Courtesy CSIR

CSIR Natural Resources and the Environment researcher, Arno de Klerk, is looking into the possible degree of risk for a variety of potential impacts on the water quality and aquatic ecosystems of the Mokolo River, as part of his PhD studies.

Research builds body of knowledge to protect WATERBERG RIVERS

While a growing number of developers are staking a claim in the coal-rich Waterberg, researchers are building a body of knowledge to ensure the sustainable development of this Limpopo region's unique aquatic ecological infrastructure. Article by Lani van Vuuren.

Coal contributes 93% of the total electricity consumed in the country. Growing demand for electricity in South Africa has resulted in a massive electrification programme, with several new power stations being built or on the cards. In turn, this increases the demand for coal.

The Waterberg is considered the 'next frontier' in terms of coal-mining in South Africa, cited by many as the answer to much of the country's future additional energy requirements. Home to what is believed to be the third-largest coal reserves in South Africa, the area is set to become a new powerhouse for coal-fuelled electricity production in the country – a far cry from the agriculture-dominated area it is today.

Development has been triggered by Eskom's new Medupi Power Station outside Lephalale. According to Eskom's website, the power station, which is currently under

construction, will be the 'fourth-largest coal plant in the Southern Hemisphere', and will be 'the biggest dry-cooled power station in the world'.

This has prompted various mining companies to start prospecting in the Waterberg region. Further expansion could see more new power stations being constructed and several more new coal mines being added to the region to supply the necessary coal for these large operations. This will undoubtedly lead to dramatic changes in the landscape.

WATER RESOURCES

All of these economic developments, with accompanied population growth and urbanisation (Lephalale, for example, is currently the fastest growing town in South Africa), are likely to have an effect on the Waterberg's water resources. Ironically, the Waterberg has not been blessed with an abundance of water and does, in fact, have a dry climate. Even before all the economic expansion in the area there was hardly any additional water left in the region to meet future demands.

This has prompted authorities to seek additional water in other catchments. To meet the future water demand in the Waterberg, the Department of Water Affairs (DWA) has embarked on the Mokolo Crocodile Water Augmentation Project, which entails the phased construction of two main bulk raw water transfer systems, as well as associated infrastructure to transfer water from the Crocodile (West) and Marico catchments to the Mokolo River catchment, the main catchment of the Waterberg. The first phase of this project is expected to be completed in 2015.

IMPACT ON RIVERS

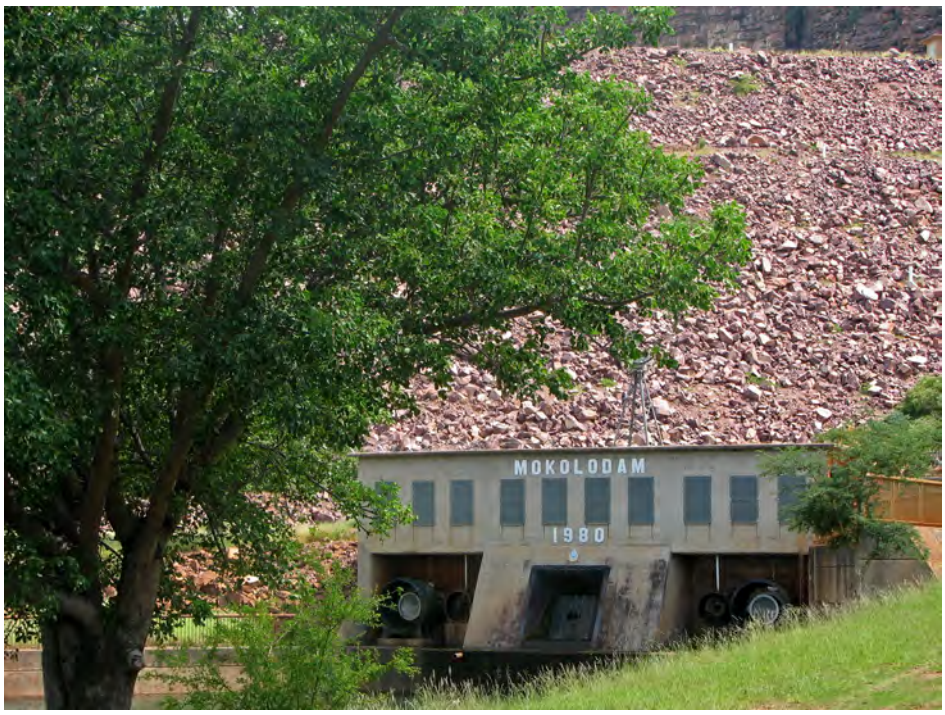
The projected increase in water abstraction, coupled with a rise in pollution associated with mining, power generation and related development, could have far reaching consequences for the Waterberg's rivers. The Waterberg hills form the headwaters of four main rivers, namely the Lephalale, Mokolo, Matlabas and Mogalakwena rivers. These rivers are also important tributaries of the internationally significant Limpopo River, which forms the border between South Africa and Botswana, between South Africa and Zimbabwe, while flowing downstream through Mozambique.

A few years ago, a team from the CSIR's Natural Resources & the Environment (NRE) started conducting a series of in-depth investigations into the state of the Waterberg's river systems. The studies have included numerous sampling trips to the region's main rivers over the years during different seasons, with a great deal of samples being collected across different tropic levels (benthic algae, phytoplankton, protozoans, macroinvertebrates and fish) from the rivers.

In addition, water quality analyses, isotope analyses of macroinvertebrates, as well as investigations into riparian vegetation have been undertaken. Funding for the studies, which have stretched over several years, have been provided mainly by the CSIR, with additional funding from Eskom.

"These baseline ...will provide a useful benchmark against which possible future deterioration in the water quality and ecosystem health of these aquatic ecosystems can be assessed."

The ultimate objective of these studies has been to develop a set of ecological indicators that can be used to provide an accurate baseline estimate of the ecological status and integrity of the aquatic ecosystems in the important rivers draining the Waterberg, explains CSIR NRE researcher, Arno de Klerk. "The studies have provided us with a relatively good idea of the state of the Waterberg's rivers before additional industrial and mining developments. These baseline results are of immense significance, because these data will provide a useful benchmark against which possible future deterioration in the water quality and ecosystem health of these aquatic ecosystems can be assessed."



The Mokolo Dam, located on the river of the same name, is the largest impoundment in the catchment.

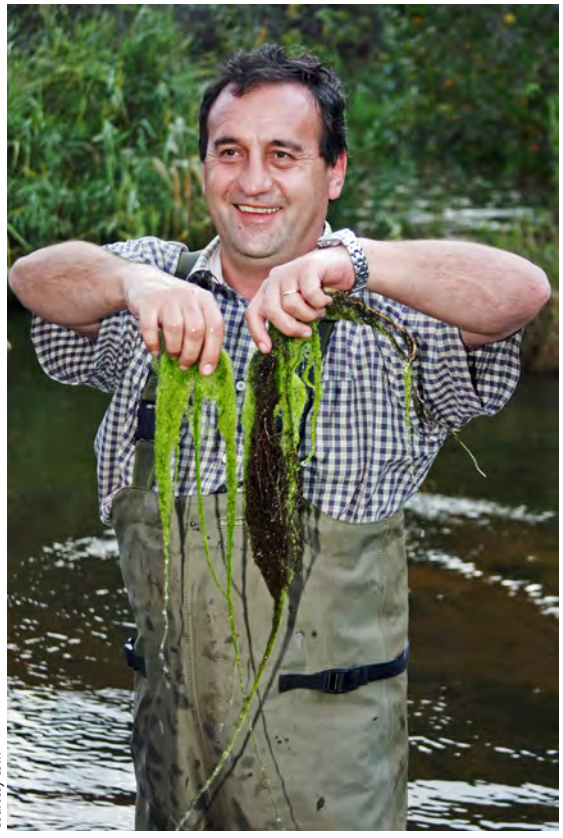
Courtesy CSIR

STATE OF THE WATERBERG'S RIVERS

Researchers have had to build good relationships with local stakeholders, such as farmers, to gain access to potentially useful monitoring sites. In addition to getting permission to enter private premises to gain access to the rivers they were studying, researchers have also had to dodge snakes, hippos and crocodiles.

Despite these challenges, their results have borne fruit, with investigations revealing that the Waterberg's main rivers are still in reasonably good condition as far as water quality and aquatic ecosystem health is concerned. In addition, researchers have also made some remarkable discoveries, which emphasise the need to preserve the generally good condition of the Waterberg rivers' waters.

One of these discoveries has been that of CSIR principal researcher, Dr Paul Oberholster, who found *Ophrydium versatile* in the Lephalala River. This was the first ever recording of this species of protozoa in an African river. *Ophrydium versatile* needs clean water and a high penetration of the sun to survive in the water. This protozoan has subsequently also been recorded in the Mokolo River.



Courtesy CSIR

CSIR principal researcher, Dr Paul Oberholster, during a site visit to the Waterberg rivers.

"The Mokolo River faces the same types of risks from activities that exert progressively more serious adverse impacts on water quality and aquatic ecosystems in the upper Olifants River, including acid mine drainage, return flows from agriculture, and discharge of sewage effluent."

Interesting biota have also been discovered in the Mokolo River. CSIR researcher, Leanie de Klerk, (with the assistance of Dr Anatoliy Levanets of North West University) has found a filament-forming desmid (a type of green algae), *Micrasterias foliacea*, in the river. The only other known report of a filament forming *Micrasterias sp*. in Southern Africa is from a stream in Lesotho.

The NRE team has also reported the discovery of a fish, *Barbus* spp., in the headwaters of the Mokolo and Lephalala rivers, the identity of which still needed to be properly investigated at the time of writing.

CAUSE FOR CONCERN

Not all is well with the Waterberg's rivers, however. The CSIR team has expressed its concern for the region's largest river system, the Mokolo River, due not only to the variety of different land use activities adjacent to the river at present (such as agriculture and municipal sewage works), but also because this river is likely to be most impacted by future development. The main impoundment on the river, the Mokolo Dam, is currently the sole surface water supply for the Lephalale Municipality and for irrigation farmers, who use the vast majority of the river's water.

According to Arno, the team has already found elevated levels of oxidative stress within certain organisms tested at both agricultural and sand-mining impacted sites. "Our studies indicate that these organisms are showing signs of stress. We are now investigating it further by employing gene expression-based biomarkers to screen for the impact of pollution in the surface waters."

In addition, researchers are looking into other potential water/sediment quality impacts, as well as impacts on the biological community structures of the algae, invertebrates and fish. "From our results to date it appears that the impact of nutrient enrichment is of specific concern [in the Mokolo River catchment]." Potential sources of nutrient enrichment are runoff from informal settlements, wastewater treatment works that are not functioning optimally, and agriculture.

Stakeholders (such as farmers) in the Lephalale area have also expressed particular concern over sand mining activities reported in the Mokolo River. "As yet we don't know enough about the specific impacts that these activities have on the Mokolo River (and its associated biota), nor the residual impacts of these activities in the long term."

Impacts on the Mokolo River are further exacerbated by relatively low water levels being experienced in the river over the past year.

MOKOLO RIVER STUDY

This research also forms part of Arno's PhD study, which is looking into the possible degree of risk for a variety of potential impacts on the water quality and aquatic ecosystems of the Mokolo River. This study will compare the results from

the Mokolo River with similar data sets collected in the upper Olifants River (in Mpumalanga), which has been heavily impacted by a variety of activities (for more on the CSIR's research activities on this river, see *the Water Wheel* May/June 2013).

"At this time the Mokolo River faces the same types of risks from activities that exert progressively more serious adverse impacts on water quality and aquatic ecosystems in the upper Olifants River, including acid mine drainage, return flows from agriculture, and discharge of sewage effluent," Arno explains.

To determine the existing levels of risk in the Mokolo River, Arno will determine several thresholds and compare them to those found in the upper Olifants River. He explains that, although aquatic ecosystems are affected by many variables, such a system is usually driven by a few key controlling variables (e.g. metals from mining activities). Associated with these key variables are threshold concentrations.

Dr Oberholster explains: "If an aquatic ecosystem consistently moves beyond a critical threshold (e.g. above a certain maximum concentration of metals) it may start to behave in a different way, often with unforeseen or undesirable consequences. These may include toxic cyanobacterial blooms, massive fish mortalities and/or high levels of microbial flora."

The outcomes of this study will be used to detect existing processes of change in the aquatic ecosystems and estimate the likely future changes that increased mining, human population growth and water transfers will cause. "These results will provide the basis for management guidelines designed to inform and direct management actions aimed at ensuring the long-term sustainable use of aquatic ecosystems," notes Arno. "Ultimately, with this study we hope to aid in the planning, prioritisation, management and remediation of freshwater ecosystems in the Waterberg area in the face of major future energy, coal and associated developments."

Courtesy CSIR

Sand mining is one of the anthropogenic activities placing increasing strain on the Waterberg rivers' ecological infrastructure.

WAY FORWARD

Results of the CSIR studies have been shared extensively with stakeholders in the Waterberg. The work has been received extremely positively to date, reports Arno, as not only water quantity but also water quality is a huge concern for many residents in the area.

The research conducted on the rivers of the Waterberg provide a strong scientific basis on which all future decisions regarding development of the area should be based, maintain the researchers. The Waterberg is an important region for South Africa, not only because of its coal but also because of its biodiversity, relative water scarcity and ecological infrastructure. "It is therefore crucial that an integrated approach be followed using thresholds of potential concern to ensure that the rivers of the Waterberg continue to flow in as natural a state as possible for generations to come." ❑

Courtesy CSIR

Currently the only power station in the Waterberg area, Matimba is soon to be joined by Medupi, which will be the largest dry-cooled power station in the world.