Mine-water management

Reading the land – new atlas set to improve decision-making around mining and water

The Water Research Commission-funded South African Mine Water Atlas will be a vital decision-making tool in assessing the impact of mining on water resources.

Article by Sue Matthews.

Headlines about acid mine drainage (AMD) have hammered home the threat posed by disused gold and coal mines to water resources on the Witwatersrand, but how much do we know about the risks associated with current and future mining activity?

After peaking in the 1970s, gold production by South Africa remained in the top spot in the world rankings until 2006, but now only manages 12th place. Today, however, the country is the world leader in the production of platinum, chromite ore, manganese, vermiculite and ilmenite, and is also among the five largest producers of palladium, zirconium, vanadium, fluorospar, rutile and gem-quality diamonds. In addition, it falls within the top 12 for coal, cobalt, iron ore, nickel and silicon production.

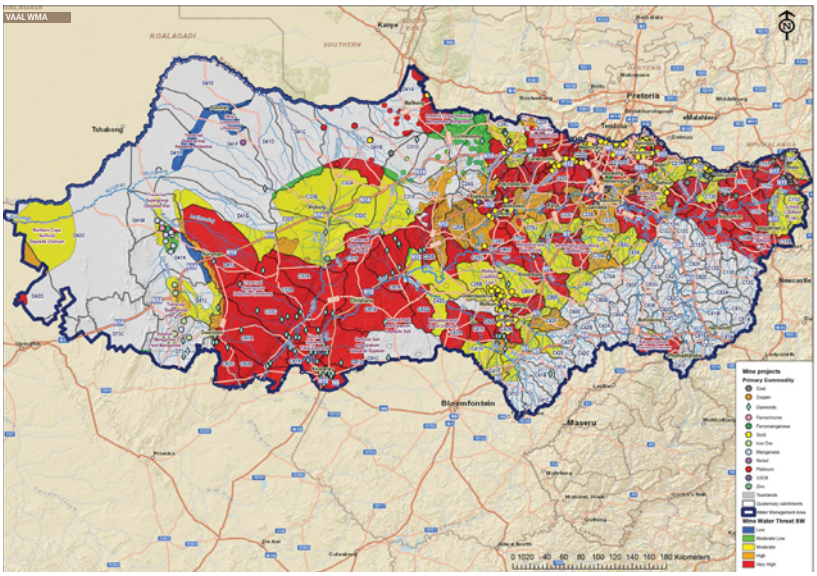
Although mining is generally derided as environmentally destructive and polluting, the industry contributed R286 billion towards South Africa's Gross Domestic Product in 2015 – representing 7.1% of overall GDP – and provided jobs for 457 698 people. There is still considerable scope for growth in some sectors, highlighting the need to plan new ventures with care, while existing operations clearly have to be managed to minimise their impact.

"We didn't have a good idea of what the risks were in the different areas though," says Dr Jo Burgess, WRC Research Manager for the portfolios Sustainable and Integrated Industrial Water Management, and Mine Water Treatment and Management. "You might, for example, have a high number of mines in an area where the rainfall is so low or the evaporation rate is so high that there's no real AMD risk, even though you'd presumed there would be. Or the opposite – you might have an area that is dry and looks good for mining, but the groundwater is vulnerable and the minerals would generate acid, which means the risk of AMD is higher than it first looks."

"So in 2014, the WRC put out a call for proposals to produce a Mine Water Atlas that covered the whole country, and Golder Associates was subsequently awarded the contract. We asked them to map environmental vulnerability and mining activity for each of the Water Management Areas, and then to overlay that with a risk assessment of ecological status."

The approach used was based on the understanding that the environmental conditions resulting from mining is controlled largely by the type of mineral deposit, the geology of the host rock, and the particular mining method. This 'geo-environmental risk' was then considered against the vulnerability of the receiving water resource to come up with a 'mine water threat' rating, which is colour-coded on the maps – red depicting areas at highest threat.

"A key aspect is that there are two reasons why areas are red," explains Dr Burgess. "We've got areas that are red because they're already badly damaged, and we shouldn't damage them any further or we're going to face a catastrophe at a local level.



The mine-water threat to surface waters in the Vaal MWA takes into account the mineral risk rating, the associated or likely mining activity, and the vulnerability of the receiving water resource. Surface waters with a very high mine-water threat, shown in red, are those that are either in a very degraded state and need remedial intervention, or alternatively in a healthy state and require protection for human use or biodiversity conservation.

But we've also put in red areas where the ecological status is currently very good, such as headwaters in rivers that are important resources for humans or for biodiversity. Those are areas that really can't take any damage, because the downstream impacts would be so great and so significant."

The threat to both surface water and groundwater resources is addressed in the Atlas, using different criteria. While surface waters are assessed in terms of present ecological state and water quality, groundwater resources are scored according to aquifer type and yield, regional and local secondary structures such as folds, dykes and quartz veins, as well as borehole yield and groundwater quality. And since the impact on aquifer systems depends on the type of mining activity, the groundwater vulnerability rating differentiates between surface mining – in the upper 100 m of the ground – and deeper underground mining, where water is mainly confined to 'fractures' in the rock.

A detailed explanation of the methodology used to arrive at the final mine water threat ratings is provided in the opening pages of the Atlas, after which each of the country's nine water management areas (WMA's) is covered in its own section. These include an introduction with an overview on the WMA and mining that occurs there as well as profiles on mineralogy, surface water and groundwater, followed by a set of thematic maps showing the various components of the assessment, namely:

- Mining and mineral resources
- Mineral risk rating
- Mine activity risk rating
- Groundwater vulnerability – surface mining
- Groundwater vulnerability – underground mining
- Surface water threat
- Mine water threat groundwater – open cast
- Mine water threat groundwater – underground
- Mine water threat surface water.

For many of us, the term 'atlas' brings to mind one of our school geography textbooks, crammed with detailed maps depicting every part of the planet, or perhaps the kind of road-map booklet that has been rendered largely redundant by dashboard GPS navigation devices or smartphone apps. With its many colourful and informative maps, the *Mine Water Atlas* certainly has much in common with these publications, and it will indeed be available in printed form – obtainable upon request at no charge, as for other WRC publications – and also as a .pdf that can be freely downloaded from the WRC website.

But it is so much more than that. It will be distributed too as a fully interactive digital database of spatial information for GIS users, while an online web map portal will allow the less technically inclined to browse the datasets, select layers, zoom in and out, and perform basic attribute queries at the click of a mouse.

"We're also printing the maps as A0 posters, so that people needing technical detail on particular WMAs can put them up on the wall," says Dr Burgess. She stresses, however, that the Atlas does not in any way replace the need for site-specific specialist studies in determining the risk, impact assessment or specific mitigation strategies associated with mining and water management.

"It will help us prioritise how we invest in mitigation and remediation activity for sites that have already been damaged though," she says. "It can also provide a guideline for new mining activity. For example, banks can use it if they're approached for capital for a new mining venture. They can look at the Atlas, and if it's in one of the areas flagged as red, it doesn't tell them they absolutely can't mine there, but it does tell them it's going to be really expensive because their liabilities are going to be high!"

To order the *South African Mine Water Atlas* (**Report No. TT 670/16**) contact Publications at tel: (012) 671-9300; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.