

## Water resource development

### Sediment yield modelling in the Mzimvubu River catchment

The Water Research Commission (WRC) has completed a study to assess the sediment yield contribution from sheet-rill and gully erosion in the Mzimvubu River catchment, where the latest bulk water resource development is planned.

#### Background

The Department of Water and Sanitation (DWS) is planning water resource development in the Mzimvubu River catchment, which is on record the only large river network in South Africa without a dam. Recent soil erosion mapping and modelling studies, however, indicate that large parts of the catchment consist of highly erodible soils with widespread soil erosion evident.

These studies, nonetheless, provide no information about where material moves to or about the sediment yield because a significant part of the eroded soil will deposit again before reaching a river channel or catchment outlet. The mean total sediment produced in a catchment usually differs from sediment yield at a catchment outlet, depending on the complex spatial configuration of topographical variables and land use-cover interactions.

Furthermore, most regional studies across the globe emphasise the sheet and rill aspects of the erosion cycle, but few map and/or model gully erosion at large spatial scales. Modelling the sediment yield contribution from gully erosion at a large catchment scale has not been performed in South Africa. However, gully erosion processes cannot be disregarded in the Mzimvubu River catchment because it will lead to the underestimation of soil losses in the catchment where gullies are prominent.

The WRC study modelled the major soil erosion processes in the catchment, as well as the sediment yield contribution from sheet-rill and gully erosion for the whole study area. Understanding these processes will enable area-specific management intervention and erosion control measures

that are currently planned for the future dam site at Ntabelanga on the Tsitsa River.

In order to provide a comprehensive overview of sediment yield in the Mzimvubu River catchment, two approaches were implemented. These include 1) model the sediment yield contribution from sheet-rill erosion using a graphical user interface and 2) modelling the sediment yield contribution from gully erosion using remote sensing techniques in an integrated GIS approach.

#### Main results

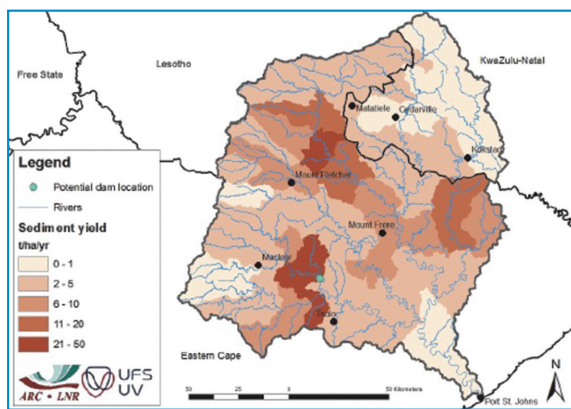
Integration of the sheet-rill and gully results produced a total sediment yield map of the Mzimvubu River catchment. In the Ntabelanga Dam catchment the sediment yield range between 1 t/ha/year upstream to 22.5 t/ha/year at the future dam outlet.

The annual average sediment output in the Ntabelanga Dam catchment range between a quarter million tons a year upstream to nearly 10 million tons a year at the future dam outlet. Gully erosion feed massive amounts of sediment into the river network, contributing about 20 times more to the sediment output than sheet-rill erosion.

The sediment output and sediment yield contribution from sheet-rill erosion for sub-catchments in the Mzimvubu River catchment is about 80 000 tons a year and a ton per hectare a year respectively. The average sediment output and sediment yield contribution from sheet-rill erosion in the sub-catchment where the future dam will be built is about 50 000 t/year and 0.1 t/ha/year respectively.

Gullied areas increased substantially since 2007 with 37 out of the 52 sub-catchments having a positive active/non-active gully ratio. The sediment yield and sediment output contribution from gully erosion for sub-catchments in the Mzimvubu River catchment is high, averaging about 5 t/ha/year and 1 787 500 t/ha/year respectively.

The average sediment output and sediment yield contribution from gully erosion in the sub-catchment where the future dam will be built is about 9.8 million t/year and 22.4 t/ha/year respectively.



*Total sediment yield map of the Mzimvubu River catchment.*

## Conclusions

Although each sub-catchment has different processes and factors contributing to the sediment yield dynamics, gully erosion is the dominant process and sediment yield contributor in the Mzimvubu River catchment. Based on sediment yield results and digital elevation data in a GIS, the life expectancy of the dam could be between 34 and 49 years without proper siltation prevention or design measures.

The future dam at Ntabelanga could therefore experience a similar fate as the Welbedacht Dam near Dewetsdorp, in the Free State, where the storage capacity reduced by more than 80% in just 20 years after completion.

However, the results should not be interpreted as absolute values. The fact that soil erosion is naturally highly variable needs to be recognised, as well as the fact that results will vary by altering certain parameters. Furthermore, the sediment yield and dam life expectancy is based on a five-year timeframe between 2007 and 2012 for which the most recent multi-temporal and high resolution imagery is available.

The sediment yield prior and after this timeframe remains uncertain. Nevertheless, modelling the flow and sediment yield in the catchment made it possible to identify major soil erosion processes and sediment generating areas.

In terms of institutional development, the results developed in this study will be useful to the DWS, as well as the Department of Environmental Affairs. Understanding these processes and factors will enable area-specific management intervention and erosion control measures, and could aid in dam design. Results will also aid in area-specific rehabilitation of gullies and the allocation of scarce conservation resources.

**Further reading:**

To order the report, *Sediment Yield Modelling in the Mzimvubu River Catchment* (**Report No. 2243/1/15**) contact Publications at Tel: (012) 330-0340, Email: [orders@wrc.org.za](mailto:orders@wrc.org.za) or Visit: [www.wrc.org.za](http://www.wrc.org.za) to download a free copy.