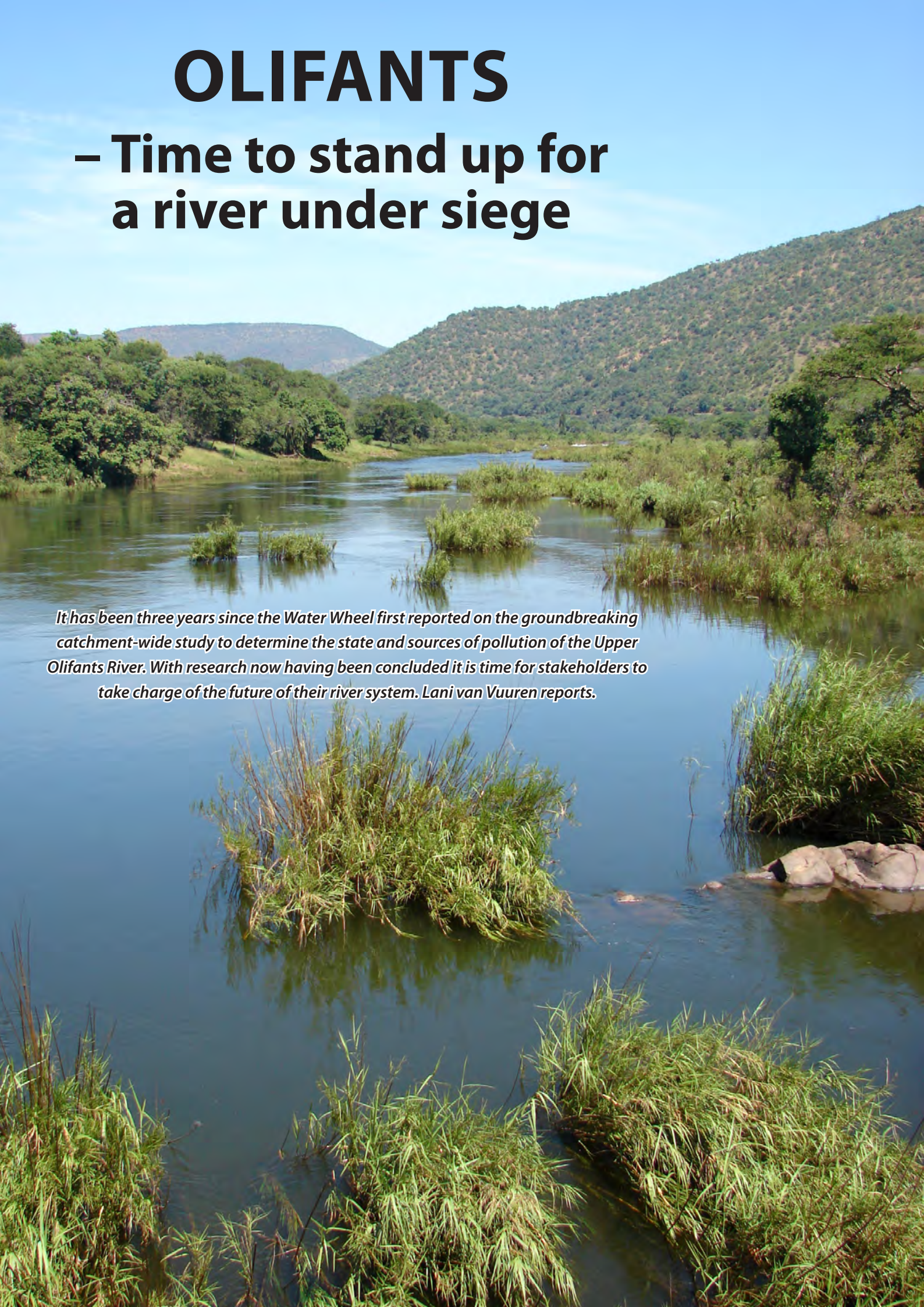
OLIFANTS
– Time to stand up for a river under siege



It has been three years since the Water Wheel first reported on the groundbreaking catchment-wide study to determine the state and sources of pollution of the Upper Olifants River. With research now having been concluded it is time for stakeholders to take charge of the future of their river system. Lani van Vuuren reports.

Few water research projects have captured the imagination of the South African public as much in the last few years as the Upper Olifants River study. The nation followed the multidisciplinary project closely as it unfolded to provide an accurate status of the health of the Upper Olifants River system, in Mpumalanga.

What followed was a detailed and accurate view of the influence of human activities on a catchment at a level of detail previously unheard of. Using various sampling techniques and research methodologies, researchers pinpointed the exact location of pollution hotspots and their repercussions on river health. Led by CSIR Natural Resources & the Environment (NRE) more than 30 researchers from various disciplines and organisations cooperated on the project.

The status of the Olifants River as one of the hardest-working rivers in South Africa was confirmed through the study, although even the researchers were surprised at the levels of pollution the river system has had to endure. It is now hoped that stakeholders will use the information generated from the research to develop and refine appropriate water quality management responses for the catchment, and institute the necessary remedial measures to reduce pollution loads in the river system.

MAIN OUTCOMES

The study focused on a variety of impacts on the Upper Olifants River system (including nutrients, metals and microbiological). While studies of this nature are expensive, it enabled the formation of a holistic view of processes occurring in the catchment and how they possibly interact with one another. This provided for an improved overview of source and effects of pollutants in the system as well as the prioritisation of mitigation and management options to improve water quality throughout the catchment.

The study underlined an acute need to improve the development and management of human activities in the Upper Olifants River catchment to halt an increasingly serious situation of poor water quality, eutrophication and contamination. Researchers identified three main sources of impacts on the quality of the Upper Olifants River and its tributaries. These are acidic water, metals and sulphates from mining and industrial activity; excessively high nutrient input from poorly operating municipal wastewater treatment works as well as some agricultural activities; and extremely high microbial input from untreated or poorly treated sewage. Some of the adverse effects of these pollutants include widespread eutrophication of the river, toxic water quality in places, and an increase in the potential for bioaccumulation of pollutants, such as metals, in organisms through the food chain.

Researchers have expressed concern about the high level of eutrophication in the river, specifically the main stem of the Upper Olifants. Here dense algal mats (resulting from high phosphate levels) are extensive – highlighting the severity of the nutrient pollution problem. Once-off sampling showed high concentrations of orthophosphate (i.e. inorganic phosphate) downstream of wastewater treatment plants.

Poorly functioning wastewater treatment works, along with informal settlements in the catchment, also contribute to high volumes of microbial pollution and pathogens (including *Vibrio cholera* and *Shigella*) in the Upper Olifants River system. This places people, specifically those in rural, poor areas, who use untreated water from the catchment, at high risk of contracting disease. The risk of faecal pollution also extends to other water users in the catchment, especially producers of export fruit and vegetables that rely on Olifants River water for irrigation.

KEY CONSIDERATIONS IN IMPROVING THE HEALTH STATUS OF THE UPPER OLIFANTS RIVER

- There is no 'quick fix' or 'one-size-fits-all' solution. The problem requires a well planned and effectively implemented long-term approach.
- The issues require a truly collaborative approach between government, water resource managers, business and communities.
- The issue cannot be solved by a single, short-term technical intervention. Solving the problems will require the implementation of a suite of social, economic and technical interventions.

Acid mine drainage (AMD), particularly from abandoned coal-mines, are having a significant impact on the current system and is the most important source of metals to the upper catchment. The Klipspruit, for example, was found to be particularly badly affected, and significantly impacts on the Olifants River downstream of the confluence, resulting in elevated metal concentrations and a decline in the aquatic ecosystem health. The potential for the Olifants and Wilge rivers to dilute this AMD input can

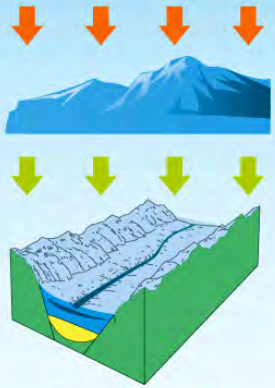
Acid mine drainage, particularly from abandoned coal-mines, is the most important source of metals to the upper catchment.

Lani van Vuuren

FRESH WATER FOR ALL

FRESH WATER IS THE COMMON DENOMINATOR OF TODAY'S MOST PRESSING CHALLENGES, LIKE HEALTH, FOOD & ENERGY. BUT IT'S OFTEN POORLY MANAGED & FACES SEVERE PRESSURE. HOW CAN THE WORLD BETTER COOPERATE AROUND THIS VITAL CAUSE?

WHAT IS FRESH WATER?



FRESH WATER ISN'T IN OCEANS OR SEAS. IT'S A GLOBAL COMMON GOOD THAT OCCURS NATURALLY IN ICE SHEETS, ICE CAPS, GLACIERS, BOGS, PONDS, LAKES, RIVERS, UNDERGROUND STREAMS, AQUIFERS.

WHAT IS WATER COOPERATION?

WATER COOPERATION MEANS GETTING EVERYONE TOGETHER - SCIENTISTS, POLICY MAKERS, GOVERNMENTS, WATER MGMT SPECIALISTS, CIVIL SOCIETY - TO ENSURE THAT FRESH WATER BEST SERVES EVERYONE'S NEEDS

WAYS TO COOPERATE

- BUILD A WATER PUMP IN A RURAL VILLAGE
- MANAGE AQUIFERS ACROSS COUNTRIES
- EXCHANGE SCIENTIFIC DATA

WHY COOPERATE FOR FRESH WATER?

THERE'S ONLY A FIXED AMOUNT OF FRESH WATER

≠∞

WATER IS NOT CONFINED TO POLITICAL BORDERS

276

OF THE WORLD'S RIVER BASINS CROSS AN INT'L BORDER

FRESH WATER IS A HUMAN RIGHT

2 BILLION

PEOPLE DEPEND ON GROUNDWATER TABLES, INCLUDING 273 TRANSBOUNDARY AQUIFER SYSTEMS

60%

OF FRESHWATER AVAILABLE IN THE ARAB REGION ORIGINATES FROM

EGYPT & ALMOST ALL COUNTRIES IN SUB-SAHARAN

~80%

OF RENEWABLE WATER RESOURCES IN THE ASIA-PACIFIC, HOME TO 2/3 OF THE WORLD'S

This poster was generated by UN Water a
Water Day 2013. It is to be used for educ

ORIGINATES FROM ANOTHER REGION

AFRICA SHARE A TRANSBOUNDARY BASIN

HUNGRY, IS CONSUMED BY IRRIGATED AGRICULTURE

TODAY

~3.5 MIL
DEATHS RELATED TO INADEQUATE WATER SUPPLY, SANITATION & HYGIENE

3-5 MIL
CHOLERA CASES

UNEQUAL ACCESS TO IMPROVED DRINKING WATER SOURCES GLOBALLY

94% FOR URBAN AREAS vs **76%** FOR RURAL AREAS

71%
OF WATER COLLECTION BURDEN FALLS ON WOMEN & GIRLS, IN SUB-SAHARAN AFRICA

6%
MINISTERIAL POSITIONS IN THE FIELD OF ENVIRONMENT & NATURAL RESOURCES ARE HELD BY WOMEN

2050

7 BIL > 9 BIL
WORLD POPULATION WILL INCREASE

+20%
GLOBAL AGRICULTURAL WATER CONSUMPTION

+ 60%
HYDROELECTRICITY & OTHER RENEWABLE ENERGY NEEDS

MORE COOPERATION IS NEEDED

450
AGREEMENTS TO SUPPORT COOPERATION AROUND INT'L WATERS SIGNED BETWEEN 1820 & 2007

90+
INT'L AGREEMENTS DRAFTED CONCERNING WATER TO IMPROVE MANAGEMENT OF DOWNSTREAM BASINS IN AFRICA

BUT **60 %**
OF THE PLANET'S 276 INT'L RIVER BASINS HAVE NO COOPERATIVE MANAGEMENT SCHEME

SUCCESS STORIES

THE GUARANI AQUIFER

ARGENTINA, BRAZIL, PARAGUAY & URUGUAY ALL SHARE THIS AQUIFER. IN AUGUST 2010, THEY FORMALLY AGREED TO ENSURE ITS EQUITABLE USE & CONSERVATION.

THE NILE BASIN

EXPERTS, PUBLIC-PRIVATE SECTORS & SOCIOLOGISTS JOINED TOGETHER TO EXPLORE ALTERNATIVE DEVELOPMENT SCENARIOS & BENEFIT-SHARING SCHEMES.

UNESCO · UN WATER · UN WATER World Water Day 2013 International Year of Water Cooperation

LET'S MAKE FRESH WATER AN INSTRUMENT FOR PEACE

and partners in celebration of World
ational/awareness purposes only.

Lani van Vuuren

Poorly functioning wastewater treatment works are one of the main contributors of pollution in the Upper Olifants River.

be significantly reduced during prolonged dry periods or winter seasons, when the flow originating from the Klipspruit can exceed that originating from the Olifants and Wilge rivers.

Other affected tributaries include the Blesbok Spruit, Kromdraai Spruit and Saalklap Spruit. Water treatment options designed to neutralise AMD and remove metals are essential to improving water quality in these catchments, the CSIR project team found.

While operational mines do not appear to contribute as much to metal concentrations in the river at present when compared to abandoned operations, it will become important to establish proper closure plans to avoid increased levels of AMD pollution once end-of-life is reached.

All of this pollution eventually lands up in the Loskop Dam, which acts as a sink for upstream pollutants. The dam is showing strong signs of becoming hypetrophic (the highest level of eutrophication) and has been experiencing occasional blooms of toxic blue-green algae.

The change in water quality and trophic status has had a marked effect on wildlife in the dam. A study of the Mozambique tilapia in Loskop Dam found that the fish survived on a diet dominated by species of blue-green algae (*Microcystis*) and a dino-flagellate (*Ceratium*), which showed elevated levels of certain metals (aluminium, iron and manganese).

The few studies that have investigated dietary exposure to elevated levels of these metals have reported an increase in lipid perodixation, a symptom of pansteatitis. The link between these two factors has not been confirmed, but warrants further research. Pansteatitis is a disease usually associated with high dietary intake of polyunsaturated or rancid fat, and the hardening of fat reserves as a result of anti-oxidant depletion. The disease is thought to be responsible for the drastic reduction in the crocodile population at Loskop Dam to just five individuals at last count.

Lani van Vuuren

The Upper Olifants River catchment supports various industries, whose effluent have a marked impact on water quality in the river.

INVOLVING ALL PARTIES

One of the greatest challenges in translating any research into action is overcoming the traditional gap that exists between science and practice. Engagement between scientists and stakeholders

becomes extremely important in this case. Since the Upper Olifants River research project was commissioned by water users themselves, acting through the Olifants River Forum, stakeholder participation has been an important element of the project from the start, reports research project leader Dr Paul Oberholster of CSIR NRE.

"Interaction with stakeholders has been a major part of the research project, and our findings have been shared on a number of fora and through various media. Our goal has always been to translate the scientific knowledge gained from the project into practice, which is why we opted for a transdisciplinary approach to the research question from the beginning." In addition to a number of technical reports, a summary report is planned that will present key findings and recommendations from the research project in an easy-to-digest format.

CSIR NRE Senior Researcher, Dr James Dabrowski, adds that reaction to the research project has been extremely positive overall. "The majority of stakeholders are aware of the fact that the Upper Olifants River catchment is in a poor condition – the study has provided a greater understanding of the variety of pollutants affecting the catchment."

Information sharing has never been about 'naming and shaming' polluters, but rather about encouraging cooperation and collaboration towards improving the status quo. For this reason stakeholders have generally been very cooperative in terms of sharing information and allowing access to property in order to perform sampling, Dr Dabrowski reports. It is expected that this interaction will continue even now that the project has been completed.

The research has shown that in some cases simple innovations can been enough to make a real difference – one of the innovations to come out of the project is a user-friendly Fish Kill website where members of the public can report fish kill events in the Upper Olifants River catchment.

Another important innovation from the study relates to the use of the SWAT model to determine phosphorus loads at catchment level. "The study has demonstrated that the successful restoration and management of eutrophication in South African rivers requires knowledge of the phosphorus sensitivity of the system and how it will respond to increases or decreases in phosphorus loads," explains Dr Oberholster. "Phosphorus sensitivity of rivers is determined by employing physical, chemical and biological processes which influence the transport, transformation and retention of nutrients during downstream transport."

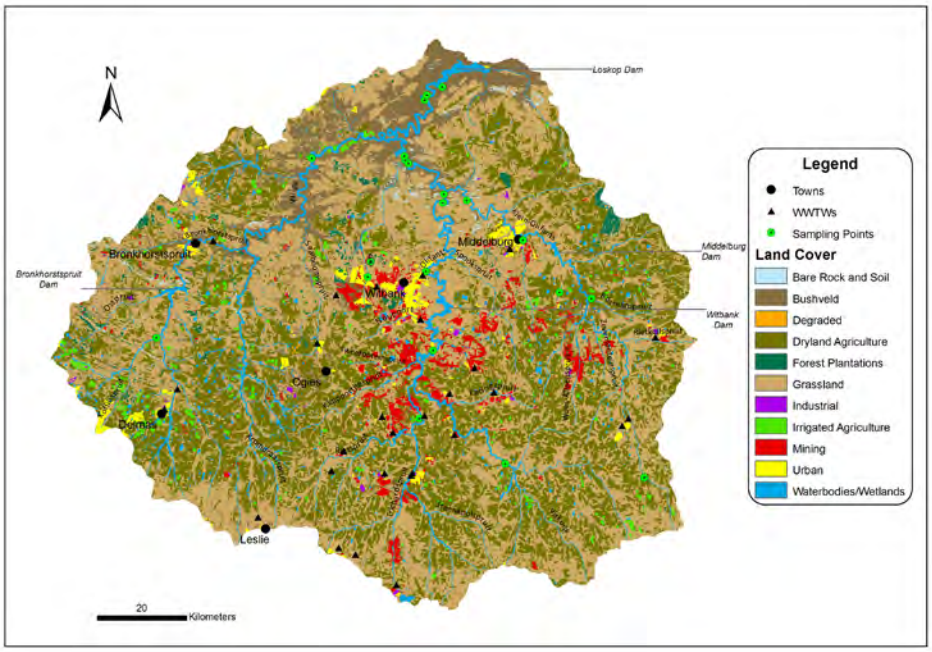
The project team has therefore developed phosphorus indices to act as decision support for assessing river phosphorus sensitivity classification to aid conservation planners and water managers in achieving the ultimate goal to manage and restore phosphorus impacted catchments by reducing high levels of phosphorus loads. It is believed that these indices can be used in other catchments to prioritise point- and non-point sources of nutrient pollution.

Other innovations to emanate from the project include the Safe Waters Earth Observation System which uses remote sensing to track toxic cyanobacterial blooms in the main dams to assist water withdrawal; the development of a DNA toolbox to determine anthropogenic impacts on sub-cellular level and to investigate mitigations in aquatic specimens over time; and a Wetlands Risk

Lani van Vuuren

Above: *Industrial pollution has wiped out aquatic biodiversity in some stretches of the Upper Olifants River system.*

Below: *The study area showing main sampling points.*



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"While there is no quick fix for pollution it is hoped that the momentum built through the Upper Olifants River study will drive its water users forward in bettering caring for their catchment together."

AFRICA'S FIRST FISH KILL WEBSITE LAUNCHED

Africa's first website where members of the public can report fish kills is now up and running for the Upper Olifants River catchment.

The website is the initiative of University of Pretoria Veterinary Science PhD Candidate, Jackie Dabrowski, and was established in an effort to improve regional responses to fish kills as a way of addressing water quality issues within the Upper Olifants River catchment. "While conducting research into fish health at Loskop Dam I struggled to put together details of the events surrounding historic fish kills at Loskop Dam," Dabrowski tells *the Water Wheel*. "Data and contacts were difficult to obtain and were scattered between institutions. I was also approached by several people with anecdotal evidence of fish kills, however, frequently too late after the event to mount any effective investigation. The fish kill website seemed to be a logical solution to these issues."

A 'fish kill' is defined as the death of a number of fish (usually greater than 25) along a 1 km stretch of river or a square kilometre in a dam over a 48-hour period due to unnatural conditions. Fish act as excellent indicators of water pollution as they are easily seen and are sensitive to changes in water quality. Fish kills can highlight problem areas where management is required to improve water quality. However, if not reported timely to authorities this can result in delayed scientific investigation and thus a loss of valuable information for efficient research, governance and management.

The fish kill website allows users to report both new and historic fish kills while providing useful information on the occurrence and causes of this phenomenon. "Both current and historic records are significant," explains Dabrowski. "Repeated fish kills at a certain location can help authorities prioritise areas that require urgent management interventions."

The website offers several benefits, especially since all reported fish kills are available for public view. Members of the public are now empowered since they have a platform upon which they can act when encountering a fish kill. It is expected that repeated reports of fish kills requiring investigation will result in pressure being applied to reduce the impact of land uses causing the problem. Archived records provide the public, non-government organisations, researchers and management bodies with evidence of water quality impacts that may be related back to certain land uses.

"The professional and timeous investigation of fish kills provides evidence that may be used in litigation, if necessary," adds Dabrowski. "This will hopefully encourage more accountability of various stakeholders in the catchment to act responsibly in terms of their impact on water quality."

Within the first month of operation the website had already proven that fish kills are a factor in the Upper Olifants River catchment, with reports of fish and ducks dying at Witbank Dam, a fish kill at Loskop Dam and a second fish kill at a pan near Middelburg being reported. All of these events were investigated by the Department of Water Affairs and researchers from the CSIR within 24 hours of receiving the report, a sign of the site's current effectiveness.

The website has spurred numerous requests for similar websites to be set up in other catchments across the country. The Upper Olifants website will provide an interesting test case into the system. To view the website and report fish kills Visit: http://www.orf.co.za/FKHome.html

Assessment Index to determine the environmental condition of wetlands. The latter has already been applied by Eskom to monitor wetlands potentially impacted by its operations.

Arguably of greatest value is the fact that the study has generated awareness of water quality in the catchment. "Through this process, people and organisations have begun talking with one another and relationships are being built. This cooperation is essential with respect to improving land management and other processes that impact on water quality," Dr Dabrowski points out.

Positive actions have already resulted from these relationships. Coaltech, in collaboration with CSIR and Working for Wetlands, are restoring some of the wetlands in the catchment that have been impacted by AMD. In another initiative, some farmers have moved away from fertilisers to more environmentally-friendly alternatives to reduce phosphates entering the system. Significant also is the fact that the Brugspruit Water Pollution Control Works, originally established in 1997

to protect Loskop Dam from the effects of AMD, has been refurbished and Rand Water has been appointed by the Department of Water Affairs (DWA) to operate and maintain the AMD neutralisation plant.

DWA's Strategic Technical Task Team for Water Quality Management has also established the Save the Olifants Coordinating Committee – an internal departmental initiative aimed at addressing water quality issues in the Olifants River catchment in a coordinated manner. The committee constitutes various directorates that have line functions in water quality management and planning, including (but not limited to) water quality planning, water services regulation, national water resources planning, resource quality services, resource protection and waste, and compliance monitoring and enforcement, among others.

Committee Chair, Pieter Viljoen, points out that the Save the Olifants Coordinating Committee is not a substitute for water quality management sections in DWA nor is it taking over the mandate or the functions of the relevant sections. "The committee's main purpose is to act as a vehicle to ensure better water quality management by enhancing cooperation between DWA internal stakeholders and improving cooperation and communication with external stakeholders."

The committee has already resulted in a number of water resource management improvements in the Olifants River catchment, despite current human resource challenges. This includes improved cooperative water resource management between various DWA water quality management sections, improved communication to external stakeholders and quicker response times to water quality incidents as well as a greater awareness among water quality managers of incidents in their area of jurisdiction.

Despite the onslaught on the system, the Upper Olifants River – like its namesake – has shown to be remarkably resilient to pollution. With time and dedicated effort researchers are positive that the condition of the river will improve.

CSIR

Stakeholders of the Upper Olifants River catchment gathered at an information sharing event in February to discuss research outputs and possible solutions to pollution in the Upper Olifants River.

VALUE TO OTHER CATCHMENTS

There is no doubt among the researchers that this type of study could – and should – be replicated in South Africa's other catchments. According to Dr Oberholster, it is also important to take the lessons learnt from the Upper Olifants River study, for example, related to AMD, and apply them to catchments where future mining is planned, such as the Waterberg. "A hundred years ago when mining started in the Olifants River catchment there were no best management practices in place. Lessons from this study can be used to develop such practices in the mining industry to ensure we protect our ecosystem services in the Waterberg where the next 200 to 500 coal deposits lie."

While there is no quick fix for pollution it is hoped that the momentum built through the Upper Olifants River study will drive its water users forward in bettering caring for their catchment together. It is only through strong leadership and collaboration that we will ensure we do not drive one of South Africa's hardest working rivers into retirement. ❑

Lani van Vuuren

Lake Loskop, which acts as a sink for pollutants from the Upper Olifants River, is in danger of becoming eutrophic should external nutrient inputs not be drastically reduced.