

Leveraging Data for Improved Mine Closure Decision-Making

CE Steyn and A Botes

Agreenco Environmental (Pty) Ltd, Route 21 Corporate Park, Irene, 0157

GreenGAB (Pty) Ltd, Route 21 Corporate Park, Irene, 0157

Environmental complexity poses significant challenges to sustainable decision-making in mine closure. To unravel this complexity, we rely on three main sources of information: previous scientific studies (what we know), observations, and monitoring data. Modern technological advancements offer opportunities to enhance decision-making by effectively integrating and utilising these information sources. A key area of advancement is data processing, which holds a virtual gold mine of potential.

Unlocking this value requires a systematic approach. First, a secure and verified tidy dataset must be established from the available monitoring data. According to Hadley Wickham, a tidy dataset adheres to three principles:

- Each variable forms a column.
- Each observation forms a row.
- Each type of observational unit forms a table.

This structure simplifies data manipulation, modelling, and visualisation. During data management, checking for errors and cross-correlations is crucial, especially given the highly intercorrelated nature of environmental monitoring data. This ensures data integrity and reliability, as environmental variables often influence each other. Identifying and addressing these intercorrelations helps understand complex interactions within the dataset and improves the accuracy of subsequent analyses. Once a validated dataset is established, maintaining a secure master dataset is essential to ensure user confidence in the data for further interpretation.

However, having a secure dataset is only part of the solution. Bridging the gap between data and decision-making requires a clear understanding of the question that needs to be answered. This understanding is key to determining the best data evaluation and interpretation methods. The question can only be refined once the environmental context is understood.

Based on the decision to be made, appropriate statistical methodologies and data manipulation techniques can be selected. These methodologies should account for variability, knowledge gaps,

and spatial-temporal distribution. Once the data is explored, the evaluation should be refined into a clear data story that informs decision-making through simplified visual representations. Numerous open-source tools and interactive methods are available for data presentation. Integrating information sources such as visual observations and literature with the data provides a unified understanding.

As environmental processes unfold, the data story should be continuously updated to reflect new insights and information, gradually improving decision-making. Modern platforms and data tools facilitate this dynamic process, allowing real-time integration of monitoring data, field observations, and scientific research. As inputs are refined; the data narrative progresses guiding decision-makers toward more informed, sustainable closure outcomes. This adaptive approach ensures the data story reaches its natural conclusion aligned with long-term environmental objectives.