Key hazard: Climate Change

The Latrobe Valley declared mines must be rehabilitated to a state which is safe, stable, sustainable and suitable for proposed post-mining land uses. Mitigating hazards, both during operations and rehabilitation, is a key responsibility of mine licensees.

A hazard is any source of potential harm, damage, or adverse health effects on individuals, assets, or the environment.

This fact sheet is part of the Key Hazards series which addresses hazards such as block sliding, floor heave and fire. Key terminology is defined in the MLRA Vocabulary on our website.

Climate Change

This fact sheet explores the link between climate change and mine rehabilitation, relevant to the Latrobe Valley. Climate change poses challenges to mine rehabilitation efforts, with potential impacts on water availability, erosion, vegetation growth, and the frequency of extreme events like floods, droughts, and bushfires. These factors can affect the long-term safety, stability and sustainability of rehabilitated landforms, making it essential to integrate climate change considerations into mine closure and rehabilitation planning for resilient outcomes.

Climate change refers to any long-term trends or shifts in climate over many decades (CSIRO, 2024). As outlined by the CSIRO (2024), these changes may be due to natural variations (such as changes in the Earth's orbit) or caused by human activities changing the composition of the atmosphere including increased greenhouse gas emissions.

Evidence for an already changing climate

According to the recently published Victoria's Climate Science Report 2024 (VCSR24), the global climate is already changing. Our understanding of the past and future climate is continually improving based on new observations, updated science on climate processes, and improvements in climate modelling. VCSR24 synthesises:

- the methodology and findings from the latest climate projections for Victoria (downscaled from global projection)
- information on the changing climate within the global and Victorian context
- the science of climate hazards relevant to Victoria and the effects of climate change on these hazards
- how climate science can be applied in decision making processes using case studies.

Since 1910, global temperatures have risen by an average of 1.1°C while temperatures in Victoria, Australia have increased by about 1.2 °C.

The VCSR24 summaries the best available scientific evidence for our state.

In addition to rising temperatures, shifts in rainfall patterns and frequency, along with an increase in extreme climatic events such as heatwaves and floods, have been observed. Victoria's average annual rainfall has decreased, whilst the frequency and intensity of extreme rainfall events has increased. Victoria has also experienced more extended dry periods, an increase in bushfire frequency and changing flood patterns (VCSR24).

Understanding our future climate

Victoria's climate is shaped by large-scale climate drivers, weather systems and seasonal influences. One of the key factors impacting current and future climate is the amount of greenhouse gases in the atmosphere (CSIRO and Bureau of Meteorology, 2024). As concentrations of greenhouse gases continue to increase in the atmosphere, further shifts in the scale and timing of climate drivers and weather systems are likely to occur, with flow-on effects for Victoria's climate (VCSR 2024). To understand and predict these changes, organisations worldwide have developed global and regional climate models. These models simulate the Earth's climate and project future changes based on different greenhouse gas emission scenarios (CSIRO and Bureau of Meteorology, 2021).
Recent climate projections for Victoria (Victorian Climate Projections 2024 (VCP24) and Victorian Climate Projections 2019 (VCP19)) consider future emission scenarios which range from low to very high. These models typically project changes from the near future to the late century, projecting likely climate futures to 2100. Some models extend projections further, noting that long-term projections are increasingly uncertain due to the inherent complexity and variability of the climate system and unpredictable future human behaviours (Jacobs, 2017).

What could the future climate look like in Victoria?

VCP24 indicates that Victoria will continue to warm, experience more frequent and intense hot days and longer heatwaves. Figure 1 below presents possible future changes in temperature under a low and high emission scenario, with the potential for temperatures in Victoria to increase by up to 5.0°C .

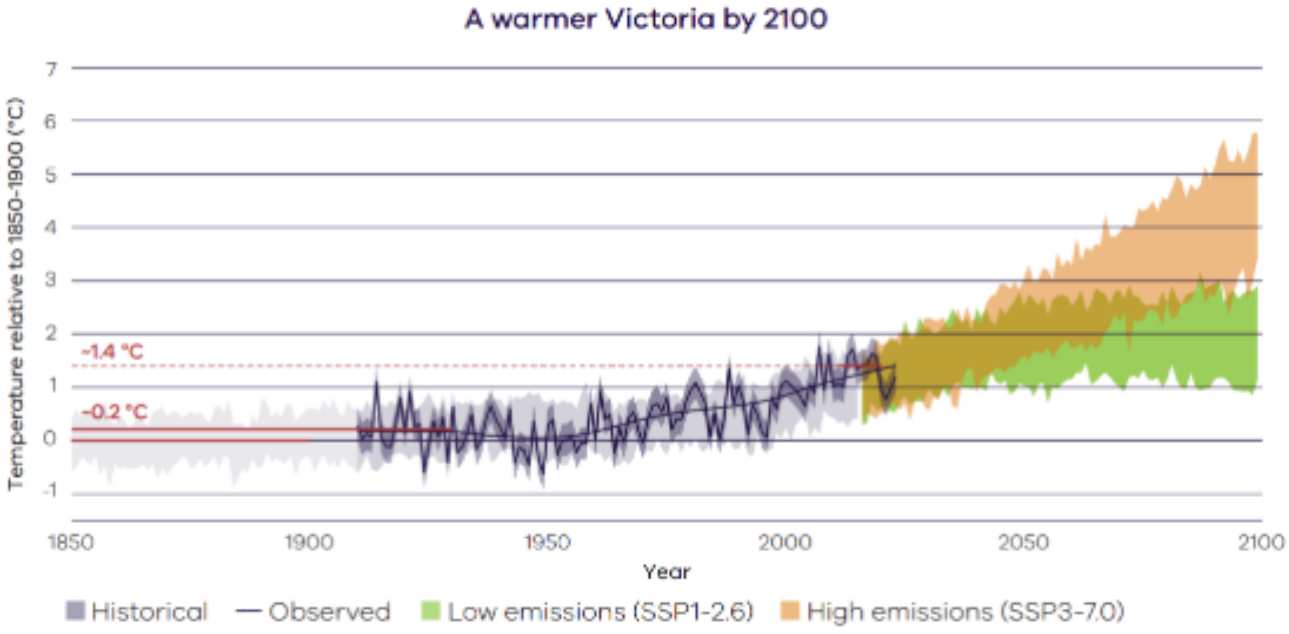

Figure 1. Victoria's projected warming climate (source: VCSR2024)

The climate is likely to continue to become drier, particularly during the winter and cool seasons (April to October). Changes to average rainfall trends during summer is less certain, although increase in variability and extremes is expected..

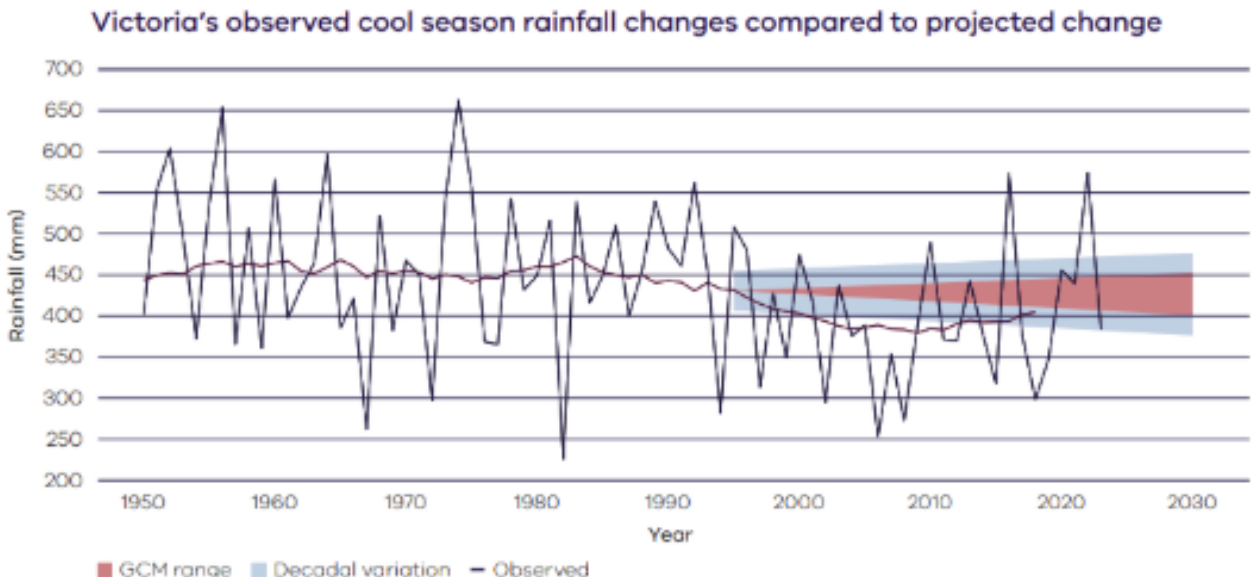

Figure 2. Observed and projected cool season rainfall in Victoria. The projected range of rainfall to 2039 is shaded in red, with decadal variation presented in blue (source: VCSR2024).

Warming temperatures allow the atmosphere to hold more water, which can cause short-duration extreme rainfall events to become heavier, more intense and more frequent.

It is noted that whilst Victoria may trend towards a drier climate in the long-term, wetter periods may still occur due to natural year-to-year and decade-to-decade climate variability.

What are some of the key potential impacts of climate change?

In addition to the warming of global temperatures and changing in rainfall patterns, the VCSR24 and other reports also note that the following key climate impacts are also projected to be exacerbated by Victoria's changing climate:

Floods: Changes in flood events and patterns are projected to continue a trend observed in historical records: smaller floods have decreased in size, while larger floods have grown more severe. This pattern is expected to intensify over time, potentially impacting the flow and health of Victoria's rivers and floodplains. These ecosystems rely on small, frequent floods to sustain their health, but larger floods can cause significant damage through excessive erosion and sedimentation of waterways (Metcalf and Costello, 2021).

Droughts: Climate change can also affect the likelihood and severity of droughts in Victoria. Declining average rainfall may lead to droughts developing more rapidly and persisting for longer durations. This can lead to a decrease in available water for consumptive users and environmental flows, impacting river and wetland health.

Bushfires: The risk of bushfire ignition and fire activity is expected to increase in the future, driven by several factors. Changes in rainfall affect vegetation growth and moisture content of flammable vegetation, which serves as bushfire fuel. Additionally, rising temperatures further contribute to heightened fire risk.

Heatwaves: Heatwaves are projected to increase in the future. A heatwave is defined as at least 3 consecutive days above the 95th percentile of daily average temperatures. Future changes in Victorian heatwaves will be driven by increasing global temperatures.

Rising sea levels: Sea-level rise is driven by oceanic and atmospheric influences and more specific mechanisms such as thermal expansion, ocean currents, melting glaciers and ice sheets, and vertical land movement. Sea level rise is inundating low lying areas in proximity to the coast. Sea levels are expected to continue rising, with the rate of increase depending on future greenhouse gas emission levels.

Soil desiccation and loss: An impact of increasing global temperatures and droughts is the desiccation of the soils, making them low quality and water repellent (hydrophobic) rather than water absorbing. Turning previously productive soils into dusty, barren, unproductive land (Xu, et al., 2024), which can then rapidly erode away when intense rainfall events / floods occur.

Figure 3. Drought landscape iStock image.

How could climate change impact the rehabilitation of the Latrobe Valley mines?

All three declared mines in the Latrobe Valley are currently considering pit lake rehabilitation concepts. Achieving these final landforms would require large amounts of water, over several decades (CRCTiME, 2022). They would also require an ongoing volume of water to 'top up' and maintain water levels in the pit lake to account for evaporative losses (DJPR, 2020a).

After mining and mine rehabilitation is completed, these rehabilitated landforms will be present for a long period of time and, as such, will likely face the long-term impacts of climate change.

Surface water

As outlined in the Victoria's Water in a Changing Climate report(DELWP, 2020), Victoria's rivers and water resources are highly climate dependent, with climate science projecting both hotter and drier conditions which could impact all water users.

In dry periods (e.g., prolonged droughts), water availability can reduce significantly, resulting in less or no water being available for mine rehabilitation (DJPR, 2020a). This could significantly lengthen mine void filling time or there may be insufficient water to top-up and maintain the rehabilitated pit lake water levels on an ongoing and long-term basis, noting that a smaller volume of water is predicted to be required for top-up compared to filling.

Erosion and vegetation

Victoria is experiencing smaller floods becoming smaller and large floods becoming larger, and this trend is expected to continue at a greater rate in the future. These events could damage rehabilitated land and water control structures by eroding soil, damaging vegetation, and impacting future vegetation growth, ultimately reducing land productivity. Similarly, periods of prolonged drought can impact rehabilitated land through different mechanisms. Both flooding and drought pose the risk of exposing covered coal, which could lead to an increased fire risk and block sliding/batter instability events.

Bushfires

With bushfires likely to become more severe and frequent, risks to rehabilitated mine land are likely to increase. Bushfires may cause a loss of vegetation on the rehabilitated land, leading to an increase in soil losses and potential for coal to be exposed. With the loss of cover material coal could more easily be ignited, further damaging the rehabilitated landform and potentially impacting on the surrounding environment and community.

Integrating climate change into mine rehabilitation

To ensure sustainable and climate-resilient rehabilitation outcomes, future climate change impacts must be incorporated into mine closure and rehabilitation planning. Climate change modelling is incorporated in many technical studies that declared mine licensees need to complete as part of their rehabilitation planning process. Additionally, strategies for managing long-term climate impacts on rehabilitated landforms should be considered in the licensees' post closure monitoring and maintenance plans, and by government in state and regional planning.

Figure 4. Erosion and vegetation comparison iStock image.

If you're reading a printed copy, you can find all hyperlinks by visiting www.mineland.vic.gov.au and searching for the relevant topic.