Ecological infrastructure

Research into ecological infrastructure steps up a gear

While coal-mining in the heartland of South Africa helps to keep our lights on, the polluted water flowing from these operations pose a serious threat to the country's water resources, particularly the wetlands of intensely mined regions, such as Mpumalanga. South Africa's aquatic scientists are working hard at finding solutions to mitigate these risks.

Article by Arno de Klerk.

All photographs courtesy CSIR

Acid mine drainage (AMD) is one of the largest threats to water resources, often disrupting the functioning of water bodies. By gaining a better understanding of ecological infrastructure – the nature-based equivalent of built or hard infrastructure – the CSIR, Water Research Commission (WRC) and its partners have developed mechanisms to help limit and mitigate the impact of coal-mining on wetlands in Mpumalanga.

Ecological infrastructure refers to naturally-functioning ecosystems that generate and deliver valuable services to people and can be just as important for providing services and underpinning socio-economic development. In 2012, the CSIR and the South African National Biodiversity Institute undertook a cooperatively applied research project funded by the Coaltech Research Association, WRC, as well as the Department of Environmental Affairs' Working for Wetlands programme.

Mpumalanga was selected as the focus area for this study due to the fact that coal has been mined in this area for more than a century. By virtue of their positions in the landscape and relationship to drainage networks, wetlands are frequently impacted by coal-mining activities. While wetlands constitute important ecological infrastructure, coal resources are of strategic importance to the province, as well as the rest of South Africa for, inter alia, economic development. However, regulatory authorities and the public now have an improved understanding of the range of economic, social, ecological and hydrological costs of wetland loss and degradation.

With this in mind, the main focus of the project was to develop mechanisms that could help to limit and mitigate the impact of coal mining on wetlands and to provide guidelines to the coal mining industry and regulators in this regard.

Some of the key outcomes of this study included:

1. A review of what is currently known about pans in South Africa;
2. A case study on the impact of rehabilitation measures on wetlands impacted by AMD;
3. An introductory guide to wetland rehabilitation in mining landscapes; and
4. A high risk wetlands atlas for Mpumalanga.

Pans in South Africa

South Africa lacks sufficient natural lakes resulting in a high dependence on dams for water supply. However, many people do rely on numerous endorheic wetlands, namely pans that are distributed throughout the country. Pans are usually regarded as relatively insignificant in respect of the total surface area that they occupy, but they are quite unique in form, function, sensitivity, as well as in the types of biota they attract and harbour.

It is based on this uniqueness that these systems are not well understood. Currently, these systems are highly vulnerable to activities such as mining and other land use practices, because often buffer zones are unable to provide sufficient protection.

Some pans may be entirely reliant on rainfall to sustain them, while others may have linkages to groundwater that are vulnerable to disruption when mining activities affect the water table. Unlike rivers that have some self-purifying capability, pans generally retain whatever drains from its immediate catchment or enters the waterbody through atmospheric deposition.

Currently, there are also no major monitoring programmes in place to deal with pans in South Africa, possibly due to the limited understanding of their functioning and associated value. Thus, with limited research to properly understand these systems, and with current information being fragmented and difficult to access, the true functioning and importance of these systems may never be realised. With this in mind, researchers from the CSIR, together with other partners have started an initiative to develop best practice guidelines for pans in South Africa.

Rehabilitation case study

The impact of surface mining on ecological infrastructure has been well studied and relates closely to the decrease in ecosystem services provided (directly and indirectly) by these systems. Generally, it is agreed that there are various benefits derived from investing in the maintenance and rehabilitation of ecological infrastructure. However, very little data exits on the impact that these measures have on ecological integrity. For this reason, the project intended to measure the extent to which rehabilitation of a degraded wetland could improve its ability to treat water impacted by mining-related pollutants.

The study entailed a number of assessments over the course of the project period which pointed to a significant improvement in the water quality flowing out of the wetland after rehabilitation. Combined with this, a reduction in toxicity and improvement in the diversity of the biological communities were observed.

From these results it was evident that the rehabilitation measures had a positive impact on the ecological integrity of the wetland system, resulting in improved ecosystem services that significantly reduced the downstream impacts. These rehabilitation efforts promoted integrated water resource management principles of coordinated development and management of water resources to maximize economic and social benefit, whilst contributing to the sustainability of vital ecosystems.

While the initial results are promising, further work remains to be done in monitoring the condition and performance of the wetland in the longer term. It is unclear, for example, whether the water purification function will improve as the wetland adjusts to its new post-rehabilitation state.

It will also be important to determine the thresholds at which pollution loads will start to have a serious impact on the sustainable functioning of the wetland. However, building on the firm foundation created during this study, a new three-year Coaltech funded project has been initiated to focus on these key elements.

This will provide useful information with regard to the assimilative capacity of the wetland, as well as an indication of its sustainability in continuing the water treatment function and its value to the mining sector. To our knowledge no such study has investigated this.

Rehabilitation in mining landscapes

The rehabilitation case study conducted during this project was evidence of the benefits of investing in the maintenance and rehabilitation of ecological infrastructure such as wetlands. Wetland rehabilitation can thus be successful if it is well planned and implemented.

Globally, various approaches have been used to rehabilitate wetlands. The introductory guide that has been developed towards wetland rehabilitation in mining landscapes is aimed at being a user-friendly guidance to specialists, mining houses and regulators. The guideline document builds on existing information to provide a consolidated approach towards wetland rehabilitation within the specific constraints and opportunities presented by mining landscapes.

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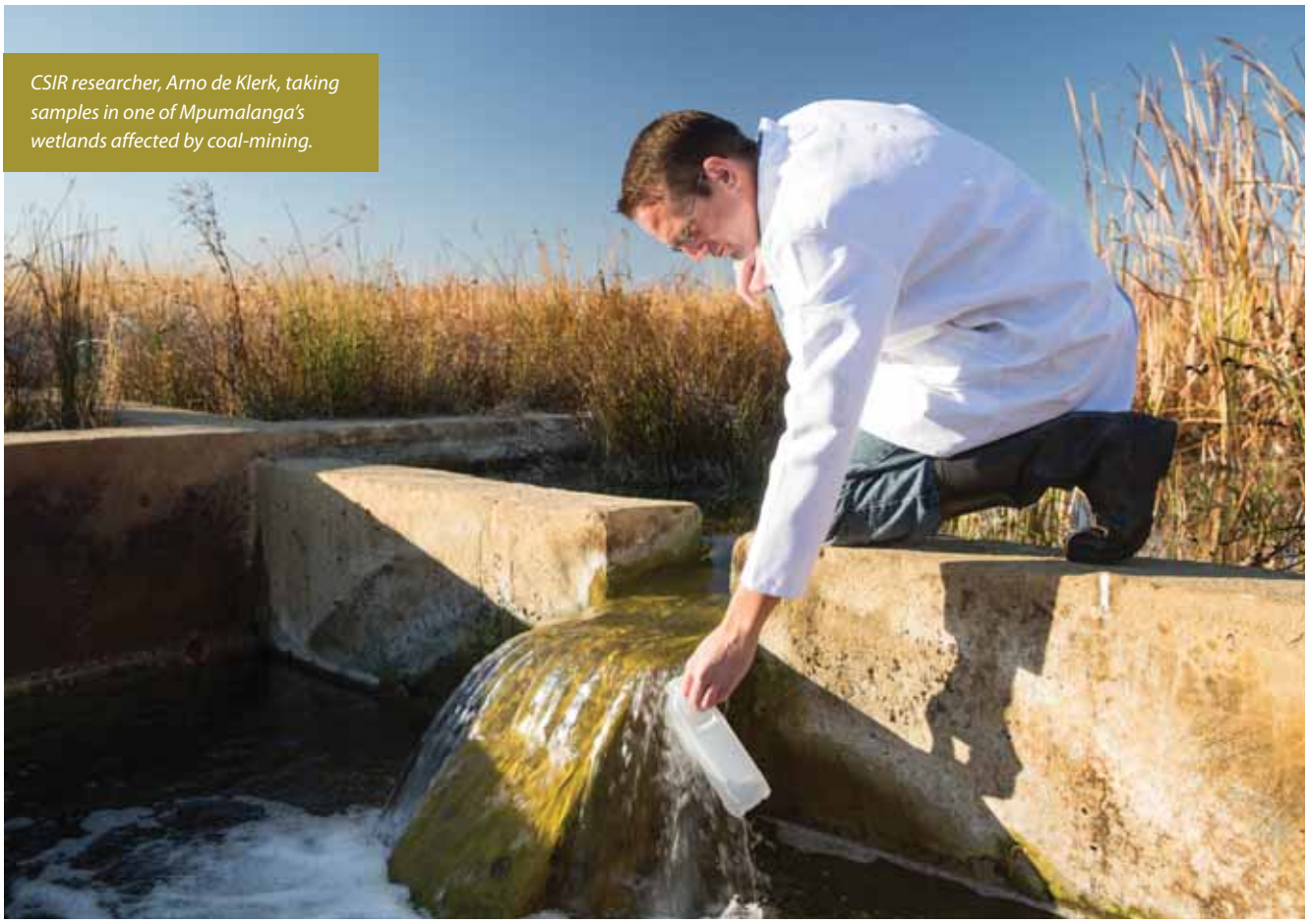


CSIR researcher, Arno de Klerk, taking samples in one of Mpumalanga's wetlands affected by coal-mining.

This document provides users with insights into key principles during the various phases in the mining lifecycle so as to assist in planning and decision-making. Reference checklists, as well as an overview of legal considerations pertaining to wetland rehabilitation have been included to assist users throughout the process of wetland rehabilitation.

SANBI Director: Ecological Infrastructure, John Dinie, Coaltech Director, Henk Lodewijks, Arno de Klerk and Dr Paul Oberholster of the CSIR discussing the improved functioning of the Zaalklap wetland, which was rehabilitated following extensive impact by coal-mining.

The document aims to promote a standardised approach concerning wetland rehabilitation so as to provide a uniform approach with respect to wetland rehabilitation planning, design and implementation in mining landscapes. In this way a range of risks for various stakeholders can be minimised and managed through proper wetland rehabilitation planning and implementation, thus ensuring compliance with environmental legislative provisions and authorisation requirements. Through the use of this guideline wetland rehabilitation activities may have the potential to leave a meaningful and lasting legacy that may, to some extent, compensate for the negative impacts that mining activities have.

High risk wetlands atlas

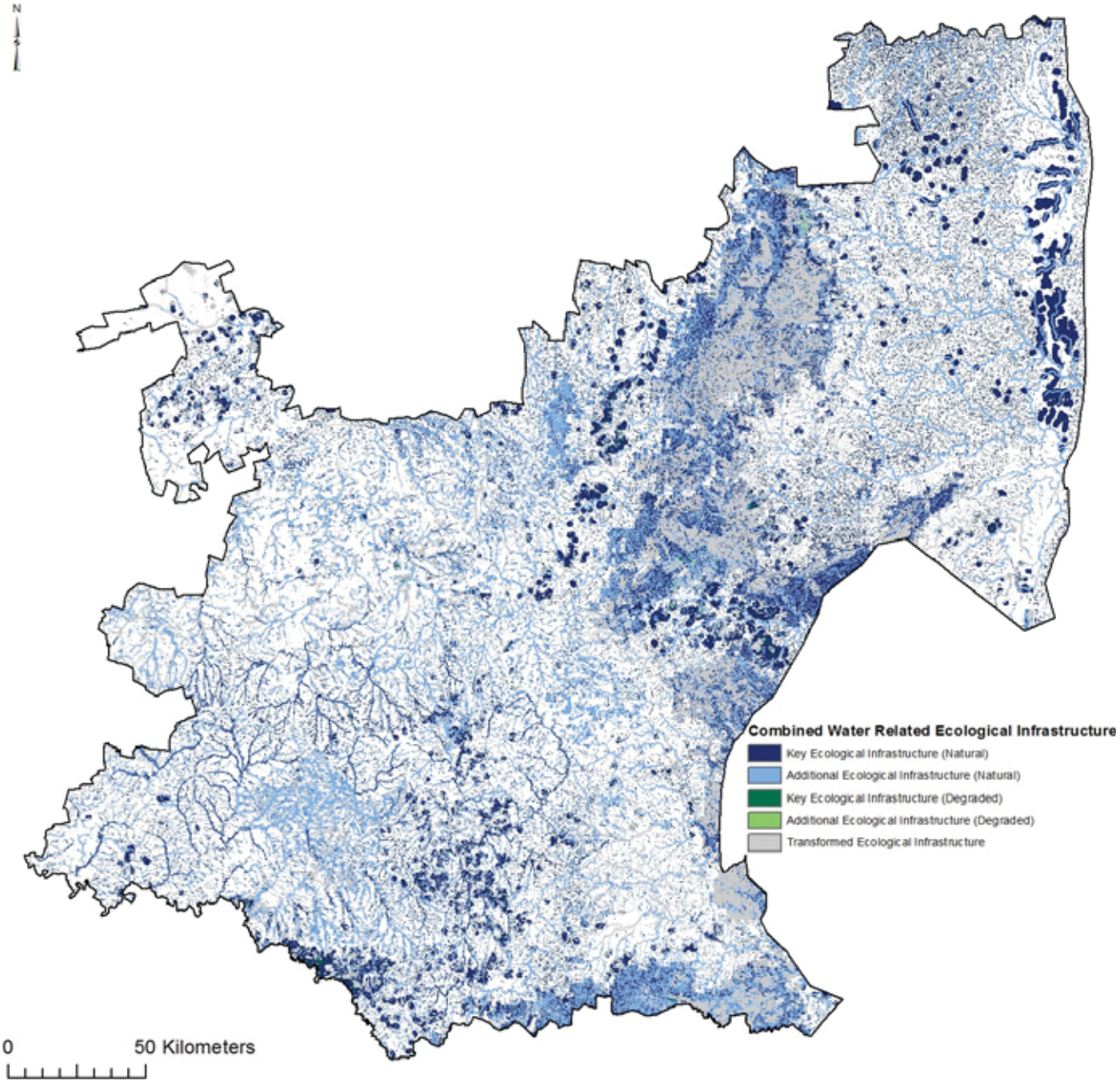
A key aim of the project was to improve the knowledge and use of appropriate spatial information so that both mining companies and regulators may be better informed during their planning and decision-making processes. A High Risk Wetlands Atlas was developed that identifies key wetland landscapes in the grassland biome of Mpumalanga that are particularly important or irreplaceable in terms of biodiversity, water resource management and other ecosystem services.

Thus, through this atlas we were able to bring together the confusing array of biodiversity data that regulators expect mining houses to consider when they are planning and implementing a mine. This atlas will improve planning and decision-making by providing a single and easily accessible access point to the most appropriate spatial information. This

includes data on threatened habitats, special wetland types, threatened species, protected areas, etc. and also includes key spatial data that has recently been developed or revised.
A very important outcome of this work was that we were able to produce new and unique maps of water related ecological infrastructure in Mpumalanga. These maps provide useful information in the following areas, namely:

- Combined ecological infrastructure for water;
- Ecological infrastructure for water production and flow augmentation;
- Ecological infrastructure for flood attenuation;
- Ecological infrastructure for water quality; and
- Ecological infrastructure for erosion control.

In conclusion, this project was a unique and excellent example of how government, academia and industry can work together for the greater good. The products developed during the project will be officially launched at the 2016 conference of the Southern African Society of Aquatic Scientists (SASAqs), to be held in the Kruger National Park, in June.



Areas of ecological infrastructure important for water production and streamflow augmentation.