

Water and the environment

One of South Africa's potential breadbaskets at risk, study shows

An extensive transdisciplinary study report – compiled by a team of natural and social scientists – confirms that the Lower Phongolo River and floodplain, in the north-eastern corner of South Africa, are struggling to maintain their socio-ecological system function. The implications are not just regional, as this fertile area has been described as potentially the breadbasket of South Africa.

Article by Kim Trollip.



The findings based on the risk model developed for this study indicate a potential for reduced biodiversity and reduced ability of this system to be sustainably utilised. "In our conclusion we actually modelled a reduced flow of 50% and clearly showed the increase in risk associated with flow and flood reductions," explains project leader and ecologist Prof Nico Smit of North-West University (NWU).

Farmers, fishermen and women, fish vendors and the community living in the area depend upon the abundance of the floodplain known as the Makhathini Flats. This region has the potential to produce food in quantities to make a significant impact on South African and international markets, according to a Department of Agriculture development plan for the region. The area is strategically placed, in close proximity to several

ports. Job opportunities in different sectors of our economy that are linked to Makhathini Flats projects include agriculture, tourism, freight and logistics, maritime, automotive, rail and manufacturing. But the plans for the area will remain tenuous if the issue of ecosystem integrity is not addressed.

Impact of organic pollutants on human health

The Phongolo system falls within South Africa's Dichlorodiphenyltrichloroethane or DDT malaria control region. The WRC study therefore also determined and evaluated the bioaccumulation and biomagnification of DDT and other relevant organic pollutants and potential impacts thereof on the river and floodplain, as well as the associated risk to the local communities.



Masters student, Jurgen de Swardt, Prof Rialet Pieters of NWU and Honours student Melissa Hannam taking sediment and water samples from the Phongolo River.

The study set out to conduct the first integrated regional scale risk assessment of the Pongolo system since the construction of the Pongolapoort Dam in the 1970s. Its aim was to:

- Establish and evaluate threats to the ecosystem;
- Carry out an ecological integrity state assessment;
- Use fish as indicators of ecological health;
- Determine and evaluate the presence of relevant organic pollutants and potential impacts thereof on the system and the associated risk thereof to the local communities;
- Provide data to conservation authorities to aid in the management of conservation areas; and
- Evaluate the economic, ecological and cultural implications associated with the use of fish as an ecosystem service.

Study leaders Profs Smit and Victor Wepener, also of NWU, concluded that despite the containment of DDT use through indoor residual spraying, high levels of the pesticide still enters the aquatic environment of the Phongolo River and floodplains. "All five species of fish and all four species of frogs studied showed high concentrations of DDT in their tissues. However, health assessments of these organisms did not reveal any adverse effect to their health. This supports a previous WRC-funded study by our team on tigerfish in Kruger National Park where high levels of DDT also did not affect their health.

"Our study showed that local communities make extensive use of fish from the Phongolo system as a source of protein (consuming fish on average twice a week). The risk assessment of the consumption of DDT contaminated fish by the local communities showed that a definite health risk does exist due to the eating of the fish, however, there are no epidemiological studies to support. This needs to be studied further, preferably through a health assessment of the local community focussing on this aspect."

Proposed interventions

The model used in the study showed that the ecosystem services provided by the Phongolo floodplain have undergone significant changes. The study strongly proposes management interventions and monitoring in future.

The intricate interlinkages between biota and the physical environment form the framework for humanity's interaction and survival. Many of the poorest and most disadvantaged in this world are critically dependent for their sustenance and health on their immediate environments and ecology. Short-term



Researchers and students at the field lab at Ndumo Game Reserve.

exploitation, whether from necessity or personal gain, often depletes and degrades the sustaining environment beyond the capacity of that environment to maintain the functions for the future. Where such a tension occurs, it is imperative to measure the stresses so that the situation can be described and information for mitigation and conservation provided.

One of the major outcomes of this project is the importance of Ndumo Game Reserve (NGR) as a refugia for aquatic biodiversity of the lower Phongolo system, thus an important management intervention should be reducing the threat of human encroachment into the reserve and thereby maintaining its essential role as supplier of ecosystem infrastructure to upstream communities. Ndumo was proclaimed a game reserve in 1924 with the primary objective of strict protection of its biodiversity. Today, the NGR is a RAMSAR site because of its unique wetlands.

Surrounding the NGR are communal areas that are heavily dependent on resources from the floodplain. However, the environmental sustainability of the floodplain has been questioned over time. Following an earlier ecological study of the floodplain system it was suggested that the ecosystem infrastructure of the Phongolo floodplain is maintained through controlled flood releases that were introduced to simulate the flood regime prior to the construction of the Pongolapoort Dam. The controlled flood releases were required to mimic the annual inundation of the floodplain. Although there are proper protocols for water releases these appear to be ignored and are therefore not in accord with ecological needs. The environmental flow requirements to maintain the physical and chemical structure, biodiversity, ecosystem processes and functions in the Lower Phongolo River and floodplain may therefore not be met.

Since the construction of the dam, there had, until now, been no major ecological studies that have monitored the floodplain wetlands of the Phongolo River. Very little was therefore known about the current ecological state as well as functioning and structure of the floodplain as a whole.

This new and comprehensive study allows scientists to recommend the implementation of an appropriate, long-term monitoring system to observe and track water quality, flow, diversity, aquatic health and levels of organic pesticides among

others. The study leaders note with concern that, of the four original, active Department of Water and Sanitation (DWS) monitoring sites in the lower Phongolo, only the one below the Pongolapoort Dam is currently operational.

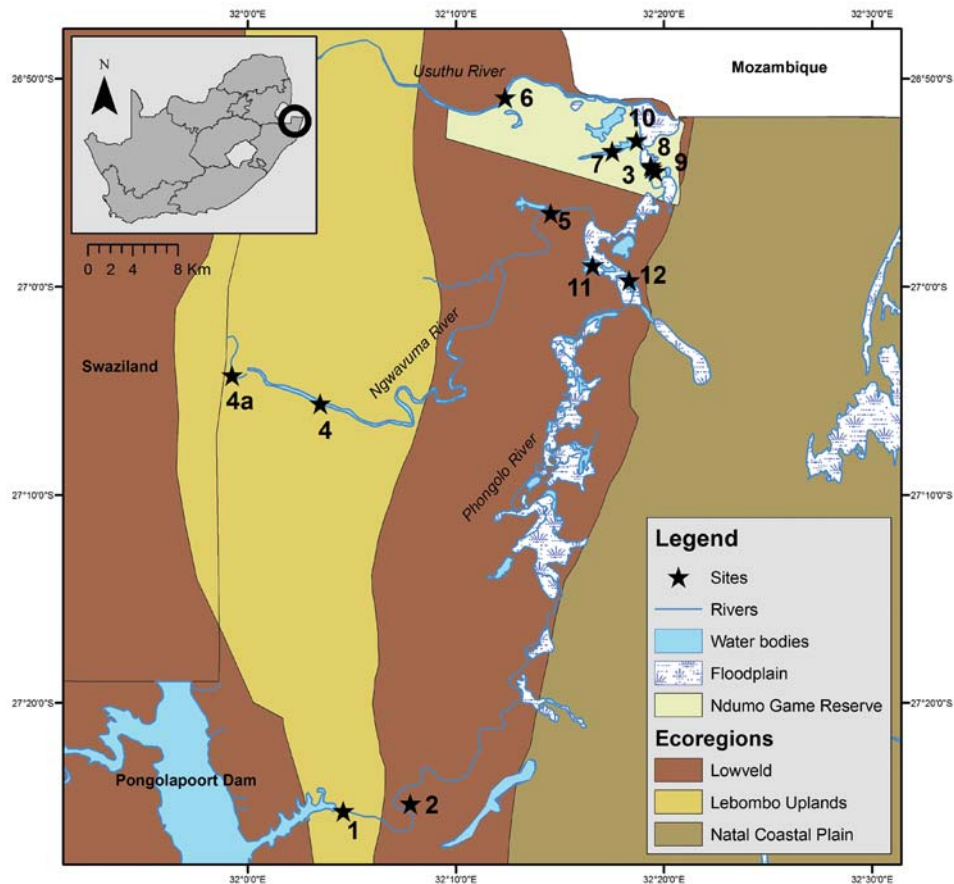
Maintaining a sustainable balance between use of resources and protection

The risk of not implementing the interventions outlined in the study was modelled according to several scenarios. In the conclusion, the researchers used the Relative Risk Model (RRM) to establish and evaluate threats to the Lower Phongolo River and floodplain ecosystem. They tested different scenarios if management practices change. One of these actually modelled the risk that should the population pressure in NGR increase to that experienced upstream, i.e. outside the game reserve, the risk to the birds, fish and subsistence fisheries endpoints would all increase to moderate risk states. This scenario would therefore remove any refuge function that the reserve provided for specifically fish and birds. Furthermore under this scenario there is a high risk that the sustainable balance between use of resources and protection would not be possible. Monitoring and management would be imperative under such a scenario.

Looking ahead, an in-depth study into the connectivity between the river and associated floodplain pans is necessary, in order to determine the ecological flow requirements to sustain the function and structure of the pans. "Fortunately we (NWU- Water Research Group) in collaboration with KU Leuven and the University of Antwerp, with funding from the Flemish Inter-university Council Team programme, are currently studying this," adds Prof Smit.



PhD student, Lizaan de Necker, collecting invertebrates as part of the study.



The Pongolapoort Dam supplies irrigation water for sugarcane and cotton plantations in the adjacent floodplain, the Makhathini Flats. The floodplain of approximately 10 000 ha increases to 13 000 ha at full inundation. The flats extend to the confluence of the Pongolo and Usutu Rivers in Ndumo Game Reserve (NGR) up to the border with Mozambique.

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What can be done in the meantime?

The study leaders urge Ezemvelo KZN Wildlife, the Department of Environmental Affairs and DWS to consider using the Relative Risk Methodology that was developed during this project as a management tool. The RRM provides an innovative way to contribute to the determination of water resource protection measures and associated objectives as required by the National Water Act (Act 108 of 1998).

In addition, the high levels of DDT detected in all the fish species tested pose a potential serious health risk to the local

community. The RRM further showed that an increase in current DDT levels will increase human health risks. Based on these findings it is imperative that the continued use of DDT in this area should be re-assessed, as well as the current health status of the people of this region should be investigated.

Finally, the role of floods in maintaining ecosystem processes in the floodplain pans will increase the certainty associated with the risk predictions. It therefore remains essential that fundamental research be conducted and supported financially in order to provide the necessary data that address these processes.

To order the report, *Socio-ecological system management of the lower Phongolo River and floodplain using relative risk methodology (Report No. 2185/1/16)*, contact Publications at Tel: (012) 761 9300, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.