Courtesy CSIR

Land use is dominated by agricultural practices at the Wilge River site.

Discovering the secrets of THE OLIFANTS SEDIMENTS

The polluted Upper Olifants River, in Mpumalanga, has been the focus for many studies in recent years. However, a group of researchers from the CSIR are now also studying an element of the system which has to date been largely overlooked, namely the sediment. Article by Chantel Petersen, Nebo Jovanovic, Bettina Genthe.

The Upper Olifants catchment and its tributaries have been a research focus of late due to its combined status of being one of the hardest working rivers in South Africa and also one of the most polluted. A large research project which was led by the CSIR and funded by non-governmental organisation, the Olifants River Forum, was initiated as a result (For more information on the overall study see 'All eyes on Olifants as experts search for answers', *the Water Wheel* May/June 2010).

Representative sites in the catchment were chosen, samples were collected and analysis of water chemistry, as well as biological indicators such as fish, macroinvertebrates, protozoa, phytoplankton, benthic algae and riparian vegetation have revealed the critical variables (heavy metals from acid mine drainage, high total phosphate concentrations from partially/untreated sewage effluent) driving pollution in the Upper Olifants catchment. Furthermore water samples were also tested for endocrine disrupting compounds, bacteria, viruses and pathogens, which impact human health.

So although most aspects of the aquatic ecosystem were covered by the project, one that was lacking was sediment. Sediment is an important component of an aquatic ecosystem in that it provides habitat, feeding and spawning areas for aquatic fauna such as fish and benthic

macroinvertebrates. Excess sediment can in itself be a deterioration of water quality and impact on river ecology but it can also be a means of attachment of pollutants such as nutrients or metals by adsorption and transport of pollutants.

Poor land management practices and catchment activities such as changes in landuse may cause erosion, siltation of rivers, unstable river banks and beds and with this mobilisation of sediment associated with pollutants. The sediments often act as a 'sink' for pollutants, which can be released back into the water column during disturbance, whether natural or anthropogenic.

Sediment monitoring programmes are generally lacking in South Africa and this limits the understanding of factors controlling sediment dynamics, the link between river processes and the land and with it effective and sustainable catchment management. So while it was known that pollutants (metals, nutrients) were associated with sediments in the Upper Olifants system and that it impacted water quality (eutrophication, sedimentation), a knowledge gap existed in the understanding of the transport mechanisms involved.

Questions that were raised included: how are sediments reaching streams and how are they transported instream? Where are they stored and how do river form, shape and type influence this? Are there mitigation measures in place and what role do they play (e.g. riparian buffer strips)? One way of trying to answer these questions is by using geomorphological techniques.

Geomorphic processes have become important in river management as they can be used in understanding the physical transport, storage and deposition of sediment-bound pollutants in water resources. These methods were applied in the Upper Olifants catchment with the aim to monitor and model sediment and geomorphic processes, their response to landuse and varying river flows and to use the information to prioritise the impacts of landuse management associated with in-stream sediment-bound pollutants to water resources.

Two sites in the Upper Olifants catchment were chosen, one on the Koffiespruit River and another on the Wilge River, both tributaries of the Olifants River, flowing into Loskop Dam. Although the sites have similar land uses they differ in their geological, geomorphological and vegetation biomes, which will result in different process controlling factors.

Characterisation of the two study sites are under way with much of the baseline data such as flow and water quality data available from the Department of Water Affairs and spatial data such as soil erosion and sediment yield compiled by the Agricultural Research Council (Institute for Soil, Climate and Water). This data will be essential to the modelling process.

"Sediment is an important component of an aquatic ecosystem in that it provides habitat, feeding and spawning areas for aquatic fauna such as fish and benthic macroinvertebrates."

Courtesy CSIR

*Clear differences can be seen between the Wilge (**below**) and Koffiespruit (**left**) sites. Geomorphologically the Wilge site occurs in the upper foothills and the Koffiespruit site in the lower foothills, which results in different factors controlling processes such as in-stream sediment transport and possible contaminants.*

Top right: *The Koffiespruit, a tributary of the Upper Olifants River.*

Middle right: *Bank erosion was evident throughout the Koffiespruit study reach. This section of river also displayed the most physical channel changes between the two sampling events.*

Bottom right: *Trampling occurring on the left hand bank of the Wilge River. Cattle occasionally drink from the river causing localised bank instability, a spource of sediment to the river.*

Courtesy CSIR

Courtesy CSIR

Courtesy CSIR

Monitoring of the sites began during 2011 with two rounds of sampling completed.

Sampling included cross-sectional surveys of the two river reaches, which provides a two dimensional view of the river channel and floodplain. The cross-sections also provide a means for the collection of long term geomorphological data in a quantitative and repeatable manner. The bedloads (sediment moving on or near the bed) were sampled to determine the distribution of bed material sizes.

This allows for the determination of the flow hydraulics and the flow competence ability to transport bedload, which allows for the prediction of how channels will behave. The finer sediment carried in suspension will be monitored by sensors equipped to record turbidity, nutrients (e.g. phosphates) known to result in eutrophication and other water quality parameters. It is hoped that the sensors will be installed at the gauging weirs to continuously log data so as to relate changes in the parameters to the discharge data from the Department of Water Affairs gauging weirs.

Preliminary results showed that the Wilge River reach remained relatively stable between the surveys whereas the Koffiespruit River displayed channel widening and erosion including bank scouring and slumping as well as trampling by animals throughout the study reach. Results on the bedload sediment samples are still being processed but this will allow the characterisation of sediments in the channel, which can be used to determine the resistance of the channel to change and the type of flows required for sediment movement.

Vegetation surveys and electrical resistivity tomography surveys (dry and wet season) are to be completed during 2012. Vegetation surveys will provide information on bank stability and electrical resistivity tomography is a geophysical technique which will provide information on the subsurface, soils and geology as well as show the preferential pathways for water, which can be correlated to borehole data for the area obtained by the Department of Water Affairs.

All monitored data will be used for model calibration and scenario analysis performed to identify key land use impacts and effective mitigation measures focussing on the selected sites. The tools and models produced in this project will contribute to improved catchment management in the Upper Olifants catchment, and the experiences may be applicable to other catchments in the same region. ❑