integrated water resource management

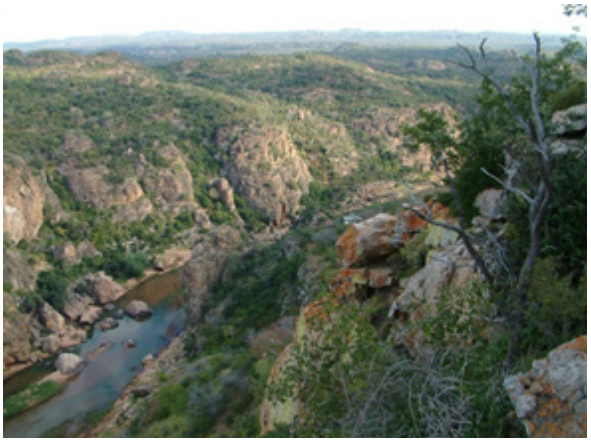
Using remote sensing to evaluate change in Luvuvhu River catchment

A newly-completed Water Research Commission (WRC) study has tested the use of GIS and remote sensing to evaluate the impact of land use and land cover change on the hydrology of the Luvuvhu River catchment.

Background

The Luvuvhu River catchment is one of the regions in South Africa which is undergoing rapid land cover and land use change.

Due to the increase in population growth and associated developments in Vhembe district, the catchment has been subjected to considerable land use change over the past decades which are causing accelerated environmental degradation and impacting negatively on the hydrology and water availability in the area.



The Luvuvhu River.

Land use and land cover changes in a catchment can impact water supply by altering hydrological processes such as infiltration, groundwater recharge, baseflow and runoff. Studies that link anthropogenic factors and land cover to hydrology and water resources have not been widely conducted in the catchment.

This WRC study was therefore conducted to evaluate the impact of land cover and land use change on the hydrology of Luvuvhu River catchment. The information derived will help prevent the potential for human conflict over diminishing resources and disease outbreaks related to waterborne vectors.

Methodology

Remotely sensed data and ground survey methods were used to evaluate the changes. A combination of multi-date fine, medium and coarse resolution remotely sensed imagery was used to detect and quantify changes.

Vegetation data was captured and automated in a GIS-compatible format, which provided flexibility in mapping, data analysis, data management and utilisation. A statistical sampling methodology based on area frame sampling was adopted for this study. The method relied on satellite imagery, orthophoto maps and topographic maps to divide the study area into sample segments.

Frequency distributions models (Generalised Extreme Value distributions, the Gumbel or Extreme Value type I distribution, the Lognormal distribution and the Log Pearson type III distribution were used to describe historical characteristics and magnitudes of floods.

Main results

This study found that there had been considerable land use and land cover change over the past decades in the catchment. The most dominant land cover was forest/bushlands/woodlands covering 32.95% of the catchment while water bodies only covered 0.29% of the catchment.

Built-up areas covered 9.86% of the land. These developments are concentrated on hillsides and hilltops in the catchment and they are of concern as they are impacting on the hydrological process.

Developments on slopes have disrupted the hydrologic process by reducing infiltration, interflow, surface runoff and preventing rainwater from reaching natural waterways. The diversity of the land use in the catchment is related to the diversity of the agroclimatic zones and land scape ecology.

The dominant land use categories concentrated specifically on the agricultural application, which is considered the most important human economic activity of the area.

SWAT was applied to the upper part of the Luvuvhu River catchment. It enabled the delineation of the 502 Hydrological Response Unit. The latter aids in efficient management of water resources at catchment level. This is because each hydrological response unit is different from the other in terms of catchment properties.

A sensitivity analysis was conducted using the SWAT tool to identify parameters that most influenced predicted flow, sediment, and nutrient outputs. By means of the LH-OAT sensitivity analysis, the dominant hydrological parameters were determined and a reduction of the number of model parameters was performed.

The study made it possible to evaluate the impact of the dynamic geomorphic processes and environmental degradation due to deforestation and intensive land use on stream flows. The impacts of land use and land cover change were determined by the cause-effect relationships of human activity, landscape dynamics and hydrology.

Through time series analysis of remotely sensed data and ground survey, it was ascertained that significant change in land cover and land use, particularly the conversion of forest and woodlands to arable and build-up land, has occurred.

The results showed that an increase in the peak discharges was to be expected, especially for the discharge range corresponding to smaller and medium flood magnitudes.

Further reading:
To obtain the report, *The use of GIS and remote sensing techniques to evaluate the impact of land use and land cover change on the hydrology of Luvuvhu River catchment in Limpopo Province* (**WRC Report No. 2246/1/15**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.