DHI CASE STORY

INTEGRATED MINE WATER BALANCE

Physics-based Groundwater and Surface Water Balance in South Africa

The Mpumalanga province in South Africa boasts some of the largest coal reserves in Southern Africa. Water is both a by-product of, and necessary for, mine operations. Striking the right balance is a challenge in a hot, dry region, where most of the limited rainfall occurs in a three-month period. Fully integrated, coupled groundwater-surface water modeling can provide a sound basis for operations and infrastructure planning related to water storage, treatment and discharge. Ultimately, accurate assessments can enhance mine profitability and reduce the risk of unintended environmental impacts.

The vast coal reserves around Middleburg in South Africa are largely mined from the surface. Mine plans generally rotate in and out of areas to extract the most profitable coal first. The open pit areas tend to be gradually extended, continuously back-filled and then rehabilitated. Mined areas are rehabilitated by backfilling with spoils, surface sculpting to minimize erosion and re-vegetating with grass.

WATER IS CRITICAL

Water is critical to coal mining in Mpumalanga. The Middleburg area receives about 700mm annual rainfall, with some 60% of that falling in short, intense events from November through January. Water is used continuously in operations for washing coal and dust suppression. To accommodate the erratic supply, rain water must be stored for supply during the dryer months. Yet clean, storm water during the wet season must be safely routed away from mine impacted areas. Rainfall in mining areas must be separated for treatment and safe disposal or re-use. To complicated matters, the coal spoils are acid forming. Thus, infiltration in spoil piles and rehabilitated areas generates acid leachate that must be treated.

A PHYSICAL WATER BALANCE

A physical water balance is key to providing clear insight into the complex relationships and feedbacks between rainfall, infiltration, evapotranspiration, groundwater flow, runoff and stream flow.

Decanting acid drainage from infiltration after rainfall

SUMMARY

CLIENT

An integrated, global coal mining company

CHALLENGE

To develop an understanding of the integrated dynamics of water movement at the mine site. Of particular interest was the spatial-temporal distribution of the water balance, with respect to recharge and evapotranspiration.

SOLUTION

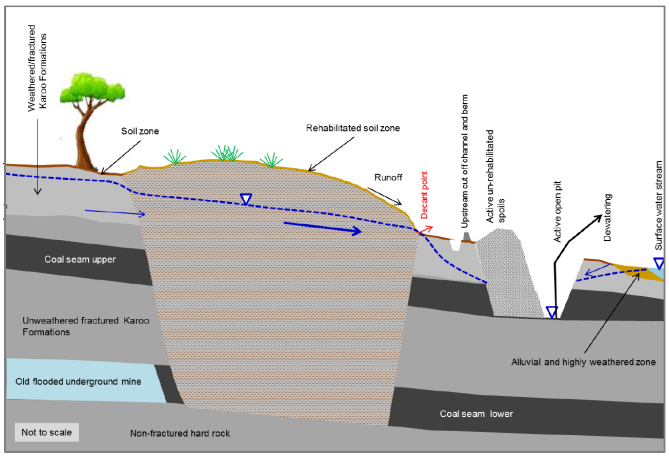
Numerical models were developed using MIKE SHE - a fully integrated, coupled groundwater-surface water modeling framework. To save computational time, separate models were developed for each of the key areas - based on the same data set. The models provided clear insight into the dynamic, spatial water balance across the mine site.

VALUE

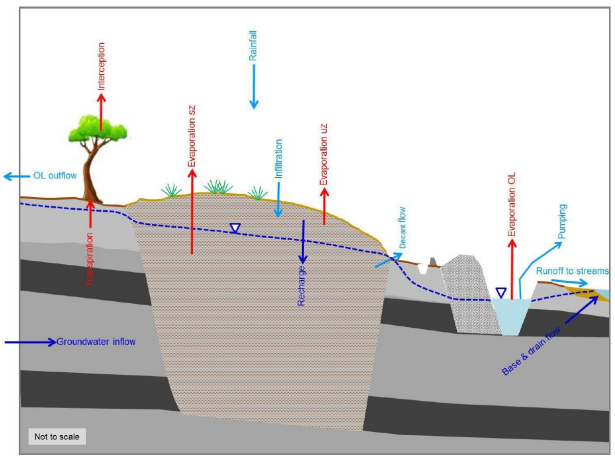
- Provide useful insights for consideration in future operational planning
- Provide more precise predictions for planning of infrastructure upgrades
- Support planning for mine water treatment and rehabilitation operations
- Reduce risk and uncertainty through improved reliability of predictions
- Reduce risk of unforeseen impacts on environmental systems.

LOCATION / COUNTRY

Middleburg, South Africa



The water balance must be built on a physical understanding of the critical drivers for water flow.

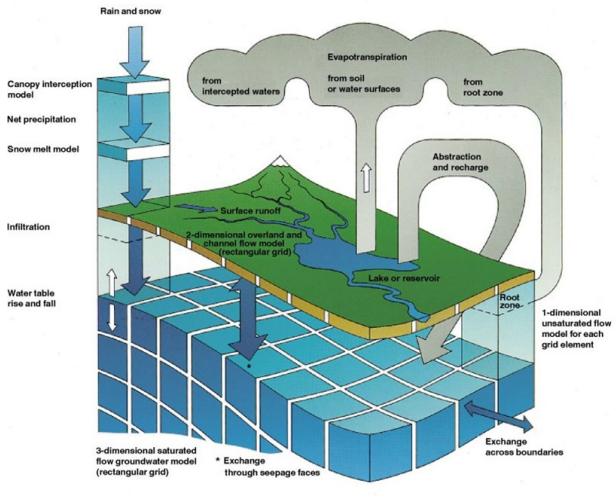


The physical water balance must consider all the sources and sinks of water in the system.

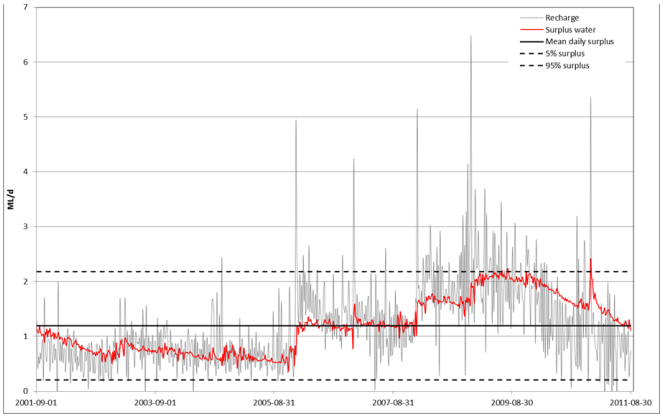
The water balance is driven by the physical characteristics of the hydrology, the geology, and the mine. Simple, lumped conceptual models that ignore the spatial and temporal relationships of these components are at serious risk of failing.

MIKE SHE

MIKE SHE is a fully integrated, physics based, coupled groundwater-surface water modeling framework. MIKE SHE simulates all the necessary components of the hydrologic cycle, including 2D dynamic overland flow and runoff, detailed channel flow hydraulics, unsaturated infiltration, vegetation, and 3D groundwater flow, plus water quality. MIKE SHE is not a software code, but a proven engineering framework with multiple numerical methods for each component of the hydrologic cycle, **and** a modern graphical user interface.



The MIKE SHE modeling framework.



The daily discharge from a rehabilitated area is a complex, temporal function of the daily rainfall and infiltration.

UNDERSTANDING THE WATER BALANCE

The MIKE SHE models of the different mine areas are able to capture the dynamics and spatial distribution of the of the water balance in a way that earlier models are unable to. The models are able to show how

- Re-infiltration in storage voids is increasing the cost of internal pumping at the mine site
- Infiltration in rehabilitated areas can be managed by vegetation cover, compaction and site grading to reduce groundwater recharge and increase runoff
- Investments in treatment plants can be reduced through more efficient planning and storage
- Risk of environmental releases can be reduced by managing storages more effectively

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