

Infrastructure Victoria

Victoria's climate risks to infrastructure

Project report

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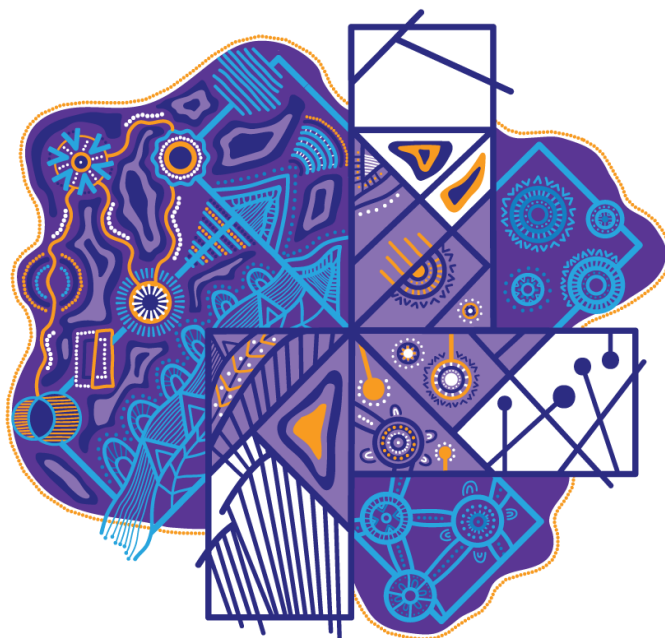
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Acknowledgement of Country

Arup acknowledges the Traditional Owners across all lands, waters and skies our firm may reach; we acknowledge their wisdom, resilience, and rich cultural heritage. We pay our respects to the Elders, past and present, and to all Aboriginal and Torres Strait Islander peoples.

We recognise the ongoing journey of healing and reconciliation, and Arup commits to walking alongside First Nations peoples, to acknowledge their teachings and foster a future of unity and respect.



‘Continuing to Shift to shape an even better world’ original artwork by Tarni O’Shea of Gilimbaa and updated by David Williams of Gilimbaa

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Executive summary

Project purpose and approach

Victoria faces an escalating climate challenge that demands urgent action. As climate change intensifies the frequency and severity of hazards – including extreme heat, floods, bushfires, droughts, landslides, damaging winds, and coastal inundation – Victoria’s infrastructure will face increased climate risks.

Arup was commissioned by Infrastructure Victoria to investigate which existing infrastructure assets are most at risk from climate change. The purpose of this work is to:

- Establish a baseline of climate hazards, sectors and identify information needs.
- Identify the location of existing owned and regulated infrastructure assets in Victoria.
- Identify the vulnerability of the assets to the climate hazards at a high-level.
- Determine the criticality of the assets (physical, functional and social criticality), based upon the magnitude of the impacts if they failed and the interdependencies of failure upon other assets or sectors.

This technical report documents the methodology, data sources, and analytical framework underpinning the climate risk assessment of Victorian infrastructure. It provides a detailed account of how climate exposure, vulnerability, and criticality have been evaluated across infrastructure sectors, establishing a transparent evidence base to support adaptation investment decisions.

Scope

This study examines the physical climate risks facing existing infrastructure assets across 10 infrastructure sectors and seven climate hazards, shown in Figure 1. The study considers Victorian government owned or regulated assets, including assets insured by the Victorian Managed Insurance Authority (VMIA). Data on insured values was sourced from VMIA, and was originally provided to VMIA by the assets’ owners or the Valuer-General Victoria, and then indexed annually by VMIA. ‘Insured value’ is used from VMIA data. Note that insurance may not cover all costs following a disaster.

The scope considers the damage, and downtime impacts to infrastructure assets that result from climate hazards, but it excludes other climate impacts, such as health impacts from a hotter future climate. While these other impacts are significant and important, they do not form part of the assessment as we focus on physical impacts to infrastructure.

Hazards

Extreme heat	Bushfire	Drought	Damaging wind	Flood	Coastal inundation	Landslide
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Sectors

Road	Rail	Ports	Energy	Health
Education and training	Cultural and community	Justice and community safety	Housing	Parks

Figure 1: Summary of Victorian infrastructure sectors and climate hazards for climate risk assessment.

This assessment considers baseline climate conditions as well as projected conditions for 2030 and 2070 under both low and high emissions futures, in order to inform near-term adaptation priorities while accounting for longer-term climate trajectories.

Analysis approach

Risk is defined as the potential adverse consequences arising from the interaction of three components, hazard, exposure and vulnerability, aligning with the IPCC Sixth Assessment Report and the National Climate Risk Assessment (NCRA). These components are described in Figure 2 below.

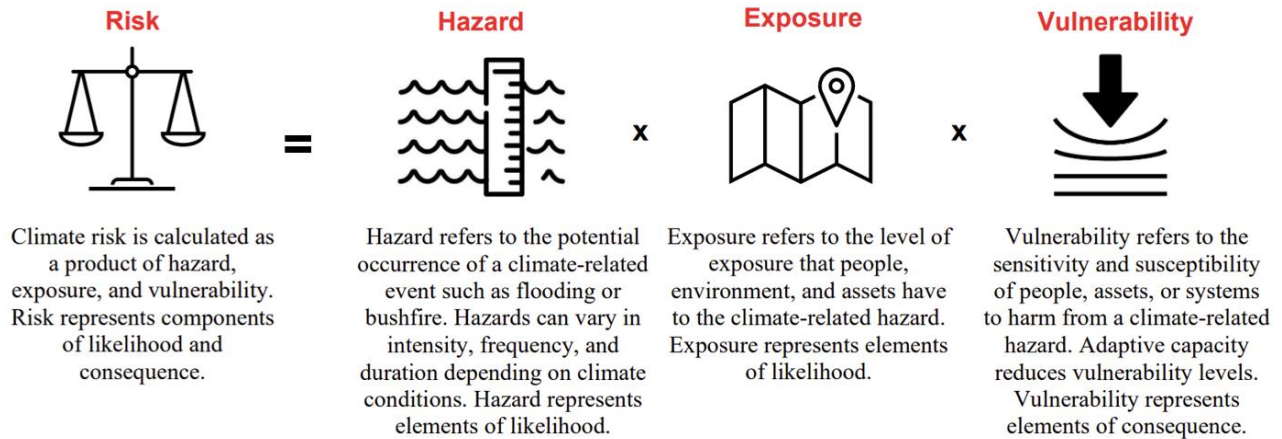


Figure 2: Composition of risk based on the IPCC Sixth Assessment Report 2021.

The analysis integrated the three components of hazard, exposure and vulnerability to inform the assessment of risk. The results were then screened for criticality for selected asset types. The project employed a structured approach that builds from asset-level detail to sector-wide priorities based on available data, as illustrated in Figure 3.



Figure 3: Visual summary of risk assessment components from asset-level detail to sector-wide priorities.

Infrastructure exposure to climate hazards

Infrastructure assets across Victoria are exposed to different climate hazards depending on their location. Geospatial climate hazard data was used to assess baseline and future scenario exposure to extreme heat, drought and bushfire. Exposure to flood, landslide and damaging wind was assessed using baseline data only, while coastal inundation was assessed for future scenarios. Future scenarios were modelled using two shared socioeconomic pathways (SSPs) – a low emissions scenario using SSP1-2.6 and a high emissions scenario using SSP3-7.0. The scenarios assessed for each hazard are summarised in Table 1 below.

Table 1: Scenarios assessed for each hazard.

Hazard	Baseline scenario	Future scenarios
Extreme heat, bushfire, drought	1986 – 2005	<ul style="list-style-type: none"> – Low emissions 2030 – High emissions 2030 – Low emissions 2070 – High emissions 2070
Damaging wind	2006 – 2023 weather station wind data	Assumed same as baseline.
Flood	Historical 1 in 100 year flood levels	Assumed same as baseline.

Hazard	Baseline scenario	Future scenarios
Coastal inundation	Not assessed	<ul style="list-style-type: none"> – Low & high emissions 2030 (20cm) – High emissions 2070 (47cm)
Landslide	1980 – 2018 rainfall data	Assumed same as baseline.

The exposure analysis identifies the location of infrastructure assets most exposed to climate-related hazards across Victoria. In terms of infrastructure sector climate exposure, the following trends emerge:

- Infrastructure in the parks, road and rail sectors face the highest levels of exposure in terms of proportion of sector value.
- Together, roads, rail and energy sectors account for two thirds of asset value with high exposure.
- Ports present a unique case of universal single-hazard exposure to coastal inundation under all future scenarios.
- All other sectors have lower proportions of asset value with high exposure to climate hazards.

Overall, the trend of increasing exposure across sectors is shown in Figure 4. The proportion of total assessed infrastructure value with high exposure to at least one hazard increases from 14% to 19% between the low emissions scenario in 2030 to the high emissions scenario in 2070. This demonstrates that climate change is projected to escalate infrastructure exposure across Victoria under a high emissions scenario.

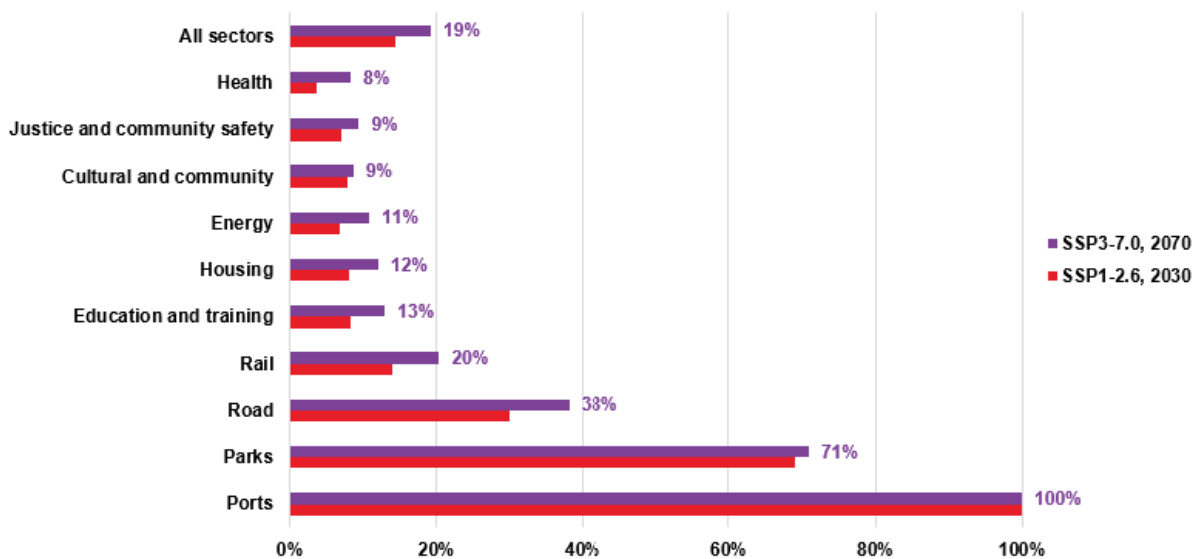


Figure 4: Proportion of infrastructure sectors asset value with high exposure to at least one climate hazard under changing climate conditions.

Vulnerability to climate hazards

Vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2022). The vulnerability assessment involved describing the potential impacts of hazards on each sector in terms of physical damage and operational downtime, and assigning them a rating of low, moderate or high based on the probable consequences of exposure.

The vulnerability assessment revealed trends in the vulnerability of infrastructure sectors to different climate hazards:

- Infrastructure is most vulnerable to coastal inundation and bushfire across nearly all sectors due to the combination of severe physical damage, prolonged operational downtime, and limited capacity for recovery. Coastal inundation poses a unique threat because it can permanently compromise assets.

- The vulnerability rating is the same or higher for downtime as it is for damage across sectors. Where the vulnerability rating is higher for downtime, that is largely driven by extreme heat and wind hazards. These two hazards have a limited impact on physical damage to the sectors but can have significant operational impacts with disruption to operations and service delivery, particularly for sectors such as housing.
- Buildings have a similar vulnerability profile for damage across sectors of health, education and training, housing, justice and community, cultural and community, and parks. This is generally characterised by high vulnerability to bushfire and coastal inundation, moderate vulnerability to heat, flood and wind and low vulnerability to drought.
- Roads and railways are highly susceptible to flooding, bushfire, extreme heat, and coastal inundation, which can cause direct physical damage such as pavement deformation, track buckling, washouts, and embankment failures, as well as prolonged closures and service disruptions.
- The energy sector faces high vulnerability to bushfire and coastal inundation, with additional risks from extreme heat and flooding that can disrupt power generation, damage transmission infrastructure, and lead to widespread outages.

Compounding and cascading climate hazards significantly amplify the vulnerability of some sectors. When multiple hazards occur in sequence or interact, these events can intensify damage and operational disruption across sectors. All assessed hazards interact with at least one hazard through compounding (co-occurring) or cascading (causal) impacts, with the exception of landslides.

Note that the vulnerability assessment was undertaken at the sector level, which may mask variation in the vulnerability of asset types within sectors. It also does not consider factors such as asset age and condition which would influence vulnerability.

Climate risks to Victorian infrastructure

To develop the risk ratings, we combined the exposure of assets across Victoria with the vulnerability assessment of the assets in each sector. It is clear that assets with low (or high) exposure and low (or high) vulnerability combined have a low (or high) risk under future climate. However, many assets may face high exposure to certain hazards but have relatively low vulnerability, or vice versa, which affects the risk rating for these assets. This is why it is important to understand both the exposure and the vulnerability in each sector so that the combined risk can be properly assessed. The resulting risk ratings clearly demonstrate that Victoria's infrastructure faces increasing risk under future climate change.

Of the assessed Victorian infrastructure assets, \$71.3b are exposed to high risk of damage from at least one climate hazard by 2070 under the high emissions scenario. This represents an increase of approximately 25% from the low emissions scenario in 2030 (\$57.2b). The value of infrastructure at high risk from at least two hazards increases from \$9.0b under SSP1-2.6 2030 to \$16.3b under SSP3-7.0 2070. The value of infrastructure at risk of damage from at least one hazard across sectors under the low emission scenario in 2030 and high emissions scenario in 2070 is illustrated in Figure 5.

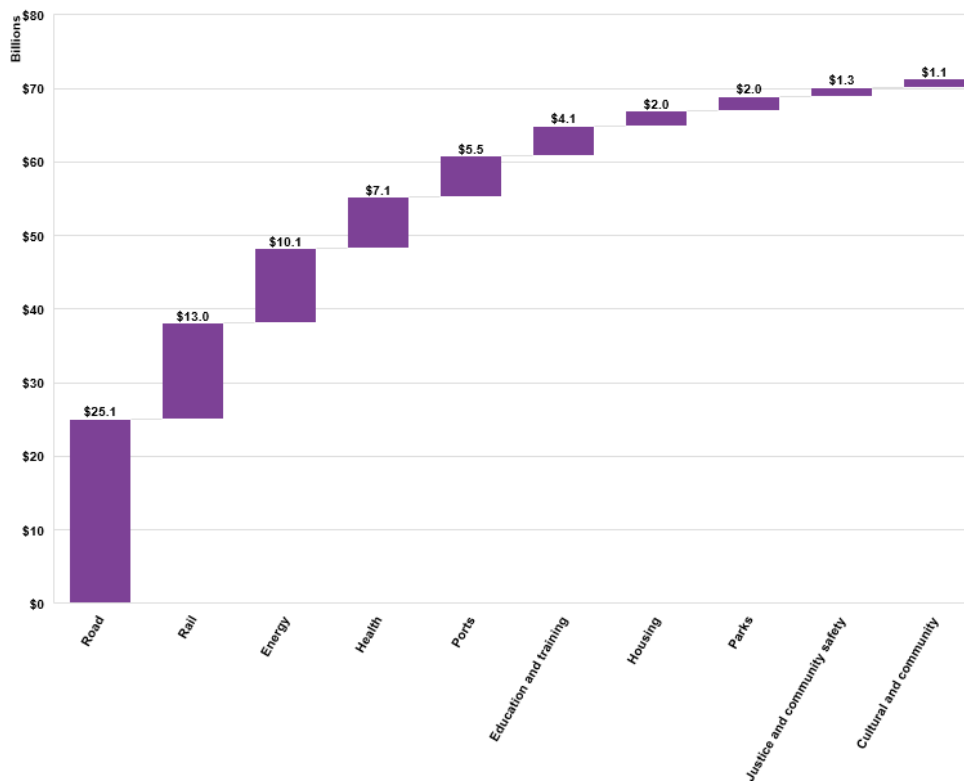
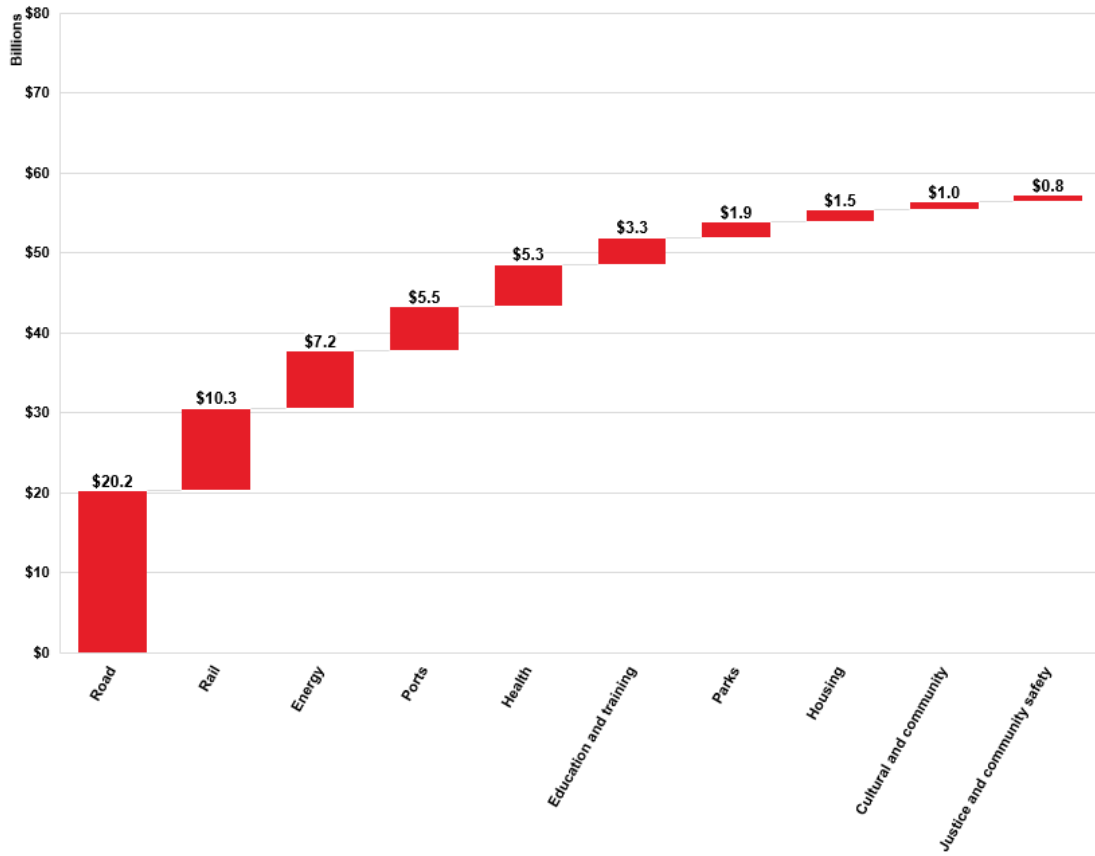


Figure 5: Total Victorian infrastructure value at risk of damage from at least one climate hazard under low emissions conditions in 2030 (top) and high emissions conditions in 2070 (bottom), by sector¹.

Different climate hazards drive climate risk to Victorian infrastructure to varying levels. The relative asset value impacted by high climate risks from each climate hazard are shown in Figure 6, for the damage and downtime impact pathways in the low emissions scenario in 2030.

Of the hazards assessed, high risks from damage from bushfire and flood affect the largest value of assessed infrastructure assets. When considering downtime, there are more high risks due to extreme heat.

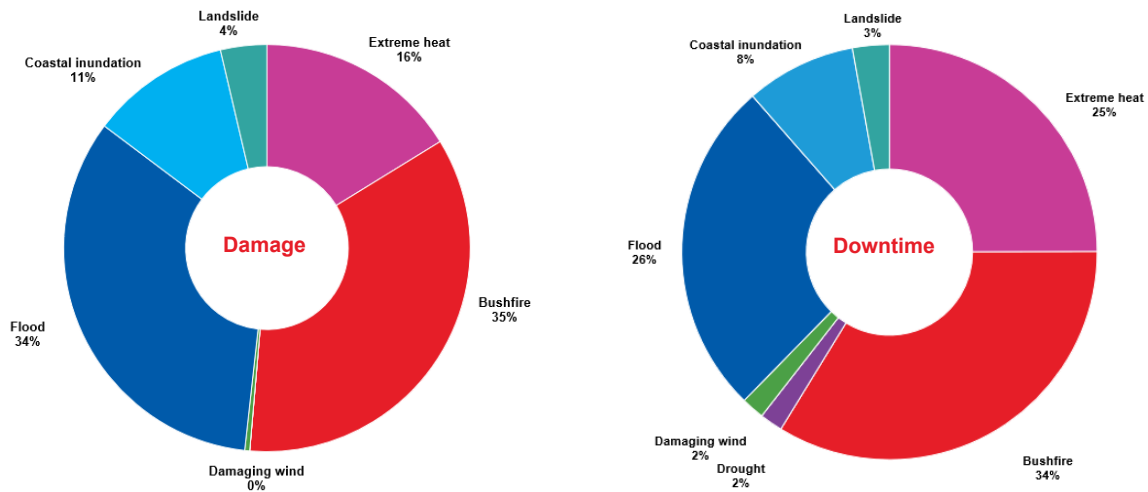


Figure 6: Hazards driving high risks for the low emissions scenario in 2030, by affected asset value for damage (left) and downtime (right).

The criticality assessment identified which asset types are most essential, and where failure would have the most significant consequences if infrastructure faces high climate risks. The criticality assessment found that energy sector asset types (generation, substations, transmission and distribution lines), as well as hospitals and roads (including bridges) are the most critical asset types. These sectors, along with rail, represent the highest value of assets at risk to climate hazards. The risk profiles of each of these asset types differs slightly:

- The energy sector faces high risks from bushfire, coastal inundation, extreme heat, drought and flood, with assets facing these risks spread across most of Victoria.
- The road sector faces high risks from flood, coastal inundation, landslide, extreme heat and bushfire. Road assets at risk are concentrated in central Victoria, from Melbourne to Bendigo and Echuca.
- The health sector faces high risks from flood, extreme heat and bushfire. Health assets with high climate risks are in discrete locations across the state, with the majority in the northern half.
- The rail sector faces high risks from extreme heat, bushfire, flood and coastal inundation. Rail assets at risk are located in Melbourne and along regional rail corridors.

Assets with lower criticality are those where services are able to be delivered out of different locations. These typically have redundancy due to multiple assets and minimal downstream interdependencies. In the criticality assessment, individual characteristics and functions of asset types within communities have not been assessed, which would adjust this generalised view.

Conclusions

Victoria’s infrastructure faces a rapidly escalating risk landscape driven by climate change.

Of the sectors assessed, the rail, road, energy and health sectors make up the vast majority of value at high risk from climate hazards. Of these, roads, hospitals and energy sector assets were identified as critical asset types, highlighting the potential for climate change to affect infrastructure providing critical functions and

¹ Please note the total sector value at risk may not add up from the graph due to rounding errors.

services to Victorians. Focusing on preventative investment in these three sectors will reduce reconstruction costs and free up resources for adaptation investment in essential community assets, like health centres and schools, which may be less critical or expensive at a state level, but are vital for local communities.

The evidence base presented in this report can be used to inform investment in adaptation for the next five years and beyond, which will need to happen alongside regulatory changes to ensure an effective response to climate change.

While this study provides a robust, state-wide evidence base, it also identifies the need for further detailed and place-based investigations to refine adaptation priorities:

- Some assets will warrant adaptation investment before others as vulnerability varies between assets within sectors. A vulnerability assessment of asset types within sectors would provide further understanding of climate risks within sectors.
- Network-wide investigations will help to further prioritise investment, including understanding network dependencies, community needs, and operational adaptive capacity.
- A more detailed review of specific places that are exposed to multiple hazards and have vulnerable assets would allow the identification of potential interventions that could have co-benefits across multiple hazards and help identify opportunities for more efficient resource allocation.
- This report frames climate risks in terms of the value of affected assets for both damage and downtime. In future studies, it could be valuable to include other metrics for measuring downtime risks, such as number of hours of lost service, or economic impact of reduced service availability.
- Assessing the planned or potential future infrastructure for climate risks would provide an opportunity to integrate adaptation investment that could improve outcomes for both existing and future assets.

This study brings together a climate risk assessment across multiple sectors for the state of Victoria, providing a common benchmarking to understand relative risk across state-owned and regulated sectors, and communities.

Disclaimer

Climate model outputs

In preparing this report we have used climate model outputs obtained from external sources including the CSIRO and state bodies, derived from Coupled Model Intercomparison Project Phase 6 (CMIP6) global climate models. These models can help consider possible future climate scenarios or outcomes, but no model that attempts to project the future can do so with certainty. Actual events may not occur as projected, and the differences may be material. As such, Arup cannot and does not make any representation or warranty, express or implied, regarding the accuracy or completeness of any such forward-looking advice, or any models, projections, forecasts, opinions or estimates, and Arup accepts no responsibility for the realisation or non-realisation of the same.

Any advice, including forward-looking advice, is time-sensitive at the time of writing. Climate models are constantly updated and there may be material differences between climate models used at the time of writing and climate models generated later. We will not be under any obligation to update our work to address changes in facts or circumstances or modelling techniques that occur after the date of our deliverables, which might affect the contents of such deliverables or any of the conclusions.

Projections and risk assessment outputs

Outcomes from the method outlined in this paper may include statements that are, or may be deemed to be, forward-looking statements or projections. These forward-looking statements or projections can be identified by use of forward-looking terminology, forecasts, or estimates including the terms “believes”, “estimates”, “plans”, “anticipates”, “targets”, “aims”, “continues”, “projects”, “assumes”, “expects”, “intends”, “may”, “will”, “would” or “should”, or, in each case, their negative or other variations or comparable terminology. These forward-looking statements or projections include all matters that are not historical and are based upon interpretations or assessments of available information at the time of writing. By their nature, forward-looking statements or projections involve risk and uncertainty because they relate to future events and circumstances.

The realisation of any forward-looking statement or projection is dependent upon the continued validity of the assumptions on which it is based. Several factors could cause actual results and developments to differ materially from those expressed or implied by the forward-looking statements or projections. Actual events frequently do not occur as expected, and the differences may be material. For this reason, we accept no responsibility for the realisation of any projection, forecast, opinion or estimate.

Findings are time-sensitive and relevant only to current conditions at the time of writing. We will not be under any obligation to update the report to address changes in facts or circumstances that occur after the date of our report that might materially affect the contents of the report or any of the conclusions set forth therein.

Glossary

Term	Definition
Adaptive capacity	The ability of institutions, systems, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of environmental variability and change (IPCC, 2022). It includes adjustments in both behaviour and in resources and technologies (PIARC, 2015).
Annual Exceedance Probability (AEP)	The probability of a hazard event occurring in any given year. For example, 1% AEP indicates there is a 1% chance of the event occurring or being exceeded in any given year.
Cascading impacts	Cascading impacts from extreme weather/climate events occur when an extreme hazard generates a sequence of secondary events in natural and human systems that result in physical, natural, social or economic disruption, whereby the resulting impact is significantly larger than the initial impact. Cascading impacts are complex and multi-dimensional and are associated more with the magnitude of vulnerability than with that of the hazard (IPCC, 2022).
Climate adaptation	In human systems, the process of adjustment to actual or expected climate and its effects, to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2022). Adaptation actions may include physical changes to an asset to achieve or facilitate adaptation including changes/upgrades to technology and equipment, design standards for particular project elements, operational actions, or natural resource management actions (e.g., assisted colonisation, mixed-provenance plantings, restoration of key connectivity pathways to enable movement).
Climate change	A change in the state of the climate that persists for an extended period, typically decades or longer (IPCC, 2022).
Climate projections	Simulated response of the climate system (including variables such as temperature, precipitation, wind, solar radiation, sea level) to a scenario of future emissions or concentrations of greenhouse gases and changes in land use, generally derived using climate models. Climate projections depend on an emission scenario, in turn based on assumptions concerning factors such as future socioeconomic and technological developments that may or may not be realised (IPCC, 2022).
Climate variables	Factors that determine and govern the climate. Main factors include rainfall, atmospheric pressure, wind speed, wind direction, humidity, average and maximum temperature (PIARC, 2015). Changes in climate variables (such as temperature) can lead to changes in climate hazards (such as heatwaves).
Climate resilience	The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure (IPCC, 2022).
Climate risk	The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Climate-related risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards (IPCC, 2021).
Compounding impacts	These arise from the interaction of hazards, which may be characterised by single extreme events or multiple coincident or sequential events that interact with exposed systems or sectors (IPCC, 2022).
Consequence	Outcome of an event affecting objectives. A consequence can be certain or uncertain and can have positive or negative direct or indirect effects on objectives. Any consequence can escalate through cascading and cumulative effects (ISO, 2019).
Criticality	Criticality is the measure of how essential a piece of infrastructure is to the continued operation of communities, the economy, and emergency response, as well as the severity of consequences if it fails. This project considers criticality in terms of how important infrastructure assets are to infrastructure system function and delivering social, economic and environmental outcomes.

Term	Definition
Exposure	The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by hazards (IPCC, 2022).
Extreme weather event	An event that is rare at a particular place and time of year. The characteristics of what is called extreme weather may vary from place to place (IPCC, 2022).
Global warming levels	Links regional climate changes to specific levels of global warming (e.g., 1.0°C, 1.5°C, 2.0°C) above a specified baseline period, typically pre-industrial (1850-1900) (Canadian Centre for Climate Services, 2024).
Hazard (climate hazard)	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (IPCC, 2022).
Interdependencies	The functional, physical, geographical, economic, policy, and social linkages through which different systems, sectors, or climate risks influence one another such that a change, disruption, or impact in one system can propagate and alter the behaviour, vulnerability, or resilience of other connected systems (Dawson, 2015).
Likelihood	The chance of something happening where this might be estimated probabilistically.
Representative Concentration Pathways (RCPs)	Four different 21st century pathways of greenhouse gas emissions and atmospheric concentrations, air pollutant emissions and land use. RCPs represent the range of emissions in the wider literature; they include a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0), and one scenario with very high emissions (RCP8.5).
Return period	An estimate of the average time interval between occurrences of an event (e.g. flood or extreme rainfall) of a defined size or intensity.
Risk	The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Climate-related risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards (IPCC, 2021).
Scenario	A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions (IPCC, 2022).
Shared Socio-economic Pathways (SSPs)	Scenarios that describe possible futures in terms of population, gross domestic product (GDP), and other socioeconomic factors relevant to understanding the implications of climate change. SSPs complement RCPs with varying socio-economic challenges to adaptation and mitigation. Based on five narratives, SSPs describe alternative socio-economic futures, comprising sustainable development (SSP1), regional rivalry (SSP3), inequality (SSP4), fossil-fuelled development (SSP5), and middle-of-the-road development (SSP2).
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2022). Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2022).

1. Introduction

1.1 Research context

Victoria faces an escalating climate challenge that calls for urgent action. Extreme weather events already cost the state approximately \$2.7 billion annually (The Productivity Commission, 2014), with damage projected to cost nearly \$1 trillion by 2100 without proactive adaptation measures (Kompas, Keegan, & Witte, 2019). As climate change intensifies the frequency and severity of hazards – including extreme heat, floods, bushfires, droughts, landslides, damaging winds, and coastal inundation – the resilience of Victoria's infrastructure has become a critical challenge that is shaping long term policy and investment decisions.

The scale of Victoria's infrastructure portfolio underscores the significance of this challenge. The Victorian Managed Insurance Authority (VMIA) insures more than \$255 billion in state infrastructure assets spanning transport networks (roads and rail), health facilities, education institutions, cultural and community assets, public housing, justice and community safety infrastructure, and national parks (Victorian Managed Insurance Authority, 2025). These assets form the backbone of essential services that Victorians rely upon daily, yet their exposure to climate hazards varies considerably across different regions and infrastructure types. Beyond VMIA-insured assets, this project also examines energy and port infrastructure, recognising their vital role in the state's infrastructure systems.

Infrastructure Victoria's *Weathering the Storm* project established important foundations for understanding climate risks to Victorian infrastructure, advancing assessment methodologies and identifying key coordination and planning improvements. Building upon that work, this research aims to deepen the evidence base during a critical five-year window for climate adaptation investment. This timing aligns with the mandatory update of sectoral Adaptation Action Plans by the Victorian Government under the *Climate Action Act 2017 (Vic)*. This requires robust data and analysis to underpin strategic investment decisions that maximise resilience outcomes. The Department of Energy, Environment and Climate Action published the government's updated climate science report and data in November 2024 to support these action plans (DECCA, 2025).

1.2 Purpose of this study

Arup was commissioned by Infrastructure Victoria to investigate which existing infrastructure assets are most at risk from climate change. The purpose of this work is to:

- Establish a baseline of climate hazards, sectors and identify information needs.
- Identify the location of existing owned and regulated infrastructure assets in Victoria.
- Identify the vulnerability of the assets to the climate hazards at a high-level.
- Determine the criticality of the assets (physical, functional and social criticality), based upon the magnitude of the impacts if they failed and the interdependencies of failure upon other assets or sectors.

Effective resilience planning must assess where hazards may occur in relation to infrastructure assets (exposure), how hazards affect different infrastructure types (vulnerability) and combine these to assess the climate risk facing each sector, and evaluate the significance of potential impacts on service delivery and broader system functioning (criticality). This integrated approach helps to enable strategic prioritisation of adaptation investments to reduce the risks of extreme events on government, infrastructure owners and operators, and the Victorian community.

Establishing a comprehensive evidence base that integrates climate science, infrastructure analysis, and impact assessment will help provide the foundation for informed decision-making on adaptation priorities across Victoria's diverse infrastructure portfolio.

1.3 Purpose of this report

This technical report documents the methodology, data sources, and analytical framework underpinning the climate risk assessment of Victorian infrastructure. It provides a detailed account of how climate exposure,

vulnerability, risk, and criticality have been evaluated across infrastructure sectors, establishing a transparent evidence base to support adaptation investment decisions.

The report is intended for Victorian Government agencies, infrastructure asset owners and operators, and other stakeholders involved in infrastructure planning and climate adaptation. It explains the technical approach taken to assess climate risks, the assumptions and limitations of the analysis, and the rationale for key methodological decisions. By providing this comprehensive documentation, the report enables informed interpretation of the findings to support decision-making for adaptation investment and helps identify where more detailed, place-based analysis may be needed to inform specific investment plans over the next five years.

1.4 Scope

This study examines the physical climate risks facing existing Victorian infrastructure assets across 10 infrastructure sectors and seven climate hazards, shown in Figure 7. The study considers Victorian government owned or regulated assets, including assets insured by the Victorian Managed Insurance Authority (VMIA). Data on insured values was sourced from VMIA, and was originally provided to VMIA by the assets' owners or the Valuer-General Victoria, and then indexed annually by VMIA. 'Insured value' is used from VMIA data. Note that insurance may not cover all costs following a disaster.

The scope considers the damage, and downtime impacts to infrastructure assets that result from climate hazards but it excludes other climate impacts, such as health impacts from a future climate with more heatwaves or economic impacts from school closures. While these other impacts are significant and important, they do not form part of the assessment as we focus on physical impacts to infrastructure.

Hazards

Extreme heat	Bushfire	Drought	Damaging wind	Flood	Coastal inundation	Landslide
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Sectors

Road	Rail	Ports	Energy	Health
Education and training	Cultural and community	Justice and community safety	Housing	Parks

Figure 7: Summary of Victorian infrastructure sectors and climate hazards for climate risk assessment.

The geographic scope encompasses the entire state of Victoria, recognising that climate risks manifest differently across metropolitan Melbourne, regional centres, and rural areas. This assessment considers current climate conditions as well as projected conditions for 2030 and 2070 under both low and high emissions futures, enabling assessment of near-term adaptation priorities while accounting for longer-term climate trajectories. The selected climate scenarios and timeframes are described in Section 2.2.

The scope is not a detailed risk analysis and further analysis will be required to make both sector- and asset-specific plans. The purpose of this work is to advance the evidence base to give more specific advice to the Victorian government on possible priority infrastructure for adaptation investment. Specifically, it aims to provide a consistent cross-sector analysis in order to identify the most affected sectors and to quantify the extent of impacts across these various sectors using insured value.

1.5 Structure of this report

This report is organised to guide readers through the methodology, analysis, and findings of the climate risk assessment:

Section 2 sets out the analytical framework and method for the study, including climate scenarios and time horizons, and explaining how exposure, vulnerability, and criticality assessments are conducted and integrated to identify potential opportunities for adaptation investment.

Section 3 presents the findings of the exposure analysis, showing how climate hazards affect infrastructure across Victoria and examining sectoral differences in exposure under a changing climate.

Section 4 documents how climate hazards cause damage and service disruption to Victorian infrastructure, including consideration of compounding and cascading impacts across infrastructure systems.

Section 5 synthesises the exposure and vulnerability assessments to present a comprehensive picture of climate risks facing all infrastructure sectors, examining how different hazards drive risk unevenly across the state, which communities face greatest impacts, and how infrastructure criticality influences risk tolerance.

Section 6 summarises the key findings and their implications for adaptation planning, including considerations for further detailed studies to support place-based investment decisions and asset-specific prioritisation.

Appendices provide supplementary technical detail supporting the analysis and findings.

2. Method

2.1 Overview

Risk is considered in this project as the potential adverse consequences arising from the interaction of three components, hazard, exposure and vulnerability, aligning with the IPCC Sixth Assessment Report and the National Climate Risk Assessment (NCRA).

The risk evaluation method for this project included three core components, exposure analysis, vulnerability assessment and risk assessment, followed by a screening based on a criticality assessment. This section the method used for each assessment, including data sources, rating criteria, and integration steps.

2.1.1 Definition of risk

According to the IPCC Sixth Assessment Report (2022), risk is defined as the potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems.

In the context of climate change impacts, risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards. Hazards, exposure and vulnerability may each be subject to uncertainty in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making. These components are described in Figure 8 below.

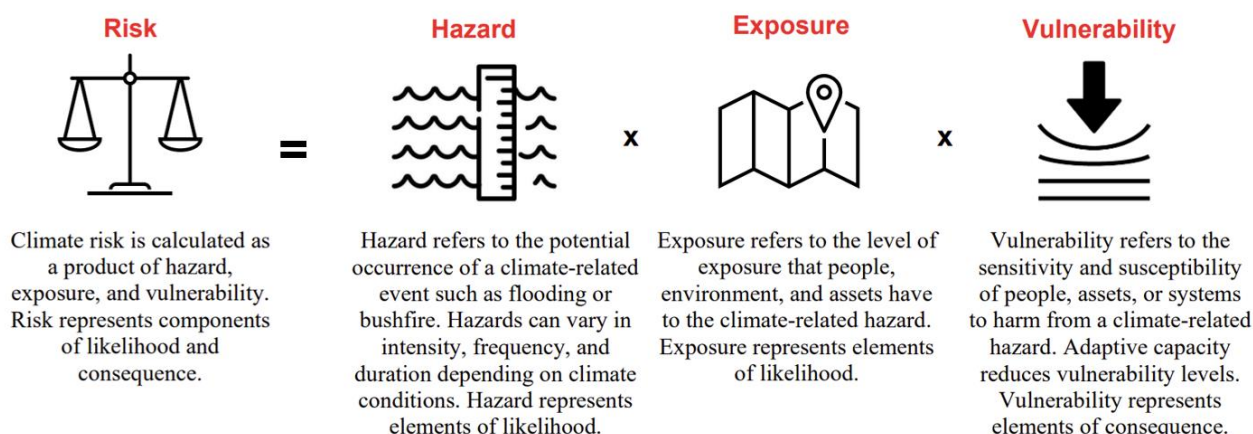


Figure 8: Composition of risk based on the IPCC Sixth Assessment Report 2022.

2.1.2 Asset-level to sector-level assessment

The analysis integrated three components of hazard, exposure and vulnerability to inform the assessment of risk. The results were then screened for criticality for selected asset types. The project employed a structured approach that builds from asset-level detail to sector-wide priorities, as illustrated in Figure 9.

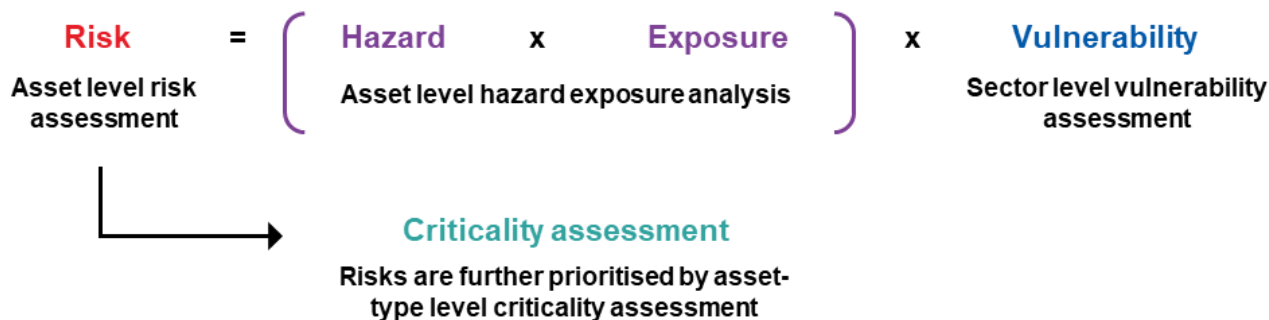


Figure 9: Visual summary of risk assessment components from asset-level detail to sector-wide priorities.

The assessment proceeds through the following key stages:

1. **Exposure analysis (asset level):** Individual existing infrastructure assets within the sectors set out in Section 1.4 were assessed against multiple climate hazards to determine their physical exposure. This asset-level analysis identified which specific infrastructure locations face climate threats, the type and severity of hazards they encounter, and how exposure varies across Victoria's diverse geographic and climatic regions.
2. **Vulnerability assessment (sector level):** Climate hazards affect different infrastructure types in different ways. Vulnerability was assessed at the sector level, examining how specific hazards impact the design, materials, operational requirements, and performance of different infrastructure categories. This recognised that assets within the same sector typically share common characteristics that influence their susceptibility to climate impacts.
3. **Risk determination:** Climate risk was calculated at the asset level by combining site-specific hazard exposure and sector-level vulnerability. This integration identifies which assets faced both significant hazard exposure and high susceptibility to impact, producing a comprehensive picture of climate risk across the infrastructure portfolio.
4. **Criticality assessment (asset type):** Not all at-risk assets warrant equal priority for adaptation investment. The criticality assessment evaluated the significance of potential failures based on asset type within sectors, considering physical, functional, and social factors including population served, economic consequences, and system interdependencies. This provided a strategic filter to focus resources on protecting the most critical infrastructure.

The sectors and asset types included in the scope of the overall assessment are shown in Figure 10. Section 2.5 summarises the asset types selected for the criticality assessment.

Asset types

Road Roads (including bridges)	Rail Rail track (including bridges) Stations Maintenance facilities and depots Tram track and stops	Ports Ports	Energy Generation Substations Transmission and distribution lines	Health Hospitals Specialist clinics Aged care Rehabilitation centres Community health centres Cemeteries
Education and training Schools TAFE Early childhood facilities Training centre	Cultural and community Museums and arts centres Community centres Sports facilities	Justice and community safety Correctional facilities Police stations Fire stations Ambulance stations Courts	Housing State-owned social housing Hostels Day centres Residences	Parks Access Buildings and services Cultural heritage assets Infrastructure services Landscaped assets Maritime and waterways Visitor facilities

Figure 10: Asset types within each sector of the study.

Several sectors were also considered out of scope including:

- Telecommunications were excluded as it is nationally regulated
- Water sector was excluded as a consolidated asset dataset was not readily available
- Non-fixed assets such as rolling stock, vehicles and vessels were excluded as the analysis was based on the geospatial location of fixed assets
- Ports were represented using the major ports dataset, rather than jetties and piers assets provided by VMIA
- Buildings and offices with no identifiable sector have not been assessed.

2.2 Climate scenarios and time horizons

Future climate scenarios are a useful tool for understanding the range of plausible climate futures and the projected changes to climate variables and hazards, helping to inform planning and adaptation for resilient infrastructure. They are defined using the latest global climate modelling framework, the Coupled Model Intercomparison Project Phase 6 (CMIP6), which underpins the IPCC Sixth Assessment Report (AR6). CMIP6 introduces shared socio-economic pathways (SSPs), which complement the representative concentration pathways (RCPs) used in the previous IPCC reports. These two sets of climate scenarios are defined as:

- SSPs are scenarios that describe possible futures in terms of population, gross domestic product (GDP), and other socioeconomic factors relevant to understanding the implications of climate change.
- RCPs are four different 21st century pathways of greenhouse gas emissions and atmospheric concentrations, air pollutant emissions and land use.

RCPs represent the range of greenhouse gas emissions in the wider literature and include a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0), and one scenario with very high greenhouse gas emissions (RCP8.5).

SSPs complement RCPs with varying socio-economic challenges to adaptation and mitigation. Based on five narratives, SSPs describe alternative socio-economic futures, comprising sustainable development (SSP1), regional rivalry (SSP3), inequality (SSP4), fossil-fuelled development (SSP5), and middle-of-the-road development (SSP2). The IPCC has adopted the SSPs for use in their Assessment Reports from the most recent (Sixth) in combination with the RCPs, however not all of the data from these scenarios have been downscaled, and so in some instances, RCPs from the previous CMIP may be used.

Figure 11 shows the projected average global temperatures under five possible emissions scenarios (very low, low, intermediate, high) up to 2100 relative to the 1850-1900 average (IPCC, 2021).

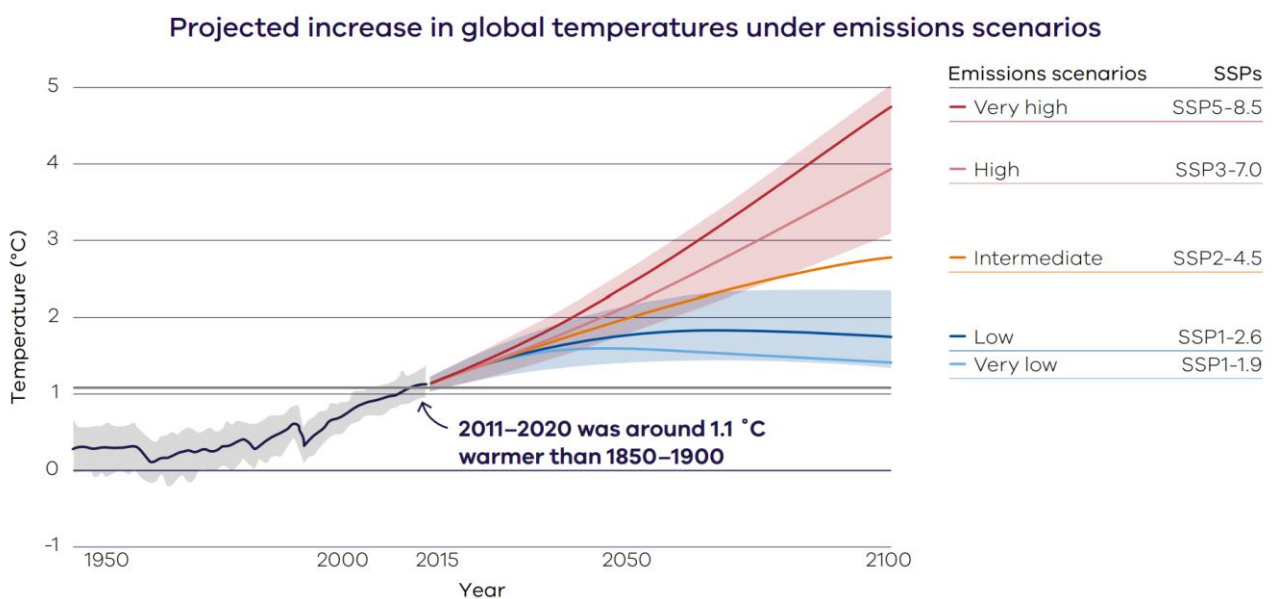


Figure 11: Projected average global temperatures under five emissions scenarios where the black line shows observational data of global average temperature from 1950 to 2015 and the blue (low) and pink (high) shading represents the range of uncertainty for emissions scenarios. Source: (DEECA, 2024).

This project adopted two climate scenarios consistent with Victoria’s Climate Science Report 2024:

- SSP1-2.6 (low emissions scenario). This results in a projected global mean surface air temperature increase of 1.3–2.4°C, with a best estimate of 1.8°C (2.6 W/m² by the year 2100).
- SSP3-7.0 (high emissions scenario). This results in a projected global mean surface air temperature increase of 2.8–4.6°C, with a best estimate of 3.6°C. (7 W/m² by the year 2100).

The project aimed to understand how existing assets that will be exposed to climate hazards over the next 30 years. These scenarios were considered under two time horizons:

- 2030 which corresponds with the update cycle for Victoria’s sectoral adaptation action plans
- 2070 which aligns with asset lifetimes of existing and planned infrastructure.

These time horizons provided an appropriate basis for considering how existing infrastructure can be adapted to future climate conditions.

Geospatial climate hazard data was used to assess baseline and future scenario exposure to extreme heat, drought and bushfire. Exposure to flood, landslide and damaging wind was assessed using baseline data

only, while coastal inundation was assessed for future scenarios. The scenarios assessed for each hazard are summarised in Table 2 below.

The results presented in this report focus on the low emissions 2030 and high emissions 2070 scenarios.

Table 2: Scenarios assessed for each hazard.

Hazard	Baseline scenario	Future scenarios
Extreme heat, bushfire, drought	1986 – 2005	<ul style="list-style-type: none"> – Low emissions 2030 – High emissions 2030 – Low emissions 2070 – High emissions 2070
Damaging wind	2006 – 2023 weather station wind data	Assumed same as baseline.
Flood	Historical 1 in 100 year flood levels	Assumed same as baseline.
Coastal inundation	Not assessed	<ul style="list-style-type: none"> – Low & high emissions 2030 (20cm) – High emissions 2070 (47cm)
Landslide	1980 – 2018 rainfall data	Assumed same as baseline.

2.3 Exposure analysis

An exposure analysis determines the presence of assets that are in areas affected by climate hazards (IPCC, 2022). It identifies which assets are most exposed under current and future climate scenarios, providing a spatial understanding of risk drivers.

The exposure analysis evaluated the level of exposure for all assets identified for the project to climate hazards under both current and future climate scenarios. The exposure analysis followed three steps:

1. Defining hazard-specific exposure rating levels that classify exposure on a five-point scale, from level 1 to level 5, based on established hazard intensity thresholds.
2. Using geographic information system (GIS) analysis, spatial overlays were applied to intersect infrastructure asset locations with climate hazard layers, enabling systematic identification of exposure across baseline and projected scenarios.
3. Exposure ratings were assigned to each asset for all relevant hazards, allowing comparison across time horizons and emissions scenarios.

The outputs of this analysis included key metrics such as the percentage of asset value exposed to climate hazards and the total value of exposed assets (in monetary terms largely using insured values), and the asset value exposed within each sector. The results of the exposure analysis are set out in Section 3.

2.3.1 Hazard screening

Climate hazards and climate scenario data were shortlisted for inclusion based on consistency with relevant studies – including the National Climate Change Risk Assessment 2025, Infrastructure Victoria’s Weathering the Storm (Phase 2), Victoria’s Climate Change Strategy 2021, and Victoria Climate Science Report 2024 – as well as their materiality for infrastructure assets in Victoria, and data quality and availability. Following the review of these studies, Table 3 below shows the climate hazards included in the exposure analysis. For each hazard, corresponding climate variables were identified as proxy indicators, and the available datasets for these variables are summarised below.

Table 3: Climate data for shortlisted climate hazards.

Climate hazard	Hazard data description	Data source	Gridded dataset resolution	Baseline data	Scenarios available	Timeframes available
Extreme heat	Number of days over 35 degrees	NARClim 2.0	4km	1986 – 2005	SSP1-2.6, SSP2-4.5 and SSP3-7.0	Continuous data from 1950 to 2100
Bushfire	Burn probability based on bushfire susceptibility factors	Developed by Arup based on methodology from academic literature ²	100m	Combines factors including vegetation type and topography with historical bushfire data to estimate burn susceptibility of the land cover, assumed to stay constant over time.		
	Forest fire danger index (FFDI) for future scenarios	NARClim 2.0	4km	1986 – 2005	SSP1-2.6, SSP2-4.5 and SSP3-7.0	Continuous data from 1950 to 2100
	Bushfire Management Overlay	VicPlan	Extent aligned to overlay	Identifies areas of very high to extreme bushfire hazard. No future projections.		
Drought	Consecutive dry days	NARClim 2.0	4km	1986 – 2005	SSP1-2.6, SSP2-4.5 and SSP3-7.0	Continuous data from 1950 to 2100
Damaging winds	Number of days with exceeding wind threshold (35m/s)	Bureau of Meteorology	Based on closest weather station to asset location.	2006 – 2023	CSIRO advises that the best estimate for future severe convective wind is the present day value.	
Flood	Land Subject to Inundation Overlay, Floodway Overlay, and Special Building Overlay	VicPlan	Extent aligned to flood overlay	Based on historical 1 in 100 year flood levels. No future projections.		
Coastal inundation	Sea level rise	CoastKit Victoria (Victorian Coastal Inundation Dataset) – adapted ³	Extent aligned to inundation overlay	×	20cm, 47cm, 82cm (1.1m for Port Philip Bay)	Approximately 2040, 2070 and 2100 ³
Rainfall-induced landslide	Landslide susceptibility	Global landslide hazard map, published by World	1km	Based on 1980 – 2018 rainfall data. No future projections.		

² Bushfire susceptibility was derived from national historical bushfire data, slope, and land-cover/vegetation datasets, using a peer-reviewed methodological framework (Verde, J. C., & Zêzere, J. L., 2010).

³ For the purpose of this study, sea level rise has been adapted from the Coast Kit dataset, to include consideration of CMIP6, as referenced in McInnes & Zhang (2024), which finds that the timeframes and rate of sea level rise are accelerating faster than indicated by the datasets used for Coast Kit. This recent research underpins our assumption that the 2040 20cm sea level rise dataset from Coast Kit is most relevant for both the 2030 timeframe high and low emissions scenarios due to the overlap in confidence interval projections in the short term; and that 47cm is relevant for the SSP3-7.0 2070 scenario.

Climate hazard	Hazard data description	Data source	Gridded dataset resolution	Baseline data	Scenarios available	Timeframes available
		Bank Group and developed by Arup ⁴				

Suitable future climate projection data were not available for the following hazards:

- Flood was based on flood overlays, which generally reflect the historical 1 in 100 year flood extent. Flooding is expected to increase in future climate scenarios. A suitable geospatial dataset that reflects future flood inundated areas is under development by CSIRO but was not available for this project.⁵ In addition, other future flood studies are underway such as Melbourne Water’s Greater Melbourne Flood Information Program (Melbourne Water, 2025).
- Damaging wind was based on historical recorded wind speed data from Bureau of Meteorology weather stations, using one-minute data from 2006 to 2023. Future projections are available for daily average wind speeds. However, these do not provide a good indication of the extremes over very short time periods, which are more likely to cause damage and downtime to infrastructure assets. There is considerable uncertainty in how severe wind may change in future climate scenarios.
- Landslide susceptibility is based on a model that uses historic median rainfall (1980-2018) as well as soil and ground conditions. Rainfall is expected to change in future climate scenarios, influencing rainfall induced landslides. It was outside the scope of this project to consider how future changes in rainfall would affect the landslide susceptibility.

The following climate hazards were excluded from the exposure analysis either due to data availability constraints or because they are not relevant to infrastructure assets in Victoria:

- Extratropical storms
- Convective storms
- Coastal erosion
- Ocean warming and acidification
- Snow depth decline.

2.3.2 Combining spatial hazard and asset data

The Victorian Managed Insurance Authority (VMIA) provided asset data (as of October 2025), for all sectors under analysis, excluding energy and ports. The data included property types, location and insured value on an asset basis and summary data of past claims paid from climate-related events on a sector basis.

Asset location data for the energy and port infrastructure sectors was sourced from the Digital Atlas of Australia and VicMap, as shown in Table 4.

Table 4: Ports and energy asset data sources.

Asset type	Data source	Dataset name
Ports	Digital Atlas of Australia (Geoscience Australia)	Major maritime ports
Electricity generation	Digital Atlas of Australia (Geoscience Australia)	Major power stations

⁴ Global dataset estimating the annual frequency of significant landslides ($\geq 100 \text{ m}^2$) per km^2 for all land areas between 60° S and 72° N . Includes separate frequency estimates for rainfall- and earthquake-triggered landslides, representing events likely to have been reported if occurring in populated areas. Rainfall-triggered landslide frequencies are provided using mean and median rainfall values for the period 1980 to 2018. This dataset does not consider the impacts of rockfall.

⁵ CMIP5 national hydrological projections, expected to be published at *Bureau of Meteorology Australian Water Outlook Service Data Collection*. Retrieved from https://geonetwork.nci.org.au/geonetwork/srv/eng/catalog.search#/metadata/f6683_9441_8676_1139

Asset type	Data source	Dataset name
Electricity transmission lines	Digital Atlas of Australia (Geoscience Australia)	Electricity transmission lines
Electricity transmission substations	Digital Atlas of Australia (Geoscience Australia)	Transmission substations
Electricity distribution lines	VicMap	VicMap Infrastructure - Power Line

Geospatial analysis was undertaken to combine the hazard and asset datasets, based on asset locations and the exposure rating matrices defined in the next section.

2.3.3 Assigning exposure ratings

Exposure ratings were assigned using a five-point scale ranging between level 1 to level 5 with hazard-specific thresholds. Within the reporting of results, exposure levels level 4 and 5 are collectively referred to as high exposure. These exposure ratings were defined in a hazard-specific way that considers the thresholds for impact from each hazard. The hazard ratings were defined to consider hazard probability as far as possible.

The exposure matrices that define the hazard ratings are set out for each hazard in Table 5 to Table 12 below. The thresholds defined for each hazard ratings are based on input from Arup's subject matter experts as well as project experience across various infrastructure sectors.

Table 5: Extreme heat hazard exposure matrix.

Hazard matrix	Number of days over 35 degrees as a % of days per year				
	> 20%	10 – 20%	5 – 10%	1 – 5%	< 1%
Hazard ratings	Level 5	Level 4	Level 3	Level 2	Level 1

Table 6: Bushfire hazard exposure matrix (assets inside a bushfire management overlay).

Hazard matrix (assets in a BMO)		Number of days per year of severe FFDI				
		≥10	≥5 & <10	≥3 & <5	≥1 & <3	<1
Bushfire susceptibility	First quintile	Level 5	Level 5	Level 5	Level 4	Level 4
	Second quintile	Level 5	Level 5	Level 4	Level 4	Level 3
	Third quintile	Level 5	Level 4	Level 4	Level 3	Level 3
	Fourth quintile	Level 4	Level 4	Level 3	Level 3	Level 2
	Fifth quintile	Level 4	Level 3	Level 3	Level 2	Level 2

Table 7: Bushfire hazard exposure matrix (assets outside a bushfire management overlay).

Hazard matrix (assets not in a BMO)		Number of days per year of severe FFDI				
		≥10	≥5 & <10	≥3 & <5	≥1 & <3	<1
Bushfire susceptibility	First quintile	Level 5	Level 4	Level 4	Level 3	Level 3
	Second quintile	Level 4	Level 4	Level 3	Level 3	Level 2
	Third quintile	Level 4	Level 3	Level 3	Level 2	Level 2
	Fourth quintile	Level 3	Level 3	Level 2	Level 2	Level 1

	Fifth quintile	Level 3	Level 2	Level 2	Level 1	Level 1
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Table 8: Drought hazard exposure matrix.

Hazard matrix	Consecutive dry days per year (days)				
	≥90	≥75	≥60	≥45	<45
Hazard ratings	Level 5	Level 4	Level 3	Level 2	Level 1

Table 9: Damaging wind hazard exposure matrix.

Hazard matrix	Number of days per year with winds above 35m/s				
	> 2	0.5 – 2	0.25 – 0.5	0.01 – 0.25	< 0.01
Hazard rating	Level 5	Level 4	Level 3	Level 2	Level 1

Table 10: Flood hazard exposure matrix.

Hazard matrix	Flood overlays		
	Within overlay	Within 10m buffer	Outside buffer
Hazard ratings	Level 4	Level 3	Level 2

Table 11: Coastal inundation hazard exposure matrix.

Hazard matrix	Coastal inundation areas		
	Within sea level rise area	Within storm tide area	Outside inundated area
Hazard ratings	Level 5	Level 4	Level 1

Table 12: Landslide hazard exposure matrix.

Hazard matrix	Landslide susceptibility				
	Very high	High	Moderate	Low	Very low
Hazard ratings	Level 5	Level 4	Level 3	Level 2	Level 1

2.4 Vulnerability assessment

Vulnerability refers to the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2022). Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2022).

A vulnerability assessment identifies and evaluates how susceptible assets and systems are to damage and disruption when exposed to climate hazards. It encompasses sensitivity to harm and the capacity to cope and adapt (DEECA, 2024).

For this project, the vulnerability assessment examined the susceptibility of infrastructure sectors to damage and service disruption when exposed to climate hazards. The assessment followed the steps below:

1. Vulnerability statements were developed for the two principal impact pathways: physical damage and operational downtime.
2. Vulnerability ratings were assigned for each sector-hazard combination for physical damage and operational downtime based on the probable consequences of exposure. This was based on evidence was

sourced from a range of materials, including data on asset conditions, records of past climate events, insurance claims, and research on adaptive capacity⁶.

3. Commentary was prepared for each of the sector-level vulnerability ratings to justify and summarise the potential impacts of each hazard scenario on the respective sectors.

The outputs of this assessment included sector-level vulnerability ratings and concise vulnerability statements, which provided a clear narrative of how each sector may be affected by the climate hazards. The vulnerability scores are applied to all scenarios, and therefore the changes in risk profile between 2030 and 2070 scenarios is driven by changes in hazard exposure only. The results of the vulnerability assessment are set out in Section 4.

2.4.1 Developing vulnerability statements

Vulnerability statements were developed for each sector, and for each hazard, to set out the possible vulnerability pathways, expressing the consequences and impacts for damage and downtime in the sector as a result of the specific climate hazard occurring. These pathways articulate the systems, processes and conditions that lead to the sectors and assets becoming more susceptible to harm from climate related hazards, through impacts of damage and downtime.

- Damage considers the physical damage to assets and sectors which would require repair, maintenance or complete replacement as a result of a hazard.
- Downtime is the impact of exposure that the hazard has to operations or usage of the asset, which can also be caused by the impact of the physical damage to the operability of the asset and sector.

For each sector there were 14 statements developed, encompassing both downtime and damage for each hazard. The statements were developed based on a comprehensive review of academic and industry literature and supplemented by inputs from Arup’s subject matter experts to articulate the specific impacts and consequences of climate hazards. The references and evidence base used to support the analysis are provided in Appendix B.

2.4.2 Rating vulnerability

A vulnerability assessment was undertaken to determine two scores for each sector, one each for the vulnerability pathways of physical damage and downtime.

The vulnerability ratings were assigned on a three-point scale of high, moderate and low, as shown in Table 13. The ratings were based on several evidence sources, including VMIA claims data, vulnerability curves, historical damage data, and average condition and age for the sector.

Table 13: Vulnerability rating criteria.

Rating	Physical damage pathway	Downtime pathway
High	Exposure to the hazard would result in severe or widespread physical damage across key systems or assets.	Exposure to the hazard would lead to prolonged or widespread service disruption, significantly impairing sector operations.
Moderate	Exposure to the hazard would cause moderate, repairable physical damage to some systems or assets. Sector-wide safeguards reduce the likelihood of severe loss.	Exposure to the hazard would cause temporary or localised service disruption. Restoration is achievable within a moderate timeframe using existing contingency or redundancy.
Low	Exposure to the hazard would cause little to no physical damage, with systems and assets largely able to withstand impacts.	Exposure to the hazard would cause minimal or no service interruption. The sector maintains functionality or rapidly recovers through redundancy and established response protocols.

⁶ Adaptive capacity is the ability of institutions, systems, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of environmental variability and change (IPCC, 2022). The vulnerability assessment takes into account how the assessed infrastructure sectors may adjust or respond to climate hazards based on published literature and records of responses to past climate events.

2.4.3 Developing justification paragraphs for each sector

The justification paragraphs for the vulnerability assessment were developed to clearly articulate the evidence and reasoning behind the vulnerability ratings assigned to each infrastructure sector. This process involved synthesising information from literature reviews, expert judgment, historical climate event records, insurance claims, and data on asset conditions. For every sector, the justification paragraphs provide a concise narrative explaining the rationale for the rating, ensuring that the vulnerability assessment is grounded in robust evidence and sector-specific expertise.

2.5 Criticality assessment

A criticality assessment determines the importance of assets in maintaining essential community functions and services. Criticality can help prioritise adaptation investment as it considers factors such as population served, redundancy, recovery time, and interdependencies to identify assets whose failure would have significant cascading impacts (Infrastructure Victoria, 2024).

The criticality assessment determined the relative importance of infrastructure asset types under climate stress. The assessment included the following steps:

1. Arup and Infrastructure Victoria worked together to determine 17 asset types from within the infrastructure sectors included in the criticality assessment.
2. A multi-criteria analysis (MCA) framework was developed with nine criteria that considered factors based on physical, social and functional attributes.
3. 17 asset types were assessed, with scores assigned based on evidence from stakeholder input, spatial data, and expert analysis. Evidence to inform the assessment was gathered, including input from Arup's subject matter experts and published literature. The scores were then validated in a workshop with the Infrastructure Victoria and Arup project team, which integrated input from relevant stakeholder discussions conducted by Infrastructure Victoria.

The outputs of this assessment included criticality scores for each asset type and an interdependency map, providing a transparent basis for prioritising assets that, if disrupted, would have significant cascading impacts across sectors. The results of the criticality assessment are set out in Section 5.4. The references and evidence base used to support the analysis are provided in B.9.

2.5.1 Selecting asset types

In the criticality assessment, 17 asset types were assessed using a multi-criteria framework. These included assets that:

- meet criteria used to measure criticality, and therefore are likely to be critical,
- have high exposure to at least one hazard, and
- provide representation of asset types across each of the infrastructure sectors.

The asset types screened into the criticality assessment are set out in Figure 12 below.

Asset types

Road	Rail	Ports	Energy	Health
Roads (including bridges)	Rail track (including bridges)	Ports	Generation	Hospitals
	Stations		Substations	Specialist clinics
			Transmission and distribution lines	Aged care
Education and training	Cultural and community	Justice and community safety	Housing	Parks
Schools	Museums and arts centres	Correctional facilities	Housing	
TAFE	Community centres and community health centres	Fire and police stations		

Figure 12: Asset types included in criticality assessment.

Note that community health centres were grouped with community centres for the purpose of the criticality assessment, as they provide similar functions in communities. For the risk assessment, community health centres are considered in the health sector.

2.5.2 Developing criteria for assessment

The assessment criteria are based on the physical, functional and social attributes, defined as follows by PIARC (2023) (adjusted for all asset types rather than just roads):

- **Physical:** related to the economic consequences of loss or damage to the asset and its elements, represent the physical magnitude of the asset. This includes the direct cost of repair or replacement of the asset, as well as wider environmental and economic impact.
- **Social:** related to the social characteristics of the area influenced by the asset can be affected by asset failure.
- **Functional:** related to the operational consequences that loss or damage may cause in terms of asset functionality.

The assessment criteria were developed based on a literature review of infrastructure criticality studies. The assessment criteria are set out in Table 14 overleaf.

Table 14: Criticality assessment criteria showing the rating framework.

	Criteria	Definition	Low (1)	Moderate (2)	High (3)
Social	Public safety	The potential risk to human life due to infrastructure failure.	Minor/no cases require hospital/ medical support.	Some people may require hospitalisation/medical support.	High/risk of large number of serious injuries and high need for immediate hospitalisation/medical support.
	Wellbeing and public health	The impact on mental health, social wellbeing, access to basic services, quality-of-life, community amenity.	Service disruption is inconvenient but manageable; limited effect on daily life or comfort	Noticeable disruption to wellbeing or amenity – e.g. temporary loss of water, transport, or services affecting lifestyle/comfort for a community.	Major disruption to social wellbeing/ amenity – e.g. prolonged loss of essential services, isolation, affecting large populations or vulnerable groups
	Affected population size and vulnerability	The number of individuals dependent on the asset and their susceptibility to service disruptions, including considerations of socioeconomic vulnerability, age, and mobility.	Small population affected; most individuals able to cope without significant hardship.	Moderate population or some vulnerable groups affected.	Very large population affected; disruption causes severe hardship for vulnerable groups at regional or state level.
Functional	Network redundancy	The availability of alternative services or routes to maintain service during disruptions.	Multiple redundancies exist; service continues uninterrupted.	Limited redundancy; partial service disruption but alternate options available.	Little or no redundancy; failure results in complete service loss, no viable alternatives.
	Recovery time and restoration capacity	The anticipated duration and complexity of restoring full functionality after asset failure, including the capacity of operators to respond.	Rapid recovery with minimal resources or effort required.	Moderate recovery time, some coordination and resource demands, but manageable with existing capacity.	Restoration is prolonged, complex, and resource-intensive, potentially requiring external support or specialised capabilities.
	Interdependencies	The degree to which failure disrupts other systems, services, or sectors.	Minimal interdependencies; failure largely contained.	Some critical services affected; limited knock-on effects.	Failure disrupts multiple sectors; cascading effects likely, may trigger systemic crisis.
Physical	Environmental impact	The potential for ecological, environmental, or long-term habitat damage resulting from asset failure, including pollution or natural resource degradation.	Negligible environmental impact; easily contained.	Localised environmental impacts; temporary or reversible damage.	Significant environmental damage; prolonged recovery of ecosystems required.
	Economic impact	The broader economic impact of asset failure, including disruption to economic activity, supply chains, labour productivity, business continuity, business isolation and public services.	Minor and short-lived economic disruption; localised business inconvenience with minimal productivity loss.	Noticeable economic disruption with measurable financial loss; temporary impacts on freight, supply chains, or commercial operations.	Significant regional economic hardship; major disruption to commercial activity or supply chains; substantial and persistent revenue losses.

	Criteria	Definition	Low (1)	Moderate (2)	High (3)
	Replacement value	The direct cost to repair or replace assets	Low capital value; repair or replacement costs are minor and easily accommodated within routine budgets.	Moderate capital value; repair or replacement costs require planned budgeting or reallocation of funds	High capital value; repair or replacement costs are substantial, potentially exceeding routine capital budgets and requiring significant new funding or multi-year investment commitments.

2.5.3 Assessing asset type criticality

For each selected asset type, scores were assigned to each criterion and added together to provide an overall score. Based on the scores of each criterion, each asset type can be categorised overall into ‘low’, ‘moderate’, or ‘high’ criticality using the score bands in Table 15.

Table 15: Criticality score categories and bands.

Category	Scoring band
Low	9-14
Moderate	15-19
High	20-27

The criticality assessment was undertaken on an asset type basis. The method, including criteria and definitions for low, moderate and high criticality can be applied to undertake an asset-level assessment.

2.6 Integrating risk findings and identifying areas for adaptation investment

Risk ratings were calculated by combining exposure and vulnerability scores, then a criticality filter was applied to highlight assets and sectors of greatest importance. This approach used a semi-quantitative formula shown in Figure 9. This integrated method ensured that priority risks reflect not only the likelihood of damage or disruption but also the societal and functional significance of the affected assets.

The outputs were presented using a risk matrix (Table 16), which categorised risks on a scale from level 1 to level 4, providing a clear basis to prioritise adaptation investments. Within the reporting of results, risk levels 3 and 4 are collectively referred to as high risk.

Note that a rating of level 1 does not imply there is no risk from climate hazards in the future – while assets may have a relatively low exposure rating, there could be significant consequences if an asset with a high vulnerability rating is impacted. However, the combination of exposure and vulnerability means that these factors combine to a relatively lower risk rating. The results of the risk assessment are set out in Section 5.

Table 16: Risk matrix combining hazard exposure and vulnerability ratings.

Risk matrix		Vulnerability rating		
		High	Moderate	Low
Exposure rating	Level 5	Level 4	Level 3	Level 2
	Level 4	Level 4	Level 3	Level 1
	Level 3	Level 3	Level 2	Level 1
	Level 2	Level 2	Level 2	Level 1
	Level 1	Level 1	Level 1	Level 1

The evaluation identified priority areas and asset types with high risk ratings and high criticality. Spatial and numerical analysis was used to identify areas and asset types for adaptation investment, including:

- Multi-hazard exposure hotspots, where assets face overlapping climate risks.
- Sectors with high vulnerability and limited adaptive capacity, indicating a greater need for resilience measures.
- Critical assets with cascading interdependencies, where failure could trigger widespread impacts across multiple sectors.

2.7 Limitations of the study

This study is subject to several important limitations that should be considered when interpreting the findings:

- **Scope of assessment:** The analysis focuses solely on the physical impacts of climate hazards on infrastructure assets and does not account for health and safety impacts to communities, or impact on natural assets (for instance, structures in parks are included, but parklands are not). This may understate the broader consequences for individuals, communities and service delivery.
- **Asset representation:** Both linear and non-linear assets, such as buildings, are represented as points in the geospatial analysis. This study uses a variety of different sources for geospatial analysis. Road, rail and energy data relating to linear assets have been included as geospatial points with different levels of granularity.
- **Data availability:** Relevant future hazard data are not available for flooding, damaging wind, and landslide hazards. This constrains the ability to assess future risks for these hazards comprehensively.
- **Hazard thresholds:** The study applies consistent hazard thresholds across all asset types. In practice, different assets are constructed to meet varying design thresholds and may respond differently to the

same hazard intensity. Additionally, the same hazard exposure thresholds have been applied to determine damage and downtime risks. The thresholds have generally been established in line with levels that would result in physical damage impacts to infrastructure, however service and comfort impacts may occur at lower levels, particularly for hazards such as wind and extreme heat.

- **Vulnerability assessment granularity:** Vulnerability is assessed at the sector level, without distinguishing between different asset types within each sector or accounting for individual asset characteristics such as age and condition. This may mask significant variations in vulnerability.
- **Asset valuation:** Asset values for energy and ports sectors were estimated rather than based on insured asset values from the VMIA, as used for other sectors. The approach and data sources used for the estimation is provided in Appendix D. For energy generation assets this is based on the capital cost to construct new assets of each fuel type. This introduces inconsistencies in the asset valuation approach.
- **Insurance claims paid data:** The VMIA provided summary data on insurance claims paid to inform the vulnerability assessment. Classification of claims information into the specific infrastructure sectors used in this analysis was not available, and therefore this information has only been used as a contributing consideration in the assessment. Note that infrastructure value at risk reported in this study is based on potential future impacts of climate hazards under the assessed climate scenarios using current insured value of assets, rather than past claims.
- **This report frames climate risks in terms of the value of affected assets for both damage and downtime.** Asset value is not the only metric to measure downtime and is not necessarily reduced during an event as an asset experiencing downtime typically retains its value despite service interruptions. Nonetheless, asset value has been selected as the metric as it allows for a comparison of damage and downtime risk across sectors.

These limitations highlight areas where further research and more detailed data could enhance the robustness and accuracy of future assessments.

This report discusses the results for the low emissions scenario (SSP1-2.6) in 2030 and the high emissions scenario (SSP3-7.0) in 2070, which represent the lower and upper bounds of the analysis. Other scenarios fall between these two extremes. Throughout this report, results are reported for these two bounding scenarios to illustrate the range of potential future exposure and risk.

3. Infrastructure exposure to climate hazards

3.1 Exposure to climate hazards varies across Victoria

Infrastructure assets across Victoria are exposed to different climate hazards depending on their location. The spatial distribution of each of the climate hazards assessed discussed below. Assets are assigned the exposure ratings shown based on their locations across the state and the hazard rating at that location.

3.1.1 Extreme heat

Exposure to extreme heat is highest in north-west Victoria and projected to increase across the state in future climate scenarios, extending areas of high exposure further south. Exposure maps for extreme heat are shown in Figure 13.

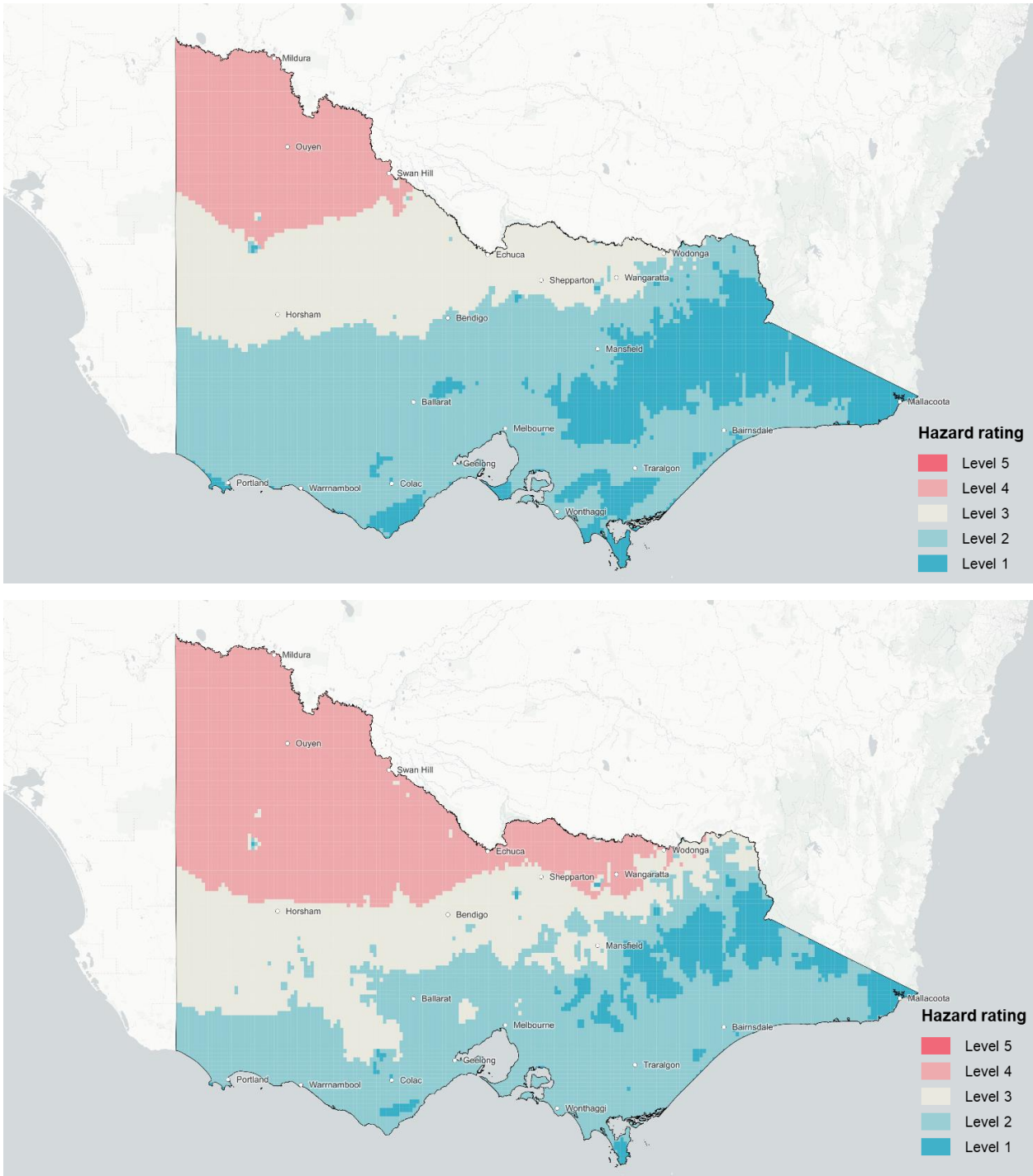


Figure 13: Extreme heat hazard exposure map for the low emissions scenario in 2030 (top) and high emissions scenario in 2070 (bottom).

3.1.2 Drought

Drought follows a similar exposure trend to extreme heat, with low exposure across the southern part of the state. Exposure to drought is projected to increase across the state in future climate scenarios, extending areas of high exposure further south. Exposure maps for drought are shown in Figure 14.

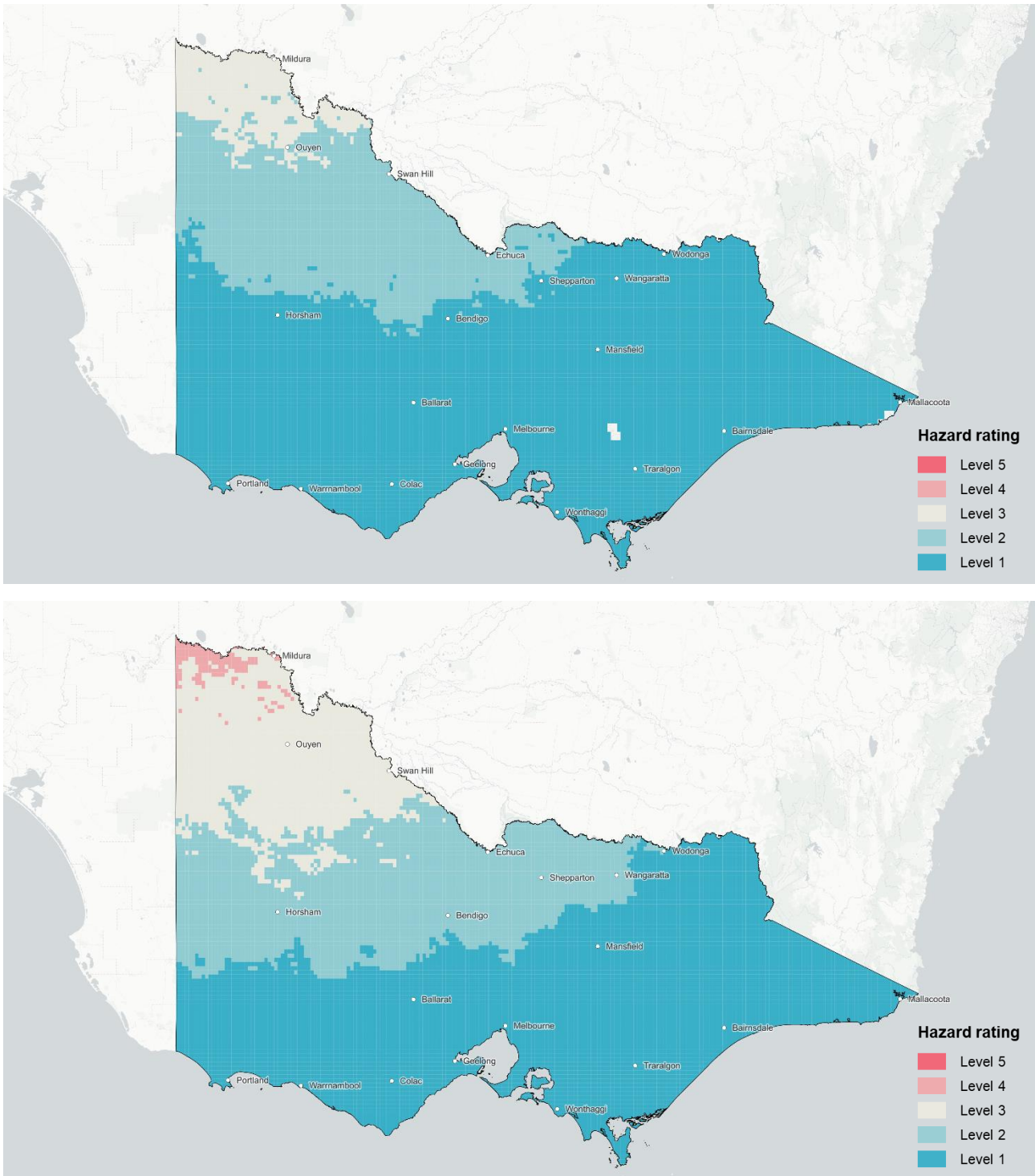


Figure 14: Drought hazard exposure map for the low emissions scenario in 2030 (top) and high emissions scenario in 2070 (bottom).

3.1.3 Bushfire

Bushfire weather (indicated by the forest fire danger index) follows a similar spatial pattern to extreme heat and drought and is similarly projected to increase in future scenarios. Combined with bushfire susceptibility factors that are high across eastern Victoria and northwest Victoria, this leads to highest bushfire exposure in northwest Victoria as shown in Figure 15. Areas of high bushfire exposure are also across central Victoria and national parks such as Wilsons Promontory, as well as eastern Victoria driven by the high bushfire susceptibility and vegetation in these locations.

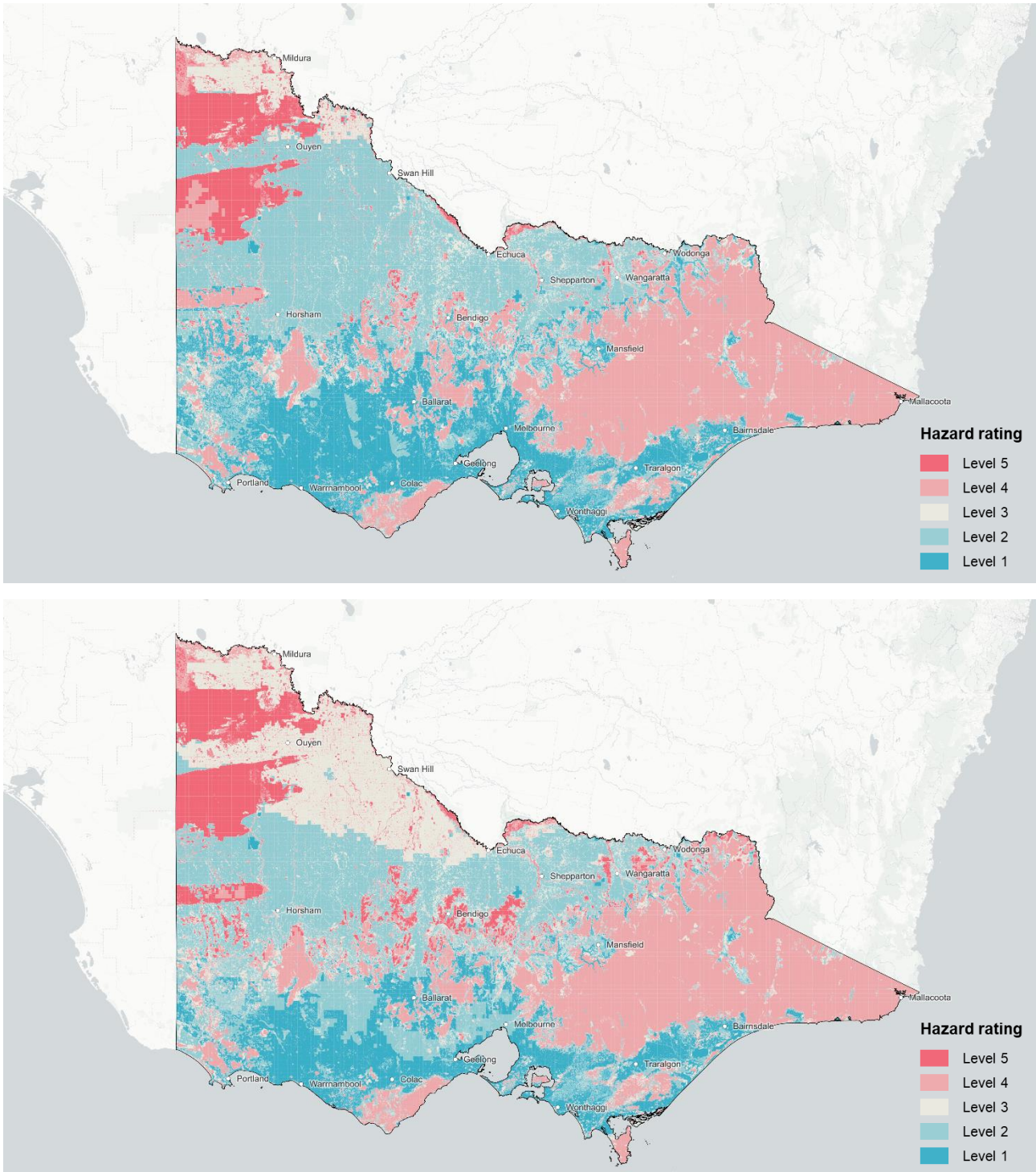


Figure 15: Bushfire hazard exposure map for the low emissions scenario in 2030 (top) and high emissions scenario in 2070 (bottom).

3.1.4 Flood

Flood exposure is localised in specific areas, particularly along river catchments in the northern and other parts of the state, as shown in Figure 16. Future hazard data is not available for flooding.

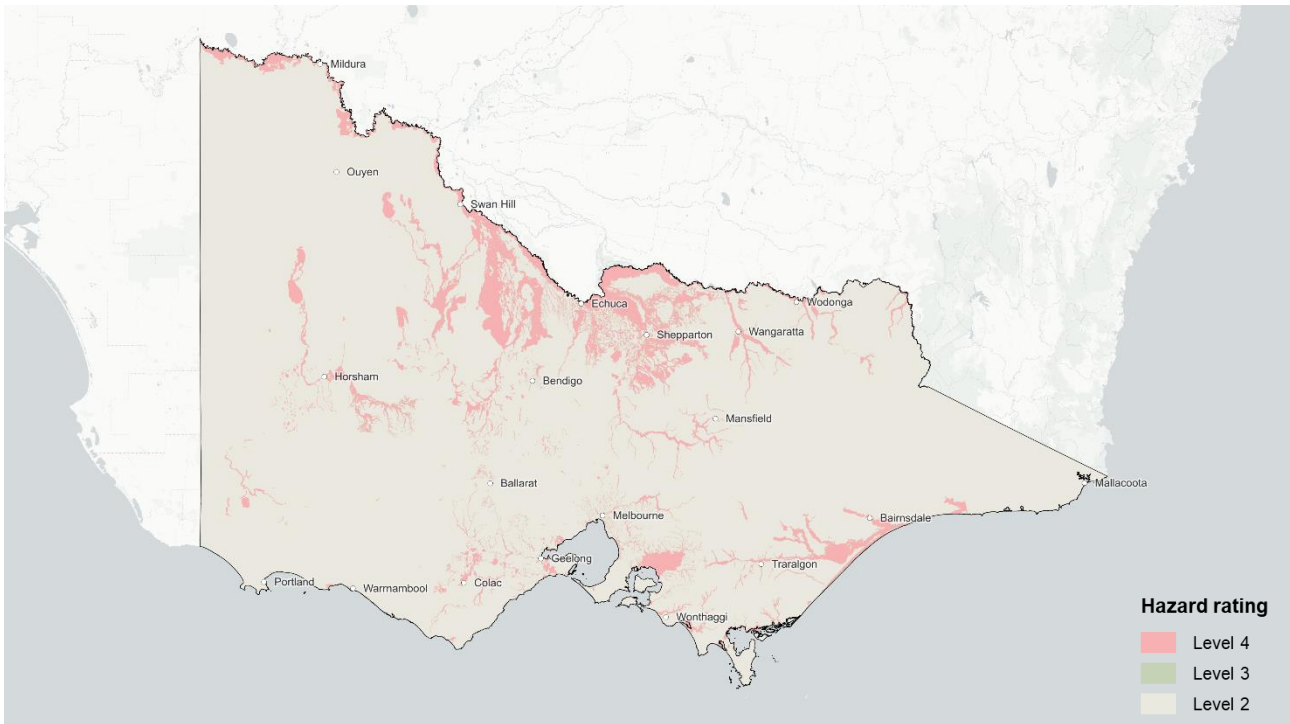


Figure 16: Flood hazard exposure map.

3.1.5 Landslide

Similarly, landslide exposure is highly localised in different areas across Victoria with a particular concentration in alpine areas, as shown in Figure 17. Future hazard data is not available for landslide.

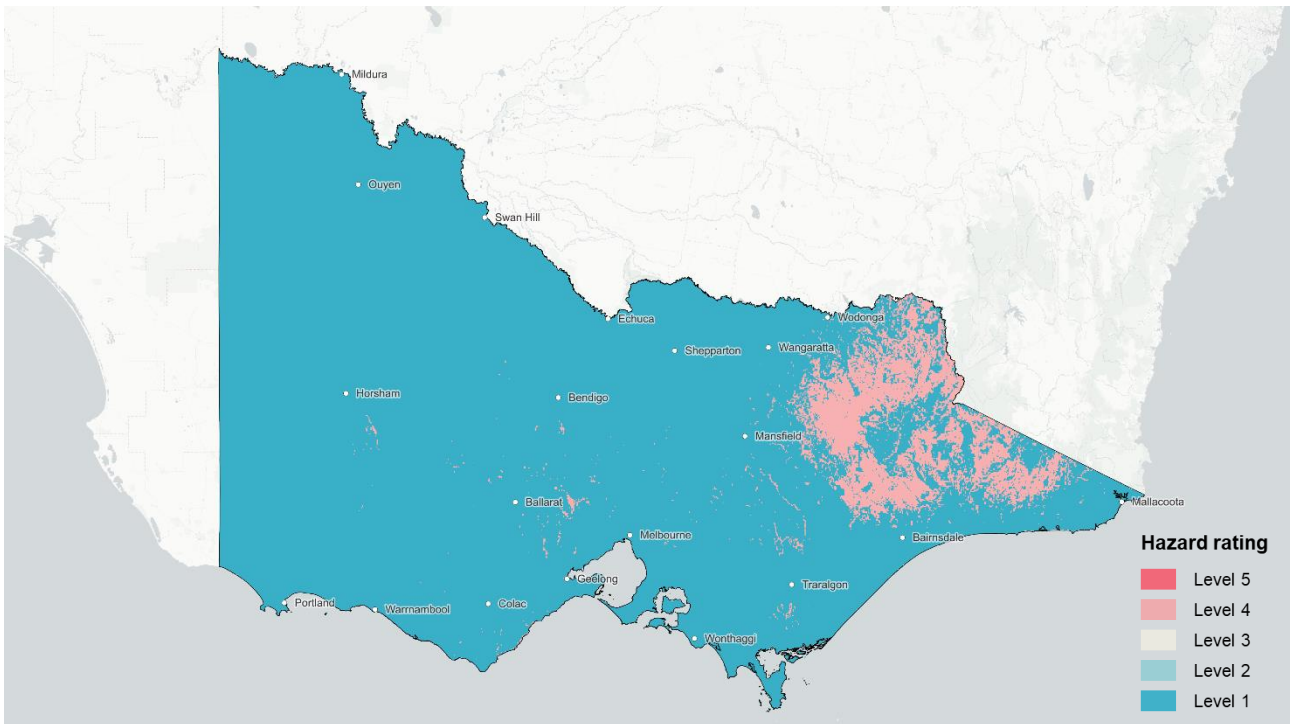


Figure 17: Landslide hazard exposure map.

3.1.6 Coastal inundation

Coastal inundation is highly localised along the coastline of Victoria, as shown in Figure 18 for 20cm inundation scenario in 2030. In the 47cm inundation scenario in 2070, exposure to sea level rise and storm surge extends further inland, as shown in Figure 19.

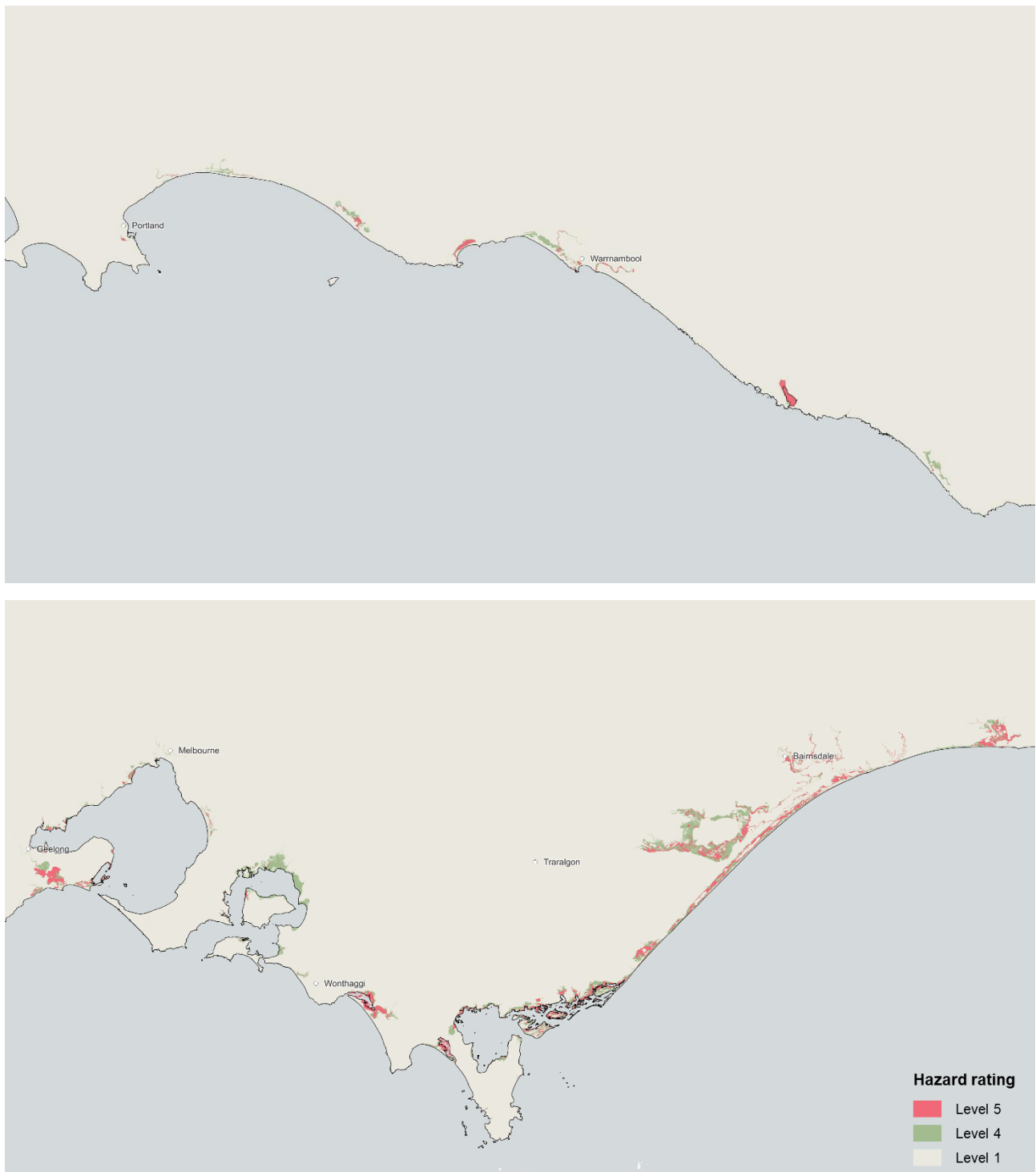


Figure 18: Coastal inundation hazard exposure map for the 20cm inundation scenario in 2030, for western Victoria (top) and eastern Victoria (bottom).



Figure 19: Coastal inundation hazard exposure map for the 47cm inundation scenario in 2070, for western Victoria (top) and eastern Victoria (bottom).

3.1.7 Damaging wind

There is low exposure to damaging winds across the majority of the state, with higher exposure in Wilsons Promontory, to the west near Horsham, and alpine areas, as shown in Figure 20. Future hazard data is not available for damaging wind.

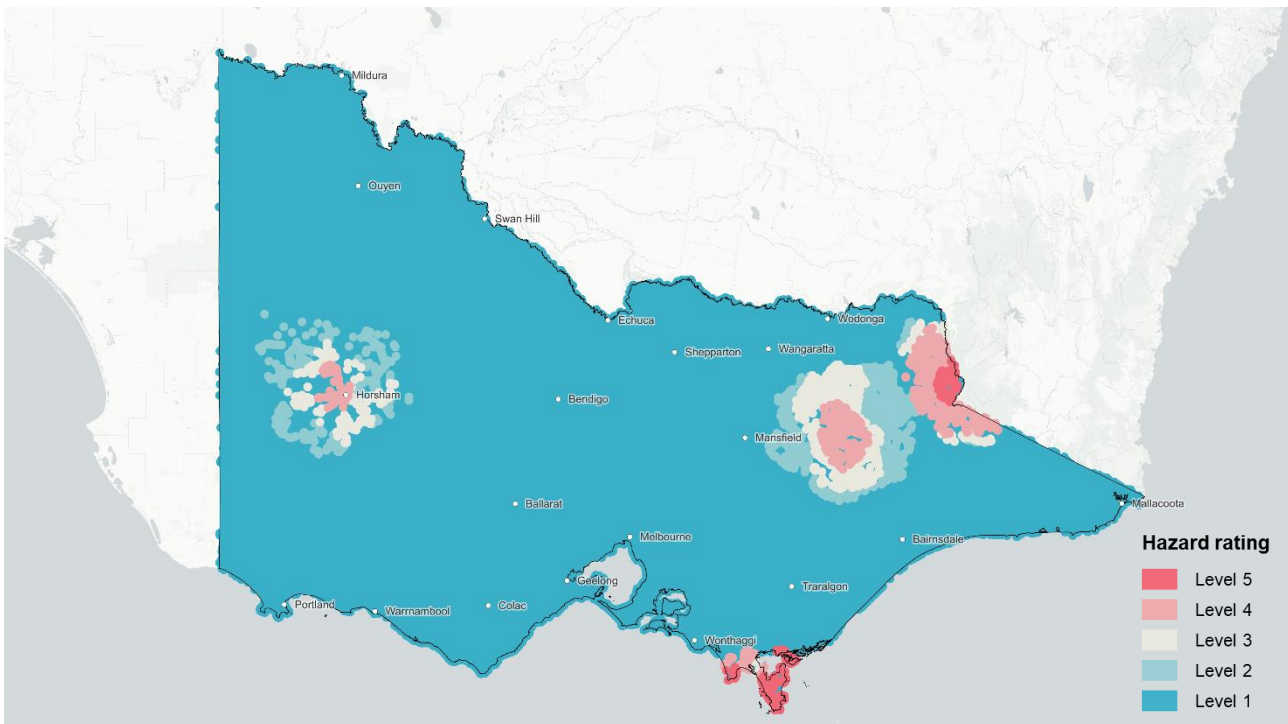


Figure 20: Damaging wind hazard exposure map.

3.1.8 Asset exposure to climate hazards

The exposure assessment considers not only the spatial patterns of climate hazards, discussed above, but also the locations of Victorian infrastructure assets. State-wide, the asset value with high (level 4 or 5) exposure to at least one climate hazard is shown in Figure 21 for the low emissions scenario in 2030 (top) and for the high emissions scenario in 2070 (bottom).

This map highlights a pattern of high exposure under the low emissions scenario in 2030 that aligns to population centres across Victoria, particularly around metropolitan Melbourne and regional centres such as Geelong, Shepparton, Wodonga, Bendigo, Warrnambool, and Mildura.

Under the high emission scenario in 2070, exposure to at least one hazard is concentrated in metropolitan Melbourne and regional centres, such as Geelong, Portland, Horsham, Bendigo, Wangaratta, Wodonga, Shepparton, Echuca, Swan Hill, Ouyen and Mildura. There is increased exposure particularly congregated to the north of the state, and north-west demonstrating increased exposure to climate hazard.

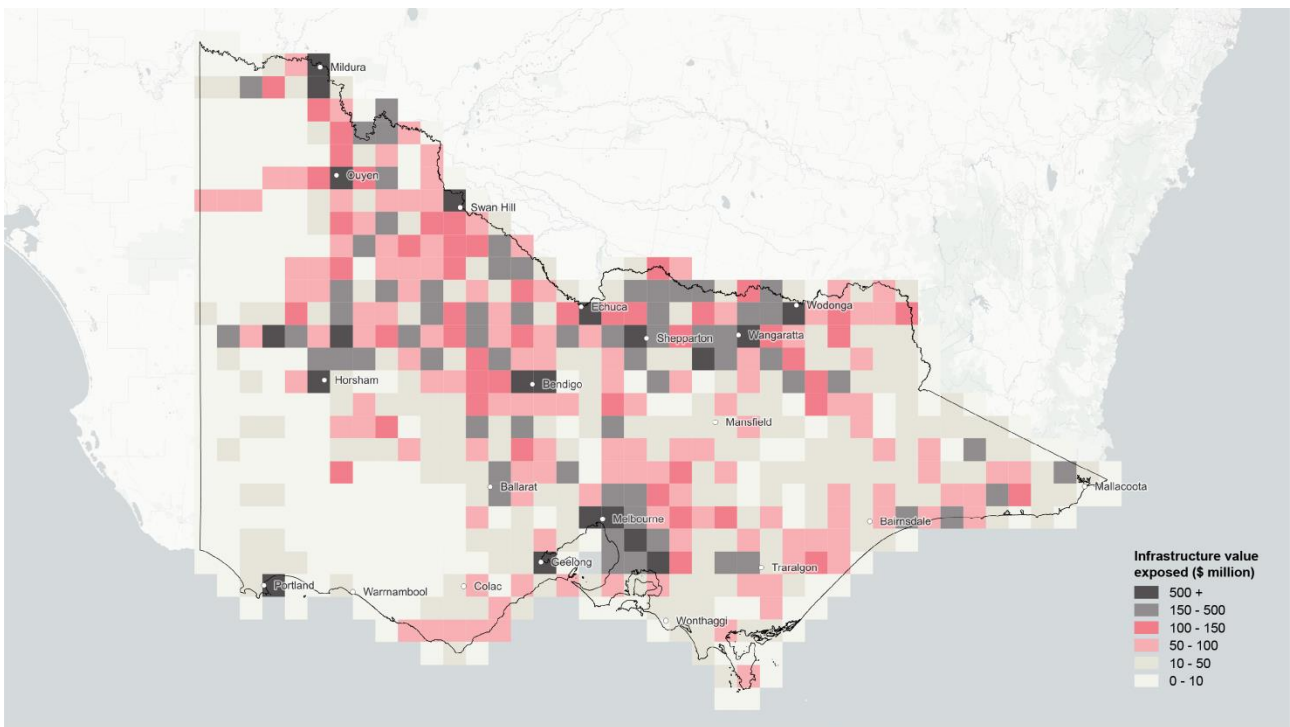
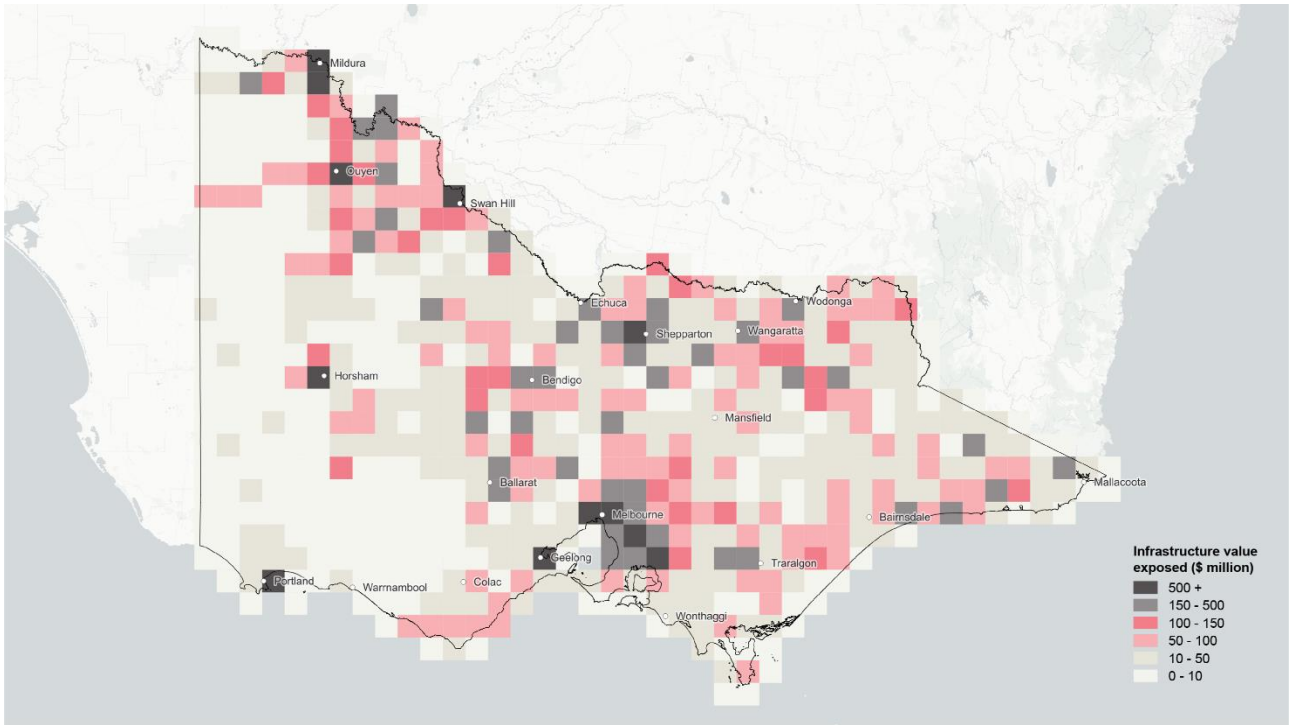


Figure 21: Distribution of infrastructure asset value with high exposure to at least one climate hazard by 25km grid square for the low emissions scenario in 2030 (top) high emissions scenario in 2070 (bottom).

3.2 Some sectors are more exposed than others under a changing climate

There is significant variation in climate hazard exposure across Victoria's infrastructure sectors, with all sectors (apart from ports) projected to experience increases in exposure to at least one hazard and to multiple hazards by 2070 under a high emissions scenario relative to the low emissions scenario in 2030. This section discusses the trends in asset value across sectors with high levels (level 4 or 5) of hazard exposure.

The proportion of infrastructure sectors based on asset value with high exposure to climate hazards is visualised in Figure 22. Under a low emissions scenario in 2030, 14% (\$45.8b) of Victorian infrastructure assets by value have high exposure to at least one climate hazard. Under a high emissions scenario in 2070,

this proportion increases to 19% (\$61.3b), representing an escalation in climate hazard exposure across the state's infrastructure portfolio.

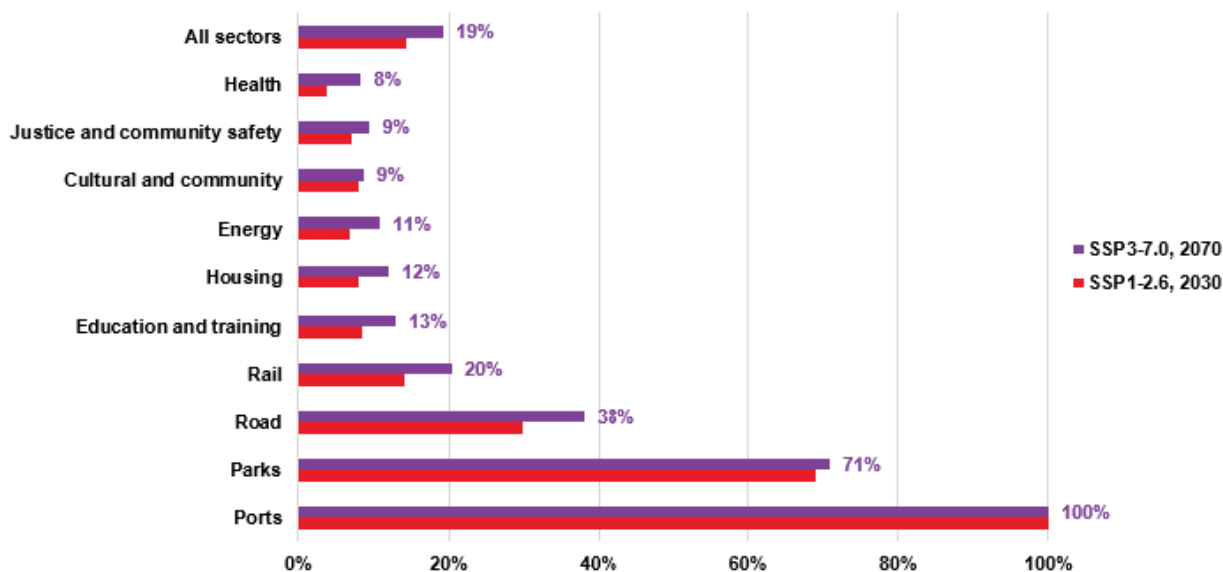


Figure 22: Proportion of infrastructure sectors by asset value with high exposure to at least one climate hazard under changing climate conditions.

3.2.1 Higher exposure sectors

Infrastructure in ports (discussed further in section 3.2.3), parks, road, and rail sectors have the most asset value with high exposure under future climate conditions, particularly to extreme heat and bushfire.

Infrastructure in parks is highly exposed in both under SSP1-2.6 2030 (\$1.72b, 69%) and SSP3-7.0 2070 (\$1.76b, 71%) to at least one hazard. This is predominantly associated with the exposure to bushfire, which aligns with the geospatial distribution of park sectors assets.

Road infrastructure with high exposure to at least one hazard is projected to increase from 30% (\$19.2b) of asset value under SSP1-2.6 2030 to 38% (\$24.2b) under SSP3-7.0 2070, associated with bushfire, extreme heat and drought. For rail infrastructure this value increases from 14% (\$5.7b) under SSP1-2.6 2030 to 20% (\$8.3b) under SSP3-7.0 2070.

3.2.2 Lower exposure sectors

The proportion of infrastructure value facing high exposure is lower across the other sectors, including education and training, housing, cultural and community, and energy sectors. Education and training infrastructure with high exposure to at least one hazard is projected to increase from 8% (\$2.8b) of asset value under SSP1-2.6 2030 to 13% (\$4.3b) under SSP3-7.0 2070. For housing this value increases from \$1.7b under SSP1-2.6 2030 to \$2.4b under SSP3-7.0 2070. For cultural and community infrastructure this value increases from \$0.95b under SSP1-2.6 2030 to \$1.0b under SSP3-7.0 2070.

While the energy sector has relatively low exposure based on proportion of asset value, it is the highest value sector at \$81.2b, so a minor increase in the proportion of asset value with high exposure between scenarios results in a significant increase in asset value exposed. The asset value with high exposure in the energy sector increases from 7% (\$5.6b) of asset value under SSP1-2.6 2030 to 11% (\$8.8b) under SSP3-7.0 2070.

The justice and community safety and health sectors are characterised by relatively lower proportional exposure levels, at 7%, and 4% of asset value under SSP1-2.6 in 2030 respectively. The health sector has the largest increase between scenarios, doubling from 4% in under SSP1-2.6 in 2030 to 8% in SSP3-7.0 in 2070, indicating significantly increased exposure to health assets.

3.2.3 Unique exposure profile: Ports

Ports present a distinct exposure pattern that distinguishes them from all other sectors. Under both emissions scenarios, 100% of the ports asset value is projected to face high exposure to at least one climate hazard, coastal inundation, the largest proportion of any sector. However, no port assets are projected to experience

compound exposure to multiple hazards under either scenario, with multi-hazard exposure remaining at 0%. This distinguishes ports from inland infrastructure sectors where multi-hazard exposure is more prevalent. Since all major ports face very high exposure (and risk, discussed in Section 5) from coastal inundation, planning for adaptation is essential because many other infrastructure sectors depend on ports in their supply chains.

3.2.4 Summary of sector exposure patterns

The analysis reveals clear stratification in climate exposure across Victorian infrastructure sectors:

- Infrastructure in the parks, road and rail sectors face the highest levels of exposure in terms of proportion of sector value.
- Together, roads, rail and energy sectors account for two thirds of asset value with high exposure.
- Ports present a unique case of universal single-hazard exposure to coastal inundation.
- All other sectors have lower proportions of asset value with high exposure to climate hazards.

Overall, the trend of increasing exposure across all sectors – with proportion of total assets value with high exposure increasing 14% under SSP1-2.6 2030 to 19% under SSP3-7.0 2070 – demonstrates that climate change is projected to escalate infrastructure exposure across Victoria under a high emissions scenario.

4. Vulnerability to climate hazards

The vulnerability assessment included the development of damage and downtime vulnerability pathways for each hazard and sector pair, assigning rating for each vulnerability pathway and describing how vulnerability to the assessed hazards may be affected by compounding and cascading interactions of hazards.

Vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2022). Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt to climate-related hazards (IPCC, 2022). Therefore, adaptive capacity can reduce vulnerability levels and reduce elements of consequence.

4.1 Climate hazards cause damage and downtime to infrastructure in Victoria

The vulnerability assessment was developed based on vulnerability statements, per sector and per impact pathway (damage or downtime), with rankings given for each combination of sector, hazard and impact pathway. These pathways articulate the systems, processes and conditions that lead to the sectors and assets becoming more susceptible to harm from climate related hazards, through impacts of damage and downtime.

- Damage considers the physical damage to assets and sectors which would require repair, maintenance or complete replacement as a result of a hazard.
- Downtime is the impact of exposure that the hazard has to operations or usage of the asset, which can also be caused by the impact of the physical damage to the operability of the asset and sector.

These vulnerability pathway statements articulate the tangible consequences for assets, operations, or safety for infrastructure in Victoria.

The full assessment is contained in Appendix C, with a summary of the results given in this section, and then justifications for ratings provided per sector type. An overview of the ratings across the sectors are provided in Table 17 and Table 18, for damage and downtime respectively. Where a range has been given to indicate variation in a sector for the purpose of analysis and mapping of the vulnerability in later sections of the report, the higher rating has been utilised.

Table 17: Vulnerability to damage summary.

Hazard	Road	Rail	Energy	Ports	Health	Housing	Education and training	Cultural and community	Justice and community safety	Parks	Commentary
Extreme heat	M	M-H	L-M	L	M	L	L	L	L	L	Rail is most vulnerable to damage from extreme heat out of all the sectors due to the buckling and expanding of rail tracks, and impacts to signalling and control systems due to heat. Energy and road sector assets also face asset and material deterioration when exposed to extreme heat, while sensitive equipment in health infrastructure is also moderately vulnerable to heat.
Flooding	H	H	M	M	H	M	M	M	M	M	Road, rail and health are highly vulnerable to flooding, whilst the rest of the sectors are moderately vulnerable. This is due to the asset typology and that flooding can severely impact subgrade and foundations of road and rail (including washout), as well as damage sensitive equipment in health infrastructure.
Bushfire	M	H	H	H	H	H	H	H	H	H	All sectors are highly vulnerable to bushfire, except for road which is moderately susceptible. Bushfire can result in complete destruction of most asset types. Vulnerability is lower for the road sector as there is normally surface damage to asphalt, but a reduced degree of damage compared to other sectors.
Landslide	M-H	M	M	M	L-M	L-M	L-M	L-M	L-M	M	Landslide has a mixture of vulnerability, this variation in vulnerability is related to the nature of landslide impacts on assets. Unless an asset is directly on the landslide, there is a reduced vulnerability to the hazard as there is less likely to be significant impacts in the debris path. Therefore, building assets are overall less vulnerable to damage from landslides, compared to linear infrastructure.
Wind	L	M	M	M-H	L	L	L	L	L	L	For wind the threshold for damage is at 35 m/s, and buildings are designed to withstand that wind speed, therefore generally have low vulnerability. However, there are implications for comfort levels, as the Beaufort scale indicates at this threshold there may be some difficulty walking into the wind. Ports have the highest vulnerability to wind due to the nature of berthing and port operations. Rail and energy sectors are also susceptible to structural damage and signalling faults/damage.
Drought	L-M	L	L-M	L	L	L	L	M	L	L	The cultural and community sector rates as being moderately vulnerable to drought, due to assets such as leisure facilities, sports grounds and pools which require water availability. Additionally, rail is vulnerable due to drought resulting in higher salinity of ground and potential for cracking, and energy is susceptible due to water requirements thermal electricity generation.
Coastal inundation	H	H	H	H	H	H	H	H	H	H	All sectors are highly vulnerable to coastal inundation – mainly due to the fact that this is a permanent impact with no recovery possible. Once an asset is impacted by coastal inundation, it is overcome and therefore the impact is irreversible.

Table 18: Vulnerability to downtime summary.

Hazard	Road	Rail	Energy	Ports	Health	Housing	Education and training	Cultural and community	Justice and community safety	Parks	Commentary
Extreme heat	L-M	M-H	H	L	H	H	M	M	M	M	Extreme heat has high impacts to rail, energy, health and housing sectors with increased service disruption to rail and energy, and potential for increased health presentations and impacts to sensitive equipment.
Flooding	H	H	M-H	M	H	M	M	M	H	M	Flooding impacts a high number of sectors with increased vulnerability for road, rail, energy, health, and justice and community safety. This is due to the impact of disruption has to those sectors, and previous VMIA paid claims data which indicates the significant damage impact resulting in downtime.
Bushfire	H	H	H	M	H	H	H	H	H	H	All sectors except ports are highly vulnerable to operational disruption from bushfire due to the widespread and severe impact which can impact service provision and operation. Port infrastructure is slightly less vulnerable due the low vegetation fuel environment common in ports where fires cannot easily ignite or spread, however port operations and freight movements can still be impacted by bushfire.
Landslide	M	M	M	M	L-M	L-M	L-M	L-M	L-M	M	Landslide moderately impacts most sectors due to the scale of impact and disruption that the debris path can have on operations.
Wind	M	M	H	H	L	L	M	M	L	M	The ports and energy sectors are highly vulnerable to the impacts of wind, with high winds disrupting port operations, and disrupting energy generation and potential impacts to transmission and distribution networks impacting electricity grid connections.
Drought	L	L	M-H	L	L	L	L	M	L	M	The energy sector is highly vulnerable to drought due to the requirement of water for cooling thermal processes, resulting in potential impacts to power generation. There are moderate operational impacts to parks, and cultural and community sectors due to the water requirements for pools, sports facilities, and parks infrastructure.
Coastal inundation	H	H	H	H	H	H	H	H	H	H	All sectors are highly vulnerable to downtime from coastal inundation due to the permanent nature of inundation resulting in ongoing disruptions for operations.

4.1.1 Infrastructure is most vulnerable to coastal inundation and bushfire

Infrastructure is most vulnerable to coastal inundation and bushfire across nearly all sectors due to the combination of severe physical damage, prolonged operational downtime, and limited capacity for recovery. Coastal inundation poses a unique threat because it can permanently compromise assets. Once inundated, infrastructure such as roads, buildings, and ports may be rendered unusable, with restoration often impossible or prohibitively expensive. This hazard affects all sectors, as the encroachment of sea level rise and storm surges can destroy foundations, erode protective barriers, and disrupt essential services, leaving communities without critical infrastructure and little opportunity for rapid recovery. While all sectors are affected, the degree of vulnerability and disruption from hazards like coastal inundation depends heavily on the geographic concentration of assets.

Bushfire, similarly, is devastating due to its ability to cause widespread destruction across multiple asset types, from transport networks and energy infrastructure to health and community facilities. The intense heat, radiant energy, and ember attacks associated with bushfires can destroy physical structures, disrupt operations for extended periods, and trigger cascading failures in interconnected systems. Recovery from bushfire damage is often slow, as assets require extensive repairs or complete rebuilding, and the loss of vegetation can further increase vulnerability to subsequent hazards like landslides.

4.1.2 Vulnerability is slightly higher for downtime than damage

Across the sectors, there are higher vulnerability impacts for downtime compared to damage. This is predominantly associated with increased impacts to downtime from extreme heat and wind hazards. These two hazards have a limited impact on physical damage to infrastructure across the sectors but can have significant operational impacts with disruption to operations and service delivery.

For extreme heat, there are additional operational impacts including increased demand for services across the health, and justice and community safety sectors; speed restrictions across the rail sector; power outages for the energy sector; and habitability issues for the housing sector, including potential temporary relocation. Additionally for the cultural and community sector, community facilities may be repurposed as heat refuges or cooling centres, limiting their ability to provide their core services. Similarly, for wind the increased downtime vulnerability results from outdoor comfort from wind impacting occupants and users, whilst not impacting on the structural integrity of the buildings.

4.1.3 The health sector is more vulnerable than other building-based sectors to extreme heat and flooding.

The sectors that are predominantly comprised of buildings, such as health, education and training, housing, justice and community, cultural and community, and parks, have a similar vulnerability profile for damage. This is due to the consistency in construction standards and how buildings are constructed to withstand certain hazards – in particular consistent thresholds for damage for wind and flooding across buildings.

The notable exception to this is the health sector, as hospitals are more vulnerable to extreme heat and flooding due to sensitive equipment and environments that require strict temperature and humidity control, and the possibility of significant structural damage. The other exception is the cultural and community sector which is slightly more vulnerable to drought due to the characteristics of that sector comprising pools and sporting fields which have a water requirement. Noting that the parks sector only includes building-based assets, and the scope excludes the natural assets and vegetation.

4.1.4 Road, rail and energy sectors are vulnerable to multiple hazards

The road, rail, and energy sectors are among the most vulnerable to both damage and downtime from climate hazards due to the nature of their assets, operational requirements, and exposure to multiple risks. Roads and railways are highly susceptible to flooding, bushfire, extreme heat, and coastal inundation, which can cause direct physical damage such as pavement deformation, track buckling, washouts, and embankment failures, as well as prolonged closures and service disruptions. The energy sector faces high vulnerability to bushfire and coastal inundation, with additional risks from extreme heat and flooding that can disrupt power generation, damage transmission infrastructure, and lead to widespread outages. This analysis maps and assesses the existing energy assets.

Additionally, these sectors are more vulnerable to damage from wind and drought compared to other sectors which experience lower vulnerability, and higher impacts to downtime from wind. Therefore, the vulnerability is increased across the sectors. These sectors are also characterised by complex interdependencies where failures in one sector can cascade into others amplifying the consequences of damage and downtime.

4.2 Compounding and cascading impacts

Compounding and cascading climate hazards significantly amplify the vulnerability of some sectors. When multiple hazards occur in sequence or interact, these events can intensify damage and operational disruption across sectors. The assessment highlights that exposure to one hazard may weaken a system's ability to cope with subsequent hazards, leading to greater consequences than if each hazard occurred independently. Additionally, there may be varied time frames and time lag for the compounding and cascading impacts of hazards. This interconnectedness means that vulnerability ratings must account not only for individual hazards but also for the potential for hazards to trigger or worsen others, resulting in complex, multi-layered impacts that challenge recovery and adaptive capacity.

The impacts of these interactions are shown in Table 19, demonstrating how a primary hazard can impact on a secondary hazard, either through:

- compounding impacts, where two or more hazards interact
- cascading impacts, when a hazard generates a sequence of secondary events, in this case exacerbating the vulnerability to other hazards.

As shown, landslide is the only hazard that does not compound any other hazards nor cascades to another hazard but is susceptible from other hazards.

Key:

(+) - Compounding vulnerability

(⇒) - Cascading impacts that lead to the secondary hazards.

Table 19: Compounding and cascading vulnerability.

Hazards		Secondary hazard						
		Extreme heat	Flooding	Bushfire	Landslide	Wind	Drought	Coastal inundation
Primary hazard	Extreme heat			⇒ Extreme heat increases the risk of bushfires occurring			⇒ Extreme causes heat stress that leads to drought.	
	Flooding				⇒ Flooding can cascade to landslide with soil saturation.			
	Bushfire	+ Bushfire can exacerbate extreme heat from reduced vegetation			⇒ Bushfires lead to landslide with reduced vegetation and increased instability		⇒ Bushfire can lead to drought due to soil damage and lack of vegetation.	
	Landslide							
	Wind		+ Flooding is exacerbated by wind through storm surges, and increased destructive force	⇒ Wind increases bushfire risk with extra oxygen, pre-drying vegetation and carrying embers.				+ Wind compounds impact of coastal inundation with storm surge and increased destructive force.
	Drought		+ Drought can degrade soil, reduce absorptive capacity of soil and increase run off, compounding flood impacts.	⇒ Drought can also cascade and result in bushfire due to the reduced water content of soil and fuel loads.	⇒ Drought can weaken soil structure, reduce absorptive capacity, and reduce vegetation cover leading to landslide			
	Coastal inundation		+ Coastal inundation compounds flooding with increased water saturation and quantity of water.					

5. Climate risks to Victorian infrastructure

This analysis evaluates climate risk to Victorian infrastructure in terms of damage and downtime for future climate scenarios. This section discusses the results for the low emissions scenario (SSP1-2.6) in 2030 and the high emissions scenario (SSP3-7.0) in 2070, which represent the lower and upper bounds of the analysis. Other scenarios fall between these two extremes. Throughout this section, results are reported for these two bounding scenarios to illustrate the range of potential future risk to assessed infrastructure.

Risk ratings for infrastructure assets are described in four categories, from level 1 (lowest) to level 4 (highest), as defined in the risk matrix in Section 2.6. Within the reporting of results, risk levels 3 and 4 are collectively referred to as high risk. A rating of level 1 does not imply there is no risk from climate hazards in the future, it indicates that the risk is relatively lower than the other risk levels.

5.1 Different climate hazards drive risk unevenly across Victoria

Different climate hazards result in different levels of climate risk to infrastructure assets under both low and high emissions scenarios. This section discusses which hazards are driving high risks to assessed infrastructure assets.

The relative asset value impacted by high climate risks from each climate hazard is shown for the damage and downtime impact pathways in the low emissions scenario in 2030 (Figure 23) and high emissions scenario in 2070 (Figure 24).

These graphs show that of the hazards assessed, high risks from damage from bushfire and flood affect the largest value of assessed infrastructure assets. Extreme heat has a greater contribution to the downtime risk profile than for damage, due to the higher vulnerability of some infrastructure sectors to downtime than damage from extreme heat.

In the high emissions scenario in 2070, extreme heat causes a relatively larger proportion of high risk to infrastructure value compared to the low emissions scenario in 2030. Note that the risks due to landslide, damaging wind and flood remain the same in all scenarios as no suitable future scenario data were available for the assessment. Risks from these hazards, particularly flood and landslide, are expected to increase in future scenarios. The future changes in damaging wind are less certain.

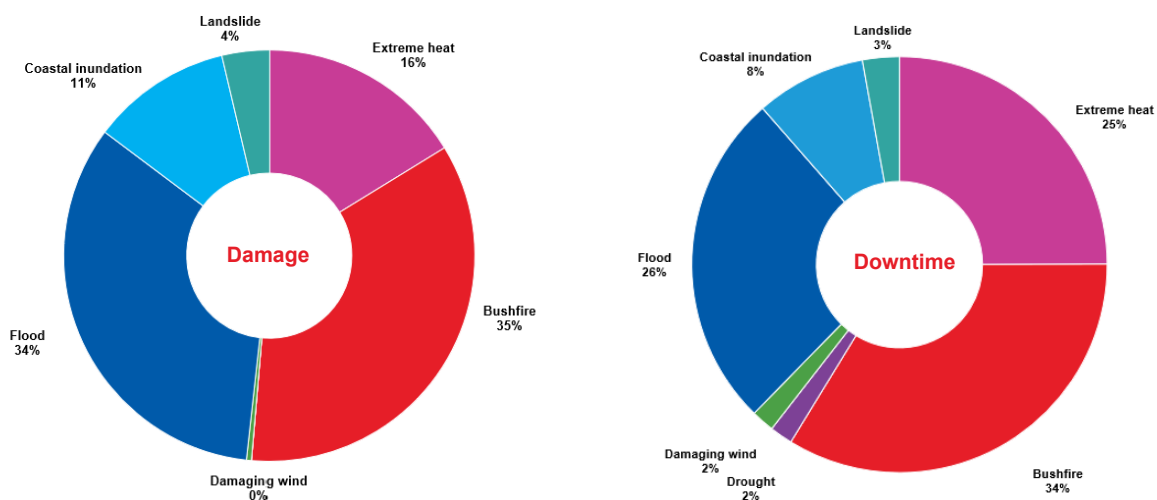


Figure 23: Hazards driving high damage (left) and downtime (right) risks for the low emissions scenario in 2030, by proportion of asset value.

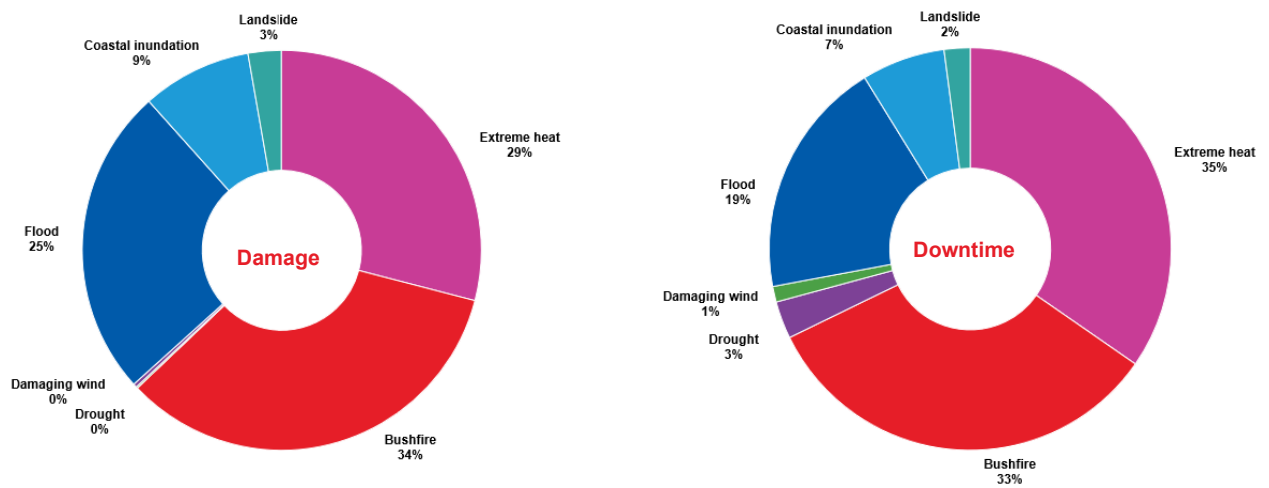


Figure 24: Hazards driving high damage (left) and downtime (right) risks for the high emissions scenario in 2070, by proportion of asset value.

Figure 25 and Figure 26 show the proportion of asset value assigned to each risk level, demonstrating how the risk from each climate hazard changes between the low emissions scenario in 2030 and high emissions scenario in 2070, for the damage and downtime pathways respectively. As noted previously, the risk profile to infrastructure from downtime is higher than damage. A comparison of the figures below shows that this difference is driven by drought, extreme heat and bushfire.

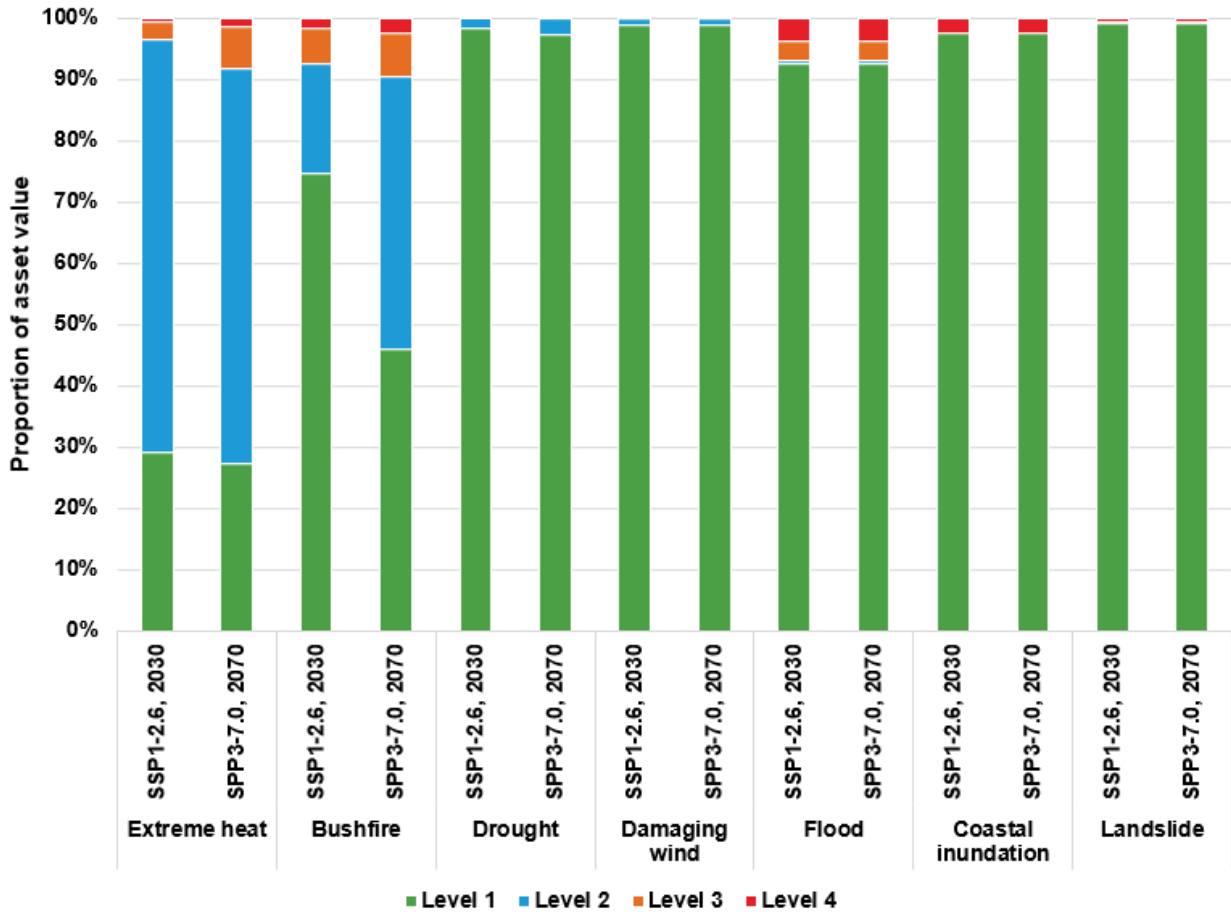


Figure 25: Victorian infrastructure risk of damage from each hazard by proportion of asset value, for the low emissions scenario in 2030 and high emissions scenario in 2070.

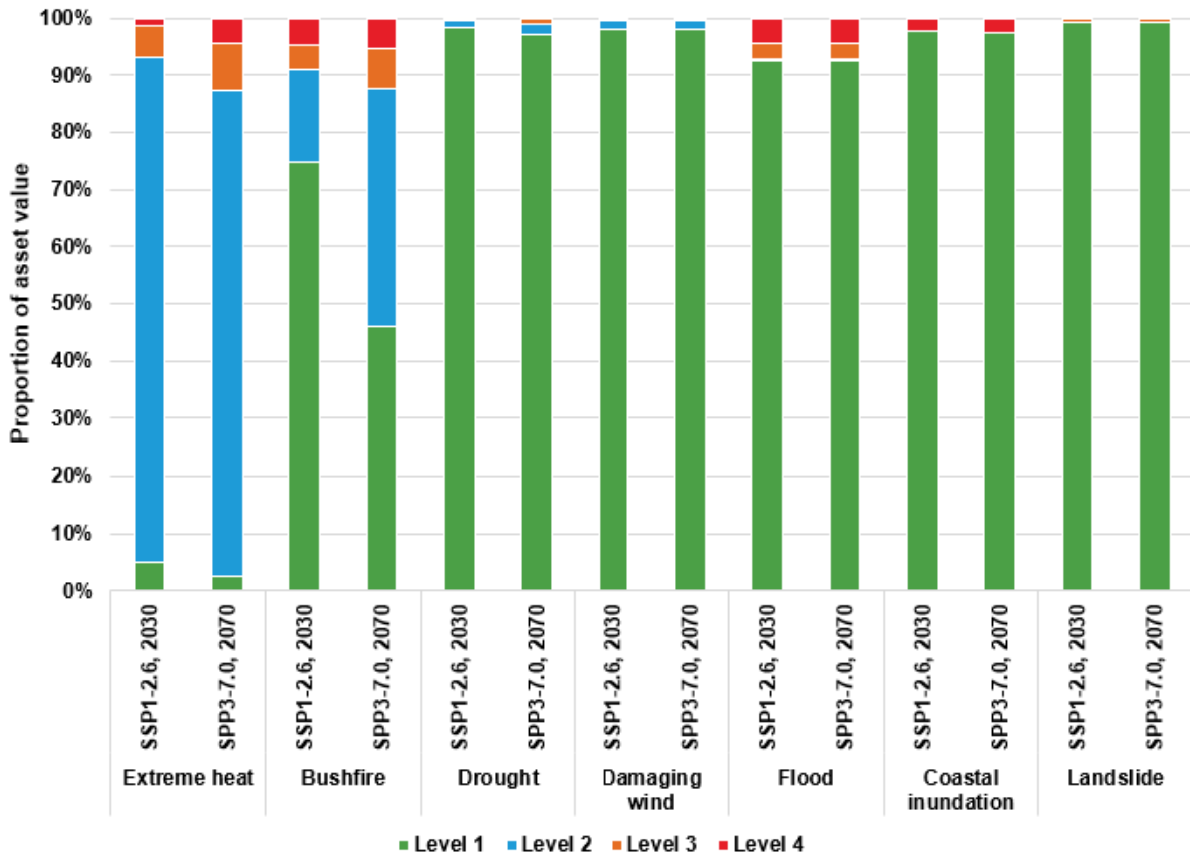


Figure 26: Victorian infrastructure risk of downtime from each hazard by proportion of asset value, for the low emissions scenario in 2030 and high emissions scenario in 2070.

5.1.1 Bushfire and flood represent the greatest risks to asset values in the short term

Bushfire and flood present high risks across all sectors except ports, and together they drive the majority of high risks from climate hazards in the short term.

Bushfire drives 35% of high risks of damage based on asset value, making it the single most significant hazard threat to Victorian infrastructure, representing \$23.4b in asset value at high risk of damage under SSP1-2.6 2030. In this scenario, of all bushfire risk ratings to assets, 2% are level 4, 6% are level 3, 18% are level 2, and 75% are level 1 (by asset value). Under SSP3-7.0 2070, this increases by 29% to \$30.2b. Bushfire particularly affects infrastructure in parks, roads, energy and rail sectors.

Flood is almost as significant, with \$22.3b of asset value affected by high risk of damage under SSP1-2.6 2030. Under SSP3-7.0 2070, this risk remains the same as the analysis is based on current flood mapping overlays rather than future climate projection data.

5.1.2 Extreme heat impacts increase in the long term

Under SSP3-7.0 2070, extreme heat represents the second largest risk driver for damage, representing \$25.9b in asset value at high risk of damage. This is an increase of 139% (\$15.1b) from SSP1-2.6 2030. Under SSP3-7.0 2070, 1% of extreme heat-related damage risks are classified as level 4, 7% are level 3, 65% are level 2, and 27% are level 1 (by asset value). Extreme heat has major impacts on fewer sectors than bushfire and flood. However, it still poses level 4 risks to the rail and housing sector, and level 3 risks to the energy, health and roads sectors.

5.1.3 Coastal inundation, landslide, wind and drought pose smaller risks based on asset value

Coastal inundation accounts for 11% of high damage-related risks by asset value under SSP1-2.6 2030. This decreases slightly to 9% under SSP3-7.0 2070, reflecting that other hazards have escalated more rapidly than coastal inundation.

Landslide risk represents 4% of high damage-related risks by asset value under SSP1-2.6 2030, which decreases to 3% under SSP3-7.0 2070. Damaging winds represent approximately 0.4% of high risks under SSP1-2.6 2030 which decreases to 0.3% under SSP3-7.0 2070. Drought is not associated with any high risks under SSP1-2.6 2030 and contributes 0.1% of assets at high risk under SSP3-7.0 2070 based on asset value, representing the smallest direct damage risk among the hazards analysed. Collectively, landslide, drought and damaging wind account for 4.4% of asset value at high risk under SSP1-2.6 2030 and 3.4% under SSP3-7.0 2070, indicating their secondary contribution to Victoria's overall infrastructure risk profile.

5.1.4 Extreme heat, drought and bushfire dominate downtime risk

The risk profile for operational downtime differs notably from physical damage risk, revealing the distinct ways various hazards disrupt infrastructure function compared to causing structural harm. Extreme heat accounts for 25% of high risks to assets by asset value across sectors of downtime under SSP1-2.6 2030 – a substantially higher proportion than its 16% contribution to damage risk. This difference highlights that extreme heat primarily threatens infrastructure functionality and service delivery rather than causing catastrophic structural failure. The trends are similar under SSP3-7.0 in 2070, with a higher contribution for extreme heat to the proportion of risks to asset value.

Drought also has a significantly higher risk profile for operational disruption compared to physical damage. Under SSP1-2.6 2030, 2% high downtime risks to assets by value from are drought, compared to 0% for damage.

Bushfire remains significant for downtime risk, accounting for 34% of high risks by asset value, compared to 35% of high damage risks under SSP1-2.6 2030. This indicates that while bushfire risk is significant for both damage and downtime, other risks (particularly extreme heat), make a proportionally greater contribution to downtime. Similarly, flood contributes 26% to downtime risks by asset value compared to 34% for damage

risks, while coastal inundation has a larger damage impact with downtime accounting for 8% of risks compared to 11% of damage risks under SSP1-2.6 2030.

5.2 Some communities will be more impacted by climate risks

In general, the locations with a large amount of infrastructure value at high risk from climate hazards aligns to locations with the greatest concentration of infrastructure value. There is a corridor of high risk to multiple climate hazards from Melbourne through central Victoria to Bendigo and Shepparton, and a higher concentration is also seen around other regional centres such as Portland, Traralgon, Geelong, Horsham, Mildura and Swan Hill.

Figure 27 shows how infrastructure assets with high damage risk from at least one climate hazards under a low emissions scenario in 2030 are distributed across Victoria. There are similar spatial trends for asset value at high damage and downtime, although with more assets at high risk of downtime.

Some communities are facing climate risks to a significant value of assets, and these are identified clearly in the analysis, and shown in dark grey in the below figure. However, limitations to the study mean that certain communities with lower value assets, which may be of critical importance to the community, may not be fully highlighted in this analysis. Nonetheless, the analysis presented in the exposure and vulnerability assessments may assist those communities in assessing their exposure and identifying the overall vulnerability of their assets, thereby informing their prioritisation decisions.

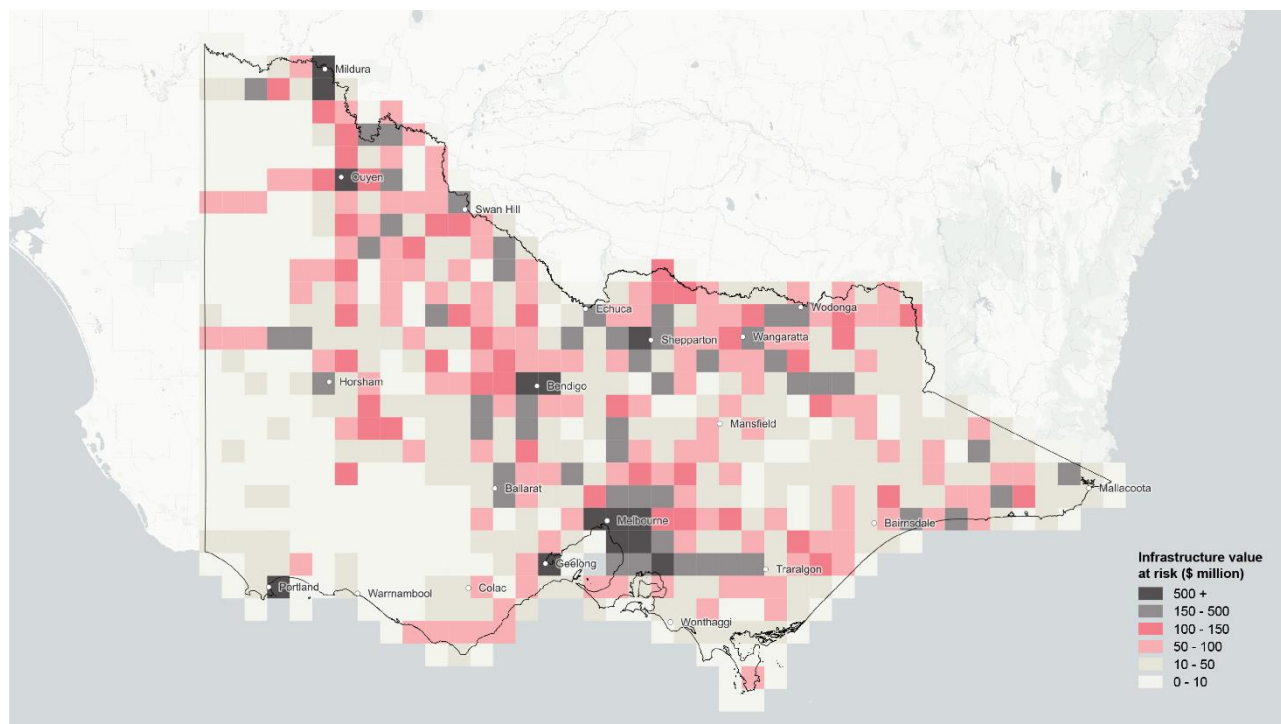


Figure 27: Distribution of infrastructure asset value with high damage risks from at least one climate hazard by 25km grid square for the low emissions scenario in 2030.

Figure 28 shows how infrastructure assets with high damage risk from at least one climate hazard under the high emission scenario in 2070 are distributed across Victoria. In comparison to the low emission scenario in 2030, risk for metropolitan Melbourne remains mainly the same, and for most of the southern parts of the state. However, there is an increase in asset value at high risk in the north and north-west in 2070 with a concentration around Shepparton and Wangaratta, as well as to the north of Bendigo and Horsham.

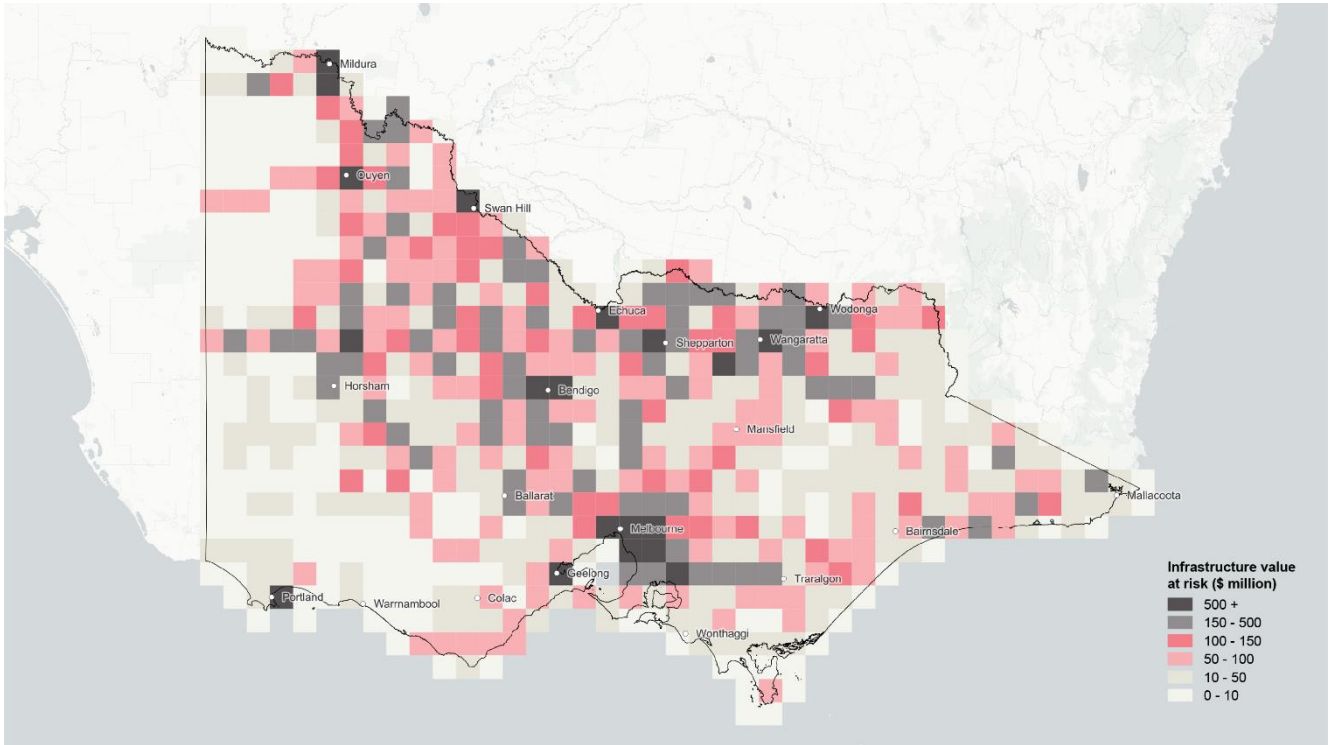


Figure 28: Distribution of infrastructure asset value with high damage risks from at least one climate hazard by 25km grid square for the high emissions scenario in 2070.

5.2.1 Bushfire affects regional towns and assets in northern and eastern Victoria

The distribution of asset value with high bushfire risk is shown in Figure 29 for the low emissions scenario in 2030 and Figure 30 for the high emissions scenario in 2070. Bushfire risk is distributed across the state, but there are several key regional centres impacted such as Mildura, Bendigo and metropolitan Melbourne under the low emissions scenario in 2030.

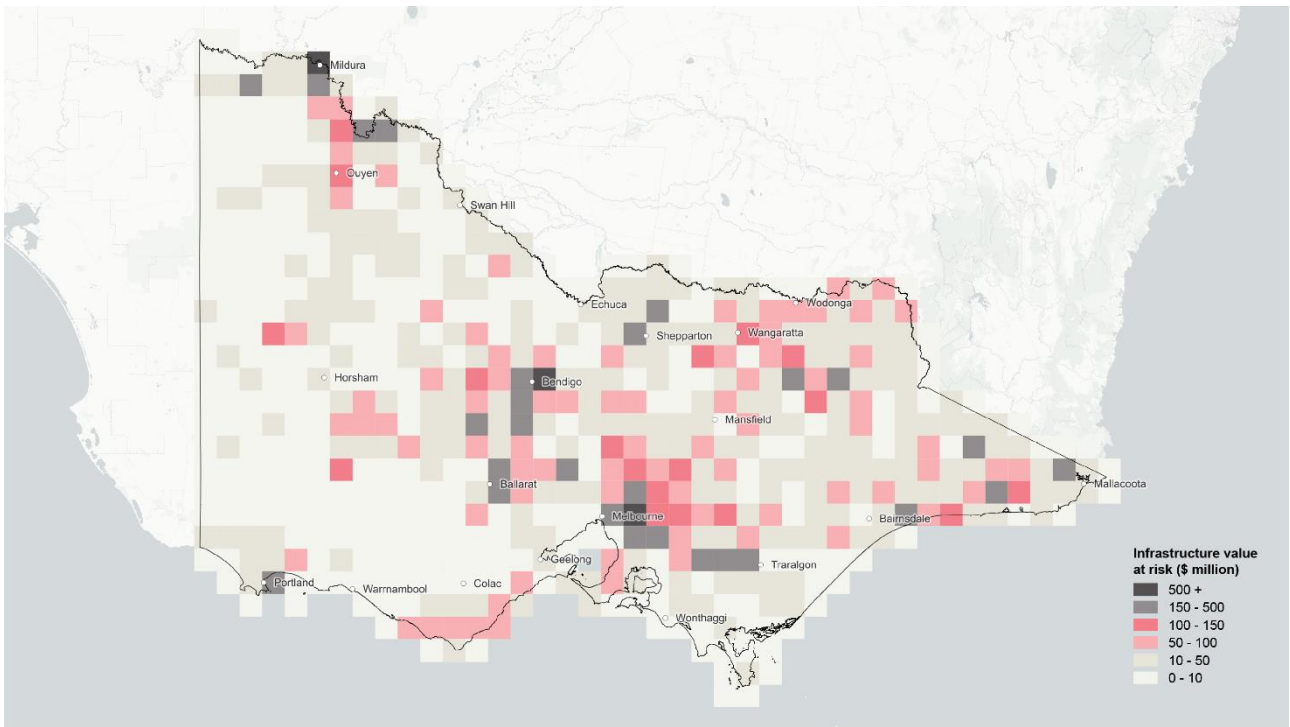


Figure 29: Distribution of infrastructure asset value with high damage risks from bushfire by 25km grid square for the low emissions scenario in 2030.

Under the high emissions scenario in 2070 this expands to impact Echuca, Swan Hill and Ouyen, with increased infrastructure value at risk. The southern coastal areas and eastern Victoria have relatively consistent infrastructure value at risk from 2030 to 2070 with hotspots around Portland, Great Ocean Road, Traralgon and eastern Gippsland.

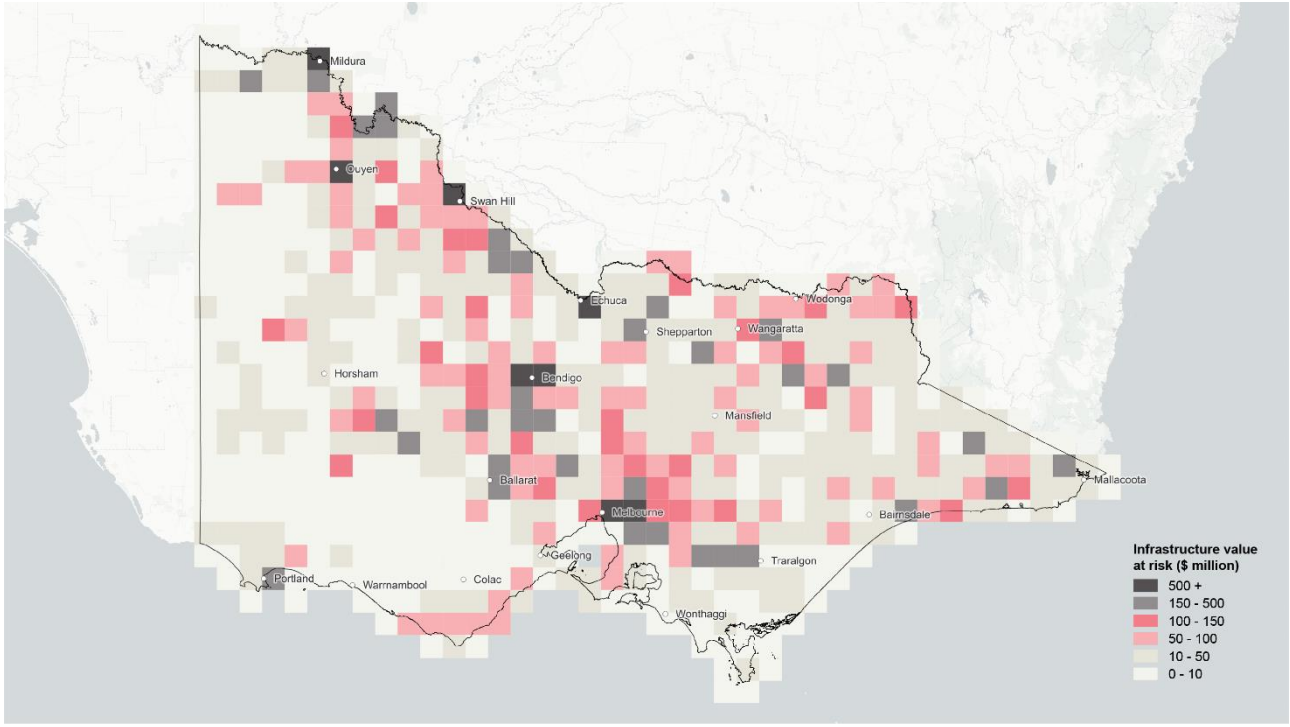


Figure 30: Distribution of infrastructure asset value with high damage risks from bushfire by 25km grid square for the high emissions scenario in 2070.

5.2.2 Flood affects metropolitan Melbourne and central northern Victoria

Flood risk predominantly impacts metropolitan Melbourne and Geelong as shown in Figure 31. Flood overlays show there is a concentration around the city and around Shepparton where the largest asset value is at risk.

Noting that flood risk only considers present day risk and is not projected into the future based on data availability. The far east and far west of the state has minimal infrastructure value at risk of flood.

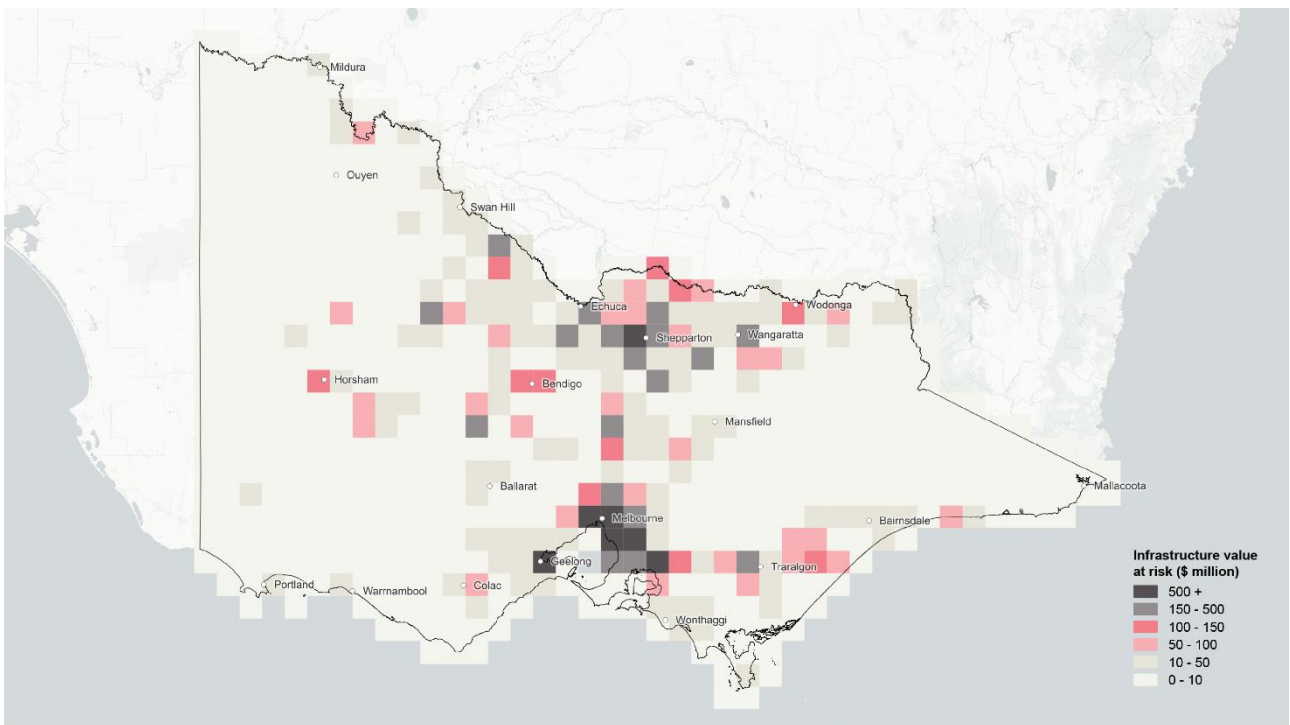


Figure 31: Distribution of infrastructure asset value with high damage risks from flood by 25km grid square.

5.2.3 Extreme heat affects predominantly north-western Victoria

The distribution of asset value with high extreme heat risk is shown in Figure 32 for the low emissions scenario in 2030 and Figure 33 for the high emissions scenario in 2070. In 2030, extreme heat impacts on the north-western area of the state, with most infrastructure value at risk around Mildura, Ouyen and Swan Hill.

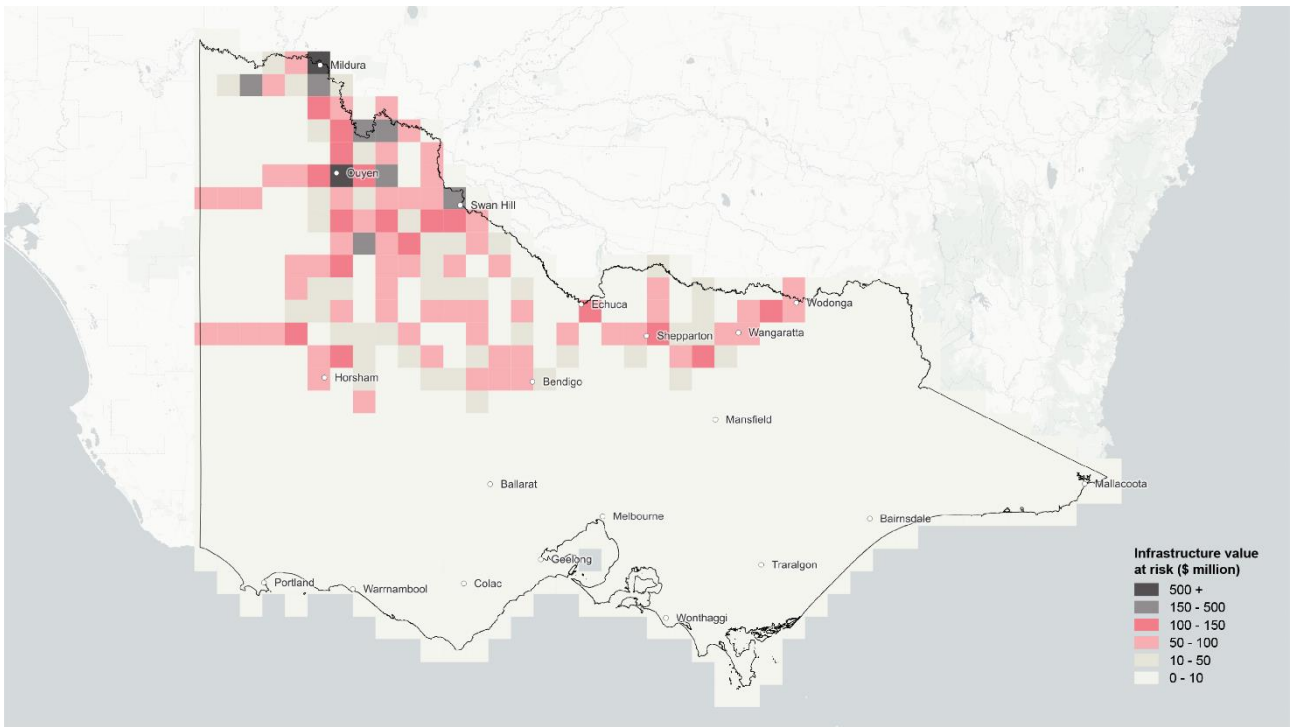


Figure 32: Distribution of infrastructure asset value with high damage risks from extreme heat by 25km grid square for the low emissions scenario in 2030.

By 2070, this expands with extreme heat impacting more of the state and progressing southwards, with Echuca, Wangaratta and north of Horsham having higher asset value at risk. Northern metropolitan Melbourne also becomes more impacted with increased infrastructure value at risk.

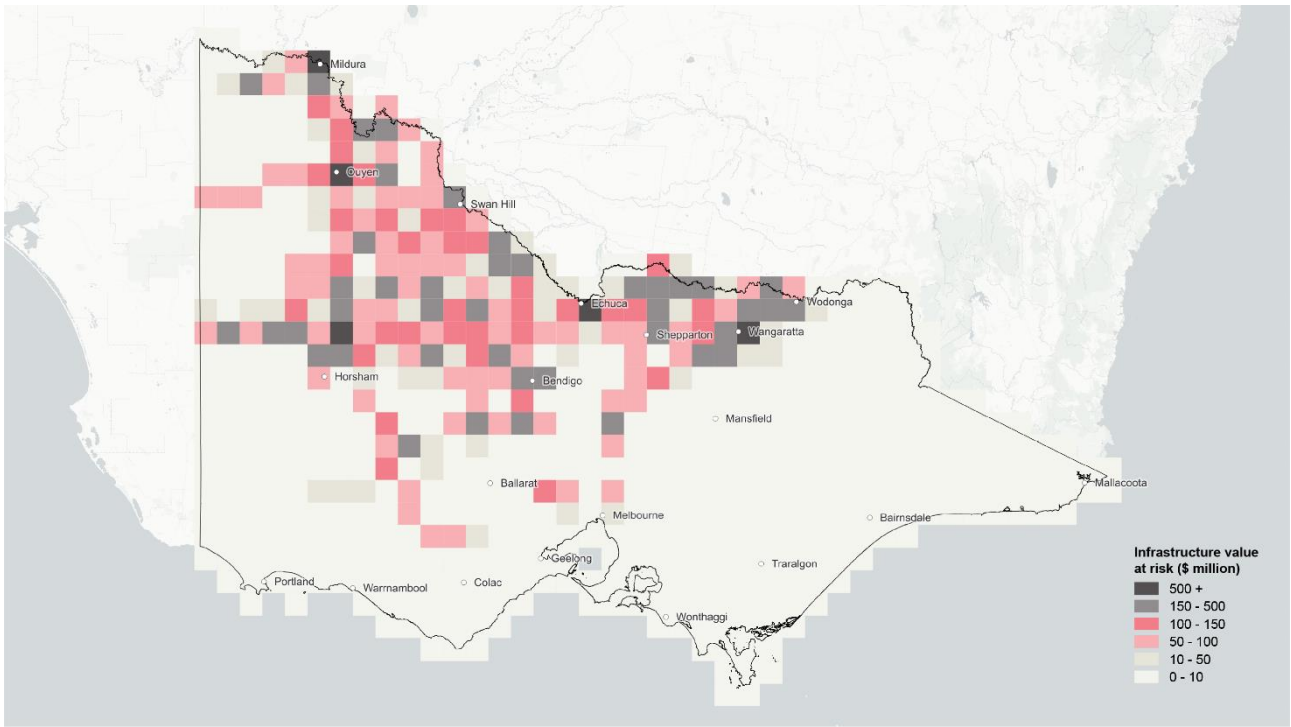


Figure 33: Distribution of infrastructure asset value with high damage risks from extreme heat by 25km grid square for the high emissions scenario in 2070.

5.3 All infrastructure sectors face climate risks

5.3.1 Climate risk escalates across all sectors

Victoria's infrastructure faces a fundamental transformation in its climate risk profile under future climate change. This section discusses the risk profile from climate hazards in terms of assets at risk from at least one hazard and at least two hazards. The latter provides an indication of where assets may face significant pressure due to cascading and compounding vulnerabilities.

Across all sectors combined, \$71.3b of Victorian infrastructure assets are exposed to high risk of damage from at least one climate hazard by 2070 under the high emissions scenario. This is an increase from \$57.2b under the low emissions scenario in 2030.

The proportion of infrastructure value in each sector exposed to high risk of damage from at least one hazard is shown in Figure 34.

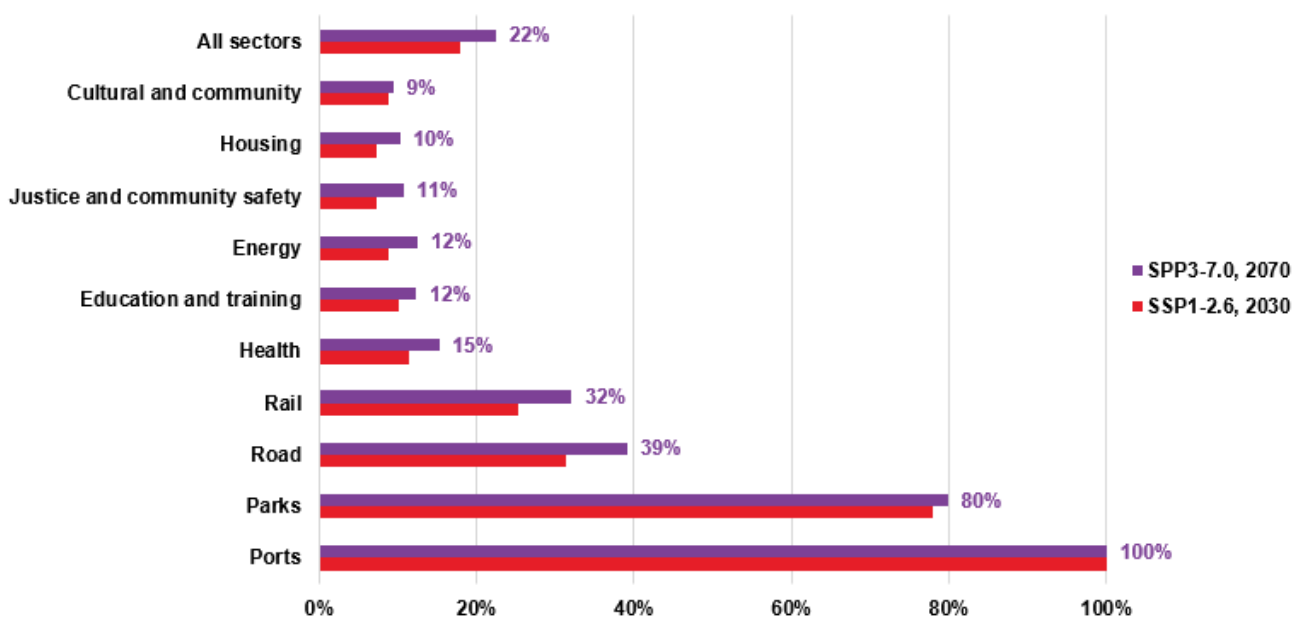


Figure 34: Proportion of infrastructure sectors by asset value at high risk of damage from at least one hazard under high and low emissions scenarios.

The infrastructure value at high risk of damage from at least one hazard by sector is illustrated in the waterfall chart in Figure 35.

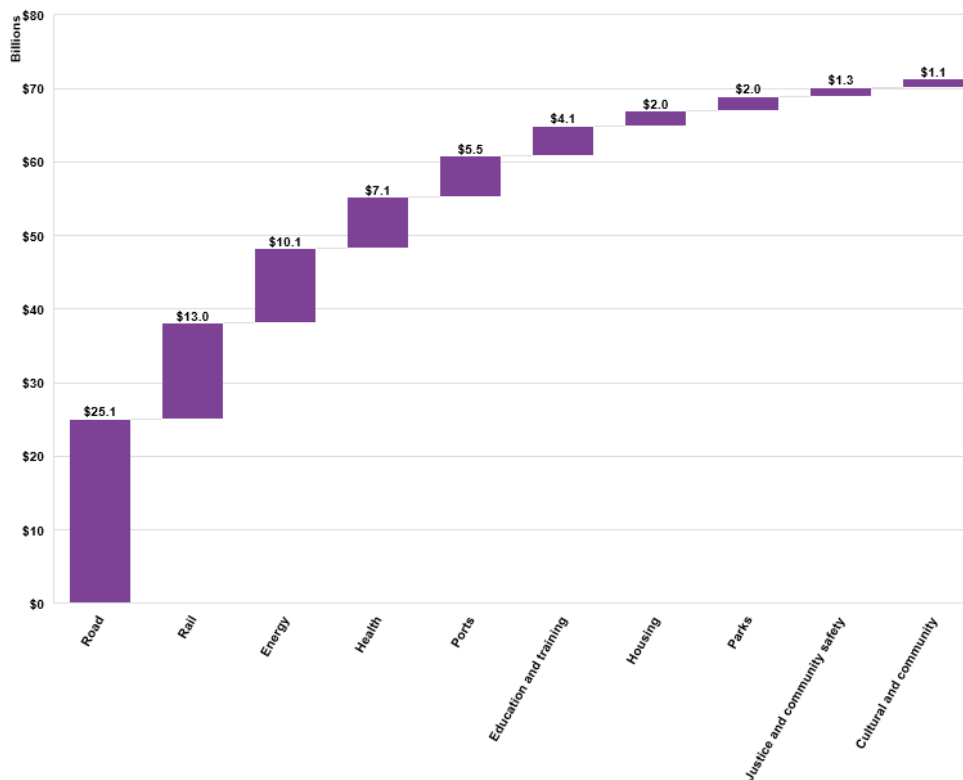
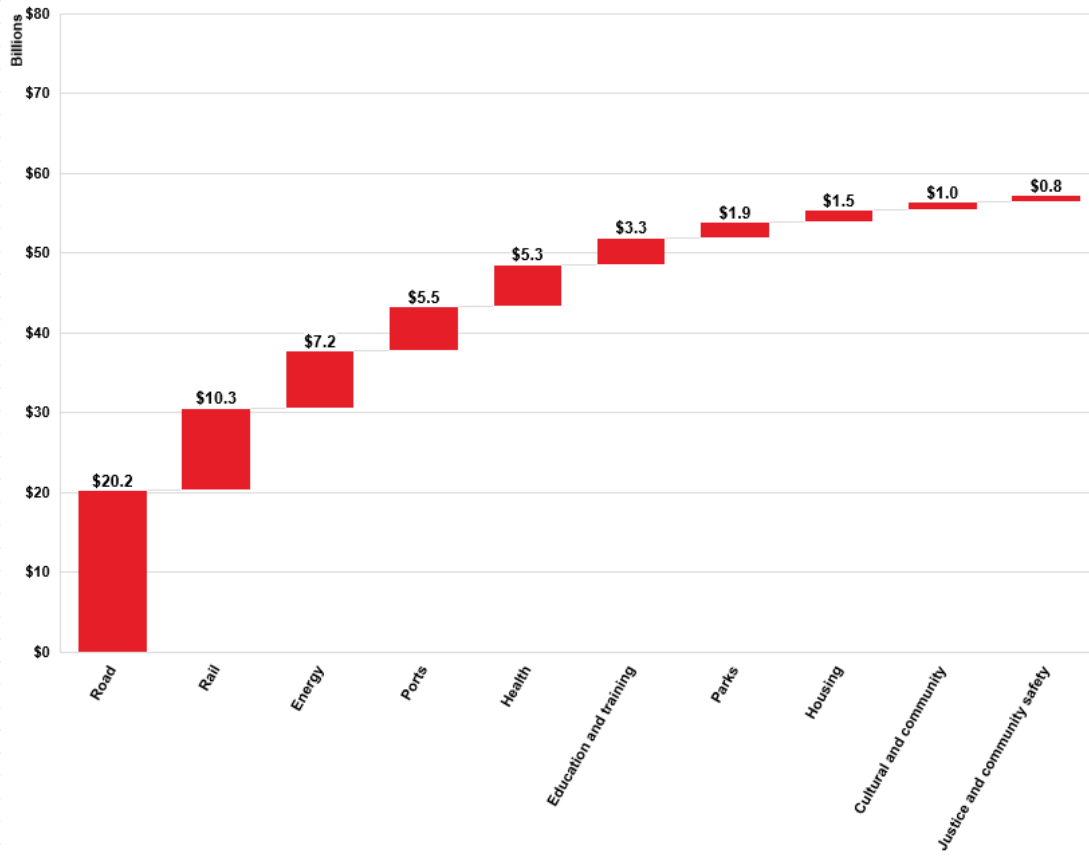


Figure 35: Total Victorian infrastructure value at risk of damage from at least one hazard under low emissions scenario in 2030 (top) and high emissions scenario in 2070 (bottom), by sector⁷.

Every infrastructure sector experiences increased climate risk, though the magnitude of change varies considerably. This universal escalation demonstrates that climate change will affect the entire infrastructure portfolio, with the upper bound scenario indicating particularly severe risk outcomes.

5.3.2 Transport networks are under increasing pressure

Road and rail networks together represent the majority of value at risk under future climate conditions.

The value of road assets at risk of damage increases from \$20.2b under SSP1-2.6 2030 to \$25.1b under SSP3-7.0 2070 for at least one hazard. For the road sector, flood is the hazard driving the majority of very high risk of damage, by proportion of asset value, as shown in Figure 36. Coastal inundation and landslide will also drive very high risks under SSP3-7.0 by 2070. The road sector had moderate vulnerability to damage from extreme heat and bushfire, therefore the highest risk rating from these hazards is high.

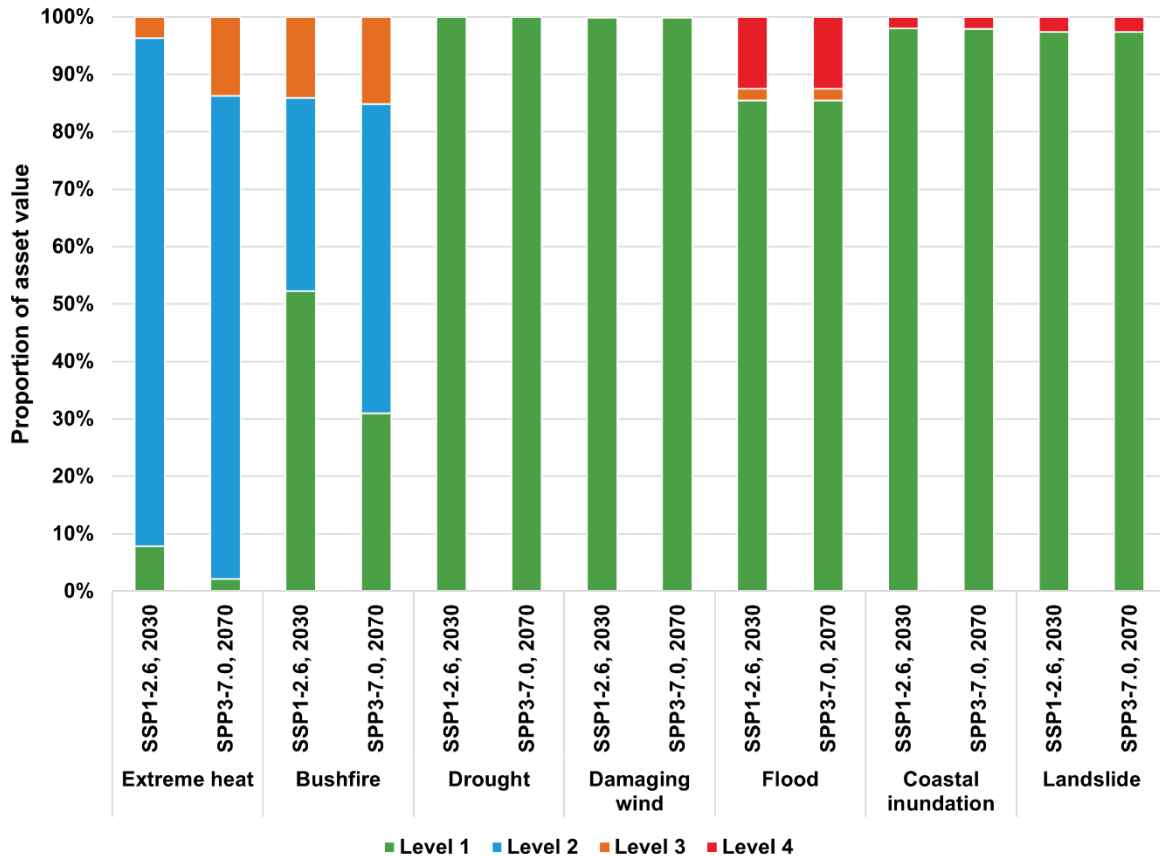


Figure 36: Victorian road sector infrastructure risk of damage from each hazard by proportion of asset value, for the low emissions scenario in 2030 and high emissions scenario in 2070.

The areas with the greatest value of road assets at risk of damage in 2030 from more than one hazard include Melbourne and major road routes toward Wangaratta and Wodonga along the Hume Highway and M1 toward Traralgon. By 2070, this increases around the north-western aspect of the state, to the north of Shepparton and Wangaratta, and to the west around Horsham, as shown in Figure 37.

⁷ Please note that total value at risk may not add up due to rounding errors.

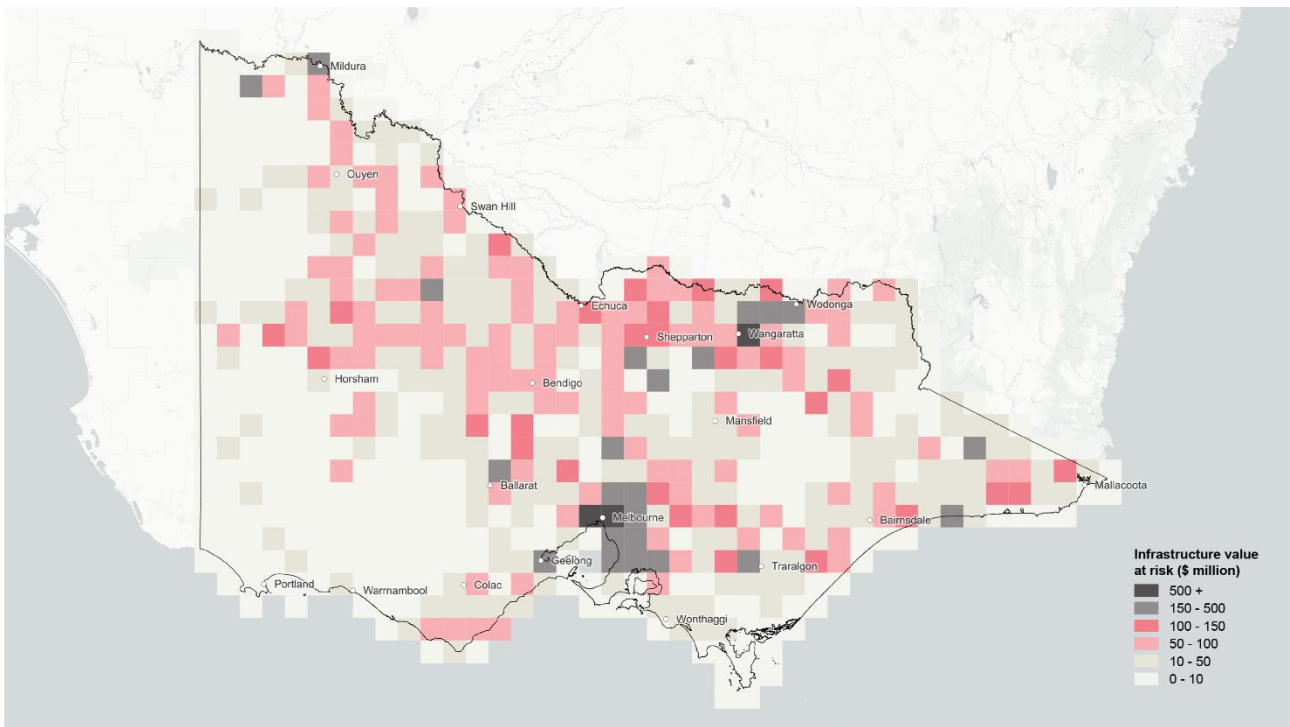
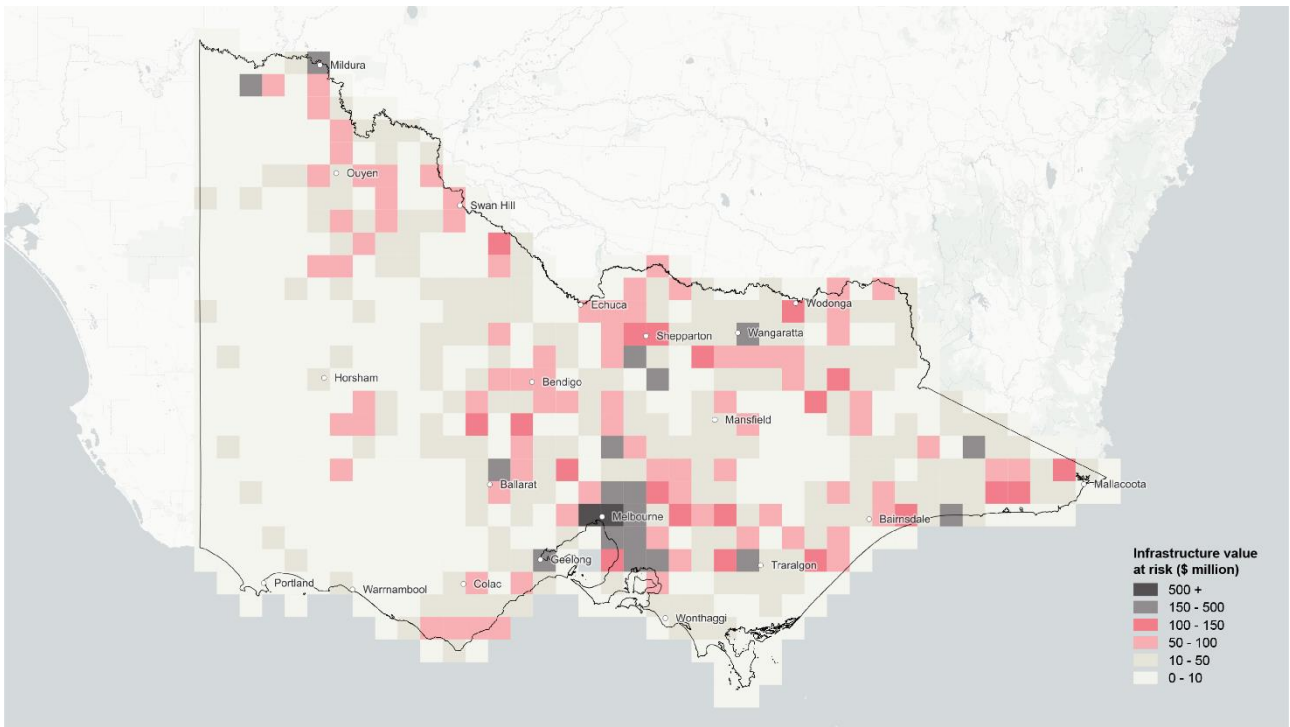


Figure 37: Distribution of road infrastructure asset value at high risk of damage from at least one climate hazard under the low emissions scenario by 2030 (top) and the high emissions scenario by 2070 (bottom), by 25km grid square.

In the rail sector, \$13.0b of asset value is at high risk of damage from at least one hazard by 2070 under SSP3-7.0, increased from \$10.3b under SSP1-2.6 2030. Figure 38 shows how the highest risk for damage comes from extreme heat, flooding and bushfire. In particular very high risk is significant in 2070 for extreme heat and flood.

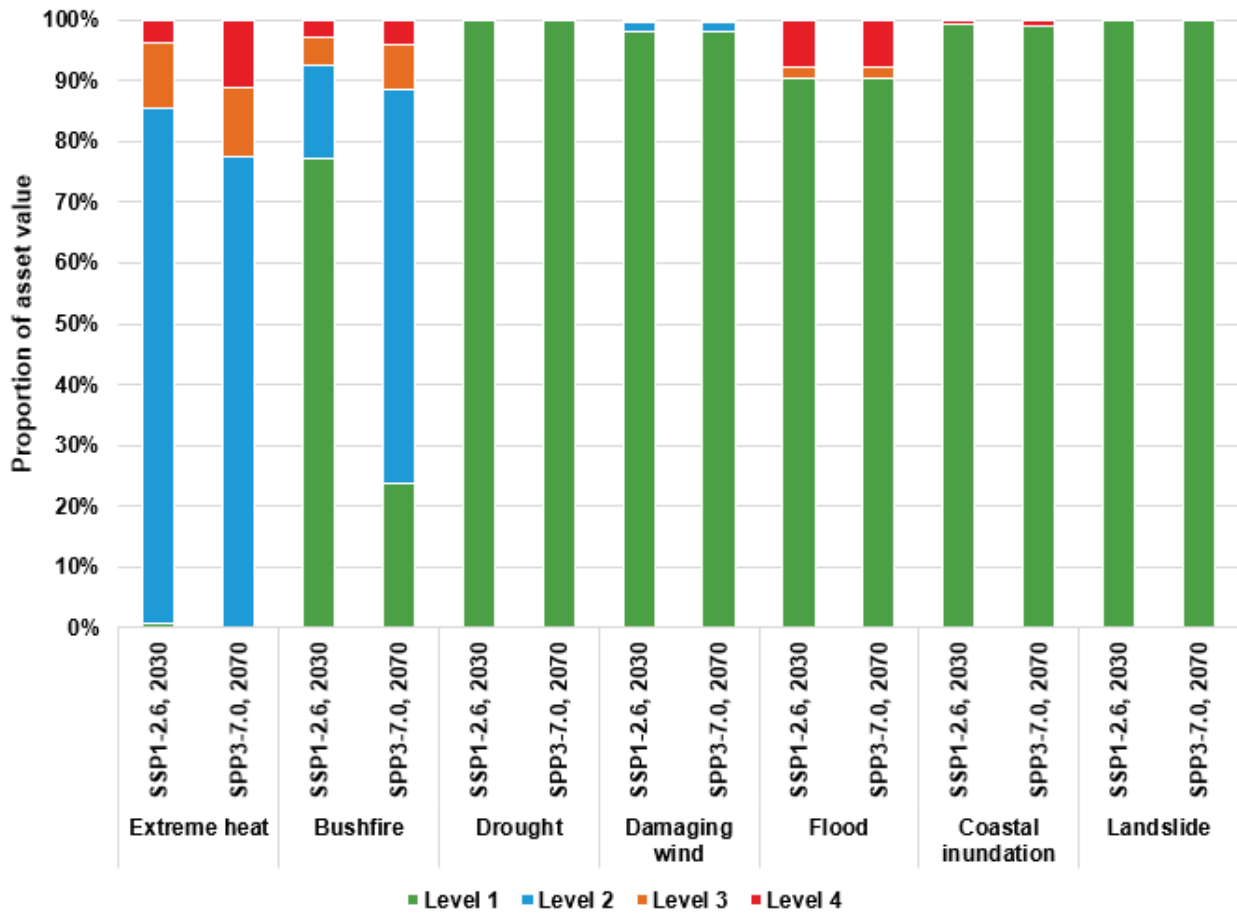


Figure 38: Victorian rail sector infrastructure risk of damage from each hazard by proportion of asset value, for the low emissions scenario in 2030 and high emissions scenario in 2070.

Similar to the spatial trends for roads, the greatest value at high risk from at least one climate hazard in 2030 is in Melbourne and along regional rail corridors. By 2070, the risk intensifies along these regional corridors with increased value at risk around Bendigo, Horsham, and along the lines to Wangaratta, Shepparton, and Wodonga, as shown in Figure 39.

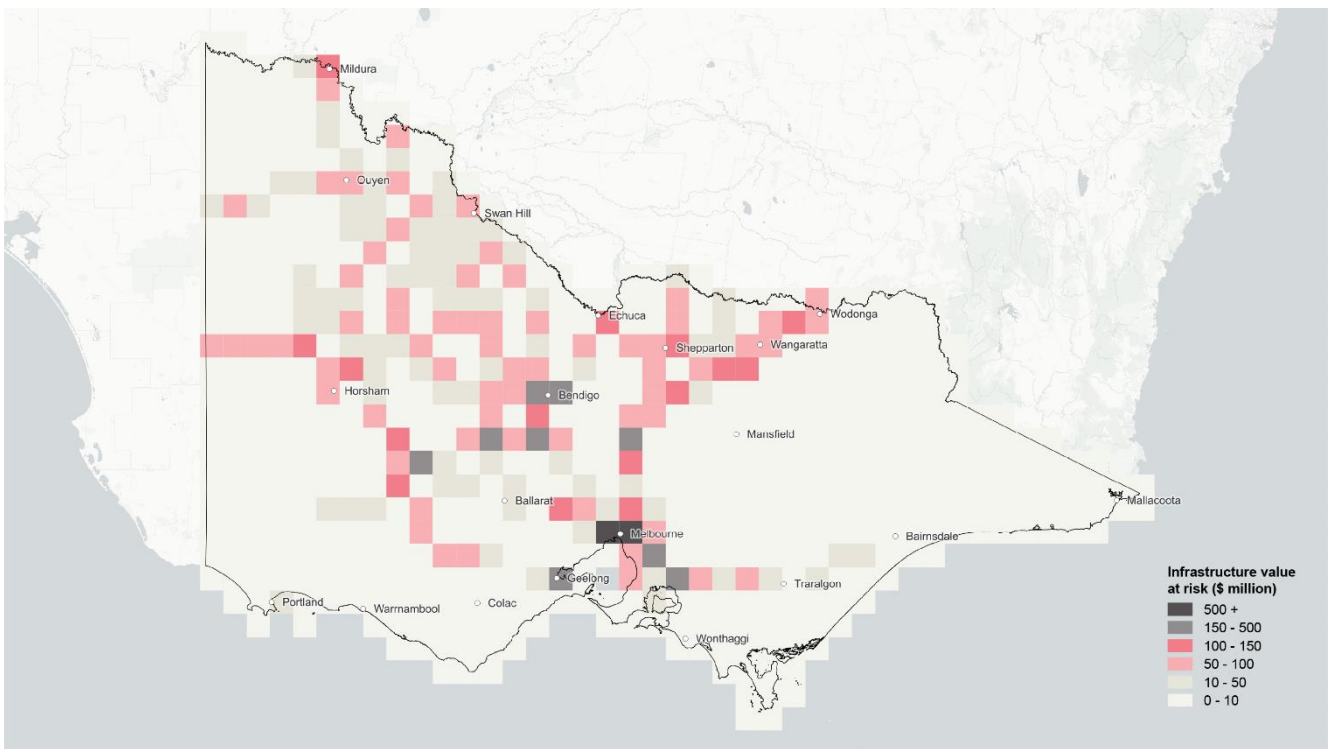
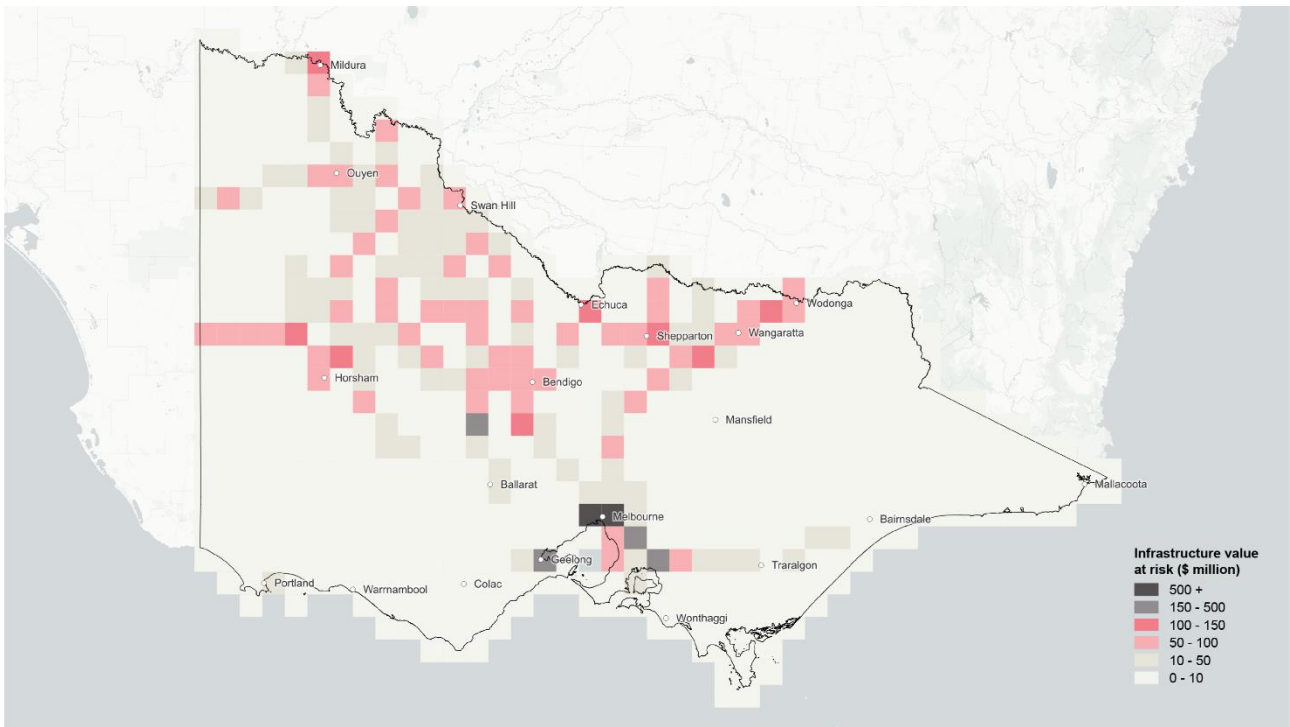


Figure 39: Distribution of rail infrastructure asset value at high risk of damage from at least one climate hazard under the low emissions scenario by 2030 (top) and the high emissions scenario by 2070 (bottom), by 25km grid square.

5.3.3 Energy sector faces significant asset value at risk, even with a small proportion of its total value exposed

In terms of value, \$10.1b of energy assets are at high risk of damage from at least one hazard under SSP3-7.0 2070, compared to \$7.2b under SSP1-2.6 2030. Figure 40 shows the proportion of asset value at risk of damage for the energy sector. Extreme heat and bushfire are the hazards driving greatest asset value with high risks of damage, as shown in Figure 40, with flooding also influencing high risk.

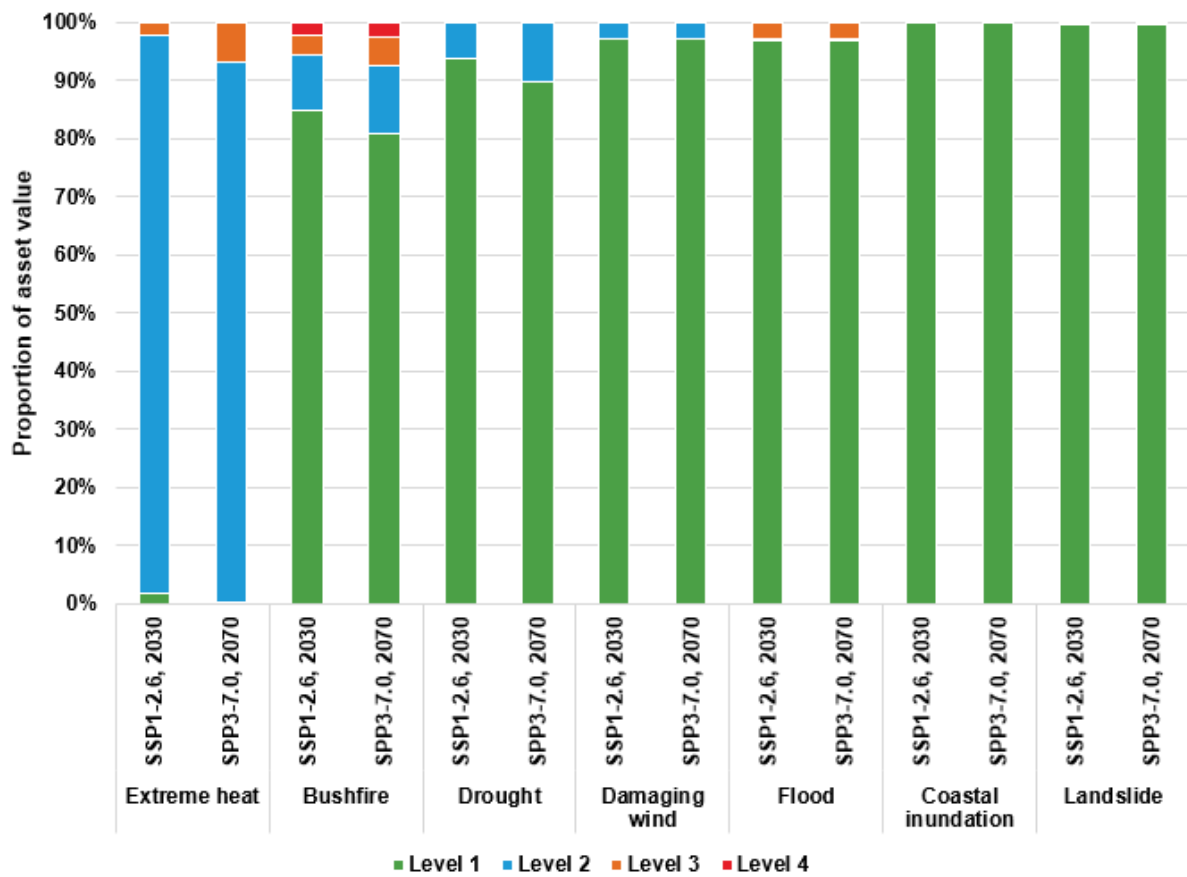


Figure 40: Victorian energy sector infrastructure risk of damage from each hazard by proportion of asset value, for the low emissions scenario in 2030 and high emissions scenario in 2070.

The spatial trends of asset value at high risk from at least one hazard show a concentration of value in Melbourne, the Latrobe Valley and other regional areas under the low emissions scenario in 2030. Under the high emissions scenario in 2070, the value at risk increases slightly along the northern border of the state and to the north of Horsham, shown in Figure 41.

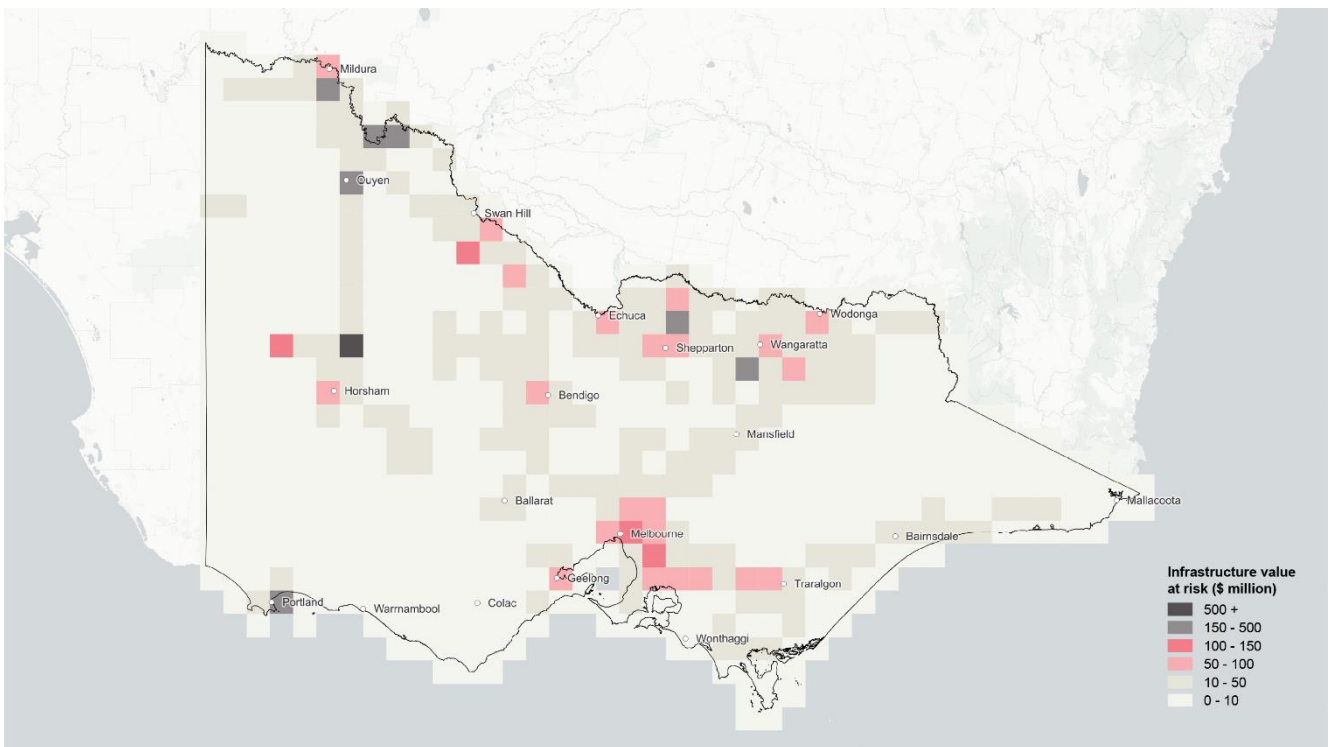
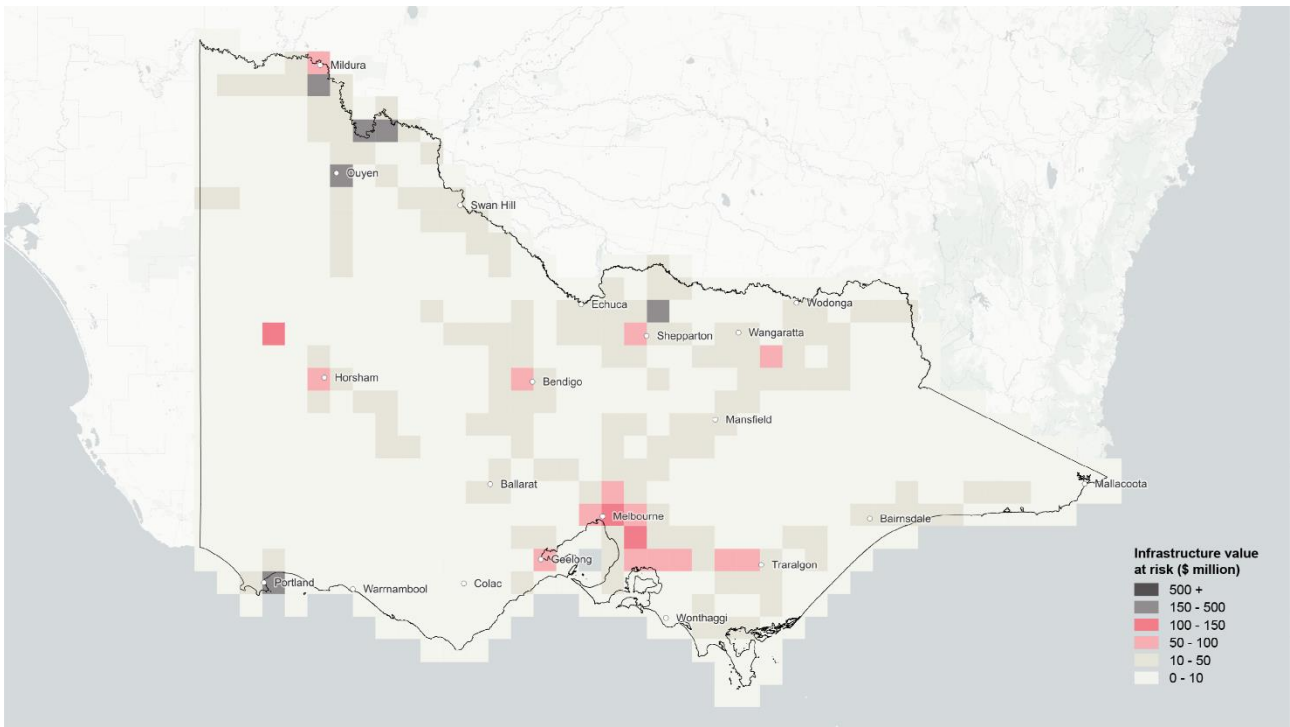


Figure 41: Distribution of energy infrastructure asset value at high risk of damage from at least one climate hazard under the low emissions scenario by 2030 (top) and the high emissions scenario by 2070 (bottom), by 25km grid square.

5.3.4 Health assets see dramatic increase in value-at-risk

Health infrastructure has a significant value-at-risk. By 2070, \$7.1b of assets are at-risk of damage from at least one hazard which is an increase of \$1.7b from SSP1-2.6 2030 (\$5.3b).

For the health sector, flood is the hazard driving the majority of high risk of damage, by proportion of asset value, as shown in Figure 42. Bushfire and extreme heat will also drive high risks under SSP3-7.0 by 2070.

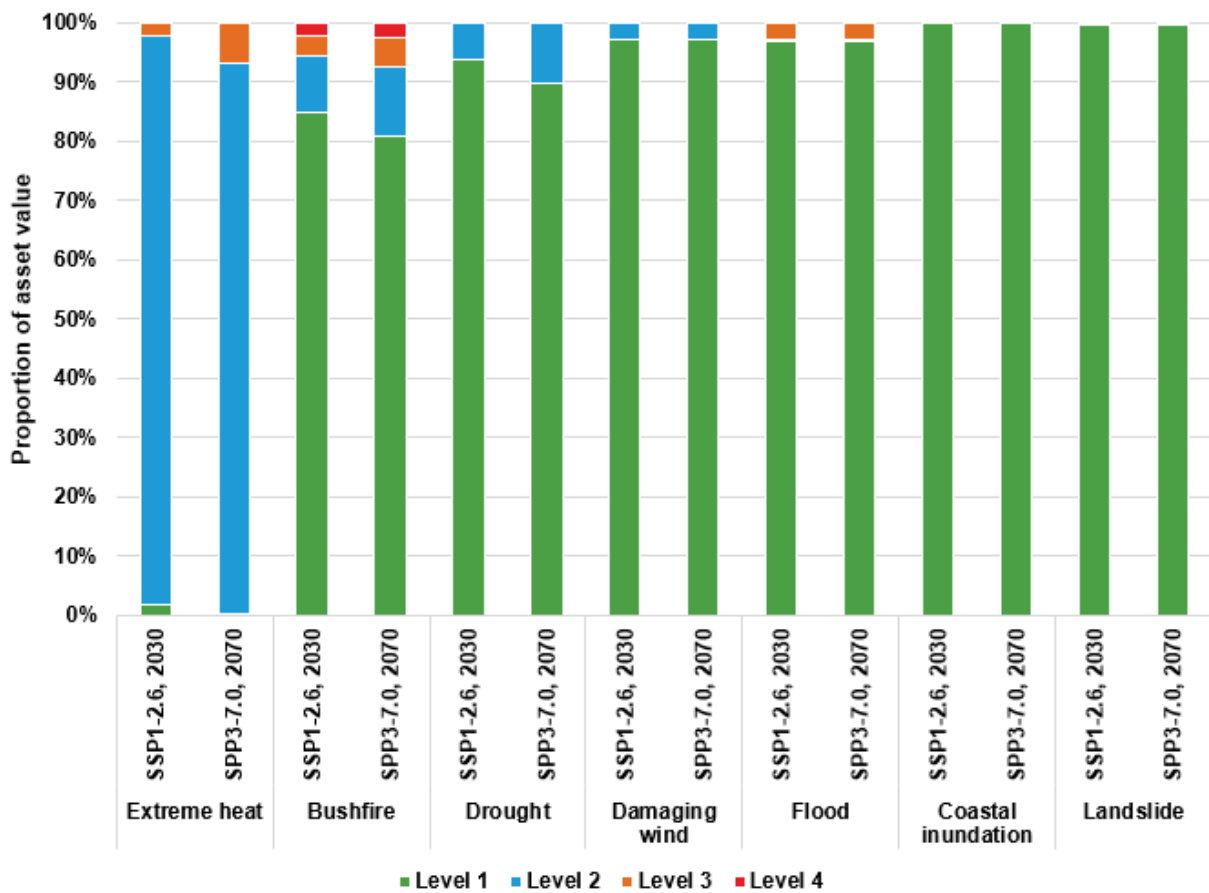


Figure 42: Victorian health sector infrastructure risk of damage from each hazard by proportion of asset value, for the low emissions scenario in 2030 and high emissions scenario in 2070.

The areas with the greatest concentration of health assets at risk of multiple hazards under the low emissions scenario in 2030 are distributed across north-western, and northern regional Victoria, in addition to metropolitan Melbourne. The value at risk increases under the high emission scenario in 2070 with a spatial trend across north-western Victoria, and increased risk around metropolitan Melbourne, Wangaratta and Echuca, as shown in Figure 43.

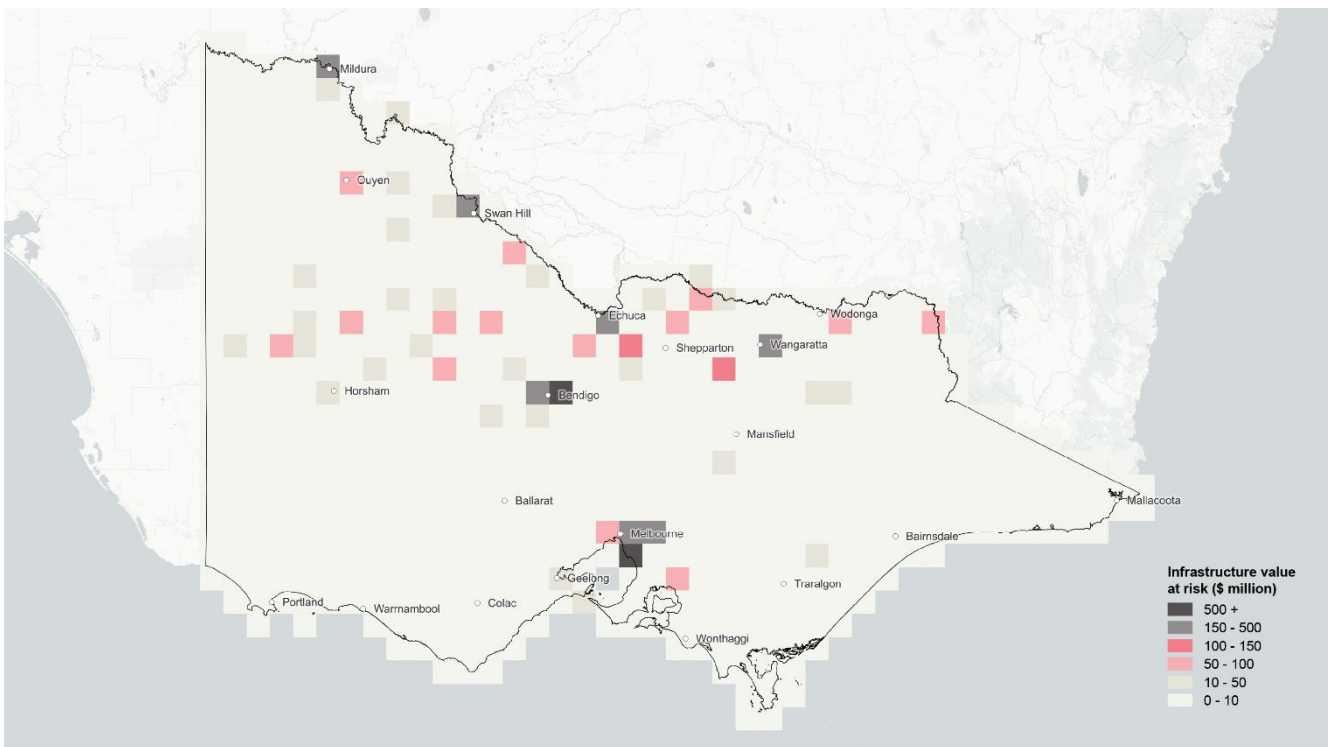
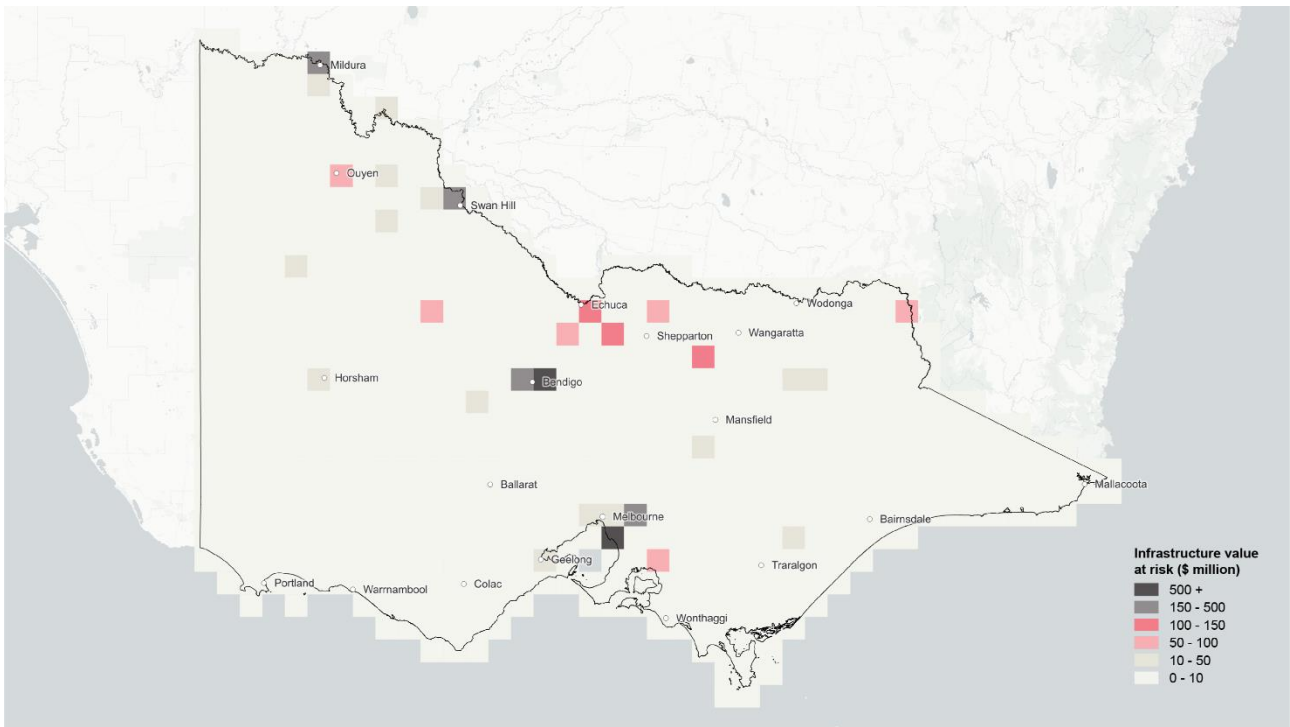


Figure 43: Distribution of health infrastructure asset value with high risk of damage from at least one climate hazard under the low emissions scenario by 2030 (top) and the high emissions scenario by 2070 (bottom), by 25km grid square.

5.3.5 All port assets face very high risks from coastal inundation only

Port infrastructure has 100% of assets at high risk from at least one hazard under both 20cm and 47cm of inundation. .. These assets are valued at \$5.5b. The sector is at high risk from one hazard, coastal inundation, and does not face compounding multi-hazard risk, reflecting the dominance of coastal inundation as the primary threat to port infrastructure. This risk level represents inherent risk due to the vulnerability of ports, based on the potential for coastal inundation to permanently compromise assets, assuming that there are no adaptation measures in place.

5.3.6 Infrastructure in parks already face substantial risk

A large proportion of asset value for park infrastructure is at high risk under both emission scenarios, though with more modest increases than other sectors when considering future climate conditions. Under SSP1-2.6 2030 conditions, 78% of parks asset value are at high risk from at least one hazard, increasing to 80% under SSP3-7.0 2070. Much of this risk is driven by exposure to bushfire, due to the location of buildings within parks in bushfire-prone locations. By 2070, \$1.98b of parks assets are exposed to risk of damage from at least one hazard, increased from \$1.94b under SSP1-2.6 2030.

5.3.7 Growing risk to community, justice and education infrastructure

Cultural and community, justice and community safety, and education and training infrastructure all experience substantial increases in climate risk, though starting from relatively lower levels under low emissions scenarios compared to transport and energy networks. These sectors collectively represent essential community services distributed across Victoria's urban, regional, and rural areas. The value of cultural and community infrastructure assets at high risk of damage from at least one hazard increases from \$1.0b under SSP1-2.6 2030 to \$1.1b under SSP3-7.0 2070. For justice and community safety infrastructure, this value increases from \$844m under SSP1-2.6 2030 to \$1.3b under SSP3-7.0 2070, while for education and training infrastructure, this value increases from \$3.3b under SSP1-2.6 2030 to \$4.1b under SSP3-7.0 2070.

5.3.8 Housing infrastructure faces higher risks from downtime than damage

The high risk to housing infrastructure from downtime from at least one hazard affects twice the value of assets compared to damage across all scenarios. The value of housing assets at high risk of damage from at least one hazard increases from \$1.5b under SSP1-2.6 2030 to \$2.0b under SSP3-7.0 2070. For downtime this value increases from \$2.9m under SSP1-2.6 2030 to \$4.1b under SSP3-7.0 2070, driven by the higher vulnerability of housing assets to downtime impacts from heat.

5.4 Some assets and locations are at risk from multiple climate hazards

Risk from at least two hazards refers to assets that are exposed to more than one climate hazard such as extreme heat, bushfire, coastal inundation, flooding, or storm surge. When multiple hazards overlap, the likelihood of damage increases, and the potential consequences can be more severe because the asset may face repeated or compounding stress. Considering multi-hazard risk is therefore important as it highlights where failure could occur through several different pathways and helps prioritise resilience measures for assets that are affected by at least two hazards.

The value of infrastructure at high risk of damage from at least two hazards increases from \$9.0b under SSP1-2.6 2030 to \$16.3b under SSP3-7.0 2070.

Infrastructure in parks, rail, road and energy sectors have the largest proportion of sector value at risk of damage from more than two hazards. The value of rail infrastructure at high risk of damage increases from \$2.7b under SSP1-2.6 2030 to \$4.8b under SSP3-7.0 2070 and the equivalent value for road infrastructure increases from \$3.5b to \$5.5b and for energy infrastructure increases from \$1.9b to \$3.8b. Infrastructure in parks shows a more modest increase in value at high risk of damage across the scenarios, from \$0.38b under SSP1-2.6 2030 to \$0.39b under SSP3-7.0 2070.

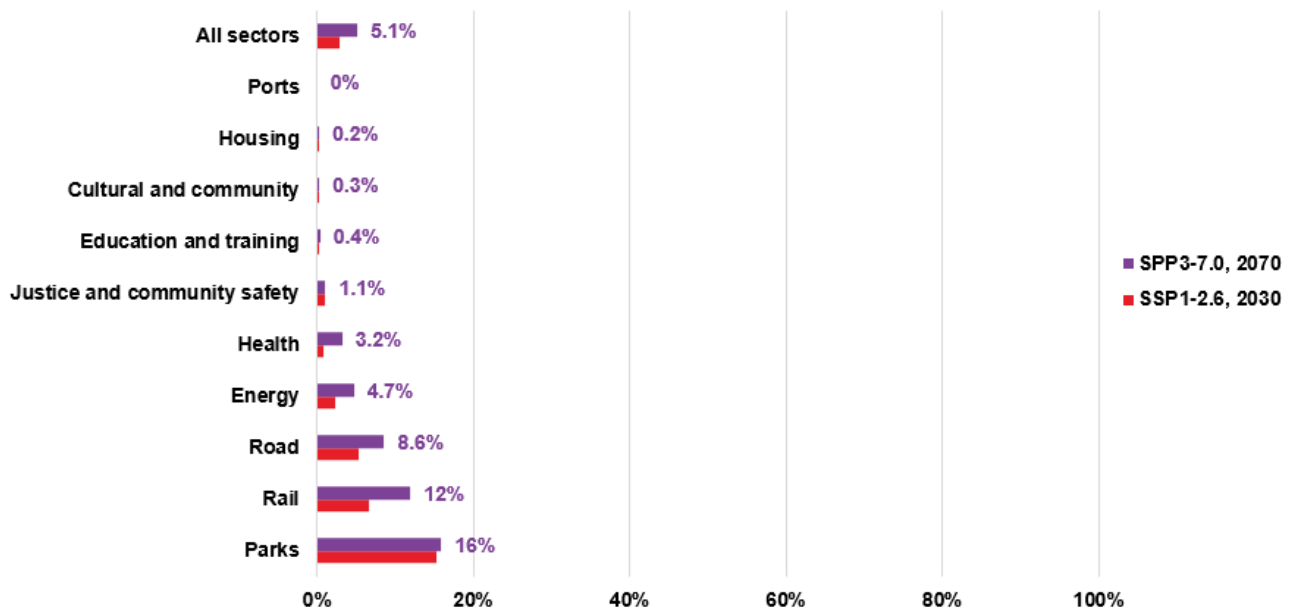


Figure 44: Proportion of infrastructure sector value with high risk from damage from at least 2 hazards.

More assets face high risk of downtime from two hazards than from damage, impacting assets with 4.7% of all value compared to 2.8% for damage under SSP1-2.6 2030, and 8.7% compared to 5.1% respectively under SSP3-7.0 2070. The downtime has a different pattern of impact across sectors compared to damage, particularly affecting assets in the housing, education and training and justice and community safety sectors, driven by higher vulnerability to downtime as a result of heat in combination with other hazards.

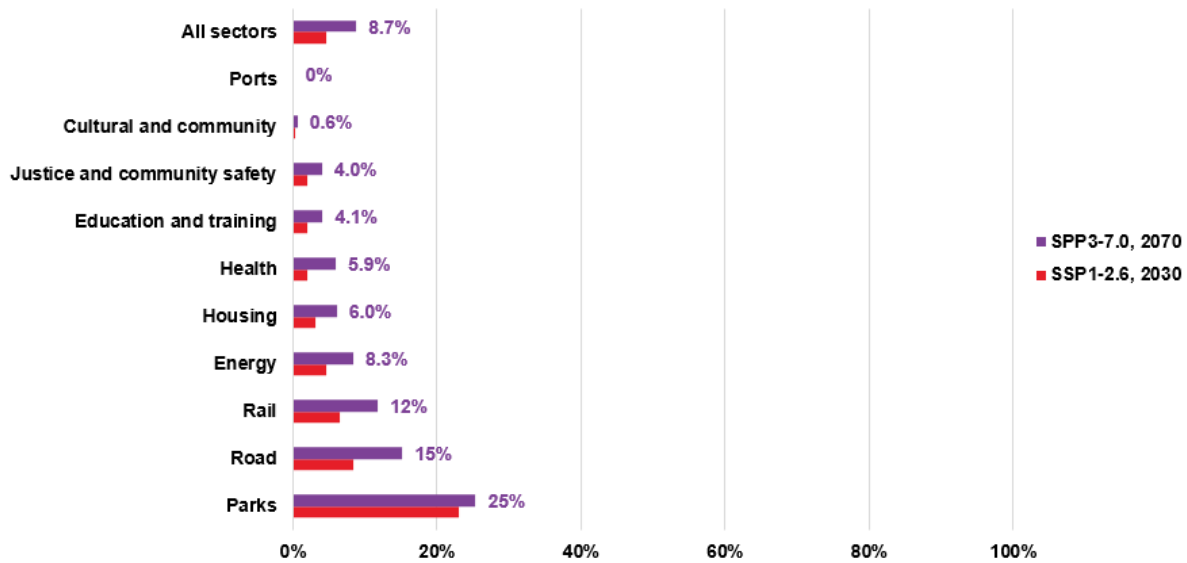


Figure 45: Proportion of infrastructure sector value with high risk from downtime from at least 2 hazards.

In terms of spatial trends, Figure 46 shows that there are similar trends across Victoria for asset value that are affected by high risk from at least two hazards compared to at least one hazards. Notably, the dominance of Melbourne as a concentration of high climate risk to infrastructure is primarily due to risk from one hazard as opposed to multi-hazard risk.

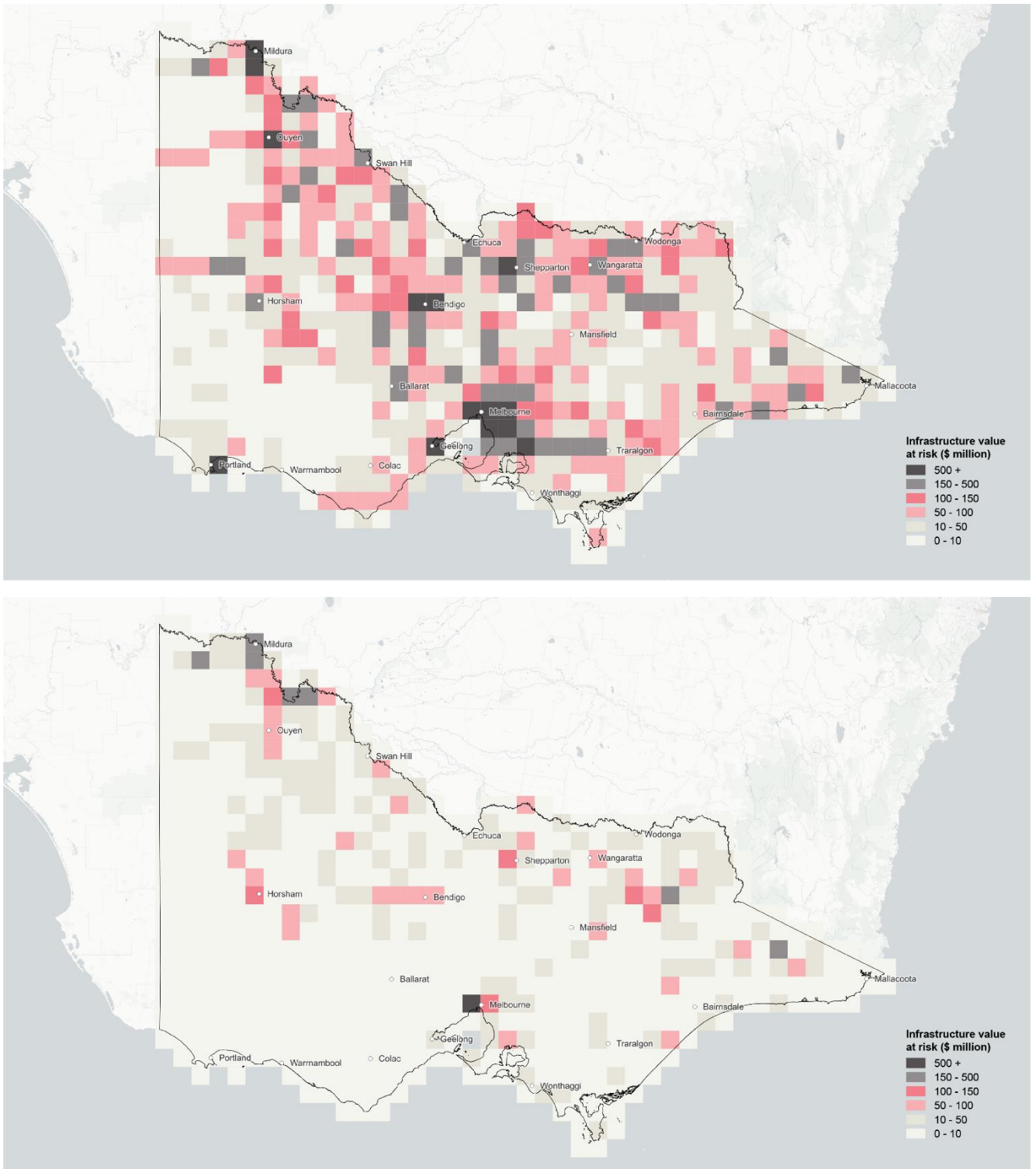


Figure 46: Distribution of infrastructure asset value with high risk of damage from at least one climate hazard (top) and at least two climate hazards (bottom) under a low emissions scenario by 2030, by 25km grid square.

5.5 Infrastructure criticality influences risk tolerance

This section introduces criticality as a lens to prioritise investment to address climate risks across Victoria. Criticality is the measure of how essential a piece of infrastructure is to the continued operation of communities, the economy, and emergency response, as well as the severity of consequences if it fails. This project considers

criticality in terms of how important infrastructure assets are to infrastructure system function and delivering social, economic and environmental outcomes.

We undertook a criticality assessment of selected asset types across the scope of infrastructure sectors included in the project. The results of the criticality assessment provide insights into the infrastructure types that are of greatest importance across Victoria and can be used to help prioritise adaptation response.

This section provides further detail of the assessment method and highlights key findings from the criticality assessment which may influence investment to address the climate risks. The evidence base that underpins the criticality assessment is in Appendix C.

5.5.1 Different asset types will have different physical, social and function impact if they fail

The criticality assessment assigned scores to 17 asset types based on nine criteria that represent aspects of criticality across physical, social and functional impacts. The scores for each asset type and criterion are shown in Table 20 below.

Table 20: Full results of the criticality assessment.

Asset type	Public safety	Wellbeing and public health	Affected population size and vulnerability	Network redundancy	Recovery time and restoration capacity	Interdependencies	Environmental impact	Economic impact	Replacement value	Total score
Energy – generation	2	3	3	3	3	3	2	3	3	25
Health – hospitals	3	3	3	3	2	2	2	3	3	24
Energy – substations	2	3	3	2	3	3	2	3	2	23
Energy – transmission and distribution lines	2	3	3	2	2	3	1	3	2	21
Road – road (including bridges)	2	2	2	2	3	3	1	3	2	20
Health – specialist clinics	2	3	2	1	2	2	2	2	2	18
Ports – port infrastructure	1	1	1	2	2	2	3	3	3	18
Justice and community safety – correctional facilities	2	2	2	3	2	1	1	2	3	18
Health – aged care	3	3	2	3	2	1	1	1	2	18
Rail – train track (including bridges)	1	1	1	3	3	2	1	3	2	17
Housing – housing	2	3	2	2	2	1	1	1	1	15
Rail – station	1	1	1	2	2	2	1	2	2	14
Cultural and community – community centres and community health centres	2	2	2	1	1	2	1	1	1	13
Education – schools	1	2	2	1	1	1	1	2	2	13
Justice and community safety – fire and police stations	2	2	1	1	2	1	1	2	1	13
Education – TAFE	1	2	1	1	2	1	1	2	2	13
Cultural and community – museums and arts centres	1	2	1	1	2	1	1	1	3	13

The results of the criticality assessment showed clear grouping of the asset types assessed into three tiers. A summary of the asset types categorised as high, moderate and low criticality is set out in Figure 47.

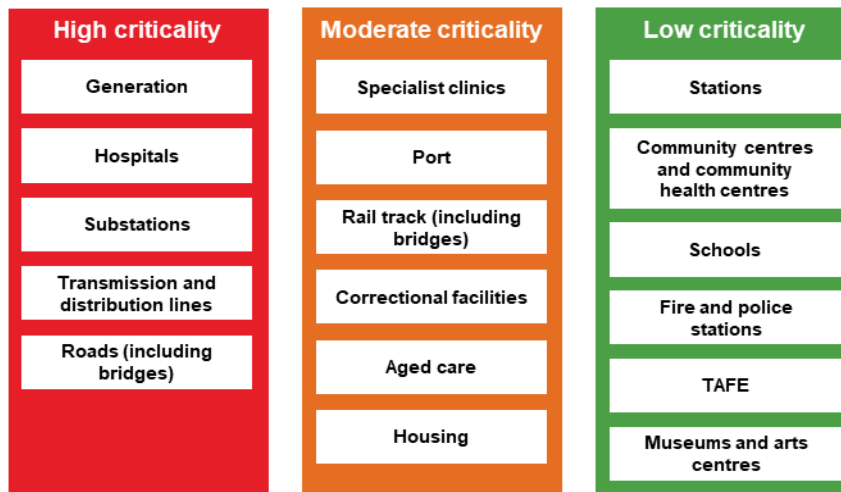


Figure 47: Summary of criticality categorisation of assessed asset types.

5.5.2 Energy assets, hospitals and roads are the most critical asset types

The criticality assessment highlighted energy sector assets, as well as road and hospital asset types as high criticality. There is generally high dependency on these asset types by other infrastructure. Therefore, there are cascading impacts on other sectors if these asset types fail, as well as broad economic impacts and social impacts. For example, if energy systems fail, all other sectors are impacted as they rely on electricity to operate.

Energy generation was the most critical asset type assessed, driven by the high dependency of other sectors on the electricity network and minimal redundancy in the system. This analysis maps and assesses existing energy assets. Currently the electricity system in Victoria includes a few large coal-fired generators which provide the majority of the state’s electricity at certain times. However, as the energy transition occurs in Victoria, this is changing towards a more distributed network of renewable energy generators throughout the state. This will increase the resilience of the energy system and decrease the negative impact if any individual generator fails, therefore reducing the criticality of each individual generation asset.

5.5.3 Asset types with lower criticality scores may play important roles within local communities

Asset types with moderate criticality are driven by different scores in different criteria, and it is the economic impact that elevates the importance of transport assets while the social impact elevates the importance of health assets. Asset types such as aged care, housing and correctional facilities support vulnerable populations and have limited spare capacity within the system to continue to deliver services if an asset is affected by a climate hazard.

Assets with lower criticality are those where services are able to be delivered out of different locations. These typically have redundancy due to multiple assets and minimal downstream interdependencies. In the criticality assessment, individual characteristics and functions of asset types within communities have not been assessed, which would adjust this generalised view. For example, some community facilities are designated as last places of refuge during emergencies, particularly in regional Victoria. This would increase the criticality of these specific assets.

6. Conclusion

Victoria's infrastructure faces a rapidly escalating risk landscape driven by climate change, with climate hazards projected to intensify in frequency and severity over coming decades. This report provides a comprehensive, evidence-based assessment of climate risks to infrastructure assets across the state, integrating exposure, vulnerability, and criticality to identify priority areas for adaptation investment. It identifies the sectors and communities that are most at risk from climate hazards under current and future climate conditions.

The increase in climate hazards means that assets valued at \$57.2b are at risk of damage due to at least one climate hazard in a low emissions scenario by 2030, increasing to \$71.3 under a high emissions scenario by 2070.

Of the sectors assessed, the ports, parks rail, road, and health sectors make up the vast majority of value at risk from climate hazards. Of these, roads, hospitals and energy sector assets were identified as critical asset types, highlighting the potential for climate change to affect infrastructure providing critical functions and services to Victorians. The high value at risk demonstrates both the exposure to hazards of the assets in those sectors, and the vulnerability of assets in those sectors to specific hazards.

This establishes a clear need to prioritise preventative investment in these sectors so that they are better prepared to withstand and recover from climate hazards. A proactive approach will reduce the need for reconstruction after events and make available resources for adaptation investment in those assets that may be less critical or expensive at a state level, but key to communities, such as health centres or schools.

This evidence base presented in this report can be used to inform investment in adaptation for the next five years, which will need to happen alongside regulatory changes to ensure an effective response to climate change. The approach outlined here can also guide communities or sectors that are in highly exposed areas to better understand the vulnerabilities of assets that they rely on, and an approach to help assess criticality of different assets.

While this study provides a robust, state-wide evidence base, it also identifies the need for further detailed and place-based investigations to refine adaptation priorities:

- We have considered vulnerability in this study at a sector level. Some assets warrant adaptation investment before others as vulnerability varies between assets. A vulnerability assessment of asset types within sectors would provide further understanding climate risks within sectors. Asset- and site-specific data on age and condition, as well as site investigations, could be used to further refine an asset-type vulnerability assessment.
- Network-wide investigations will help to further prioritise investment, including understanding network dependencies, community needs, operational adaptive capacity. These will be most effective if undertaken in close collaboration with the network operators and other stakeholders.
- A more detailed review of specific places that are exposed to multiple hazards and have vulnerable assets would allow the identification of potential interventions that could protect across multiple hazards and help identify opportunities for more efficient resource allocation.
- This report frames climate risks in terms of the value of affected assets for both damage and downtime. Other metrics for measuring downtime risks, such as affected hours with loss of service, could be used to more accurately capture the impact of downtime.
- Incorporating planned developments would provide an opportunity to integrate adaptation investment that could improve outcomes for both existing and future assets. This could also include an improved understanding of how the energy transition, and a more distributed energy network could improve resilience, without requiring significant investment. An integrated approach could result in a more nuanced prioritisation of adaptation investment.

This study brings together a high-level risk assessment across multiple sectors for the state of Victoria. While many of these sectors are undertaking more detailed risk assessments, this work provides a benchmark for those so that there is a common foundation against which to review subsequent risk assessments. It also allows

councils, communities and agencies to understand their relative risk and where they might be able to learn lessons about opportunities for adaptation.

7. References

- AEMO. (2019). *Load Shedding in Victoria on 24 and 25 January 2019*. Australian Energy Market Operator. Retrieved from https://www.aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2019/load-shedding-in-vic-on-24-and-25-january-2019.pdf?la=en&hash=5EC85A8014DC34D64DAE2E27B27D525F
- AIHW. (2020). *Emergency department visits surged during 2019-20 bushfire season*. Australian Institute of Health and Welfare. Retrieved from <https://www.aihw.gov.au/news-media/media-releases/2020/november/emergency-department-visits-surged-during-2019-20>
- AIHW. (2023). *Let's talk about the weather: injuries related to extreme weather*. Australian Institute of Health and Welfare. Retrieved from <https://www.aihw.gov.au/reports/injury/extreme-weather-injuries/contents/about>
- Arup. (2023). *Adapting Victoria's infrastructure to climate change - Phase 3: Economic analysis of adaptation for roads*. Melbourne: Infrastructure Victoria.
- Australian Energy Regulator. (2025). *State of the energy market 2025 - Performance reports*. Australian Energy Regulator. Retrieved from <https://www.aer.gov.au/publications/reports/performance/state-energy-market-2025>
- AustRoads. (2019). *Guide to Paement Technology Part 4K: Selection and Design of Sprayed Seals*. AustRoads. Retrieved from <https://austroads.gov.au/publications/pavement/agpt04k/determination-of-maximum-pavemensslknndn>
- Barzegar, M., & Wen, H. (2023). Modeling roadway temperatures for wildfire evacuation and assessment of pavement damage. *J Infrastruct Preserv Resil*, 4(18). doi:10.1186/s43065-023-00083-8
- Bovenizer, N. (2023, April 26). *Stonepeak and Spirit Super complete purchase of Australia's Geelong Port*. Retrieved from Ship Technology: <https://www.ship-technology.com/news/stonepeak-and-spirit-super-complete-purchase-of-australias-geelong-port/?cf-view>
- Bushfire Recovery Victoria. (2020). *After the flames - Community Reflections: Voices from the 2019/2020 bushfire season*. Melbourne: Victorian Government. Retrieved from <https://www.vic.gov.au/sites/default/files/2020-09/After%20The%20Flames%20-%20Community%20Reflections%202019-20.pdf>
- Cadario, A. (2024, November 20). Climate adaptation in ports: a global imperative for resilience. *Global Center on Adaptation*. Retrieved from <https://gca.org/climate-adaptation-in-ports-a-global-imperative-for-resilience/>
- Canadian Centre for Climate Services. (2024). *Introduction to Global Warming Levels*. Retrieved from Climate Data Canada: <https://climatedata.ca/resource/introduction-to-global-warming-levels/>
- Carroll, B. (2020, February 5). Parliamentary Debates (Hansard). *Legislative Assembly, Fifty-Ninth Parliament, First Session, 97*. Melbourne: Parliament of Victoria.
- Castillo, A. P., & Herazo, J. C. (2024). A Review of Wind Impact on Container Port Operations: Current Technologies, Strategies and Future Perspectives. *Procedia Computer Science*, 251, 783-788. doi:<https://doi.org/10.1016/j.procs.2024.11.185>
- Centre for Education Statistics and Evaluation. (2020). *The impact of bushfires on student wellbeing and student learning*. Sydney: NSW Government: Centre for Education Statistics and Evaluation.
- CFA. (2023). *Black Saturday 2009*. Retrieved December 2025, 15, from <https://www.cfa.vic.gov.au/about-us/history-major-fires/major-fires/black-saturday-2009>
- CFA. (2025). *Community Fire Refuges*. Retrieved from Country Fire Authority: <https://www.cfa.vic.gov.au/plan-prepare/your-local-area-info-and-advice/community-fire-refuges>

- Climate Change in Australia. (2020). *Case Study: Bushfire & Distribution*. Retrieved from Climate Change in Australia: <https://www.climatechangeinaustralia.gov.au/en/projects/esci/esci-case-studies/case-study-fire-distribution/>
- Climate Change in Australia. (2026). *Case Study: The impact of climate change on transmission line ratings*. Retrieved from Climate Change in Australia: <https://www.climatechangeinaustralia.gov.au/en/projects/esci/esci-case-studies/case-study-heat-transmission/>
- Clinical Excellence Commission. (2024). *Risk assessment and escalation of temperature or humidity variation in perioperative and sterile stock environments*. NSW Government. Retrieved from https://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0007/941560/Risk-assessment-and-escalation-of-temperature-or-humidity-variation-in-perioperative-and-sterile-stock-environments.pdf
- CSIRO. (2025). *2025-26 GenCost Report*. Commonwealth Scientific and Industrial Research Organisation. Retrieved from <https://www.csiro.au/en/research/technology-space/energy/Electricity-transition/GenCost%20>
- Cuffe, H. (2020). *Operation BUSHFIRE ASSIST 2019–2020: The Royal Australian Navy’s Role and Response*. Commonwealth of Australia. Retrieved from <https://seapower.navy.gov.au/publications-and-research/operation-bushfire-assist-2019-2020-royal-australian-navys-role-and-response>
- Dawson, R. J. (2015). Handling Interdependencies in Climate Change Risk Assessment. 1079-1096. doi:<https://doi.org/10.3390/cli3041079>
- DECCA. (2025). *Victoria's changing climate: understanding Victoria's past and future climate*. Retrieved from Department of Energy, Environment and Climate Action: <https://www.climatechange.vic.gov.au/victorias-changing-climate>
- DEECA. (2024). *Victoria's Climate Science Report*. State of Victoria Department of Energy, Environment and Climate Action.
- DELWP. (2022). *Electricity Distribution Network Resilience Review: Final Recommendations Report*. Melbourne: Electricity Distribution Network Resilience Review Expert Panel. Retrieved from https://www.energy.vic.gov.au/__data/assets/pdf_file/0030/594930/network-resilience-review-final-recommendations-report.pdf
- DELWP. (2022). *Marine and Coastal Strategy*. Melbourne: The State of Victoria Department of Environment, Land, Water and Planning.
- Department of Health. (2012). *Residential aged care services natural hazards ready resource*. Department of Health. Retrieved from www.health.vic.gov.au/sites/default/files/migrated/files/collections/policies-and-guidelines/r/racs_nathazards.pdf
- Department of Health. (2024, April 20). *Heat Health*. Retrieved from Victorian Government: Department of Health: <https://www.health.vic.gov.au/your-health-report-of-the-chief-health-officer-victoria-2018/environmental-health/heat-health>
- Department of Justice and Community Safety . (2025). *24-25 Annual Report*. Melbourne: Victorian Government. Retrieved from <https://files.justice.vic.gov.au/2025-10/DJCS%20Annual%20Report%202024–25.pdf>
- Emergency Management Victoria. (2024). *Victoria's Critical Infrastructure: All sectors resilience report 2023*. State of Victoria. Retrieved from <https://files.emv.vic.gov.au/2024-09/Victoria%27s%20Critical%20Infrastructure%20All%20Sectors%20Resilience%20Report%202023.pdf>
- Energy Networks Australia. (2018). *Heatwaves and Electricity Supply*. Energy Networks Australia and Australian Energy Council. Retrieved from <https://www.energynetworks.com.au/resources/fact-sheets/heatwaves-and-energy-supply-explained/>

- Energy Networks Australia. (2022). *Electricity networks: a guide to climate change its likely effects*. Energy Networks Australia. Retrieved from <https://www.energynetworks.com.au/resources/reports/electricity-networks-a-guide-to-climate-change-and-its-likely-effects/>
- Engage Victoria. (2024, August 01). *Network Outage Review*. Retrieved from Engage Victoria: <https://engage.vic.gov.au/network-outage-review>
- Environmental Justice Australia. (2024). *Climate hotbeds: Extreme heat in social housing*. Melbourne: Climate Justice Legal Project. Retrieved from https://envirojustice.org.au/wp-content/uploads/2024/11/EJA_Climate-hotbeds-report_241112.pdf
- Forest Fire Management Victoria. (2023). *Past Bushfires*. Retrieved 12 08, 2025, from <https://www.ffm.vic.gov.au/history-and-incidents/past-bushfires>
- GAC. (2020, Jan 07). *Bushfires impacting port operations*. Retrieved from GAC: <https://www.gac.com/hot-port-news/bush-fires-impacting-port-operations>
- Garcia-Alonso, L., Zanon Moura, T. G., & Roibas, D. (2020). The effect of weather conditions on port technical efficiency. *Marine Policy*, 113, 103816. doi:<https://doi.org/10.1016/j.marpol.2020.103816>
- Gibbs, L., Nursey, J., Cook, J., Ireton, G., Alkemade, N., Roberts, M., . . . Forbes, D. (2019). Delayed Disaster Impacts on Academic Performance of Primary School Children. *Child Development*, 90(4), 1402-1412. doi:<https://doi.org/10.1111/cdev.13200>
- Gracia, V., Sierra, J. P., Pedrol, M., Sampe, S., Garcia-leon, M., & Gironella, X. (2019). Assessing the impact of sea level rise on port operability using LiDAR-derived digital elevation models. *Remote Sensing of Environment*, 232, 111318. doi:<https://doi.org/10.1016/j.rse.2019.111318>.
- Hannam, P. (2018, January 11). 'Worse than Liddell': Another coal-fired power plant develops conniptions. *The Sydney Morning Herald*. Retrieved from <https://www.smh.com.au/environment/worse-than-liddell-another-coalfired-power-plant-develops-conniptions-20180110-h0g9y4.html>
- Heffernan, T. (2025, July 30). Climate disasters are pushing people into homelessness - but there's a lot we can do about it. *ANU Policy Brief*. Retrieved from <https://policybrief.anu.edu.au/climate-disasters-are-pushing-people-into-homelessness-but-theres-a-lot-we-can-do-about-it/#:~:text=Like%20'living%20a%20disaster%20every,the%20area%20or%20became%20uncontactable>
- Henry, L. (2012, November 7). Floods disrupt Victorian rail services. *Bendigo Advertiser*. Retrieved from <https://www.bendigoadvertiser.com.au/story/713392/floods-disrupt-victorian-rail-services/>
- Heritage Collections Council. (2001). *Guidelines for environmental control in cultural institutions*. Commonwealth of Australia. Retrieved from <https://aiccm.org.au/wp-content/uploads/2020/01/Heritage-Collections-Council-Guidelines-for-Australian-Museums.pdf>
- Huizinga, J., De Moel, H., & Szewczyk, W. (2017). *Global flood depth-damage functions: Methodology and the database with guidelines*. Luxembourg: EUR 28552 EN, Publications Office of the European Union. doi:10.2760/16510
- Infrastructure Victoria . (2025). *Victoria's infrastructure strategy 2025-2055*. Melbourne: Infrastructure Victoria.
- Infrastructure Victoria. (2024). *Learning for life: Preparing kindergarten, school and TAFE infrastructure for the future*. Melbourne: Infrastructure Victoria. Retrieved from <https://assets.infrastructurevictoria.com.au/assets/Resources/Learning-for-life-preparing-kindergarten-school-and-TAFE-infrastructure-for-the-future.pdf>
- Infrastructure Victoria. (2024). *Weathering the storm*. Retrieved from <https://www.infrastructurevictoria.com.au/resources/weathering-the-storm>
- IPCC. (2021). *The concept of risk in the IPCC Sixth Assessment Report: a summary of cross working group discussions*.

- IPCC. (2022). Annex II: Glossary. In IPCC, & V. R. Möller (Ed.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to* (pp. 2897–2930). Cambridge, UK and New York, NY, USA: Cambridge University Press. doi:10.1017/9781009325844.029
- ISO. (2019). *ISO 14090: 2019 Adaptation to climate change - Principles, requirements and guidelines*.
- Kim, K., Spirandelli, D., Rother, D., Yamashita, E., & Toner, M. (2025). Tracking wildfire risk to California railroads: integrating environmental data and railway operations. *Transportation Research Interdisciplinary Perspectives*, 32. doi:10.1016/j.trip.2025.101526
- Kompas, T., Keegan, M., & Witte, E. (2019). Australia's clean economy future: costs and benefits. *Melbourne Sustainable Society Institute, University of Melbourne*(MSSI Issues Paper 12), 38. Retrieved from <https://apo.org.au/node/240366>
- Legislative Council Environment and Planning Committee. (2024). *The 2022 flood event in Victoria: Final Report*. Parliament of Victoria. Retrieved from https://www.parliament.vic.gov.au/495fa6/contentassets/a1a3e3c7d84c4a059b7f8ad12089af06/lcepc-60-02_2022-flood-event-in-vic_final-report.pdf
- Maghsoodifar, F., Radfar, S., Moftakhari, H., & Moradkhani, H. (2025). Establishing closure criteria for coastal roadways under flooding conditions. *International Journal of Disaster Risk Reduction*, 130. doi:10.1016/j.ijdr.2025.105805
- Maner, M., Forrest Behne, M., Cullins, Z., Cowan, K. N., Peterson, M., & Brinkley-Rubinstein, L. (2022). Where Do You Go When Your Prison Cell Floods? Inadequacy of Current Climate Disaster Plans of US Departments of Correction. *Am J Public Health*, 112(10), 1382-1384. doi:0.2105/AJPH.2022.307044
- McCormick, F., & Showers, C. (2020). *Ecosystem services from forest in Victoria: Impact of the 2019-20 bushfires*. Melbourne: Department of Environment, Land, Water and Planning. Retrieved from https://www.environment.vic.gov.au/__data/assets/pdf_file/0023/555116/Ecosystem-services-from-forests-in-Victoria-Impact-of-the-2019-20-bushfires.pdf
- Melbourne Centre for Cities. (2024). *Life-Cycle Impacts of Public Housing in Victoria*. Melbourne: University of Melbourne. Retrieved from https://www.unimelb.edu.au/__data/assets/pdf_file/0004/4873630/Public-Housing-Renewal-Victoria-Evidence-Review.pdf
- Melbourne Water. (2025, October 23). *Greater Melbourne Flood Information Program*. Retrieved from Melbourne Water: <https://www.melbournewater.com.au/water-and-environment/flooding-and-drainage/greater-melbourne-flood-information-program>
- Melina Bath MP. (2023, September 6). *Morwell National Park Infrastructure neglect*. Retrieved from Melina Bath MP: Member for Eastern Victoria Region: <https://www.melinabath.com.au/morwell-national-park-infrastructure-neglect/>
- Metro Trains. (2026). *Hot Weather*. Retrieved from Metro Trains: <https://www.metrotrains.com.au/hot-weather/>
- Network Rail. (n.d.). *Buckled rail*. Retrieved from <https://www.networkrail.co.uk/rail-travel/delays-explained/buckled-rail-and-summer-heat/>
- Ogge, M., & Aulby, H. (2017). *Coal and gas a reliability liability in the heat: report*. Retrieved from <https://australiainstitute.org.au/report/coal-and-gas-a-reliability-liability-in-the-heat-report/>
- PIARC. (2012). *Dealing with the effects of climate change on road pavements*. World Road Association (PIARC).
- PIARC. (2015). *International Climate Change Adaptation Framework for Road Infrastructure*. . World Road Association.
- PIARC. (2023). *PIARC International Climate Change Adaptation Framework - 2023 Version*. World Road Association.

- Policy and Advisory Library. (2023, March 30). *Bushfire and Grassfire Preparedness*. Retrieved from Victorian Government | Policy and Advisory Library: <https://www2.education.vic.gov.au/pal/bushfire-and-grassfire-preparedness/guidance/community-bushfire-safety-options-school-premises>
- Port of Hastings Corporation. (2025). *Annual Report 2024-2025*.
- Premier of Victoria. (2024). *Six New State-Run Childcare Centres Opening In 2027*. Retrieved December 08, 2025, from <https://www.premier.vic.gov.au/six-new-state-run-childcare-centres-opening-2027>
- Robbins, I. P. (2005). Lessons from Hurricane Katrina: Prison Emergency Preparedness as a Constitutional Imperative. *University of Michigan Journal of Law Reform*, 42. Retrieved from https://digitalcommons.wcl.american.edu/facsch_lawrev/1026
- SBS News. (2018). *Traffic delays after 10 kilometres of Victoria's Hume Freeway melts*. Retrieved December 08, 2025, from <https://www.sbs.com.au/news/article/traffic-delays-after-10-kilometres-of-victorias-hume-freeway-melts/jlwxbywpm>
- Taylor, M. (2025). Preparing the access to justice sector for climate change: insights from Australian lawyers. *International Journal of the Legal Profession*, 32(2), 225-249. doi:10.1080/09695958.2025.2458031
- The Productivity Commission. (2014). *Natural Disaster Funding Arrangements. Productivity Commission Inquiry Report Vol. 1*. Canberra: Australian Government.
- Verde, J. C., & Zêzere, J. L. (2010). Assessment and validation of wildfire susceptibility and hazard in Portugal. *Natural Hazards and Earth System Sciences*, 10(3), 485–497. doi:<https://doi.org/10.5194/nhess-10-485-2010>
- Vic Emergency. (2026). *January 2026 fires*. Retrieved from VIC Emergency: https://www.emergency.vic.gov.au/relief/#january_2026_fires
- Victoria Government Gazette. (2016). *Port Management Act 1995 (Vic.)*. Melbourne: Victoria Government Printer. Retrieved from <https://www.gazette.vic.gov.au/gazette/Gazettes2016/GG2016S201.pdf>
- Victorian Auditor-General. (2017). *Managing Victoria's Public Housing: Victorian Auditor-General's Report*. Victorian Auditor-General's Office. Retrieved from <https://www.audit.vic.gov.au/sites/default/files/20170621-Public-Housing.pdf>
- Victorian Auditor-General. (2017). *Victorian Auditor-General's Report: Managing School Infrastructure*. Melbourne: Victorian Government. Retrieved from <https://www.audit.vic.gov.au/report/managing-school-infrastructure?section=#:~:text=11%20May%202017-,Audit%20overview,avoid%20costly%20repairs%20and%20reconstruction.>
- Victorian Government. (2022). *October 2022 Victorian floods*. Retrieved from Victorian Government: <https://www.vic.gov.au/2022-flood-recovery>
- Victorian Government. (2023). *Sustainable Local Ports Framework*. Melbourne: Victorian Government. Retrieved from <https://www.vic.gov.au/sites/default/files/2023-09/Local-Ports-Sustainable-Framework.pdf>
- Victorian Government Department of Health. (2010). *Residential aged care services heatwave ready resource*. the Ageing and Aged Care: Victorian Government Department of Health. Retrieved from <https://www.health.vic.gov.au/publications/residential-aged-care-services-heatwave-ready-resource>
- Victorian Managed Insurance Authority. (2025). *Annual report 2024-2025*. Victoria State Government.
- Victorian Managed Insurance Authority. (2026, February 2). *About Us*. Retrieved from vmia: <https://www.vmia.vic.gov.au/about-us>
- Victorian School Building Authority. (2025). *New Schools*. Retrieved December 09, 2025, from <https://www.schoolbuildings.vic.gov.au/new-schools>
- Victorian State Emergency Service. (2023). *Annual report 2022-2023*. Victoria State Emergency Service.

- Victoria's Big Build. (2025). *Bogong High Plains Road Landslip*. Retrieved December 09, 2025, from <https://bigbuild.vic.gov.au/projects/roads/bogong-high-plains-road-landslip>
- VMIA. (2025). VMIA Claims Data. Provided by VMIA to Infrastructure Victoria on 27 October 2025.
- Vranešić, K., & Haladin, I. (2025). The Effects of Extreme Weather Conditions on Rail Traffic. *Transportation Research Procedia*, 91, 273-280. doi:10.1016/j.trpro.2025.10.036
- VSBA. (2024, January 9). *Clifton Creek Primary School*. Retrieved from Victorian School Building Authority: <https://www.schoolbuildings.vic.gov.au/clifton-creek-primary-school>
- Zaveri, P. (2014). Damage to Libraries due to Water Related Disasters. *Library Philosophy and Practice*. Retrieved from <https://files.core.ac.uk/download/pdf/33139428.pdf>

Appendix A

Risk result data tables

A.1 Risk result data tables by hazard

Table 21: Risk rating asset values by hazard – all sectors.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total ⁸	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	237.5	57.3	17.9	5.51	318.2	237.5	51.7	14.4	14.6	318.2
Coastal inundation	310.8	0	0	7.38	318.2	310.8	0	0	7.38	318.2
Damaging wind	315.0	2.96	0.262	0	318.2	311.6	5.11	1.36	0.119	318.2
Drought	313.1	5.16	0	0	318.2	312.9	3.90	1.46	0	318.2
Extreme heat	93.0	214.4	9.28	1.54	318.2	15.4	281.4	16.7	4.62	318.2
Flood	294.5	1.42	10.5	11.8	318.2	294.5	1.22	8.08	14.4	318.2
Landslide	315.8	0	0.756	1.70	318.2	315.8	0	2.45	0	318.2
Maximum risk level across all hazards	64.7	196.4	31.0	26.2	318.2	3.40	246.4	30.2	38.3	318.2
SSP3-7.0, 2070										
Bushfire	146.2	141.9	22.7	7.45	318.2	146.2	133.1	21.8	17.2	318.2
Coastal inundation	310.3	0	0	7.90	318.2	310.3	0	0	7.90	318.2
Damaging wind	315.0	2.96	0.262	0	318.2	311.6	5.11	1.36	0.119	318.2
Drought	309.7	8.43	0.112	0	318.2	309.3	5.37	3.46	0.0845	318.2
Extreme heat	87.1	205.3	21.3	4.54	318.2	7.80	269.7	27.2	13.6	318.2
Flood	294.5	1.42	10.5	11.8	318.2	294.5	1.22	8.08	14.4	318.2
Landslide	315.8	0	0.756	1.70	318.2	315.8	0	2.45	0	318.2
Maximum risk level across all hazards	29.2	217.7	40.6	30.7	318.2	0.181	233.3	36.6	48.2	318.2

⁸ Asset values may not add to totals due to rounding of presented values.

Table 22: Risk rating asset values by hazard – cultural and community sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	10.8	0.707	0.145	0.227	11.9	10.8	0.707	0.145	0.227	11.9
Coastal inundation	11.9	0	0	0.00166	11.9	11.9	0	0	0.00166	11.9
Damaging wind	11.9	0	0	0	11.9	11.9	0.00880	0.0140	0	11.9
Drought	11.8	0.0644	0	0	11.9	11.8	0.0644	0	0	11.9
Extreme heat	11.9	0	0	0	11.9	0.0172	11.8	0.0476	0	11.9
Flood	11.2	0.0441	0.663	0	11.9	11.2	0.0441	0.663	0	11.9
Landslide	11.9	0	0.00138	0	11.9	11.9	0	0.00138	0	11.9
Maximum risk level across all hazards	10.1	0.701	0.806	0.229	11.9	0.00953	10.8	0.833	0.229	11.9
SSP3-7.0, 2070										
Bushfire	0.753	10.7	0.170	0.234	11.9	0.753	10.7	0.170	0.234	11.9
Coastal inundation	11.8	0	0	0.0487	11.9	11.8	0	0	0.0487	11.9
Damaging wind	11.9	0	0	0	11.9	11.9	0.00880	0.0140	0	11.9
Drought	11.7	0.174	0.0274	0	11.9	11.7	0.174	0.0274	0	11.9
Extreme heat	11.9	0	0	0	11.9	0.0134	11.8	0.0844	0	11.9
Flood	11.2	0.0441	0.663	0	11.9	11.2	0.0441	0.663	0	11.9
Landslide	11.9	0	0.00138	0	11.9	11.9	0	0.00138	0	11.9
Maximum risk level across all hazards	0.751	10.0	0.828	0.283	11.9	0	10.7	0.859	0.283	11.9

Table 23: Risk rating asset values by hazard – education and training sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	27.2	3.96	1.41	0.540	33.1	27.2	3.96	1.41	0.540	33.1
Coastal inundation	33.1	0	0	0.0245	33.1	33.1	0	0	0.0245	33.1
Damaging wind	33.1	0	0	0	33.1	32.8	0.203	0.147	0	33.1
Drought	33.1	0	0	0	33.1	33.1	0	0	0	33.1
Extreme heat	33.1	0	0	0	33.1	0.887	31.5	0.774	0	33.1
Flood	31.1	0.599	1.40	0	33.1	31.1	0.599	1.40	0	33.1
Landslide	33.1	0	0.0499	0	33.1	33.1	0	0.0499	0	33.1
Maximum risk level across all hazards	25.7	4.06	2.77	0.565	33.1	0.655	28.8	3.10	0.565	33.1
SSP3-7.0, 2070										
Bushfire	18.1	12.4	1.91	0.704	33.1	18.1	12.4	1.91	0.704	33.1
Coastal inundation	33.0	0	0	0.149	33.1	33.0	0	0	0.149	33.1
Damaging wind	33.1	0	0	0	33.1	32.8	0.203	0.147	0	33.1
Drought	33.1	0	0	0	33.1	33.1	0	0	0	33.1
Extreme heat	33.1	0	0	0	33.1	0.149	30.8	2.21	0	33.1
Flood	31.1	0.599	1.40	0	33.1	31.1	0.599	1.40	0	33.1
Landslide	33.1	0	0.0499	0	33.1	33.1	0	0.0499	0	33.1
Maximum risk level across all hazards	17.1	11.9	3.24	0.854	33.1	0.0156	28.0	4.30	0.854	33.1

Table 24: Risk rating asset values by hazard – energy sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	68.8	7.94	2.76	1.71	81.2	68.8	7.94	2.76	1.71	81.2
Coastal inundation	81.1	0	0	0.0894	81.2	81.1	0	0	0.0894	81.2
Damaging wind	78.9	2.21	0.119	0	81.2	78.9	1.83	0.374	0.119	81.2
Drought	76.1	5.10	0	0	81.2	76.1	3.64	1.46	0	81.2
Extreme heat	1.55	77.7	1.90	0	81.2	1.55	73.1	4.61	1.90	81.2
Flood	78.8	0.141	2.30	0	81.2	78.8	0	0.141	2.30	81.2
Landslide	80.9	0	0.315	0	81.2	80.9	0	0.315	0	81.2
Maximum risk level across all hazards	0.540	73.5	5.36	1.80	81.2	0.540	70.2	4.94	5.49	81.2
SSP3-7.0, 2070										
Bushfire	65.6	9.62	3.99	1.98	81.2	65.6	9.62	3.99	1.98	81.2
Coastal inundation	81.1	0	0	0.123	81.2	81.1	0	0	0.123	81.2
Damaging wind	78.9	2.21	0.119	0	81.2	78.9	1.83	0.374	0.119	81.2
Drought	72.9	8.25	0.0845	0	81.2	72.9	4.83	3.42	0.0845	81.2
Extreme heat	0.211	75.5	5.53	0	81.2	0.211	71.1	4.30	5.53	81.2
Flood	78.8	0.141	2.30	0	81.2	78.8	0	0.141	2.30	81.2
Landslide	80.9	0	0.315	0	81.2	80.9	0	0.315	0	81.2
Maximum risk level across all hazards	0.147	70.9	8.04	2.10	81.2	0	68.1	4.29	8.69	81.2

Table 25: Risk rating asset values by hazard – health sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	33.3	11.7	1.63	0.0458	46.6	33.3	11.7	1.63	0.0458	46.6
Coastal inundation	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Damaging wind	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Drought	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Extreme heat	0.723	45.2	0.687	0	46.6	0.723	42.5	2.77	0.687	46.6
Flood	43.4	0	2.53	0.722	46.6	43.4	0	2.53	0.722	46.6
Landslide	46.6	0	0.0793	0	46.6	46.6	0	0.0793	0	46.6
Maximum risk level across all hazards	0.617	40.7	4.56	0.768	46.6	0.617	38.5	6.07	1.43	46.6
SSP3-7.0, 2070										
Bushfire	19.6	24.1	2.02	0.966	46.6	19.6	24.1	2.02	0.966	46.6
Coastal inundation	46.6	0	0	0.0296	46.6	46.6	0	0	0.0296	46.6
Damaging wind	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Drought	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Extreme heat	0.0266	44.3	2.32	0	46.6	0.0266	40.0	4.30	2.32	46.6
Flood	43.4	0	2.53	0.722	46.6	43.4	0	2.53	0.722	46.6
Landslide	46.6	0	0.0793	0	46.6	46.6	0	0.0793	0	46.6
Maximum risk level across all hazards	0.00132	39.6	5.36	1.71	46.6	0.00132	36.6	6.42	3.64	46.6

Table 26: Risk rating asset values by hazard – housing sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	18.1	2.08	0.454	0.0253	20.7	18.1	2.08	0.454	0.0253	20.7
Coastal inundation	20.7	0	0	0.0181	20.7	20.7	0	0	0.0181	20.7
Damaging wind	20.7	0	0	0	20.7	20.7	0	0	0	20.7
Drought	20.7	0	0	0	20.7	20.7	0	0	0	20.7
Extreme heat	20.7	0	0	0	20.7	0.416	18.2	1.53	0.487	20.7
Flood	19.1	0.545	1.02	0	20.7	19.1	0.545	1.02	0	20.7
Landslide	20.7	0	0.0266	0	20.7	20.7	0	0.0266	0	20.7
Maximum risk level across all hazards	16.9	2.30	1.48	0.0434	20.7	0.388	17.4	2.38	0.528	20.7
SSP3-7.0, 2070										
Bushfire	8.81	10.9	0.878	0.0851	20.7	8.81	10.9	0.878	0.0851	20.7
Coastal inundation	20.6	0	0	0.0658	20.7	20.6	0	0	0.0658	20.7
Damaging wind	20.7	0	0	0	20.7	20.7	0	0	0	20.7
Drought	20.7	0	0	0	20.7	20.7	0	0	0	20.7
Extreme heat	20.7	0	0	0	20.7	0.105	17.3	2.07	1.19	20.7
Flood	19.1	0.545	1.02	0	20.7	19.1	0.545	1.02	0	20.7
Landslide	20.7	0	0.0266	0	20.7	20.7	0	0.0266	0	20.7
Maximum risk level across all hazards	8.34	10.3	1.88	0.151	20.7	0.00134	16.6	2.73	1.33	20.7

Table 27: Risk rating asset values by hazard – justice and community safety sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	9.56	1.60	0.273	0.279	11.7	9.56	1.60	0.273	0.279	11.7
Coastal inundation	11.7	0	0	0.0452	11.7	11.7	0	0	0.0452	11.7
Damaging wind	11.7	0.00113	0	0	11.7	11.7	0.00113	0	0	11.7
Drought	11.7	0	0	0	11.7	11.7	0	0	0	11.7
Extreme heat	11.7	0	0	0	11.7	0.234	11.3	0.198	0	11.7
Flood	11.3	0.0607	0.307	0	11.7	11.3	0	0.0607	0.307	11.7
Landslide	11.7	0	0.0558	0	11.7	11.7	0	0.0558	0	11.7
Maximum risk level across all hazards	9.33	1.54	0.520	0.324	11.7	0.125	10.6	0.413	0.570	11.7
SSP3-7.0, 2070										
Bushfire	2.64	8.11	0.643	0.327	11.7	2.64	8.11	0.643	0.327	11.7
Coastal inundation	11.7	0	0	0.0522	11.7	11.7	0	0	0.0522	11.7
Damaging wind	11.7	0.00113	0	0	11.7	11.7	0.00113	0	0	11.7
Drought	11.7	0	0	0	11.7	11.7	0	0	0	11.7
Extreme heat	11.7	0	0	0	11.7	0.0345	11.2	0.515	0	11.7
Flood	11.3	0.0607	0.307	0	11.7	11.3	0	0.0607	0.307	11.7
Landslide	11.7	0	0.0558	0	11.7	11.7	0	0.0558	0	11.7
Maximum risk level across all hazards	2.59	7.87	0.873	0.379	11.7	0.00404	10.2	0.859	0.619	11.7

Table 28: Risk rating asset values by hazard – ports sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	4.35	1.20	0	0	5.55	4.35	1.20	0	0	5.55
Coastal inundation	0	0	0	5.55	5.55	0	0	0	5.55	5.55
Damaging wind	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Drought	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Extreme heat	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Flood	5.54	0.00840	0	0	5.55	5.54	0.00840	0	0	5.55
Landslide	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Maximum risk level across all hazards	0	0	0	5.55	5.55	0	0	0	5.55	5.55
SSP3-7.0, 2070										
Bushfire	0.848	4.70	0	0	5.55	0.848	4.70	0	0	5.55
Coastal inundation	0	0	0	5.55	5.55	0	0	0	5.55	5.55
Damaging wind	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Drought	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Extreme heat	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Flood	5.54	0.00840	0	0	5.55	5.54	0.00840	0	0	5.55
Landslide	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Maximum risk level across all hazards	0	0	0	5.55	5.55	0	0	0	5.55	5.55

Table 29: Risk rating asset values by hazard – parks sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	0.435	0.242	0.335	1.47	2.49	0.435	0.242	0.335	1.47	2.49
Coastal inundation	2.37	0	0	0.113	2.49	2.37	0	0	0.113	2.49
Damaging wind	2.41	0.0751	0	0	2.49	2.15	0.201	0.131	0	2.49
Drought	2.49	0	0	0	2.49	2.29	0.198	0	0	2.49
Extreme heat	2.49	0	0	0	2.49	0.715	1.64	0.133	0	2.49
Flood	2.27	0.0221	0.191	0	2.49	2.27	0.0221	0.191	0	2.49
Landslide	2.26	0	0.227	0	2.49	2.26	0	0.227	0	2.49
Maximum risk level across all hazards	0.346	0.201	0.365	1.57	2.49	0.0272	0.514	0.370	1.57	2.49
SSP3-7.0, 2070										
Bushfire	0.258	0.373	0.332	1.52	2.49	0.258	0.373	0.332	1.52	2.49
Coastal inundation	2.37	0	0	0.119	2.49	2.37	0	0	0.119	2.49
Damaging wind	2.41	0.0751	0	0	2.49	2.15	0.201	0.131	0	2.49
Drought	2.49	0	0	0	2.49	2.11	0.365	0.00960	0	2.49
Extreme heat	2.49	0	0	0	2.49	0.323	1.95	0.216	0	2.49
Flood	2.27	0.0221	0.191	0	2.49	2.27	0.0221	0.191	0	2.49
Landslide	2.26	0	0.227	0	2.49	2.26	0	0.227	0	2.49
Maximum risk level across all hazards	0.197	0.312	0.350	1.63	2.49	0.00247	0.503	0.353	1.63	2.49

Table 30: Risk rating asset values by hazard – rail sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	31.4	6.26	1.83	1.20	40.7	31.4	6.26	1.83	1.20	40.7
Coastal inundation	40.4	0	0	0.282	40.7	40.4	0.0	0	0.282	40.7
Damaging wind	39.9	0.606	0.143	0	40.7	39.9	0.606	0.143	0	40.7
Drought	40.7	0	0	0	40.7	40.7	0	0	0	40.7
Extreme heat	0.295	34.5	4.34	1.54	40.7	0.295	34.5	4.34	1.54	40.7
Flood	36.8	0	0.745	3.11	40.7	36.8	0	0.745	3.11	40.7
Landslide	40.7	0	0.00123	0	40.7	40.7	0	0.00123	0	40.7
Maximum risk level across all hazards	0.227	30.2	4.75	5.56	40.7	0.227	30.2	4.75	5.56	40.7
SSP3-7.0, 2070										
Bushfire	9.69	26.3	3.04	1.63	40.7	9.69	26.3	3.04	1.63	40.7
Coastal inundation	40.3	0	0	0.397	40.7	40.3	0	0	0.397	40.7
Damaging wind	39.9	0.606	0.143	0	40.7	39.9	0.606	0.143	0	40.7
Drought	40.7	0	0	0	40.7	40.7	0	0	0	40.7
Extreme heat	0.0234	31.5	4.64	4.54	40.7	0.0234	31.5	4.64	4.54	40.7
Flood	36.8	0	0.745	3.11	40.7	36.8	0	0.745	3.11	40.7
Landslide	40.7	0	0.00123	0	40.7	40.7	0	0.00123	0	40.7
Maximum risk level across all hazards	0	27.7	4.77	8.20	40.7	0	27.7	4.77	8.20	40.7

Table 31: Risk rating asset values by hazard – road sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Bushfire	33.6	21.6	9.05	0	64.3	33.6	16.0	5.59	9.05	64.3
Coastal inundation	63.0	0	0	1.26	64.3	63.0	0	0	1.26	64.3
Damaging wind	64.2	0.0681	0	0	64.3	61.5	2.26	0.551	0	64.3
Drought	64.3	0	0	0	64.3	64.3	0	0	0	64.3
Extreme heat	5.05	56.9	2.36	0	64.3	5.05	56.9	2.36	0	64.3
Flood	54.9	0	1.32	8.02	64.3	54.9	0	1.32	8.02	64.3
Landslide	62.6	0	0	1.70	64.3	62.6	0	1.70	0	64.3
Maximum risk level across all hazards	0.862	43.2	10.4	9.80	64.3	0.814	39.3	7.29	16.8	64.3
SSP3-7.0, 2070										
Bushfire	19.9	34.6	9.73	0	64.3	19.9	25.8	8.80	9.73	64.3
Coastal inundation	62.9	0	0	1.37	64.3	62.9	0	0	1.37	64.3
Damaging wind	64.2	0.0681	0	0	64.3	61.5	2.26	0.551	0	64.3
Drought	64.3	0	0	0	64.3	64.3	0	0	0	64.3
Extreme heat	1.37	54.0	8.85	0	64.3	1.37	54.0	8.85	0	64.3
Flood	54.9	0	1.32	8.02	64.3	54.9	0	1.32	8.02	64.3
Landslide	62.6	0	0	1.70	64.3	62.6	0	1.70	0	64.3
Maximum risk level across all hazards	0.0186	39.1	15.2	9.90	64.3	0.00880	34.9	12.0	17.4	64.3

A.2 Risk result data tables by sector

Table 32: Risk ratings for drought by sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Cultural and community	11.8	0.0644	0	0	11.9	11.8	0.0644	0	0	11.9
Education and training	33.1	0	0	0	33.1	33.1	0	0	0	33.1
Energy	76.1	5.10	0	0	81.2	76.1	3.64	1.46	0	81.2
Health	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Housing	20.7	0	0	0	20.7	20.7	0	0	0	20.7
Justice and community safety	11.7	0	0	0	11.7	11.7	0	0	0	11.7
Ports	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Parks	2.49	0	0	0	2.49	2.29	0.198	0	0	2.49
Rail	40.7	0	0	0	40.7	40.7	0	0	0	40.7
Road	64.3	0	0	0	64.3	64.3	0	0	0	64.3
Total	313.1	5.16	0	0	318.2	312.9	3.90	1.46	0	318.2
SSP3-7.0, 2070										
Cultural and community	11.7	0.174	0.0274	0	11.9	11.7	0.174	0.0274	0	11.9
Education and training	33.1	0	0	0	33.1	33.1	0	0	0	33.1
Energy	72.9	8.25	0.0845	0	81.2	72.9	4.83	3.42	0.0845	81.2
Health	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Housing	20.7	0	0	0	20.7	20.7	0	0	0	20.7
Justice and community safety	11.7	0	0	0	11.7	11.7	0	0	0	11.7
Ports	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Parks	2.49	0	0	0	2.49	2.11	0.365	0.00960	0	2.49
Rail	40.7	0	0	0	40.7	40.7	0	0	0	40.7
Road	64.3	0	0	0	64.3	64.3	0	0	0	64.3
Total	309.7	8.43	0.112	0	318.2	309.3	5.37	3.46	0.0845	318.2

Table 33: Risk ratings for extreme heat by sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Cultural and community	11.9	0	0	0	11.9	0.0172	11.8	0.0476	0	11.9
Education and training	33.1	0	0	0	33.1	0.887	31.5	0.774	0	33.1
Energy	1.55	77.7	1.90	0	81.2	1.55	73.1	4.61	1.90	81.2
Health	0.723	45.2	0.687	0	46.6	0.723	42.5	2.77	0.687	46.6
Housing	20.7	0	0	0	20.7	0.416	18.2	1.53	0.487	20.7
Justice and community safety	11.7	0	0	0	11.7	0.234	11.3	0.198	0	11.7
Ports	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Parks	2.49	0	0	0	2.49	0.715	1.64	0.133	0	2.49
Rail	0.295	34.5	4.34	1.54	40.7	0.295	34.5	4.34	1.54	40.7
Road	5.05	56.9	2.36	0	64.3	5.05	56.9	2.36	0	64.3
Total	93.0	214.4	9.28	1.54	318.2	15.4	281.4	16.7	4.62	318.2
SSP3-7.0, 2070										
Cultural and community	11.9	0	0	0	11.9	0.0134	11.8	0.0844	0	11.9
Education and training	33.1	0	0	0	33.1	0.149	30.8	2.21	0	33.1
Energy	0.211	75.5	5.53	0	81.2	0.211	71.1	4.30	5.53	81.2
Health	0.0266	44.3	2.32	0	46.6	0.0266	40.0	4.30	2.32	46.6
Housing	20.7	0	0	0	20.7	0.105	17.3	2.07	1.19	20.7
Justice and community safety	11.7	0	0	0	11.7	0.0345	11.2	0.515	0	11.7
Ports	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Parks	2.49	0	0	0	2.49	0.323	1.95	0.216	0	2.49
Rail	0.0234	31.5	4.64	4.54	40.7	0.0234	31.5	4.64	4.54	40.7
Road	1.37	54.0	8.85	0	64.3	1.37	54.0	8.85	0	64.3
Total	87.1	205.3	21.3	4.54	318.2	7.80	269.7	27.2	13.6	318.2

Table 34: Risk ratings for bushfire by sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
SSP1-2.6, 2030										
Cultural and community	10.8	0.71	0.145	0.227	11.9	10.8	0.707	0.145	0.227	11.9
Education and training	27.2	3.96	1.41	0.540	33.1	27.2	3.96	1.41	0.540	33.1
Energy	68.8	7.94	2.76	1.71	81.2	68.8	7.94	2.76	1.71	81.2
Health	33.3	11.7	1.63	0.0458	46.6	33.3	11.7	1.63	0.0458	46.6
Housing	18.1	2.08	0.454	0.0253	20.7	18.1	2.08	0.454	0.0253	20.7
Justice and community safety	9.56	1.60	0.273	0.279	11.7	9.56	1.60	0.273	0.279	11.7
Ports	4.35	1.20	0	0	5.55	4.35	1.20	0	0	5.55
Parks	0.435	0.242	0.335	1.47	2.49	0.435	0.242	0.335	1.47	2.49
Rail	31.4	6.26	1.83	1.20	40.7	31.4	6.26	1.83	1.20	40.7
Road	33.6	21.6	9.05	0	64.3	33.6	16.0	5.59	9.05	64.3
Total	237.5	57.3	17.9	5.51	318.2	237.5	51.7	14.4	14.6	318.2
SSP3-7.0, 2070										
Cultural and community	0.753	10.7	0.170	0.234	11.9	0.753	10.7	0.170	0.234	11.9
Education and training	18.1	12.4	1.91	0.704	33.1	18.1	12.4	1.91	0.704	33.1
Energy	65.6	9.62	3.99	1.98	81.2	65.6	9.62	3.99	1.98	81.2
Health	19.6	24.1	2.02	0.966	46.6	19.6	24.1	2.02	0.966	46.6
Housing	8.81	10.9	0.878	0.0851	20.7	8.81	10.9	0.878	0.0851	20.7
Justice and community safety	2.64	8.11	0.643	0.327	11.7	2.64	8.11	0.643	0.327	11.7
Ports	0.848	4.70	0	0	5.55	0.848	4.70	0	0	5.55
Parks	0.258	0.373	0.332	1.52	2.49	0.258	0.373	0.332	1.52	2.49
Rail	9.69	26.3	3.04	1.63	40.7	9.69	26.3	3.04	1.63	40.7
Road	19.9	34.6	9.73	0	64.3	19.9	25.8	8.80	9.73	64.3
Total	146.2	141.9	22.7	7.45	318.2	146.2	133.1	21.8	17.2	318.2

Table 35: Risk ratings for damaging winds per sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
Cultural and community	11.9	0	0	0	11.9	11.9	0.00880	0.0140	0	11.9
Education and training	33.1	0	0	0	33.1	32.8	0.203	0.147	0	33.1
Energy	78.9	2.21	0.119	0	81.2	78.9	1.83	0.375	0.119	81.2
Health	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Housing	20.7	0	0	0	20.7	20.7	0	0	0	20.7
Justice and community safety	11.7	0.00113	0	0	11.7	11.7	0.00113	0	0	11.7
Ports	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Parks	2.41	0.0751	0	0	2.49	2.15	0.201	0.131	0	2.49
Rail	39.9	0.606	0.143	0	40.7	39.9	0.606	0.143	0	40.7
Road	64.2	0.0681	0	0	64.3	61.5	2.26	0.551	0	64.3
Total	315.0	2.96	0.262	0	318.2	311.6	5.11	1.36	0.119	318.2

Table 36: Risk ratings for flooding by sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
Cultural and community	11.2	0.0441	0.663	0	11.9	11.2	0.0441	0.663	0	11.9
Education and training	31.1	0.599	1.40	0	33.1	31.1	0.599	1.40	0	33.1
Energy	78.8	0.141	2.30	0	81.2	78.8	0	0.141	2.30	81.2
Health	43.4	0	2.53	0.722	46.6	43.4	0	2.53	0.722	46.6
Housing	19.1	0.545	1.02	0	20.7	19.1	0.545	1.02	0	20.7
Justice and community safety	11.3	0.0607	0.307	0	11.7	11.3	0	0.0607	0.307	11.7
Ports	5.54	0.00840	0	0	5.55	5.54	0.00840	0	0	5.55
Parks	2.27	0.0221	0.191	0	2.49	2.27	0.0221	0.191	0	2.49
Rail	36.8	0	0.745	3.11	40.7	36.8	0	0.745	3.11	40.7
Road	54.9	0	1.32	8.02	64.3	54.9	0	1.32	8.02	64.3
Total	294.5	1.42	10.5	11.8	318.2	294.5	1.22	8.08	14.4	318.2

Table 37: Risk ratings for coastal inundation per sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
Sea level rise of 20cm										
Cultural and community	11.9	0	0	0.00166	11.9	11.9	0	0	0.00166	11.9
Education and training	33.1	0	0	0.0245	33.1	33.1	0	0	0.0245	33.1
Energy	81.1	0	0	0.0894	81.2	81.1	0	0	0.0894	81.2
Health	46.6	0	0	0	46.6	46.6	0	0	0	46.6
Housing	20.7	0	0	0.0181	20.7	20.7	0	0	0.0181	20.7
Justice and community safety	11.7	0	0	0.0452	11.7	11.7	0	0	0.0452	11.7
Ports	0	0	0	5.55	5.55	0	0	0	5.55	5.55
Parks	2.37	0	0	0.113	2.49	2.37	0	0	0.113	2.49
Rail	40.4	0	0	0.282	40.7	40.4	0	0	0.282	40.7
Road	63.0	0	0	1.26	64.3	63.0	0	0	1.26	64.3
Total	310.8	0	0	7.38	318.2	310.8	0	0	7.38	318.2
Sea level rise of 47cm										
Cultural and community	11.8	0	0	0.0487	11.9	11.8	0	0	0.0487	11.9
Education and training	33.0	0	0	0.149	33.1	33.0	0	0	0.149	33.1
Energy	81.1	0	0	0.123	81.2	81.1	0	0	0.123	81.2
Health	46.6	0	0	0.0296	46.6	46.6	0	0	0.0296	46.6
Housing	20.6	0	0	0.066	20.7	20.6	0	0	0.066	20.7
Justice and community safety	11.7	0	0	0.0522	11.7	11.7	0	0	0.0522	11.7
Ports	0	0	0	5.55	5.55	0	0	0	5.55	5.55
Parks	2.37	0	0	0.119	2.49	2.37	0	0	0.119	2.49
Rail	40.3	0	0	0.397	40.7	40.3	0	0	0.397	40.7
Road	62.9	0	0	1.37	64.3	62.9	0	0	1.37	64.3
Total	310.3	0	0	7.90	318.2	310.3	0	0	7.90	318.2

Table 38: Risk ratings for landslide per sector.

Category	Asset value with damage risk rating (\$ billion)					Asset value with downtime risk rating (\$ billion)				
	Level 1	Level 2	Level 3	Level 4	Total	Level 1	Level 2	Level 3	Level 4	Total
Cultural and community	11.9	0	0.00138	0	11.9	11.9	0	0.00138	0	11.9
Education and training	33.1	0	0.0499	0	33.1	33.1	0	0.0499	0	33.1
Energy	80.9	0	0.315	0	81.2	80.9	0	0.315	0	81.2
Health	46.6	0	0.0793	0	46.6	46.6	0	0.0793	0	46.6
Housing	20.7	0	0.0266	0	20.7	20.7	0	0.0266	0	20.7
Justice and community safety	11.7	0	0.0558	0	11.7	11.7	0	0.0558	0	11.7
Ports	5.55	0	0	0	5.55	5.55	0	0	0	5.55
Parks	2.26	0	0.227	0	2.49	2.26	0	0.227	0	2.49
Rail	40.7	0	0.00123	0	40.7	40.7	0	0.00123	0	40.7
Road	62.6	0	0	1.70	64.3	62.6	0	1.70	0	64.3
Total	315.8	0	0.756	1.70	318.2	315.8	0	2.45	0	318.2

Appendix B

Vulnerability assessment

B.1 Introduction

The full vulnerability assessment is contained in this appendix, discussed by sector for each hazard and vulnerability impact pathway of damage and downtime. Commentary is provided to articulate explanations for each sector rating for the physical damage and downtime pathways. Where a range has been given to indicate variation in a sector for the purpose of analysis and mapping of the vulnerability in later sections of the report, the higher rating has been utilised in the risk assessment, and the colour rating demonstrates the high colour. The sectors are presented alphabetically.

B.2 Cultural and community sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Low	Prolonged extreme heat can damage HVAC systems, warp roofing and flooring materials, and degrade sensitive cultural assets (artworks, books) and sports equipment. Aquatic centres may experience accelerated wear on pool infrastructure and filtration systems.	Moderate	Extreme heat can lead to closures or reduced operating hours due to unsafe conditions for visitors and staff, failure of cooling systems, and increased health risks during events or sports activities. Community centres and civic halls may be repurposed as emergency shelters or heat relief areas, disrupting normal operations.
Flooding	Moderate	Flooding can damage building structures, electrical systems, and cultural collections (e.g. books, artworks), and water ingress may destroy archives and IT infrastructure. Sports facilities may suffer damage to playing surfaces, pools, and mechanical systems.	Moderate	Flooding can force temporary closure of centres due to unsafe conditions, blocked access roads, and the need for extensive cleanup and restoration before reopening. Community centres and civic halls may be repurposed as emergency shelters, disrupting normal operations.
Bushfire	High	Bushfires can destroy buildings, outdoor spaces, and utilities, while smoke and ash can damage sensitive cultural materials, contaminate indoor air quality, and affect HVAC systems. Sports facilities may suffer damage to outdoor fields and spectator areas.	High	Bushfire smoke and evacuation orders can lead to prolonged closures, cancellation of events, and disruption of scheduled programs due to safety concerns and air quality issues. Community centres and civic halls may be repurposed as emergency shelters, disrupting normal operations.
Rainfall-induced landslide	Low - Moderate	Landslides can damage building foundations, retaining walls, and access roads, compromising structural safety and utility connections for museums, libraries, and sports complexes.	Low - Moderate	Landslides can isolate centres by blocking transport routes, delaying staff and visitor access, and forcing temporary closure until safe passage and repairs are completed. Community centres and civic halls may be repurposed as emergency shelters, disrupting normal operations.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Damaging winds	Low	High winds can damage roofs, windows, signage, and outdoor facilities, while flying debris can harm landscaping and external utilities.	Moderate	Damaging winds can lead to closures due to safety hazards, power outages, and the need for repairs before reopening, disrupting cultural events and sporting schedules. Community centres and civic halls may be repurposed as emergency shelters, disrupting normal operations.
Drought	Moderate	Prolonged drought can increase shrink and swell of soils, leading to structural cracking of building foundations. Additionally, drought can damage landscaped areas.	Moderate	Water restrictions during drought can disrupt operations, including cleaning, cooling, and pool maintenance, leading to partial or full closures of facilities.
Coastal inundation	High	Coastal inundation can damage buildings near shorelines, corrode structural materials, and destroy electrical and IT systems through saltwater intrusion. Cultural collections and sports equipment are highly susceptible to water damage.	High	Coastal inundation can render buildings and outdoor facilities inaccessible or unsafe, requiring precautionary closure during and after events due to public safety requirements, contamination, and loss of essential services, or permanent closure. Community and cultural facilities may also be temporarily repurposed as emergency shelters, disrupting normal operations and resulting in partial or full closures.

The cultural and community sector is highly vulnerable to bushfire and coastal inundation, with moderate vulnerability to flooding, landslides, and drought. Bushfires can result in severe physical damage through direct destruction of buildings and outdoor spaces. The 2009 Black Saturday bushfires demonstrated this vulnerability, destroying over 3,500 buildings including the Marysville Community Hall and Kinglake Memorial Hall, which required years to rebuild (CFA, 2023). Smoke and ash can damage sensitive cultural materials and contaminate indoor air quality. Prolonged closures result from evacuation orders and air quality concerns, with community centres and civic halls frequently repurposed as emergency shelters such as a Community Fire Refuges (CFA, 2025), or relief centres, recovery hubs or information centres during bushfires (Vic Emergency, 2026), disrupting normal operations.

Coastal inundation and flooding present high to moderate vulnerability for cultural and community facilities. Water depths of 50 cm or greater typically cause structural damage to walls and foundations, while depths exceeding 100 cm result in extensive damage requiring prolonged restoration (Huizinga, De Moel, & Szweczyk, 2017). For museum collections and archival materials, even shallow inundation can cause irreversible damage to ground-floor storage, with paper-based materials particularly vulnerable to moisture infiltration that enables mould growth and causes warping (Zaveri, 2014). Flood velocity compounds damage, with flows exceeding 2 m/s generating sufficient hydraulic forces to cause structural damage and debris impact (Huizinga, De Moel, & Szweczyk, 2017). Victoria's 2022 and 2023 flooding events caused extensive damage to community facilities, with some libraries and community centres experiencing months of closure due to water damage (Victorian State Emergency Service, 2023).

Drought presents moderate vulnerability through soil shrink-swell effects, where abnormal soil moisture conditions may induce sufficient ground movement (typically 25-50 mm) to crack masonry walls and damage heritage buildings (AS2870-2011: Residential slabs and footings – Construction).

Damaging winds present low vulnerability, with building envelope components including roofs, windows, and external cladding potentially susceptible to failure. However, wind speeds exceeding 25 m/s (90 km/h) can damage roof cladding and external fixtures, while speeds above 33 m/s (approximately 120 km/h) substantially increase the probability of roof sheathing failure and window breakage (based on the Beaufort

scale). For heritage buildings with older construction standards, vulnerability thresholds may be lower due to aging materials and less wind-resistant design. In addition, vulnerability to downtime from damaging winds is moderate, predominantly due to outdoor comfort for sport and recreation facilities as the thresholds are lower at 8 m/s.

Extreme heat creates moderate downtime vulnerability. Community facilities may be repurposed as heat refuges or cooling centres during heatwaves, disrupting normal operations. When indoor temperatures exceed recommended ranges of 18-28°C (varying by climate zone), facilities face closures due to unsafe conditions for visitors and staff, particularly where cooling systems are inadequate (Heritage Collections Council, 2001). Museums and cultural facilities face additional challenges as high temperatures accelerate deterioration of collections, with damage rates doubling for every 10°C temperature rise. Materials including paper, photographs, films, and objects containing waxes are particularly vulnerable to heat damage. Temperature increases also cause relative humidity to drop, and when humidity falls below 40%, organic materials including wood, textiles, and leather begin to dry out and crack (Heritage Collections Council, 2001). HVAC system failures during heatwaves can lead to rapid temperature rises that necessitate emergency closure and removal of sensitive collections to prevent irreversible damage.

B.3 Education and training sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Low	Education and training buildings and facilities are vulnerable to structural degradation during extreme heat, as high temperatures can warp roofing materials, damage HVAC systems, and compromise IT equipment.	Moderate	Extreme heat can lead to cancellations or reduced hours due to unsafe conditions for children, students and staff, and potential failure of cooling systems.
Flooding	Moderate	Flooding can damage classrooms, education and training facilities, and electrical systems, and water ingress can destroy educational materials and IT infrastructure.	Moderate	Flooding can force temporary closure of education and training facilities due to unsafe conditions, blocked access roads, and the need for cleanup and repairs.
Bushfire	High	Bushfires can destroy education and training buildings, facilities, playgrounds, and utilities, while smoke can damage equipment and building interiors and contaminate indoor air quality.	High	Bushfire smoke and evacuation orders can lead to prolonged facility closures, staff shortages, and disruption of learning activities and pastoral care. In addition, some school grounds are considered Neighbourhood Safer Places as a last resort evacuation point posing downtime implications.
Rainfall-induced landslide	Low - Moderate	Landslides can damage facility foundations, retaining walls, and access roads, compromising structural safety.	Low - Moderate	Landslides can isolate education and training facilities by blocking transport routes, delaying student and staff access, and forcing temporary closure until safe passage is restored.
Damaging winds	Low	High winds can damage roofs, windows, shade sails and outdoor facilities, while flying debris can harm playgrounds and external utilities.	Moderate	Damaging winds can lead to education and training facility closures due to safety hazards, power outages, and the need for repairs before reopening.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Drought	Low	Prolonged drought can damage landscaping and water-dependent systems such as cooling towers and sanitation infrastructure, increasing fire risk.	Low	Water restrictions during drought can disrupt operations including cleaning and cooling.
Coastal inundation	High	Coastal inundation can damage education and training buildings near shorelines, corrode structural materials, and destroy electrical and IT systems through saltwater intrusion.	High	Inundation can render education and training facilities inaccessible, contaminate water supplies, and require extensive restoration, causing prolonged closures.

The education and training sector assets across schools and TAFEs are varied in age and condition. With rapid population growth, new schools are required to meet demand with 19 new schools are planned to open in 2026 (Victorian School Building Authority, 2025), and 24 government-run early learning facilities between 2025 and 2027 (Premier of Victoria, 2024). In 2024, the Victorian Government invested \$470 million into repairs and refurbishment of school infrastructure (Infrastructure Victoria, 2024). The Victorian Auditor-Generals report in 2017 found that most school assets are relatively new, with 60% of Victoria’s government school buildings having been built since 1992 and are therefore only just over 30 years old – however an audit in 2012 found that 34% of building elements were rated as below ‘good’ (Victorian Auditor-General, 2017). There are over 100 TAFE campuses across 12 institutions and 4 universities in Victoria which are valued at \$3.5 billion, with many considered ageing and due for replacement (Infrastructure Victoria, 2024).

Hazards that impact on educational facilities will also have operational impacts with disruptions on learning, pastoral care, and students and staff’s wellbeing. Social disruption from experiencing hazards and natural disasters can interrupt educational opportunities and impacts on learning and operation of educational facilities (Gibbs, et al., 2019). This is due to stress and trauma reactions from experiencing hazards that disrupt students’ memory and concentration which impairs their performance (Gibbs, et al., 2019).

The education and training sector is highly vulnerable to bushfires and coastal inundation. In addition to operational disruptions, these hazards may also cause physical direct impacts impeding access to educational facilities, destroy facilities or disrupt staffing (Centre for Education Statistics and Evaluation, 2020). This was shown in the 2019-20 Black Summer fires when Clifton Creek Primary School in Gippsland burnt down, resulting in a complete rebuild that was only finished in 2022. Students were temporarily relocated to Nicholson Primary School and used portable classrooms to continue their education (VSBA, 2024). In addition, some government schools are designated as a Neighbourhood Safer Place, as an option of last resort during bushfire events, having impacts on downtime and community resilience (Policy and Advisory Library, 2023).

Flooding and coastal inundation can result in the sector having a high vulnerability to damage. Similar to the health sector, water depths of 50 cm or greater typically cause structural damage to walls and foundations, while depths exceeding 100 cm result in extensive damage requiring prolonged restoration (Huizinga, De Moel, & Szewczyk, 2017). Flood velocity compounds damage, with flows exceeding 2 m/s generating sufficient hydraulic forces to cause structural damage and debris impact (Huizinga, De Moel, & Szewczyk, 2017).

The sector is moderately vulnerable to wind from a downtime and operational perspective. Operational outdoor discomfort occurs at speeds exceeding 8 m/s and consideration of wind blown debris impacting operations and damaging buildings around 20 m/s.

The education and training sector has low vulnerability to drought for both damage and downtime, and low vulnerability for extreme heat and damaging winds for damage pathways. The low damage pathways are as a result of minimal or localised impact of the hazard, with compliance with building codes and Australian standards. Whilst extreme heat and damaging winds increase in vulnerability for the downtime pathway due

to disruptions to staff and students, the vulnerability remains low for drought as there is minimal impact to essential water provision from water restrictions.

B.4 Energy sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Low - Moderate	Prolonged extreme heat can damage generation equipment, transformers, and overhead lines by causing thermal expansion, degradation, and accelerated wear on cooling systems. Increased faults and damage to equipment is possible with overheating. Transmission and distribution lines may sag excessively, or transmission towers may buckle, causing damage through short circuits and flashovers.	Moderate	Extreme heat reduces the capacity of transmission lines, distribution lines, and transformers in substations, while increased energy demand from extreme heat causes increased load on networks, leading to brownouts and blackouts. Increased temperatures may also decrease the efficiency of energy generation (for example, solar panels and coal power stations) with potential for overheating and downtime.
Flooding	Moderate	Flooding can damage power plants, substations, and underground distribution networks, while water ingress can destroy electrical components and compromise structural integrity of transmission towers and distribution poles.	Moderate - High	Flooding can force shutdown of generation units and substations and disrupt control centre operations. Downtime may result from damaged assets due to flooding and restoration of services may be delayed due to cleanup and safety inspections.
Bushfire	High	Bushfires may directly impact and damage transmission and distribution networks, substations, and energy generation with direct damage resulting in destruction of assets, and impact of smoke on operations.	High	Downtime may result from direct bushfire damage, while ash and smoke may decrease solar panel output. Transmission lines, distribution lines, and substations may be operating at lower capacity or shut down during bushfire conditions to manage safety and ignition risks or may be directly impacted by bushfire. Restoration of services following bushfire may be delayed by inability to access sites and safety inspections.
Rainfall-induced landslide	Moderate	Landslides can cause displacement, tilting or collapse of transmission and distribution line structures, and substations.	Moderate	Network downtime may result from damage to transmission and distribution lines, and substations, and restoration of services following landslides may be delayed by inability to access sites and safety inspections.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Damaging winds	Moderate	Extreme winds can damage above-ground powerlines, distribution poles, substations and transmission towers both directly and from debris and tree fall.	Moderate	Extreme winds may cause downtime from damaged infrastructure and assets such as above-ground powerlines, distribution poles, and transmission towers. Powerlines may be shutdown pre-emptively if there is a risk of powerline damage and potential for bushfire ignition from downed electrical assets. Wind generation capability may be disrupted with shutdown generation in times of high wind.
Drought	Low - Moderate	Drought may result in reduced water availability which may damage cooling systems in thermal plants and increasing fire risk to transmission infrastructure. Extended periods of low rain may lead to flashovers in electricity lines causing damage. Prolonged drought can increase shrink and swell of soils, leading to structural cracking of foundations.	Moderate - High	Reduced water availability can impact hydropower resulting in operational downtime or reduced capacity. Impacts to water-cooling capability for thermal power plants can lead to increased downtime. Flashovers between electricity lines can lead to power outages.
Coastal inundation	High	Impacts to assets, including corrosion and submersion, damaging the integrity of electricity assets, particularly generation assets, substations and underground transmission and distribution lines.	High	Damaged infrastructure due to coastal inundation combined with storm surges may result in energy service disruptions.

The Energy sector is highly vulnerable to bushfire and coastal inundation but also experiences significant impacts from extreme heat and flooding.⁹

Despite existing adaptive measures such as bushfire assessment requirements in planning approvals and summer readiness programs, vulnerability damage and downtime as a result of bushfire remains high. During the 2019-2020 bushfire season, the distribution network was impacted with 280,000 customers losing power for periods ranging from 1 to 10 days (Climate Change in Australia, 2020), due to 5,000 power poles being destroyed across Victoria and NSW (Energy Networks Australia, 2022). It was found that isolated communities are more vulnerable as they are at the end of single high voltage distribution lines (Climate Change in Australia, 2020).

Extreme heat poses considerable challenges to energy generation, as demonstrated during the February 2017 heatwave when 14% of coal and gas generation capacity across the National Electricity Market failed during peak demand (Ogge & Aulby, 2017). In Victoria in January 2018, Loy Yang Coal power station experienced six failures over three weeks, tripping numerous times partly due to maintenance faults as well as extreme heat (Hannam, 2018). In January 2019, load shedding occurred across the National Electricity Market due to shortage of electricity supply as a result of thermal inefficiencies, unexpected equipment failures, urgent maintenance activity and reduced generation capacity during extreme heat demand on electricity (AEMO, 2019). Heat impacts extend across generation types: ambient temperatures above approximately 34°C reduce wind turbine output by 5-10%, while solar panel efficiency degrades from 27°C onwards, resulting in 5-40% energy losses⁹. In addition, heat impacts powerlines with sag in lines, and potential reduced capacity to avoid damage to infrastructure (Energy Networks Australia, 2018).

⁹ Insights on the vulnerability of the energy sector have been informed by discussion with our energy infrastructure subject matter expert.

Extreme wind impacts upon wind farms the most as they operate within narrow wind thresholds, with turbines beginning rotation at 4m/s, achieving full generation at 12m/s, and safely shutting down at 25m/s windspeeds.

Vulnerability to flooding is mainly linked to flood velocity, with damage to infrastructure causing downtime and saturated assets requiring careful inspection processes before returning to service, potentially causing prolonged outages. While coal generation facilities incorporate retention zones to manage flood events, legacy issues such as water ingress leading to ground heave and batter instability may persist. In addition, flooding can damage substations, transformers and circuit breakers, indirectly damage underground equipment and reduce clearance to overhead lines (Energy Networks Australia, 2022).

The sector is moderately vulnerable to drought, particularly for coal generation facilities which cannot operate at full capacity and become derated when water supply is insufficient. For overhead electricity lines, extended periods of drought can lead to increased particulate deposition on lines, increasing the chance of flashovers causing both damage and downtime. Drought, wind, and flood events contribute to erosion-induced instability of transmission and distribution infrastructure – with particular vulnerability arising when drought and flood occur in combination, or when wind and flood coincide – and localised events capable of causing disruptions. For example in February 2024, storms resulted in 530,000 electricity customers without electricity and for 10% of those customers, particularly located in the Dandenong Ranges, it took several weeks to get power restored (Engage Victoria, 2024). This prolonged outage occurred as 12,000 kilometres of distribution lines and 1,100 powerlines were impacted, and 6 transmission towers collapsed. In addition, the Loy Yang A power station generation units were disconnected and so with widespread impacts to generation, transmission and distribution networks the impacts were compounded. Similarly in June 2021, large storms resulted in prolonged electricity outages - 297,000 electricity customers without power initially, however 68,000 customers were still without power after 72 hours, and 9,000 still did not have power 7 days after the event (DELWP, 2022).

The energy sector does not have a low vulnerability to any hazards, however both extreme heat and drought for the damage pathway have been rated low-moderate. This variation is as a result of the different assets within the energy sector and variation between minimal, localised impacts, to more widespread impacts that have more of a disruption to the sector. For example, renewable generation assets have low vulnerability to drought as they do not require water for cooling. However thermal generation assets have moderate vulnerability to drought as they require water for cooling.

B.5 Health sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Moderate	Health facilities are vulnerable to structural and equipment damage during extreme heat events, as high temperatures can degrade facade materials, overheat medical devices, and compromise the performance of equipment such as refrigeration for medicines and vaccines.	High	Extreme heat can lead to operational downtime through HVAC system failures, and increasing disruption to utilities including power outages, which disrupt critical healthcare services. Extreme heat may also increase demand on services contributing to operational disruption.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Flooding	High	Flooding can damage health infrastructure, electrical systems, and medical equipment, while water ingress can contaminate sterile areas and destroy pharmaceutical supplies.	High	Flooding can force temporary closure of health facilities due to unsafe conditions, blocked access roads, interrupted electricity, contaminated or reduced water supply, and the need for extensive cleanup and decontamination before resuming services. Flooding may also disrupt personnel from reaching facilities or result in supply chain delays for essential deliveries, it may also require patient evacuation. The recovery from flood may also result in increased demand on services contributing to operational disruption.
Bushfire	High	Bushfires can destroy health facilities, damage external utilities, and contaminate air quality inside buildings, affecting sensitive medical equipment and supplies.	High	Bushfire smoke and evacuation orders can lead to service suspension, supply chain disruption, staff shortages, and patient relocation, causing prolonged operational disruptions. Bushfires may also impact operations through water-scarcity, power outages and contamination from smoke and debris – this may also result in reduced amenity with extreme heat and smoky conditions. Bushfires may also increase demand on services, particularly from respiratory and cardiovascular issues and mental health support, contributing to operational disruption.
Rainfall-induced landslide	Low - Moderate	Direct impact from debris flow can damage building assets, access roads, and utility connections.	Low - Moderate	Landslides can isolate health facilities by blocking transport routes, delaying emergency response and supply deliveries, and forcing temporary closure until access is restored. Landslides may also increase demand on services contributing to operational disruption.
Damaging winds	Low	High winds can damage roofs, windows, and external medical infrastructure, while flying debris can harm critical systems such as power lines and backup generators.	Low	Damaging winds can lead to operational downtime by causing power outages, restricting patient and staff movement, and requiring repairs before services can resume. Damaging winds may also increase demand on services contributing to operational disruption.
Drought	Low	Prolonged drought can damage water-dependent systems in health facilities, such as cooling towers and sanitation infrastructure, and increase fire risk to buildings.	Low	Water restrictions during drought can disrupt operations including cleaning and cooling.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Coastal inundation	High	Coastal inundation can damage health facilities located near shorelines, corrode building materials, and destroy electrical and medical systems through saltwater intrusion.	High	Inundation can render centres inaccessible, contaminate water supplies, disrupt supplies, and require extensive restoration, causing prolonged closures. Coastal inundation may also increase demand on services, from injuries and mental health concerns, contributing to operational disruption.

The health sector is most vulnerable to flooding, bushfire and coastal inundation, but also experiences increased operational disruption as a result of most hazards due to increased demand for services during emergencies, and potential of relocation for residents from residential aged care facilities. For example, over 1,000 residents were relocated from aged care facilities from the 2009 ‘Black Saturday’ bushfires combined with the 2010-2012 floods (Department of Health, 2012) , and potential of relocation for residents from residential aged care facilities.

Both flooding and coastal inundation present high vulnerability for the health sector. The Victorian Managed Insurance Authority has paid \$45.6 million in claims associated with public hospitals from flooding and rainfall events between 1 July 2019 and 22 October 2025 (VMIA, 2025). Water depths of 50 cm or greater typically cause structural damage to walls and foundations, while depths exceeding 100 cm result in extensive damage requiring prolonged restoration (Huizinga, De Moel, & Szewczyk, 2017). Flood velocity compounds damage, with flows exceeding 2 m/s generating sufficient hydraulic forces to cause structural damage and debris impact to buildings (Huizinga, De Moel, & Szewczyk, 2017). Therefore, flood and coastal inundation remain a key concern for the health sector with potential for large physical damage and impact.

Bushfires result in significant operational disruptions for the health sector. The smoke-related health cost of the 2019-2020 bushfire season was estimated to be \$1.95 billion across Australia, and during that season in key impacted areas, emergency department visits rose more than 50% during peak bushfire activity (AIHW, 2020). In addition, there were almost 19,000 bushfire-related Medicare-subsidised mental health services accessed by 5,092 patients as of October 2020 across Australia (AIHW, 2020). Bushfire can have direct impact and damage on facilities, destroying facilities and equipment.

Extreme heat has a high downtime vulnerability and a moderate damage vulnerability. When extreme heat and heatwaves occur, this causes thermal discomfort and an increase in presentations to healthcare facilities with heat related issues (Department of Health, 2024). Exposure to excessive natural heat is the most common causing leading to injury hospitalisation in Victoria (AIHW, 2023). For aged care residents, heatwaves are considered a major health hazard and can result in increased number of deaths, and therefore vulnerability is increased (Victorian Government Department of Health, 2010). In addition, there is a moderate damage pathway due to the sensitivity of equipment temperature thresholds. Operating theatres, sterile stock areas, perioperative environments must have temp thresholds of 22°C, 25°C and 25°C respectively, when this is exceeded, damage to supplies can occur and unsafe environment may result (Clinical Excellence Commission, 2024). Hospital design (HVAC) and power redundancy increases adaptive capacity of high-risk and critical areas, thereby reducing vulnerability from high.

The health sector is least vulnerable to damaging winds and drought due to the limited and localised impact of these hazards. Damaging winds has the potential to impact buildings, however building codes and Australian standards consider this hazard (AS1170.2 Structural design actions, Part 2: Wind actions). For downtime, damaging winds could result in increased demand for health services and may result in power outages, but is considered to be localised, with adequate redundancy and established response protocols. Drought mainly impacts on water-dependent systems and water restrictions may minimally impact the health sector.

B.6 Housing sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Low	Prolonged extreme heat can damage roofing materials, degrade insulation, and overheat electrical systems in social housing units, reducing structural integrity and energy efficiency.	High	Extreme heat can lead to habitability issues, forcing temporary relocation of residents due to unsafe indoor temperatures and failure of cooling systems.
Flooding	Moderate	Flooding can damage building foundations, walls, and electrical systems, while water ingress can destroy flooring and compromise structural safety.	Moderate	Flooding can render housing units uninhabitable until cleanup, repairs, mould remediation and / or rebuild are completed, requiring resident displacement.
Bushfire	High	Bushfires can destroy housing structures, external utilities, and landscaping, while smoke and ash can contaminate indoor spaces, pipes and drainage, and HVAC systems.	High	Bushfire risk and evacuation orders can lead to temporary displacement of residents and prolonged closures for cleanup, repairs and potential rebuilding.
Rainfall-induced landslide	Low - Moderate	Landslides can damage housing foundations, retaining walls, and access roads, compromising structural stability and utility connections.	Low - Moderate	Landslides can isolate housing complexes by blocking access routes, delaying emergency services, and forcing temporary relocation until repairs are completed.
Damaging winds	Low	High winds can directly damage roofs, windows, and external structures, while flying debris can damage utilities and outdoor areas.	Low	Damaging winds can lead to temporary displacement of residents due to safety hazards, power outages, and the need for repairs before reoccupation.
Drought	Low	Prolonged drought can increase shrink and swell of soils, leading to structural cracking of foundations. Additionally, drought can damage landscaped areas.	Low	Water restrictions during drought can disrupt services, including cleaning and cooling.
Coastal inundation	High	Coastal inundation can damage housing near shorelines, corrode structural materials, and destroy electrical and plumbing systems through saltwater intrusion.	High	Inundation can render housing units inaccessible and unsafe, requiring extensive restoration and permanent resident displacement.

State-owned housing across Victoria faces growing vulnerability to climate-driven hazards, particularly bushfires and coastal inundation. State-owned housing has an ageing stock which makes it more vulnerable to climate hazards. The average age of Victoria's public housing stock in 2017 was 35 years, with over 60% of the stock over 30 years old (Victorian Auditor-General, 2017). In addition, any climate hazards raise complex and interdependent issues for tenants who are already considered a vulnerable population based on their social, economic and community considerations, that exacerbate their vulnerability to climate hazards (Melbourne Centre for Cities, 2024). Additionally, climate hazards will increase demand for social housing with loss of housing and displacement from communities compounding vulnerability and impacts – on average 22,261 Australians are displaced by climate disaster each year which are disproportionately represented by people with low incomes and socio-economic status (Heffernan, 2025).

Climate hazards such as bushfire, coastal inundation and flooding pose adverse impacts for social housing, included state-owned housing, with physical damage having severe implication for vulnerable residents such as loss of access and heightened displacement risks that aggravate social and economic inequality that tenants face (Heffernan, 2025). As demonstrated by the 2022 floods, there was a lack of temporary

accommodation and systemic issues with accessing housing and temporary accommodation (Legislative Council Environment and Planning Committee, 2024). Similar to the health sector, and education and training, water depths of 50 cm or greater typically cause structural damage to walls and foundations, while depths exceeding 100 cm result in extensive damage requiring prolonged restoration (Huizinga, De Moel, & Szewczyk, 2017). Flood velocity compounds damage, with flows exceeding 2 m/s generating sufficient hydraulic forces to cause structural damage and debris impact (Huizinga, De Moel, & Szewczyk, 2017). The physical damage failure has the potential to result in asset failure with adverse impacts for the sector.

The sector is highly vulnerable to extreme heat for the downtime pathway. A key concern and vulnerability for state-owned housing comprised of ageing homes is that they are not built to withstand heatwaves with a lack of cooling infrastructure and low thermal performance, or if of new stock, high energy costs are a barrier for residents (Environmental Justice Australia, 2024).

B.7 Justice and community safety sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Low	Prolonged extreme heat can damage HVAC systems, degrade roofing and structural materials, and overheat IT and security systems critical for justice and emergency operations.	Moderate	Extreme heat can lead to operational disruptions due to unsafe conditions for staff and detainees, increased risk of power outages, and failure of cooling systems, forcing temporary closures or reduced services. Extreme heat may also increase demand on emergency service operations contributing to operational disruption.
Flooding	Moderate	Flooding can damage building structures, electrical systems, and critical infrastructure such as holding cells, evidence storage, and emergency response equipment.	High	Flooding can force temporary closure of facilities due to water ingress, contamination, and blocked access routes, delaying court proceedings and emergency response operations. Flooding may also increase demand on emergency service operations and justice services (e.g. from increased insurance claims, tenancy disputes and civil issues) contributing to operational disruption.
Bushfire	High	Bushfires can destroy buildings, outdoor security perimeters, and utilities, while smoke and ash can damage sensitive IT systems and contaminate indoor air quality.	High	Bushfire smoke and evacuation orders can lead to prolonged closures, disruption of court schedules, and relocation of detainees and emergency services personnel. Bushfire may also increase demand on emergency service operations and justice services (e.g. from increased insurance claims, tenancy disputes and civil issues) contributing to operational disruption.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Rainfall-induced landslide	Low - Moderate	Landslides can damage facility foundations, retaining walls, and access roads, compromising structural integrity and utility connections.	Low - Moderate	Landslides can isolate facilities by blocking transport routes, delaying staff and detainee movement, and forcing temporary closure until safe access and repairs are completed. Landslides may also increase demand on emergency service operations and justice services (e.g. from increased insurance claims, tenancy disputes and civil issues) contributing to operational disruption.
Damaging winds	Low	High winds can damage roofs, windows, and external security infrastructure, while flying debris can harm vehicles and outdoor equipment essential for emergency response.	Low	Damaging winds can lead to closures due to safety hazards, power outages, and the need for repairs before resuming court sessions or emergency operations. Damaging winds may also increase demand on emergency service operations and justice services (e.g. from increased insurance claims, tenancy disputes and civil issues) contributing to operational disruption.
Drought	Low	Prolonged drought can increase shrink and swell of soils, leading to structural cracking of foundations. Additionally, drought can damage landscaped areas.	Low	Water restrictions during drought can disrupt operations, including cleaning and cooling.
Coastal inundation	High	Coastal inundation can damage facilities near shorelines, corrode structural materials, and destroy electrical and IT systems critical for justice and emergency services.	High	Inundation can render facilities inaccessible, contaminate water supplies, and require extensive restoration, causing prolonged closures and disruption of judicial and emergency functions. Coastal inundation may also increase demand on emergency service operations and justice services (e.g. from increased insurance claims, tenancy disputes and civil issues) contributing to operational disruption.

The justice and community sector is highly vulnerable to bushfire and coastal inundation due to its reliance on physical infrastructure and the need for continuous service delivery. Courthouses, correctional facilities, and emergency service buildings are key services that are considered under the justice and community sector. Disruptions to transport networks and power supply from climate hazards can hinder access to legal services and emergency support and increase adverse impacts.

The justice and community safety sector is moderately vulnerable to damage from flooding. Similar to the housing, health and education and training sectors, water depths of 50-100+ cm typically cause structural damage to walls and foundations, with increased flood velocity compounding damaging with debris impact (Huizinga, De Moel, & Szewczyk, 2017).

Incarceration status may exacerbate the impact of climate hazards disproportionality due to inequality and vulnerability of populations (Maner, et al., 2022). In addition, some correctional facilities may be more vulnerable to climate hazards or require evacuation during disaster events (Robbins, 2005). During 2019-20 Black Summer bushfires, 190 prisoners were evacuated from the Beechworth Correctional Facility due to

concerns about the nearby Corryong fire and smoke (Carroll, 2020). In 2024 prisoners from Langi Kal Kal prison were also evacuated due to the Bayindeen bushfire in the Grampian region and were temporarily relocated to the Western Plains prison (Department of Justice and Community Safety, 2025).

Demand on justice services is likely to increase due to climate hazards, and with a limited adaptive capacity currently, climate change may undermine the sector’s ability to provide justice capability and services (Taylor, 2025). Climate hazard events can strain community resources, increase demand for crisis assistance, and exacerbate social inequities, leaving vulnerable populations at greater risk of harm and reducing the sector’s capacity to maintain essential operations.

The sector has low vulnerability to damage from extreme heat, wind and drought as these hazards have a reduced damage impact on buildings as they are constructed to the building code. For extreme heat, the vulnerability rating increases to moderate for downtime due to increased demand on emergency services and operational disruptions from unsafe conditions. For damaging winds and drought, downtime vulnerability remains low due to the local and limited impact to buildings.

B.8 Parks sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Low	Prolonged extreme heat can damage building materials, HVAC systems, and water-dependent infrastructure at visitor centres and coastal facilities. It can also degrade outdoor assets such as signage, boardwalks, and recreational equipment.	Moderate	Extreme heat can lead to closures or restricted hours due to health risks for visitors and staff, failure of cooling systems, and increased fire danger in parks.
Flooding	Moderate	Flooding can damage visitor centres, coastal infrastructure, and park amenities such as trails, bridges, and picnic areas. Water ingress can destroy electrical systems and interpretive displays.	Moderate	Flooding can force temporary closure of parks and facilities due to unsafe conditions, blocked access roads, and the need for cleanup and restoration.
Bushfire	High	Bushfires can destroy visitor centres, signage, and park infrastructure, while smoke and ash can damage HVAC systems and contaminate indoor spaces.	High	Bushfire smoke and evacuation orders can lead to prolonged closures of parks and facilities, cancellation of events, and disruption of tourism activities.
Rainfall-induced landslide	Moderate	Landslides can damage visitor centre foundations, retaining walls, and access roads, compromising structural safety and utility connections.	Moderate	Landslides can isolate parks and facilities by blocking transport routes, delaying visitor and staff access, and forcing temporary closure until safe passage and repairs are completed.
Damaging winds	Low	High winds can damage roofs, windows, signage, and outdoor structures such as boardwalks and shelters. High winds and debris can also harm landscaping, habitats and coastal infrastructure.	Moderate	Damaging winds can lead to closures due to safety hazards, power outages, and the need for repairs before reopening, disrupting tourism and community activities.
Drought	Low	Prolonged drought can damage landscaping, water-dependent systems, and coastal facilities, while increasing fire risk to visitor centres and park assets.	Moderate	Drought conditions may reduce amenity of parks, reducing visitation.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Coastal inundation	High	Coastal inundation can damage visitor centres and coastal infrastructure, corrode structural materials, and destroy electrical systems through saltwater intrusion.	High	Inundation can render parks and facilities inaccessible, contaminate water supplies, and require extensive restoration, causing prolonged closures and disruption of tourism activities.

The parks sector, which includes visitor facilities, buildings, cultural assets and landscaped assets within parks managed by Parks Victoria, is highly vulnerable to coastal inundation and bushfire hazards. The parks sector has ecosystems services which include opportunities for recreation and tourism, benefits from retention of soil and carbon, and the biodiversity systems including water and biomass (McCormick & Showers, 2020). These services are vulnerable to climate hazards and the multi-benefits they provide.

Bushfires can negatively impact infrastructure within the parks sector. For example, the 2019-20 fire season impacted an estimated 1,024 park assets, with more than \$15 million in damage attributed to assets such as shelters, walkways, bridges, crossings, signage and BBQs (Bushfire Recovery Victoria, 2020). The season resulted in 1.2 million hectares of forest in east and north-east Victoria burnt across 49 state forests and 98 parks and reserves (McCormick & Showers, 2020). This had a significant impact on biodiversity and the provision of parks services from various bases. It was estimated from this that there would be an additional 724,000 tonnes of soil erosion across the region from the fire (McCormick & Showers, 2020), posing increased risk for landslides. Similar in 2009, the Black Saturday fires resulted in 230,000 hectares burned including 70 national parks and reserves (Forest Fire Management Victoria, 2023). These bushfire events result in significant physical damage to the infrastructure in the sector, but also severe operational disruption with closure or limited access to parks and recreation.

Damaging winds present low damage vulnerability, with building envelope components including roofs, windows, and external cladding particularly susceptible to failure. Wind speeds exceeding 25 m/s (90 km/h) can damage roof cladding and external fixtures, while speeds above 33 m/s (approximately 120 km/h) substantially increase the probability of roof sheathing failure and window breakage (based on the Beaufort scale). For example, in the June 2021 storms, Morwell National Park experienced extensive damage to infrastructure including 3 access bridges, walking tracks, picnic tables and barbecue facilities. It took over 2 years for this to be repaired and remediated, resulting in increased downtime for the park (Melina Bath MP, 2023). Operational outdoor discomfort occurs at speeds exceeding 8 m/s, which the sector has a moderate vulnerability to due to visitors to parks.

Infrastructure in the parks sector is moderately vulnerable to damage from flooding. Similar to the other sectors which include building assets water depths of 50 cm or greater typically cause structural damage to walls and foundations, while depths exceeding 100 cm result in extensive damage requiring prolonged restoration (Huizinga, De Moel, & Szewczyk, 2017). Flood velocity compounds damage, with flows exceeding 2 m/s generating sufficient hydraulic forces to cause structural damage and debris impact (Huizinga, De Moel, & Szewczyk, 2017).

Infrastructure in the parks sector is considered to have a low vulnerability to damage from extreme heat, wind and drought, as these hazards have a reduced damage impact on buildings as they are constructed to the building code. However, these low ratings increase to moderate for downtime due to the impact on visitors to parks who predominantly are accessing outdoor areas.

B.9 Ports sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Low	Extreme heat causing thermal expansion and contraction of concrete and steel components of wharves and docks resulting in damage from cracking, warping or accelerated material degradation. Extreme heat may also deform infrastructure like lifting bridges and lock gates, or result in overheating of equipment resulting in damage.	Low	Extreme heat resulting in overheating of equipment such as cranes, conveyor systems and refrigerator containers which may result in shutdowns or reduced operating hours. Extreme heat may also deform infrastructure leading to downtime whilst repairs occur.
Flooding	Moderate	Prolonged water exposure of port infrastructure impacts the wharves, access roads, electrical systems and storage facilities. This may result in damage to foundations, corrosion to metal components and damage to electrical utilities. It may also damage cargo integrity and goods.	Moderate	Flooding can restrict access to berths, warehouses and transport links resulting in reduced activity or shutdowns until water recedes and clean-up is completed.
Bushfire	High	Bushfires may directly damage port infrastructure including storage, facilities and electrical systems. Fuel storage may also contribute to the damage of bushfire with intense heat and flames. Smoke and ash may contaminate cargo and mechanical components requiring repair.	Moderate	Evacuation orders, road closures and reduced visibility from smoke can halt cargo handling and vessel movements. In addition, direct damage to port facilities may result in reduced or halted operations.
Rainfall-induced landslide	Moderate	Heavy precipitation can destabilise surrounding port terrain, causing soil movement that undermines foundations, damages access roads, and disrupts retaining structures. Landslides can also bury critical assets such as pipelines, electrical systems, and storage areas, leading to costly repairs and long-term structural risks.	Moderate	Landslides may block access routes, damage transport links, and create hazardous conditions for port operations resulting in downtime. Clean up and restoration may require extended periods of time.
Damaging winds	Moderate - High	Extreme winds may damage cranes, container stacks, warehouses and powerlines. They may also topple stacked containers, dislodge roofing and create damaging debris.	High	Extreme wind events resulting in reduced or closed operations of ports, due to unsafe conditions for cargo handling and vessel berthing.
Drought	Low	Prolonged drought conditions can lead to reduced soil moisture and ground subsidence around port infrastructure, including quay walls, foundations, and access roads. This can cause cracking, uneven settlement, and structural instability, particularly for assets built on reclaimed or soft soils.	Low	Drought can disrupt port operations by reducing water levels in adjacent channels and harbours, limiting vessel access and draft capacity. Restrictions on water use may also affect operational activity such as dust suppression, cleaning, and cooling systems for equipment.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Coastal inundation	High	Ports are vulnerable to physical damage from storm surges or rising sea levels. Saltwater intrusion may accelerate corrosion, degrade concrete structures and damage electrical or mechanical systems. Prolonged exposure may compromise the structural integrity of port infrastructure, requiring extensive repairs.	High	Coastal inundation may result in downtime or permanent shutdown of infrastructure due to flooding and restricted access to critical infrastructure. Storm surges may also shift sediment, impacting the depth of berths or channels, restricting access by ships.

The ports sector is vulnerable to and impacted by changes in climate conditions, for example ship manoeuvres and port operations are highly dependent on weather and climatic conditions (Garcia-Alonso, Zanon Moura, & Roibas, 2020). The sector is most vulnerable to damage and downtime caused by damaging winds and storm surges.

Coastal inundation is a significant consideration for the ports sector. Coastal inundation and sea level rise can significantly impact on port operability, due to potential for flooding of dock and port infrastructure, and the reduction of freeboard in berthing areas, which means that there is reduced vertical distance between the waterline and ship deck which may impact mooring, loading and access to the ship. In addition, this can change water depth in and around ports which may change current wave propagation patterns creating additional impacts for ports with changes in agitation (physical motion of water in the port) which might impact moorings and operations, siltation with the accumulation of fine sediments in the berths and channels or structure stability of the docks (Gracia, et al., 2019). Physical damage to warehouses, docks and other facilities is possible from rising sea levels and coastal inundation, since this infrastructure is typically located adjacent to coastal areas (Cadario, 2024).

The ports sector has a high vulnerability to bushfire damage due to the potential for large scale impact of damage, and moderate vulnerability to downtime due to the impact to operations from the bushfires. In 2020, bushfires halted operations at the port of Eden in NSW due to the fires threatening the area, with passenger ships cancelled and exports were halted (GAC, 2020). In addition, during the 2019-2020 bushfire season, Operation Bushfire Assist was launched by the Australian Defence Force (ADF), with large support from the Navy. This included assistance evacuating residents of Mallacoota by boat to the Port of Hastings, and providing additional support equipment, fuel and water for bushfire impacted areas, impacting upon port operations (Cuffe, 2020).

Wind impacts port activities such as container handling, and vessel berthing and unberthing, and can result in physical damage to infrastructure (Castillo & Herazo, 2024). Wind can impact on the stability of ships, reach stacker, cranes and other port equipment (Castillo & Herazo, 2024).

The ports sector has low vulnerability to extreme heat and drought for both damage and downtime. Extreme heat was considered to have a minimal impact to damage pathways as the concrete and steel components of wharves and docks are designed and built to Australian standards which incorporate this. Additionally, the downtime impact of equipment overheating or potentially deforming is likely to be limited and localised within port assets. Similarly for drought, the damage pathway articulates potential cracking and impacts to foundations, but this likely to be localised due to Australian design standards. Downtime as a result of drought is also localised with potential water restrictions which would have negligible impact on operations.

B.10 Rail sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Moderate - High	High temperatures can cause rail tracks to buckle or expand, leading to alignment issues and increased risk of derailment. Signalling and control systems may malfunction due to overheating. Fuel storage and mechanical equipment are also at risk of performance degradation or failure.	Moderate - High	Extreme heat can force speed restrictions, service cancellations, or partial closures to ensure safety. Staff and passenger comfort may be compromised with disruptions to ventilation systems in underground stations, and construction and maintenance requirements may increase due to heat-related wear and tear.
Flooding	High	Water ingress can erode track foundations, wash away ballast, and corrode electrical components, compromising structural integrity. Flooding of underground tunnels may damage components and assets.	High	Flooding can disrupt rail operations by inundating tracks, stations, and maintenance depots, making them unsafe or inaccessible. Signal failures and submerged tracks can halt train movements, while cleanup and restoration efforts may lead to extended service interruptions.
Bushfire	High	Rail track elements (such as sleepers and bearers), signalling equipment, and buildings are at risk of damage from radiant heat, ember attack, and direct flame exposure during bushfire events.	High	Rail operations, including access via tunnels, can be disrupted due to bushfire smoke or active fire zones, causing prolonged network inaccessibility and rerouting.
Rainfall-induced landslide	Moderate	Heavy precipitation can destabilise slopes adjacent to rail corridors, causing soil movement that undermines track foundations, damages retaining structures, and compromises drainage systems. Direct impact from debris-flow can damage track and trackside assets.	Moderate	Rainfall-induced landslides can disrupt rail operations by blocking tracks, damaging signalling equipment, and creating hazardous conditions for maintenance crews. Cleanup and restoration efforts may lead to extended service interruptions.
Damaging winds	Moderate	High winds and storms, including debris, can damage rolling stock, overhead lines, signals, structures, and trackside equipment.	Moderate	Storms may cause operational delays due to track obstructions, power outages, or the need for post-event inspections and repairs. Service reliability can be reduced during and after severe wind events.
Drought	Low	Prolonged dry conditions can cause ground shrinkage and subsidence, leading to cracking and wear of track foundations, noise barriers, and other structures. Increased dust can accelerate wear on moving parts and require more frequent cleaning and maintenance.	Low	Drought may limit water availability for operations (e.g., cleaning, cooling, fire suppression), resulting in operational constraints and potential delays.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Coastal inundation	High	Rail corridors, stations, and associated infrastructure located in coastal or low-lying areas are vulnerable to inundation from storm surges, sea level rise, and coastal flooding. This can result in water ingress, corrosion of metal components, and structural damage to tracks, bridges, and buildings.	High	Flooding can cause track inundation or damage to critical systems (e.g. signalling, power supply) leading to operational shutdowns, restricted access to rail corridors, and delays in freight and passenger services. Access to underground stations can be disrupted due to flooding.

The rail sector is highly vulnerable to damage and downtime from pluvial, fluvial, and coastal flooding. Water depths of 0.3–0.5 m disrupt operations, while deeper or fast-flowing floods cause ballast washout, embankment erosion, and signalling damage, leading to prolonged closures (Vranešić & Haladin, 2025). Victorian flood events have previously required full track rebuilds and extended service suspensions, demonstrating the sector’s high sensitivity to inundation and drainage failure – like in 2012 when sections of V/Line track between Mitiamo and Pyramid Hill was washed away after a flooding event (Henry, 2012)

The sector has high vulnerability to extreme heat, driven by thermal expansion and rail buckling risk once air temperatures exceed 30°C (rail temperature of ~45–55 °C) (Vranešić & Haladin, 2025). Mandatory speed restrictions are triggered by extreme heat days, producing substantial delays despite limited permanent damage (Metro Trains, 2026).

Bushfires pose high damage and downtime vulnerability, with extreme heat and intense radiation from the fire with a radiant heat flux of 15-30kW/m² (in comparison to 1 kW/m² from the sun at midday on a summers day) ember attack, and equipment failure affecting sleepers, cabling, signalling cabinets, and polymer components (Kim, Spirandelli, Rother, Yamashita, & Toner, 2025). Even when tracks remain intact, mandatory exclusion zones and post-fire inspections cause extended shutdowns. Damaging winds create moderate damage and moderate downtime vulnerability. For instance, 60km/h winds may cause operational disruption, while 90-115km/h plus winds may cause structural damage from debris fall and critical damage to signalling systems (Vranešić & Haladin, 2025).

For the rail sector, the vulnerability to drought is rated as low for both damage and downtime due to the limited damage from drought, and small disruption that reduced water availability poses on operations. Wind and rainfall-induced landslide hazards were considered as moderate vulnerability for both damage and downtime as they cause some damage and disruption that requires restoration or repair within a short timeframe.

B.11 Road sector

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Extreme heat	Moderate	Extreme heat can soften, rut, or crack asphalt pavements and degrade bitumen performance or cause thermal expansion of bridge joints. Roadside electrical equipment (signals, communications, ITS assets) may overheat, leading to malfunction or accelerated wear.	Low - Moderate	Heat-related surface deformation and equipment faults can require speed restrictions, temporary lane closures and detours, limitations on periods of construction activity, or maintenance interventions to preserve safety and operational continuity.

Hazard	Rating (damage)	Physical damage pathway	Rating (downtime)	Downtime pathway
Flooding	High	Floodwaters can erode or wash out road bases and shoulders, undermine pavements, damage culverts and drainage systems, increase scour of pipeline roadbeds, and impact on soil moisture levels causing structural weakening from prolonged saturation. Tunnels and bridges may also be damaged from floodwater inundation and water debris.	High	Roads may be closed until floodwaters recede and structural inspections are completed; debris and sediment cleanup, as well as repairs to washed-out sections, extend recovery times. Increased occurrence of accidents, and disruptions to road construction may occur, with partial or minor flooding.
Bushfire	Moderate	Bushfire heat can melt or degrade road surfaces, burn signage and safety barriers, destroy roadside electrical systems, and weaken bridge or culvert components.	High	Roads may be closed due to active fire fronts, hazardous smoke, or falling debris; reopening may be delayed by safety assessments, debris removal, and asset replacement. Smoke and ash impacts from nearby bushfires may also cause an increase in safety concerns and accidents for road users and construction activity.
Rainfall-induced landslide	Moderate - High	Heavy rainfall can saturate and weaken slopes and embankments, triggering landslides and debris flows that bury, displace, or structurally damage embankments, pavement, retaining structures, and drainage assets.	Moderate	Road corridors may remain closed until debris is cleared, slopes are stabilised, and geotechnical assessments confirm safety, often resulting in prolonged traffic disruption.
Damaging winds	Low	High winds can topple trees, light poles, signs, and powerlines onto road corridors, damaging roadside infrastructure such as barriers, lighting, and traffic control systems. While road surfaces are generally resilient to falling debris on roads, debris loading may occasionally damage road shoulders or pavement edges.	Moderate	Obstructed lanes due to debris and damaged roadside assets can require temporary road closures, traffic restrictions or limit construction activity, while debris is cleared and electrical or traffic control systems are restored, leading to operational delays, higher incidence of accidents and reduced network capacity.
Drought	Low - Moderate	Prolonged drought can cause soil shrinkage and ground movement beneath pavements, leading to cracking, subsidence, and deformation of both flexible and rigid pavements.	Low	Structural instability or pavement failure may require speed restrictions, maintenance work, or partial closures until ground conditions are stabilised, and surface defects repaired.
Coastal inundation	High	Coastal flooding from storm surge, high tides, or permanent sea-level rise can scour and undermine road foundations, accelerate corrosion of metal components, flood underground tunnels, and degrade pavements through repeated saltwater exposure, compromising the structural integrity of the roadway. Impacts to bridges may include erosion of road base and bridge supports, bridge scour and, reduced clearance under bridges.	High	Roads may be closed during storm-surge events or high-tide flooding, and areas subject to permanent or recurrent inundation from sea-level rise may experience chronic accessibility constraints. Reopening may be delayed by debris removal, drainage interventions, and repair or elevation of affected road assets.

The road sector is highly vulnerable to damage and downtime from flooding and coastal inundation. Even shallow inundation (~15cm) can force road closures as vehicle operability is compromised (Arup, 2023; Maghsoodifar, Radfar, Moftakhari, & Moradkhani, 2025), while deeper floods with sufficient velocity cause erosion, scour, and wash-outs that undermine pavement foundations and damage drainage infrastructure (PIARC, 2012). Victoria's widespread flooding in 2022 and 2023 demonstrated this vulnerability, causing extensive road damage and prolonged closures across the state (Victorian Government, 2022).

The sector is moderately vulnerable to extreme heat, particularly given poor pavement condition across Victoria (Victorian Auditor-General, 2017). When air temperatures reach 35°C, pavement surfaces can exceed 50–60°C, softening conventional bitumen binders (softening range: 45–55°C) and causing rutting and deformation (AustRoads, 2019). In 2018, 10 km of the Hume Freeway melted during extreme heat, causing significant delays (SBS News, 2018). Most Victorian roads use conventional or polymer-modified bitumen surfaces, with few concrete roads that better tolerate high temperatures.

Bushfires and rainfall-triggered landslides also present moderate to high vulnerability. Bushfires generating high radiant heat flux and flame lengths exceeding several metres can damage guardrails, signage, asphalt surfacing, and drainage assets, often resulting in prolonged closures (Barzegar & Wen, 2023). Landslides can block lanes, trigger embankment failures, or cause shoulder collapse, with restoration typically requiring three or more weeks (Arup, 2023). The 2022 Bogong High Plains Road landslip required months of closure, with single-lane access restored only in April 2023 and full two-lane access in May 2024 (Victoria's Big Build, 2025).

The road sector has the lowest damage vulnerability pathway from wind, as generally road infrastructure is resilient to falling debris. Drought has the lowest vulnerability downtime pathway as the impact from operational disruption due to maintenance work is minimal and local, similar downtime due to extreme heat is rated as low-medium due to the local and temporary impact of disruption.

Appendix C

Criticality assessment

C.1 Criticality assessment evidence base

The following evidence sources were used to inform the matrices and scoring assigned to each criterion and asset sector:

- Emergency Management Victoria (EMV) (2024). Victoria's Critical Infrastructure All Sectors Resilience Report 2023.
- Infrastructure Australia (IA) (2021). A Pathway to Infrastructure Resilience: Advisory Paper 2: Guidance for asset owners and operators in the short term.
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2025). National Climate Risk Assessment (NCRA) – Critical Infrastructure Technical Report, prepared for the Australian Climate Service.
- Committee for Sydney (2024). No Weak Links: Strengthening Critical Infrastructure Resilience.
- New Zealand Lifelines Council (2023). Aotearoa New Zealand's Critical Infrastructure: A National Vulnerability Assessment. Part B: Main Report – Infrastructure Resilience in New Zealand.
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2025). Protecting Critical Infrastructure Against Emerging Threats: Sector Interdependencies, prepared for the Department of Home Affairs' Cyber and Infrastructure Security Group.

The rationale for scoring each criterion is outlined in the following sections.

C.1.1 Public safety

EMV (2023) identifies health facilities as the most critical life-safety assets as their disruption can result in immediate risks to life and acute health harm. Therefore, hospitals and aged care facilities receive high scores under the safety and public health criteria, reflecting their essential role in emergency care, treatment of vulnerable populations, and high dependency on continuous operation. EMV (2023), IA (2021) and the CSIRO (2025) emphasise that energy infrastructure also underpins life safety, particularly during extreme heat or cold, where extended power loss can cause severe health outcomes. Therefore, energy assets receive moderate to high scores, recognising both their broad population exposure and partial mitigation through backup supply in critical sites such as hospitals and specialist clinics. Roads are also identified across the three reports as essential for emergency access, justifying their moderate to high scores. However, assets such as schools, community centres and cultural facilities are not associated with immediate health consequences when disrupted, aligning with a low score.

C.1.2 Wellbeing and public health

IA (2021) and the Committee for Sydney (2024) identify the wellbeing impacts of disrupted housing, energy services, and healthcare access as critical as these can cause displacement, heightened stress, and long-term trauma. Housing, hospitals, and energy infrastructure receive high scores, reflecting their central role in physical comfort, psychological safety, and continuity of daily life. The Victorian resilience report identifies transport disruptions as impactful on routine functioning, supporting moderate scores for rail and roads, where alternatives (e.g., replacement buses or alternate roads) reduce prolonged individual hardship. Ports also receives moderate scores as their disruption affects wellbeing indirectly, largely through supply chain delays rather than personal hardship. This score is dependent on the length of the disruption. The NCRA's Social Cost metric (CSIRO, 2025) evidence indirect wellbeing effects mediated through transport and telecommunication outages, which further supports a higher wellbeing scoring of energy, housing and hospitals and moderate scoring for roads and rail as temporary alternatives can exist. Schools, community centres, and cultural assets receive low scores as these can be inconvenient and socially disruptive but can be mitigated through relocation or remote service delivery.

C.1.3 Affected population size and vulnerability

EMV (2024) highlights energy systems and health networks as serving the largest, most vulnerable, and most diverse populations. This evidence supports high scores for hospitals, major energy assets, and large transport corridors, as their failure affects both essential service users and entire regional populations. IA (2021) also identifies social housing as serving highly vulnerable groups with limited adaptive capacity, which justifies moderate to high scores for housing assets. Specialist clinics, community health centres, and correctional facilities serve smaller but still vulnerable groups, supporting moderate scores. Meanwhile, schools, community centres, and cultural assets serve more defined and less vulnerable populations, and their services can be more readily substituted, therefore, they receive low scores.

C.1.4 Network redundancy

National and state infrastructure resilience guidance consistently identify infrastructure with limited alternatives or single points of failure as high criticality. The Committee for Sydney (2024) report identifies ports, certain rail corridors, transmission lines, and correctional facilities as assets with very low redundancy due to their limited substitutes and highly specialised roles. As a result, these assets receive high scores. EMV (2024) identifies critical transmission routes as having limited rerouting capacity, reinforcing moderate to high scores for electricity network elements. CSIRO (2025) supports high redundancy scores for energy and telecommunications due to an elevated multi-hazard risk with few practical alternative routes. Conversely, schools, TAFE, and community facilities have demonstrated high adaptability, including rapid relocation and online delivery, justifying low scores. Roads and parts of the rail network have multiple alternative routes in metropolitan areas but fewer in regional areas, supporting moderate scores.

C.1.5 Recovery time and restoration capacity

Scores for the recovery time and restoration capacity criteria are dependent on the hazard type and hazard intensity. Evidence from EMV (2024), IA (2021) and CSIRO (2025) identify hospitals, major transport infrastructure, and high-voltage energy assets as complex, specialist-built systems requiring long restoration times. These assets therefore receive high scores, as repairs after severe weather, flooding, or structural damage can take months and require specialised equipment or regulatory oversight. Energy infrastructure can have prolonged recovery time, particularly following flood events, due to the safety inspections required prior to restoring service. Roads and rail infrastructure often have moderate restoration times, depending on the scale of damage, so they receive moderate scores. Ports also receives moderate scores, reflecting their highly specialised assets but moderate repairability. Schools, community centres, and TAFE facilities are consistently identified as easier and faster to restore or replace, often through temporary facilities, justifying low scores.

C.1.6 Interdependencies

Arup developed an interdependency matrix to inform the scoring of downstream interdependencies. The matrix followed the approach and score definitions set out by the New Zealand Lifelines Council’s report on Infrastructure Resilience in New Zealand (2023).

Table 39: Interdependency matrix.

The degree to which assets listed on the right are dependent on assets listed below	Energy – generation	Energy – transmission and distribution lines	Energy – substations	Road – road (including bridges)	Rail – train track (including bridges)	Rail – station	Health – hospitals	Health – specialist clinics	Housing – housing	Ports – port infrastructure	Education – schools	Correctional facilities	Fire and police stations	Community and community health centres	Health – aged care	Education – TAFE	Museums and arts centres
Energy – generation	-	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
Energy – transmission and distribution lines	3	-	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3

Energy – substations	3	3	-	3	2	3	3	3	3	3	3	3	3	3	3	3	3
Road – road (including bridges)	2	2	2	-	2	2	3	3	3	3	3	3	3	3	3	3	3
Rail – train track (including bridges)	1	1	1	1	-	3	1	1	1	2	1	1	1	1	1	1	1
Rail – station	1	1	1	1	3	-	1	1	1	1	1	1	1	1	1	1	1
Health – hospitals	1	1	1	1	1	1	-	2	1	1	1	1	1	1	2	1	1
Health – specialist clinics	1	1	1	1	1	1	2	-	1	1	1	1	1	1	2	1	1
Housing – housing	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1
Ports – port infrastructure	2	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1
Education – schools	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1
Correctional facilities	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1
Fire and police stations	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1
Community and community health centres	1	1	1	1	1	1	1	1	2	1	1	1	1	-	2	1	1
Health – aged care	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1
Education – TAFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1
Museums and arts centres	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-

Key

3: Required for service to function, 2: Important but can partially function and/or has full backup, 1: Minimal requirement for service to function.

Energy and transport networks have been identified in the interdependency matrix, as well as other sources, as critical to the functioning of nearly all asset classes. EMV (2024) identifies electricity as the most critical enabler for all sectors, driving high scores for energy assets. Roads similarly support all supply chains and emergency services, warranting high scores. IA (2021) also identifies significant interdependency between transport, ports, and freight supply chains, supporting moderate scores for ports and rail. The CSIRO (2025) Sector Interdependencies report confirms foundational interdependencies between energy and telecommunications. This is also supported by the CSIRO (2025) NCRA report which frames telecommunications as a key enabler with a high hazard index, reinforcing high interdependency scores for energy and transport infrastructure. Health assets depend heavily on energy, transport, and other utilities, but have fewer assets depending on them, justifying moderate scores. Schools, community centres, cultural assets, and housing have minimal cascading effects on other sectors and therefore receive low scores.

C.1.7 Environmental impact

EMV (2024) identifies ports as high-environmental-risk assets due to potential for chemical spills, fuel leaks, marine contamination, and hazardous cargo incidents. Similarly, energy generation and substations carry risk of major fires, chemical releases, or pollution, justifying high scores. Hospitals and specialist clinics handle medical waste and chemicals, but at a smaller scale, and therefore have moderate scores. Roads, rail, housing, and community assets generally have limited environmental hazard potential. These are mainly relating to debris rather than irreversible contamination; therefore, receive low scores. Committee for Sydney’s (2024) analysis also highlights the difference between assets with reversible versus irreversible environmental impacts, supporting this differentiation.

C.1.8 Economic impact

Economic analyses, including IA (2021), CSIRO (2025) and the Committee for Sydney (2024), identify energy, transport networks, and ports as central economic enablers. Their disruption directly halts supply chains, workforce mobility, and industrial activity; therefore, these assets receive high scores. Hospitals,

education facilities, emergency services, and specialist clinics play important enabling roles for productivity and workforce participation, warranting moderate scores. However, housing, aged care, community centres, and cultural assets generate social rather than economic value and are not directly linked to large-scale productivity, receiving low scores.

C.1.9 Replacement value

Based on the insurance data provided by VMIA for asset types included in the project scope, Arup compiled insured values for asset types other than energy and maritime infrastructure. Arup made estimates of asset value for energy and major ports infrastructure. Note that the data considers insured value rather than replacement value and not all assets will be insured for full replacement and insurance may not cover all costs following a disaster. This value is used as a proxy in the criticality assessment to provide an indication of the relative replacement values across sectors. This data is shown in the Figure 48 below.

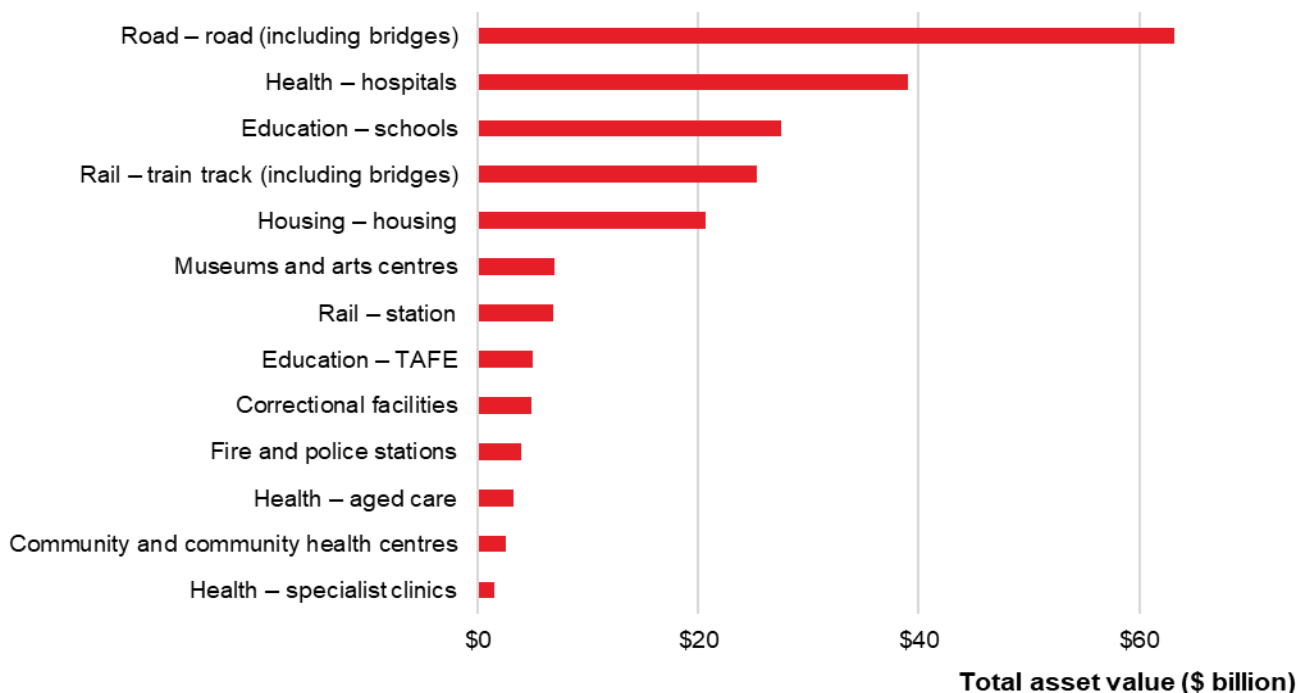


Figure 48: Total asset value from VMIA insurance data.

The replacement value was considered in combination with the number of assets within each sector to assign scores with the following rationale:

- High scores assigned to asset types with a high asset value– energy generation, ports, museums and arts centres, correctional facilities and hospitals.
- Moderate scores assigned to asset types with a moderate asset value– schools, stations, specialist clinics, aged care and TAFEs.
- Moderate scores assigned to asset types with a lower individual asset value but high value as a network – roads, train track, substations, and transmission and distribution lines.
- Low scores assigned to asset types with low asset values– housing, fire and police stations, community and community health centres.

IA (2021) and CSIRO (2025) note that health, energy, and major transport infrastructure require large capital investment, specialised construction, and long lead times, further supporting these scores.

Appendix D

Asset value data sources

D.1 Asset value data sources

VMIA provided insured asset values for the following sectors:

- Road
- Rail
- Health
- Education and training
- Cultural and community
- Justice and community safety
- Housing
- Parks.

For the energy and port sectors, Arup made assumptions about asset value based on publicly available information. These values and any relevant assumptions are set out in Table 40 below.

Table 40: Asset value assumptions.

Asset	Value	Method and assumptions	Reference
Port of Melbourne	\$3.5 billion	Based on initial capital asset value used to set tariffs, 2016 value.	(Victoria Government Gazette, 2016)
Port of Geelong	\$1.2 billion	Based on purchase price in 2023 transaction.	(Bovenizer, 2023)
Port of Hastings	\$8.4 million	Based on reported value of “Infrastructure at fair value” in FY25 annual report. Note that this decreased from \$138 million the previous year, due to a re-valuation.	(Port of Hastings Corporation, 2025)
Port of Portland	\$840 million	No public information available to base a value assumption. Scaled from the value of Port of Geelong based on the quantity of tonnes imported by each port.	Scaled from Port of Geelong based on tonnes imported (factor of 0.7)
Transmission line	\$595,000 per km	Calculated based on line length and RAB value. Substations not assigned a value separately.	(Australian Energy Regulator, 2025)
Distribution line	\$120,500 per km	Calculated based on line length and RAB value.	(Australian Energy Regulator, 2025)
Electricity generation	Wind - \$3,248 per kW Solar - \$1,621 per kW Gas open cycle - \$2,886 per kW Gas reciprocating - \$2,022 per kW Brown coal - \$10,725 per kW	Based on the capital cost to construct new assets of each fuel type. No values available for biomass or hydroelectricity.	(CSIRO, 2025)