Managing climatic variability risks for mining operations

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Abstract Australia is known as a country of climatic extremes. The state of Queensland has typified this situation over the last 10 years – a severe drought from 2000 to 2007 has been followed most recently by successive years of flooding and record-breaking rainfall. These extremes have had dramatic impacts on operations at and production from coal mines within the Bowen Basin – the largest source of seaborne coking coal in the world. Variability in climatic conditions has not typically been considered when planning or developing a new mine. Similarly, existing mines have generally given little or no consideration to their ongoing water management strategies – the approach has generally been one of adaptation to the emerging risks of a variable climate as they arise, rather than planning for and mitigating the potential risks in advance. Recent climatic events in Queensland have demonstrated the need to not only understand what these extremes may be, but the risks and associated implications for water management infrastructure. This greater understanding enables the range of options that may be available to be assessed, both within the mine site itself (in terms of onsite water management) and for external water sources and associated infrastructure. This paper presents case studies for two typical coking coal mining operations (an existing and a proposed mine) to provide insights on managing the risk of climatic extremes through improved onsite and offsite water management and infrastructure planning. This paper addresses:

- The climatic extremes and potential production and operational risks for mining operations in the Bowen Basin
- How these risks can not only be managed, but mitigated, from both an infrastructure and non-infrastructure perspective
- How these lessons apply to all mining operations

Key Words climate, risk, planning, infrastructure, management

Introduction

Nearly all mining operations depend on the availability of a raw water supply source for various uses on site, ranging from minerals processing to dust suppression, and providing hydraulic power to longwall equipment.

Water presents challenges for many organisations in the mining sector. In the last decade, the extremes of the Australian climate have highlighted the risks of both water scarcity and abundance. Maintaining the right balance of water is critical to the success of all mining operations.

The continued operation of and planning for new mining operations in Australia has historically relied on recorded rainfall and evaporation data to assess the climatic variation, and therefore, the extremes in water availability. However, recent climatic events within the Bowen Basin in Queensland highlighted deficiencies and the potential vulnerability mining operations as a result of inadequate mine water management both on site and off site when challenged by the extremes of a variable climate.

This paper outlines variable climate issues and uses two case studies to highlight how a risk-based approach can be used to assess climatic variability to help water planning.

Recent Climatic History in the Bowen Basin

Mining operations have increased exposure to the water risks associated with climate variability. With life spans of up to 50 years, mining operations will typically be exposed to more than one climate cycle. This risk is increased when several companies are operating multiple sites within a region which may rely on the same water sources.

In January 2011, the Australian Bureau of Meteorology (BOM) described December 2010 as the wettest December for Queensland in recorded history. This followed the wettest spring (September to November) on record, meaning catchments throughout Queensland (including the Bowen Basin) were wet before the December rainfall. The BOM categorised this event as one of the four strongest events in the last century, and the strongest since 1974 (also a year of record rainfall and flooding). The 2010/2011 wet season caused 85% of mines to be only partially or fully non operative (Queensland Mining and Energy Bulletin, 2011).

This rainfall event and strong La Niña event followed a series of El Niño events which resulted in significant rainfall deficits across Eastern Australia from 2001 to 2007. These events resulted in record periods of below-average and lowest on-record rainfall. Coupled with increased higher than average evaporation, this resulted in less runoff to water storages which provide water for most mining operations.

This last period of drought (2001—2007) in Queensland's Bowen Basin saw allocations from some government-owned raw water supply infrastructure reduce as water storage volume reached very low levels. This exposure across several assets presented a significant potential risk to continued production for mining companies and highlighted the vulnerability of mining operations to climatic variability.

As the demand for resources increases, these companies are expanding and increasing their presence within a region. They are increasingly aware of the need for strategic planning to meet water demands now and into the future. Recent flooding within Queensland's mining heart, the Bowen Basin, demonstrated the need to maintain a balance between the capture of site water for raw water supply and reducing operational exposure to flooding and excess water.

Approach to Managing Climatic Risk

Water issues as a result of climatic variability cannot be managed until they are characterised and understood. The first step in understanding vulnerability of an operation to climate variability is to have a robust understanding of the site water management. This includes knowing the water movements on site, including demands, pump movements, storage volumes and water quality. Coupled with this is the need to understand future mine planning in terms of production and mining sequence, and how it will affect the water management of the site.

Characterising the risk to the operations can be addressed through a portfolio risk management approach, using an integrated stochastic climate analysis with advanced water modelling software. The development and application of stochastic climate series allows mining companies to quantify the risk of future climate variability. This can be enhanced using water modelling software to link individual site water balances across several operations to water supply storages and delivery infrastructure. The stochastic assessment simulates climate variability and allows the impacts to a range of outcomes to be quantified, including uncontrolled releases, pit flooding and lost production.

Coupling stochastic climate analysis with water balance modelling across an entire portfolio of assets and operations provides a versatile, risk-based assessment and decision-making tool to support the organisation's operations. The tool has a customised interface to allow the user to independently and directly test the implications of changes to their operating scenario as their planning evolves.

This approach enables mining companies to understand the manner in which different sites will respond to a particular water strategy, and respond accordingly. Ultimately, it enables them to:

- Identify opportunities to move water between sites
- Manage the draw-down on site water storages to use site water more efficiently
- Identify the impact of risks to third party infrastructure (government-owned raw water infrastructure) on their operations
- Conduct trade-off studies to identify and prioritise operational activities during climate extremes
- Identify a different security of supply or acceptable risk level at each operation based on the economics of each operation
- Prioritise and justify capital spending for supporting infrastructure such as raw water pipelines and on site water management infrastructure.

The portfolio risk management tool provides valuable input to cost benefit assessments, which enables the value proposition on an infrastructure investment decision to be understood. The capital expenditure on infrastructure for risk mitigation is best justified by calculating the value of the lost production. This is particularly valuable during the strategic planning for expansion projects, where significant capital costs are required to provide or upgrade infrastructure.

Case Studies

Existing Mine – Open Cut

This case study is based on a typical mining operation located in the Bowen Basin, Queensland. This operation has several active pits, water storages and water infrastructure. Water is sourced from third party infrastructure and allocation. The focus of this case study was to determine the risk to the operation for water shortage. The operation is planning to expand. Figure 1 presents a comparison of the water demand, water allocation and delivery infrastructure for the site. This figure shows that the site demand will exceed allocation in approximately 2013 and exceed the infrastructure delivery capacity in 2015.

Figure 2 presents the risk to the operation due to climatic variability. This graph shows the results for the median, 1st and 5th percentile rainfall. The 1st and 5th percentiles represent dry conditions. Figures 1 and 2 show the operation is at significant risk of water shortages after 2015, when the site water allocation is largely exceeded. The capacity of the infrastructure to deliver water to

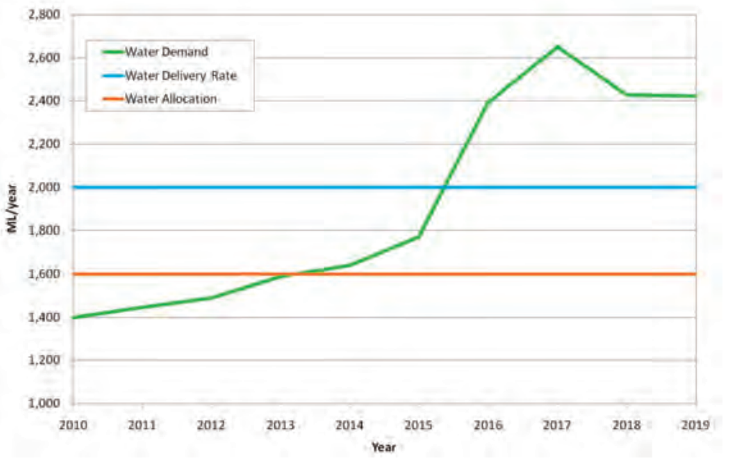

Figure 1 *Existing Mine: Comparison of Water Demands, Delivery and Available Allocation.*

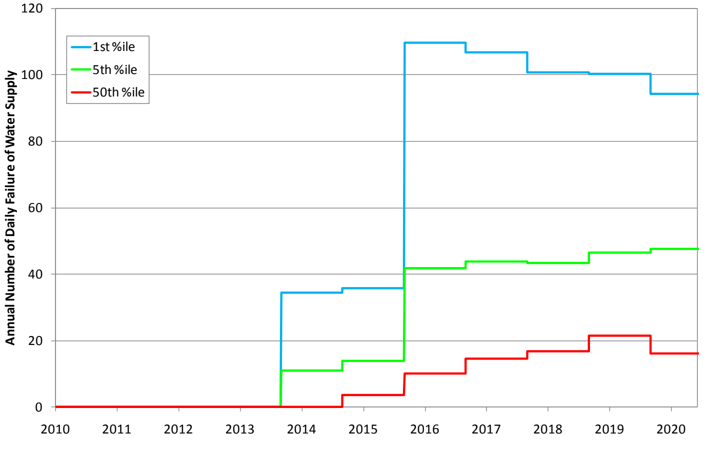

Figure 2 *Existing Mine: Risk of Failure to Mine Operation (Production Risk).*

site can support more than the water allocation for the site. The risk between 2013 and 2016 could be managed by sourcing additional allocations. However, after 2016, an infrastructure solution is likely to be required to reduce the risk of water shortage. The infrastructure solution can be better determined by understanding the level of risk due to the climatic variability, and considering water availability during drier periods.

Proposed Mine – Open Cut

This case study is for a proposed open cut mine in the Bowen Basin, in Queensland. This case study focuses on climate variability and risk of pit flooding which has production impacts. The proposed mine water management system has been designed and its performance is being tested in the water balance model to assess the overall risk to operations from climatic variability. This is to inform if additional measures are needed to reduce this risk.

Figure 3 presents the risk of excessive quantities of water in the pits for a percentage of days in the mine life (due to climatic variability) for three pits in the proposed operation. It shows that, for the currently designed system, there is a 50% chance that Pit 1 will be affected by flooding for less than 3% of days in the mine life and a 1% chance that Pit 1 will be affected by water in the pit for 5% of days in the mine.

Figure 4 presents the chance of excessive quantities of water in the proposed operations' pit for 7, 14 or 30 consecutive days. This graph shows there is approximately a 10% chance of having at least one (1) occurrence in the mine life of water in the pit for 30 consecutive days. Similarly, there is approximately 10% chance of having at least three (3) occurrences of 14 days and six (6) occurrences of 7 days of continuous water in the pit over the mine life. These risks can be equated to potential lost production to determine what risk is acceptable and if further investment should be made to reduce this risk.

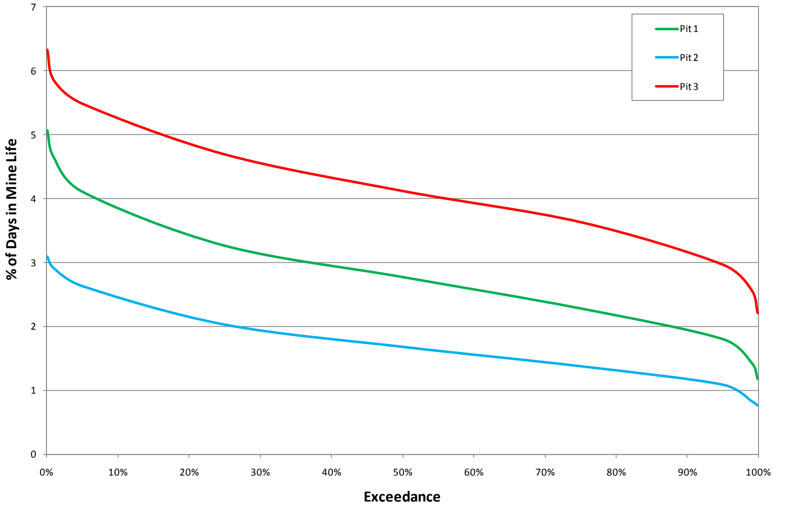

Figure 3 *Proposed Mine: Risk of Water in Pits – Percentage of Days in the Mine Life.*

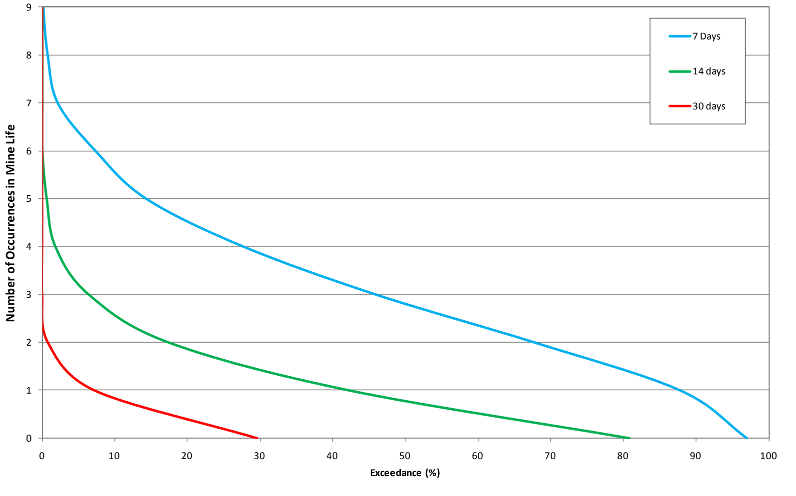

Figure 4 *Proposed Mine: Risk of Water in Pits – Number of Occurrences in the Mine Life.*

Risks to Operations

The greatest risk to operations is due to insufficient raw water for the various activities on site, but particularly for processing coal. The greatest risk is not just the supply risks; it is the limited understanding of climatic variability, their risk to and impacts on operations, and a lack of planning to mitigate these risks.

High rainfall generally has a more immediate, operationally-focused management and compliance issues, associated with discharging the water off site, and less long-term, production-related impacts. Rainfall events in the Bowen Basin are typified by short, intense events, whilst periods of rainfall deficit are sustained over a number of years. Therefore, rainfall events only result in short-term production losses and, therefore, short-term risk. However, droughts present sustained and prolonged risk to operations which could shut down production for periods ranging from a month to years.

Although climatic extremes always present a risk to operations and production, advanced planning and an understanding of climatic variability can mitigate the potential impact of climatic extremes. The stochastic analysis undertaken for these two case studies identified that peaks in raw water demand are not sustained for long periods

– their duration is up to six months. If the peaks in raw water demand are utilised as the design basis for external water supply, this results in oversizing and under-utilisation of the external water supply infrastructure (pipelines and pump stations). This is an ineffective use of capital. Peak water demand, and therefore infrastructure required, can be reduced and appropriately managed through continued supply of raw water from external sources over a longer period. This reduces the peak demand whilst maintaining operations.

Critical to the ability to draw raw water via existing infrastructure during these periods are large on-site storages. Existing mines are advantaged by generally having large storages from previous mining operations. However, new mines do not and therefore are more dependent on external infrastructure (pipelines and pump stations) and more susceptible to variable climatic conditions. New mines can also be at risk when raw water supply is unavailable due to infrastructure outages. As they are dependent on continued supply, any disruption to supply during climatic extremes can place them at elevated levels of operational risk, and therefore, risk of lost production.

Application to other mining operations

Risk management and mitigation is an ever-present component of mining. Climatic conditions are an element of risk, however, it is more unpredictable and can present greater challenges to manage. However, there are a range of opportunities available to minimise the risk for existing and new operations.

The best method for managing the potential risk to operations is by understanding the extremes of climatic variability for the existing operations and the mitigating triggers for action when challenged with climatic extremes.

Secondarily, the continuous review of current operations and the prevailing and long-term forecast environmental conditions enables on-site water uses to be adjusted or modified at the earliest possible opportunity. This helps mitigate the potential impacts of prolonged periods of low rainfall and run-off.

Both of the above actions are founded on a detailed understanding of current and proposed operations, including the existing water demands and uses, and continuous review and planning. By taking a balanced, statistical view of the potential climatic extremes, planning can be undertaken to minimise the production risk. In addition, modifying the mine water management system and providing sufficient flexibility in its operation can mitigate the potential risk and allow for rapid response to changing conditions, particularly for periods of excessive rainfall.

Through advanced planning for climatic variability, the mining operation (and its owner) can proactively manage the risks and plan for potential solutions. Infrastructure planning plays an important role in minimising the potential timeframes required to implement solutions.

Fundamental to the management of water on site is understanding the demands and volumes of water required under a range of climatic conditions. Whilst this understanding will be limited for new mines (where no historic data is available), water use data at existing mines is invaluable for informing the demands and options for on-site management. Data collection for all water uses is critical to the success of all mine water strategies. Coupled with the continuous review of operations, this can aid in managing the risk.

Conclusions

Climatic variability is an ever-present challenge to the ongoing operation of coal mines around the world, but particularly in regions where climatic extremes can and do occur, such as Queensland's Bowen Basin.

Climatic extremes – both excesses and shortfalls of water – have the potential to constrain production. However, shortfalls in raw water availability have a greater impact and potential operational risk, due to their longer duration and direct impact on operations.

The key to overcoming these challenges is having a detailed understanding of current and proposed operations, and their associated demands. Coupled with a stochastic assessment of the local climatic system, the specific risk to operations can be determined and appropriate, cost-effective water management measures identified, planned and implemented as required to minimise the risk of lost production.

References

National Climate Centre (2011), Special Climate Statement 24, www.bom.gov.au/climate/current/statements/scs24b.pdf, Australian Bureau of Meteorology 2011.

National Climate Centre (2007), Special Climate Statement 14, www.bom.gov.au/climate/current/statements/scs14.pdf, Australian Bureau of Meteorology 2007.

Finch J (2011), Queensland Mining Devasted by 'Worst Flooding on Record'. QLD Mining and Energy Bulletin Winter 2011.