Digital technologies for mine water management

There is limited research on the application of digital technologies at mine sites for treating and managing mine water. **Christian Wolkersdorfer** and **Kagiso More** – part of the South African Research Chair Initiative (SARChI) for mine water management at Tshwane University of Technology (TUT) – have identified theories and frameworks that can 'smartly' treat and manage mine water.

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The mining industry is confronted with challenges such as low commodity prices, the increasing cost of electricity and production, and pressures from non-governmental organisations to provide fast and useful monitoring data. These issues are driving the mining sector to Industry 4.0, which leads to industrial transformation. However, the implementation of digital technologies drives an increase in skills demand — resulting in high-quality job creation. As much as these technologies will not change basic mining principles, using electricity and mechanics, mine workers and their equipment will communicate through the internet of things (IoT).

Mine water treatment plants must start embracing the advantages that come with Industry 4.0. Digital technologies will enable 'smooth' reactions to changing water quality or quantity conditions in the mine. For example, a mine will know whether a pump has stopped and why. This means that the pump, as well as its control systems and motor, will be connected to a network that will allow for an operator to know everything.

The SARChI Chair for mine water management at TUT will prove that upgrading mines to Industry 4.0 will result in the creation of new jobs that require a higher level of qualifications and better education. New skills will be needed to configure wireless devices and set up networks or knowledge on internet protocols.

These technological advancements will benefit the mining sector — increasing the safety and security on the mine site, enabling the mines to reach higher production levels and optimising mine water management. With a data lake in the picture, communication between all the mine departments that deal with water becomes faster, easier and more reliable (Figure 1).

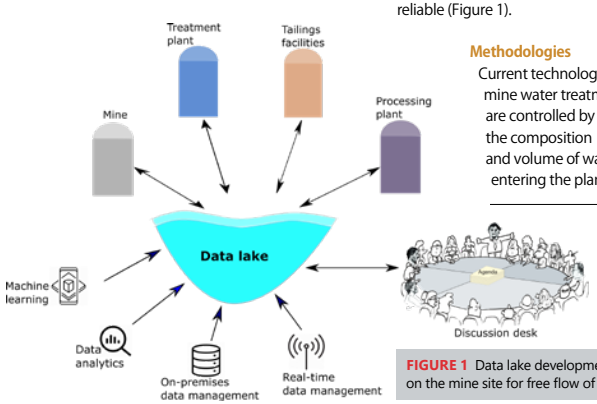


FIGURE 1 Data lake development on the mine site for free flow of data

Methodologies

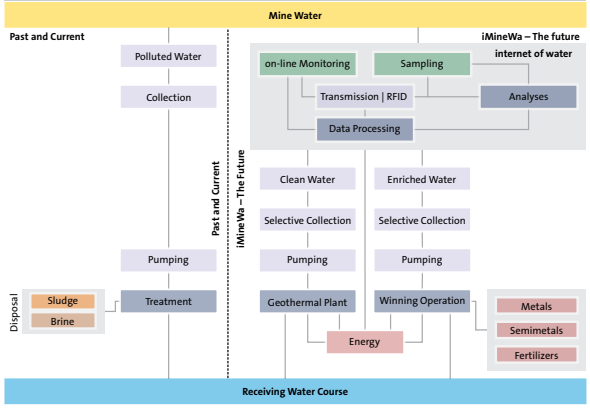
Current technologies in mine water treatment are controlled by the composition and volume of water entering the plant at any given time (left-hand side of Figure 2). Often, this requires the plant to react instantly on volume or chemistry changes, as there is no foresighted interaction between monitoring data and operational parameters. Data includes precipitation, water inflow into the mine, technological changes within the mine, water analyses of the plant, and the outflow of the treated water.

TUT's research will ensure that the mine's technology will be improved, and all aspects needed for mine water management are considered adequately. These include sampling and monitoring data to develop intelligent mine water management (iMineWa) (right-hand side of Figure 2).

Internet of mine water

IoT is a system of sensors, electronics and software that allows for the overall communication and information exchange of all connected devices. It is all things that are tangible that could be reached by an internet address. Internet of mine water (IoMW) (Figure 3) is derived from the idea of IoT. IoMW refers to more than things. It also includes data and the results of data processing coming from common statistical procedures or the procedures involved to analyse big data.

FIGURE 2 The past and current mine water treatment plant (left) vs the future mine water treatment plant using elements of iMineWa (right)



Big data is extremely large amounts of data that can only be analysed computationally to reveal patterns and trends. These non-touchable objects are commonly referred to as digital objects and they can be referenced by persistent identifiers, such as digital object identifiers (DOI) or uniform resource names (URN).

AI systems

Artificial intelligence (AI) needs to be implemented for optimising mine water management. This will utilise smart data and machine learning to enhance mine water operations, as well as safety at the mine and workflow production.

Introducing AI in mine water management will be implemented as computational modelling driven by numerical algorithms that utilise expert systems and fuzzy concepts to support decisions. Machine learning models include, but are not limited to, deep neural networks (DNN), expert systems, hybrid intelligent systems, support vector machines (SVM), and k-nearest neighbours (kNN) technology. These numerical models and codes consist of numerous processing elements that receive input data and immediately produce an output.

Using AI will ensure that data will be processed faster than currently. TUT's SARChI Chair will transfer the growing popularity of AI and machine learning to assist mines in their future choices of mine water management. 35

Download the full paper here:
https://dx.doi.org/10.1016/j.wri.2020.100136

FIGURE 3 Relevant steps and their connection in the internet of mine water