INFRASTRUCTURE VICTORIA

May 2026

Warning signs

Climate change risks to Victoria's infrastructure

About us

Infrastructure Victoria is an independent advisory body with 3 functions:

- preparing a 30-year infrastructure strategy for Victoria, which we review and update every 3 to 5 years
- advising the government on specific infrastructure matters
- publishing research on infrastructure-related issues.

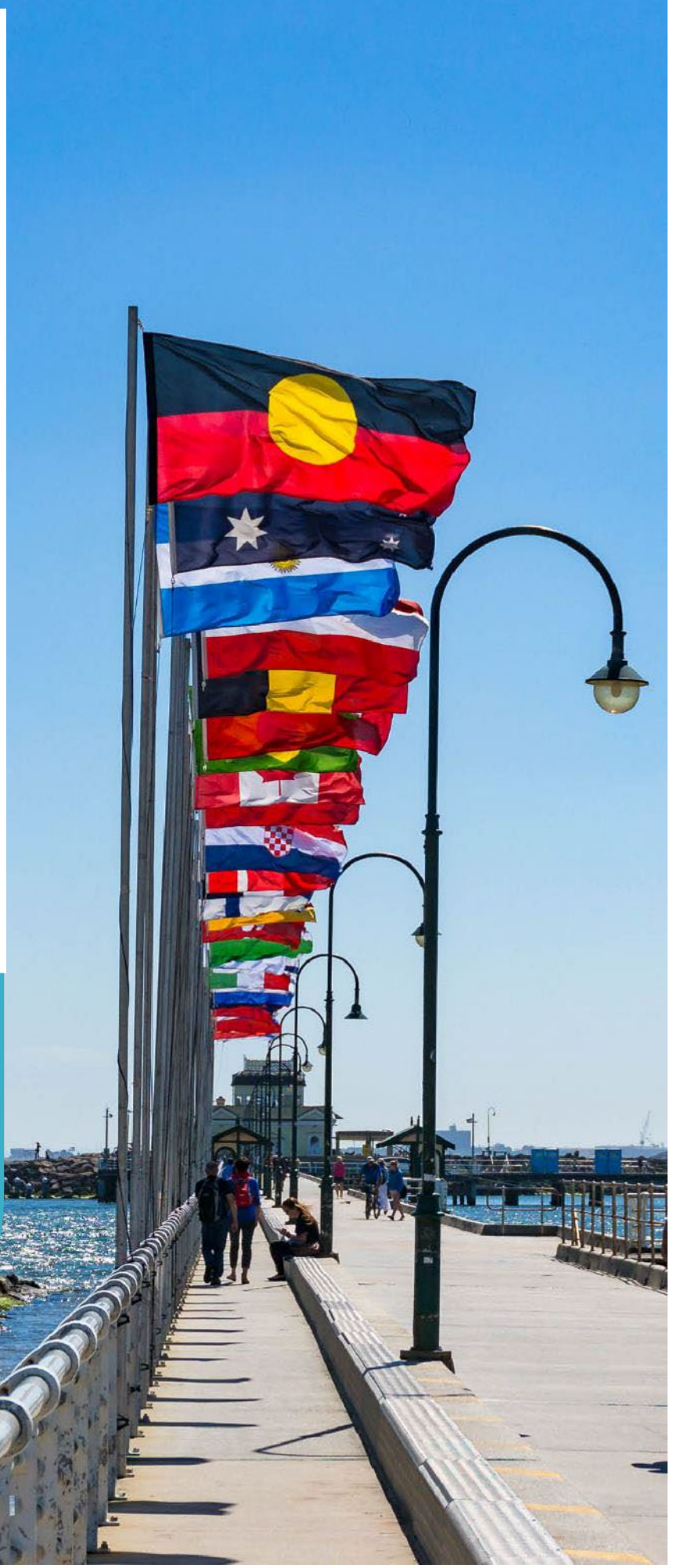
Infrastructure Victoria also helps government departments and agencies develop sectoral infrastructure plans.

Infrastructure Victoria aims to take a long-term, evidence-based view of infrastructure planning, and we inform community discussion about infrastructure provision.

Infrastructure Victoria does not directly oversee or fund infrastructure projects.

Acknowledgement

Infrastructure Victoria acknowledges the Traditional Owners of Country in Victoria and pays respect to their Elders past and present, as well as Elders of other First Peoples' communities. We recognise that Victoria's infrastructure is built on land that has been managed by Aboriginal people for millennia.



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Summary

Climate change in Victoria means extreme weather events will become more frequent, more severe and less predictable.[1] Climate hazards can damage or destroy infrastructure, or render it inoperable or unusable during extreme events.

We estimate that over $57 billion of existing Victorian Government owned or regulated infrastructure will be at risk of damage or destruction from extreme weather events by 2030. By 2070, this will increase to more than $71 billion.[2] Our analysis of the infrastructure types and locations most at risk from climate hazards shows that:

- much road infrastructure is at risk from floods, bushfires and extreme heat, with a large value of road assets at risk located in Melbourne, central Victoria, and along major roads towards Wodonga and Traralgon
- rail infrastructure is at risk from extreme heat, floods and bushfires, with a large value of assets at risk located around Melbourne, Geelong and along regional rail corridors in northern Victoria
- energy assets are at risk from bushfires, floods and extreme heat, with a large value of energy assets at risk in northern Victoria near Ouyen and Mildura, from Melbourne extending east to the Latrobe Valley, and in Portland
- health assets across Victoria are at risk from floods, bushfires and extreme heat, with a large value at risk in Bendigo, Swan Hill, Mildura and south-east of Melbourne.

Figure 1: Areas and infrastructure categories with a large value of infrastructure at risk to climate change hazards

Value of infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). Note: 'At risk' infrastructure means infrastructure assessed at level 3 or more on a 4-point risk scale. Areas with a large value at risk represent a 25 square kilometre grid with $100 million or more of infrastructure at risk to one or more of the 7 climate hazards in our analysis. Assets might be at risk to more than one climate hazard. Source: Infrastructure Victoria.

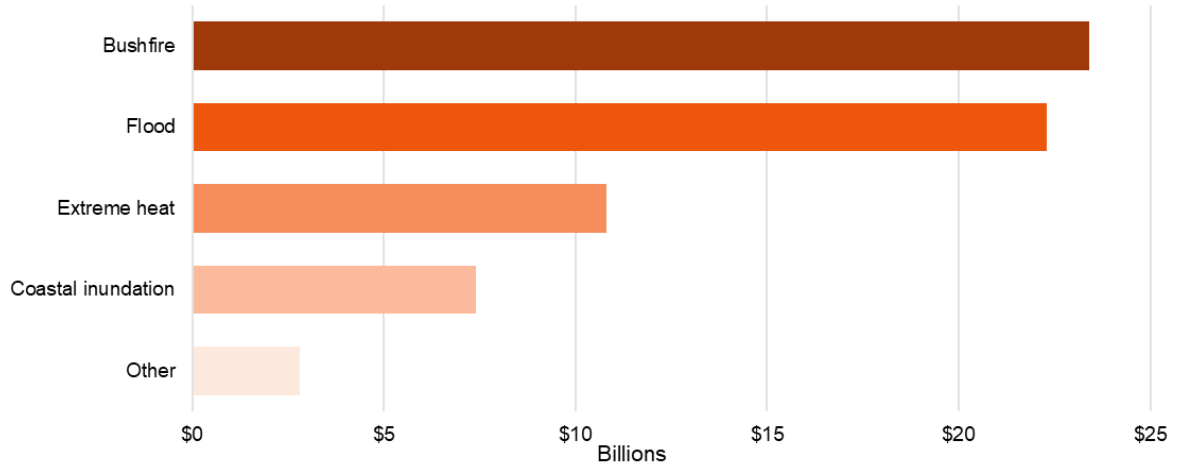
In our previous research, *Weathering the storm: adapting Victoria's infrastructure to climate change,* we found Victoria's infrastructure was not built for more frequent and severe weather events.[3] There are costs and consequences for governments and communities when infrastructure is damaged. In that report, we found adapting infrastructure has many benefits. It can be an effective way to reduce the risk of infrastructure damage and the cost of recovery.[4]

This research report assesses the harm climate change can cause to Victorian Government owned or regulated infrastructure, now and in the future. It is the largest analysis of climate change risks to Victoria's infrastructure we are aware of. We analysed data on $318 billion of infrastructure assets

in 10 infrastructure categories. We examined risks from 7 climate change hazards: bushfires, drought, floods, landslides, damaging wind, coastal inundation and extreme heat.

Bushfires pose a risk to the most infrastructure by value, with more than $23 billion worth of infrastructure at risk from bushfire by 2030. Over $22 billion of infrastructure is also at risk from flood, and nearly $11 billion is at risk from extreme heat.[5]

Figure 2: Risk to Victoria's infrastructure in 2030 varies by hazard

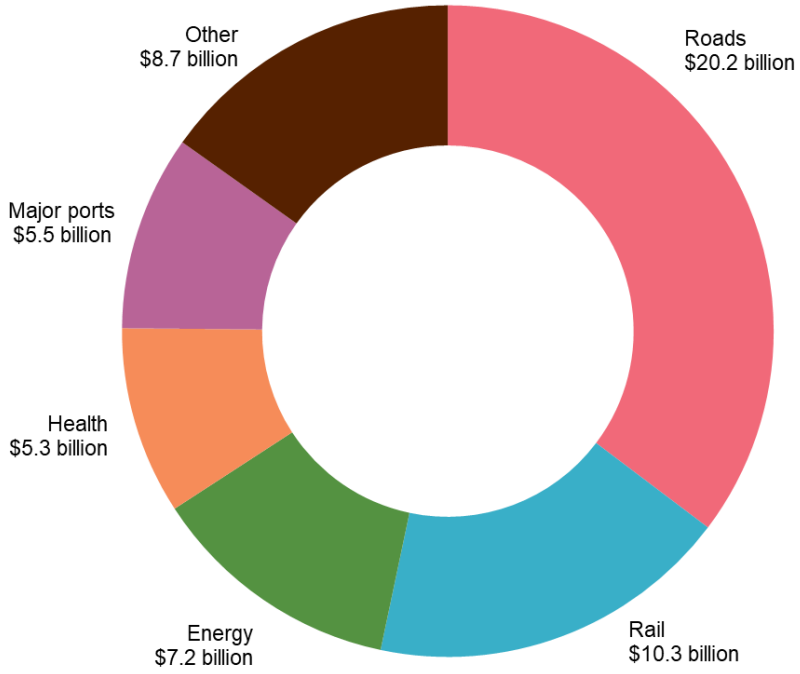


Value of infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). An asset might be at risk from more than one hazard, and 'at risk' infrastructure means infrastructure assessed at level 3 or more on a 4-point risk scale. 'Other' includes damaging winds, landslides and drought. Source: Arup, *Victoria's climate risks to infrastructure*, report to Infrastructure Victoria, 2026.

We used the best climate hazard data available to us at the time of this research. Our analysis shows that many hazards will become more widespread and more severe by 2070. Future climate projections were not available for all hazards. In 2070, $30 billion of existing infrastructure is at risk from bushfires, and $26 billion becomes at risk from extreme heat. Some infrastructure may be at risk to more than one hazard.[6]

Our assessment finds Victoria's road infrastructure is most at risk to climate change by value. Roads valued at $20.2 billion are at risk to climate hazards in 2030. This accounts for over a third of all infrastructure at risk. Next is rail, which has infrastructure valued at $10.3 billion at risk to climate hazards in 2030. Other large infrastructure categories include energy and health, which respectively have $7.2 billion and $5.3 billion of infrastructure at risk to climate hazards in 2030.[7]

Figure 3: Value of infrastructure at risk to climate hazards in 2030



Value of infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). Note: 'At risk' infrastructure means infrastructure assessed at level 3 or more on a 4-point risk scale. 'Other' includes justice and community safety, cultural and community, parks, housing, and education and training infrastructure. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

This analysis uses the insured or estimated value of Victorian Government owned or regulated infrastructure to estimate the value of infrastructure at risk from climate change hazards. Our analysis does not reflect all costs associated with climate hazards.

Climate change hazards can have other devastating consequences for people, communities and the environment, such as destroying homes, properties and businesses, or causing entire ecosystems to collapse.[8] These are important but beyond the scope of this research, which analyses the types and locations of Victorian Government owned or regulated infrastructure most affected by climate hazards.

This research does not consider other types of infrastructure that might be at risk from climate hazards, such as local government infrastructure. But other organisations can use the established method we used in this analysis to identify climate change risks to different types of infrastructure.

The Victorian Government can use the findings and the analysis in this report to prioritise when and where it adapts infrastructure. Early adaptation can reduce the costs of future damage.[9] When assessing adaptation options, infrastructure managers can assess a range of measures. Infrastructure owners will need to undertake deeper analysis to determine the best options, such as detailed vulnerability assessments that incorporate the age and condition of specific assets. We previously developed a methodology that can help infrastructure managers assess whether different adaptation measures are cost-effective.[10]

The *Climate Action Act 2017* requires the Victorian Government to complete revised adaptation action plans in 2026.[11] Adaptation action plans guide the government's response to the risks and opportunities of climate change and set out adaptation actions.[12] They present a once in a 5-year opportunity for government to prioritise and fund infrastructure adaptation. This report advises infrastructure managers about the climate change risks to Victoria's infrastructure and can inform

their further work to prioritise infrastructure adaptation, including in the forthcoming adaptation action plans.

Other governments have committed significant funds to adapting public infrastructure. For instance, New Zealand is investing $353 million in early preventative works to protect its transport network.[13] Canada has a Disaster Mitigation and Adaptation Fund that has committed $2.5 billion for both built and natural infrastructure projects.[14] In *Victoria's infrastructure strategy 2025–2055*, we recommended the Victorian Government fund high-priority, cost-effective infrastructure adaptation actions when climate adaptation action plans are updated in 2026.[15] Better prioritising adaptation action can help governments target spending and reduce long term costs. This report assists the Victorian Government to implement this recommendation. It provides guidance on where to focus adaptation action and funding by identifying the infrastructure types and locations most at risk from climate hazards.

Our research approach

The Victorian Government can adapt Victoria's infrastructure to better withstand more frequent and extreme weather events. We did this research to help find out which infrastructure owned or regulated by the Victorian Government is most at risk from climate change. This can help the Victorian Government prioritise when, where and at what cost it should adapt infrastructure in the short and longer term. The Victorian Government and its agencies can use our findings to inform decisions to adapt Victoria's infrastructure, including in its forthcoming climate adaptation action plans.

This research used an established methodology to estimate the value of Victorian Government owned or regulated infrastructure at risk from climate hazards. Other organisations, such as local governments, can also use this methodology to identify climate change risks to different types of infrastructure or infrastructure in other locations.

This report builds on our earlier report: *Weathering the storm: adapting Victoria's infrastructure to climate change*.[16] Compared to that earlier report, this research analyses more hazards and more risks to Victoria's infrastructure. It provides a more detailed exposure and vulnerability analysis of climate change risks to infrastructure. And it shows which types of infrastructure are most affected, the size of these impacts and their location.

We analysed data on the location and value of Victoria's infrastructure

Infrastructure Victoria commissioned Arup to assist with our climate risk assessment. Arup's technical report outlines the research methodology and findings in more detail.[17] To conduct our analysis, we used data on the location and value of Victoria's infrastructure, and climate data and projections.

We analysed infrastructure data on $318 billion of transport, energy, ports, health, education and training, housing, cultural and community, parks, and justice and community safety infrastructure. Table 1 shows the infrastructure categories and asset types we included in our analysis. We received asset data on the location and insured value of infrastructure from the Victorian Managed Insurance Authority. The authority also provided information on past paid insurance claims from extreme weather events. We supplemented this data with data from the Digital Atlas of Australia and VicMap for some sectors not insured by the authority, such as energy and major ports.[18]

We used the insured or estimated value of infrastructure to identify the value of Victorian Government owned or regulated infrastructure at risk from climate change hazards. Insured or estimated value might be different from the actual costs incurred to replace an asset or repair damage from a climate hazard event. For instance, it may cost more than the insured value to help communities recover and clean up after damage to infrastructure.

Our analysis only considered existing infrastructure currently operating. It does not consider future decisions about new or existing infrastructure, such as current assets that might not be operational in 2030 or 2070.

The research includes state-owned and some regulated infrastructure, such as energy. Our analysis does not include private toll roads, telecommunications infrastructure, data centres, local government-owned assets or aviation assets. We also excluded water infrastructure from our analysis because asset data was not readily available.[19]

Table 1: Infrastructure categories within scope of analysis

Infrastructure category	Value	Asset types
Energy	Estimated value: $81.2 billion	Large scale generation; substations; transmission and distribution lines
Road	Insured value: $64.3 billion	Roads and bridges
Health	Insured value: $46.6 billion	Hospitals; specialist clinics; aged care; rehabilitation centres; community health centres; cemeteries
Rail	Insured value: $40.7 billion	Rail tracks and bridges; stations; maintenance facilities and depots; tram tracks and stops
Education and training	Insured value: $33.1 billion	Schools; TAFEs; early childhood facilities; training centres
Housing	Insured value: $20.7 billion	State-owned social housing; hostels; day centres and residences
Cultural and community	Insured value: $11.9 billion	Museums and arts centres; community centres; sports facilities
Justice and community safety	Insured value: $11.7 billion	Correctional facilities; police, fire and ambulance stations; courts
Major ports	Estimated value: $5.5 billion	Major ports
Parks	Insured value: $2.5 billion	Access; building and services; cultural heritage assets; infrastructure services; landscaped assets; maritime and waterways; visitor facilities

Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

We examined climate change hazards that can damage or prevent infrastructure functioning

We used climate data to analyse how bushfires, drought, floods, landslides, damaging wind, coastal inundation and extreme heat affect Victoria, now and in the future. We used climate hazard data from several sources, including the Bureau of Meteorology, the NSW and Australian Regional Climate Modelling project (NARCliM 2.0) and VicPlan.[20] Appendix 1 details the data we used for each climate hazard.

We selected projections that show how these climate hazards will change in 2030 and 2070 under different climate scenarios. We used projections with plausible climate impacts at lower and higher levels (see box on shared socio-economic pathways). In this report, we use a 2030 lower emission scenario and a 2070 higher emission scenario to present our findings.

Shared socio-economic pathways

We used shared socio-economic pathways (SSPs) to provide a low and high climate projection. Shared socio-economic pathways are narratives and quantitative scenarios that describe how global society, demographics, and economics might evolve over the 21st century. They help model future emissions, the ability and capacity to adapt, and vulnerability based on socio-economic conditions. Socio-economic pathways are used internationally for climate analysis, including by the Intergovernmental Panel on Climate Change.[21]

We used SSP1-2.6 and SSP3-7.0 scenarios for the years 2030 and 2070. In an SSP1-2.6 scenario there is a rapid move towards sustainability. Global temperature increases may stabilise at 1.8°C by 2100.[22] In contrast, the SSP3-7.0 scenario expects higher emissions and temperature increases reaching about 3.6°C by 2100.[23]

These scenarios show a possible range of lower and higher climate futures and align with *Victoria's climate science report 2024*.[24] The 2030 and 2070 timeframes align with what we used in the *Weathering the storm*, which documented how current infrastructure can be adapted to future climate conditions.

We did not have data on future projections for floods, landslides or damaging winds. Future flood data is currently being developed by the Bureau of Meteorology and Melbourne Water but was not available for this project. Future landslide projections were not developed because the susceptibility model relies on historical rainfall data, and assessing how changing rainfall patterns may alter landslide risk was outside the scope of this project. Damaging wind projections are not available because future climate data only provides daily average wind speeds, which do not capture the short-duration extreme gusts that cause infrastructure damage, and there is high uncertainty about how these extremes may change over time.[25] In our analysis, we used the same historical data for these 3 hazards in both our 2030 and 2070 scenarios. This may underestimate the future effect of these hazards on Victoria's infrastructure.

Exposure

The Intergovernmental Panel on Climate Change defines exposure as 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.[26]

We overlaid the climate hazard data with spatial data on Victorian infrastructure to identify the location of assets most exposed to each climate hazard. We then assigned exposure ratings for each asset to each climate hazard in each of the climate scenarios in 2030 and 2070. We used exposure ratings from 1 to 5, with a higher rating indicating a higher exposure to the hazard.

You can find more detail on the methodology, including shared socio-economic pathways and how we used them for this research, in Arup's technical report.[27]

We assessed the vulnerability of Victoria's infrastructure

Vulnerability

Vulnerability is how sensitive infrastructure is to climate hazards, including how easily damaged or compromised the infrastructure is when exposed.[28]

The Intergovernmental Panel on Climate Change say vulnerability 'encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.'[29]

We defined a vulnerability rating criteria based on the extent of physical damage and downtime (see Table 2: Vulnerability rating criteria). Downtime means how long the infrastructure is not operating at full capacity because of the impact of climate events.

Table 2: 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.

Source: Arup, *Victoria's climate risks to infrastructure*, report to Infrastructure Victoria, 2026.

We then developed vulnerability statements for each infrastructure category and climate hazard pairing. These outline the damage and disruption each climate hazard could cause to each infrastructure category. They are available in Arup's technical report.[30] The vulnerability statements considered average infrastructure condition, design standards, insights from previous climate hazard events and ability to adapt.

We rated which infrastructure categories are most sensitive to damage (see Appendix 2) and downtime (see Appendix 3) from climate hazards using the vulnerability criteria in Table 2.

We identified climate change risks to Victoria's infrastructure

To identify climate change risks to Victoria's infrastructure we considered how exposed infrastructure is to climate hazards as well as the likely damage and downtime from a climate hazard event. We used a method to calculate climate risk that is consistent with the Intergovernmental Panel on Climate Change's sixth assessment report and the Australian Government's national climate risk assessment.[31] These explain climate change risks as the combined effect of climate hazards, what is exposed, and how well it can cope. To identify risks to Victoria's infrastructure, we integrated results from the exposure and vulnerability assessments using a risk equation:[32]

> Risk = climate hazard × exposure × vulnerability

We analysed the value of infrastructure at risk for each of the 10 infrastructure categories in our analysis. To do this, we assigned each asset a risk rating based on its exposure and vulnerability. We used a 4-point risk scale and considered infrastructure as 'at risk' when it is at level 3 or more on this scale. We then aggregated the value of assets at risk using the assets insured or estimated value. We did this for each infrastructure category and climate hazard in our analysis. This enabled us to examine climate risks to Victoria's infrastructure by infrastructure category, by hazard and by location.

Victoria is increasingly exposed to climate change hazards

Victoria's climate is changing

Greenhouse gas emissions have caused global temperatures to rise above their long-term average.[33] Globally, 2024 was the hottest year on record.[34] Each of the past 11 years rank among the hottest on record.[35] This rise in global temperatures is affecting climate and weather patterns all over the world.[36] It means the world will experience more extreme weather events, more often.[37]

The Intergovernmental Panel on Climate Change says immediate action is needed to keep global temperature increases below 1.5°C.[38] If the world successfully reduces greenhouse gas emissions and limits global warming below 1.5°C, some of the most serious effects of climate change can be avoided.[39] But the United Nations Environment Programme found global temperature increases are likely to exceed 1.5°C in the next decade.[40] They estimate global temperatures will increase by between 2.3°C and 2.5°C this century.[41]

The Australian Climate Service says that no part of Australia will be safe from climate change.[42] The Commonwealth Scientific and Industrial Research Organisation (CSIRO) expects temperatures to keep rising across Australia over the coming decades.[43] The Victorian Government's *Climate science report 2024* found that Victoria's average temperature could rise by 1.5°C by 2050 and 3.1°C by 2090 in a high emissions scenario.[44]

Climate change already affects Victoria. Victoria's average yearly temperature has risen by 1.2°C since 1910.[45] Heatwaves are now more intense, more frequent and last longer.[46] Bushfires burn more often, for longer and in more places.[47] Victoria now gets less rain overall every year, but heavy rain events happen more often and are more intense.[48] Changes to rainfall will also affect flood patterns as large floods are likely to get larger.[49] Victoria has had multiple damaging floods since 2022.[50]

Victoria is exposed to many increasing climate change hazards

Australia's weather can vary significantly from one year to the next.[51] It has long been known for this variability. In the early 1900s, Dorethea Mackellar famously described Australia as a land 'of droughts and flooding rains'.[52] But higher global temperatures are influencing the climate drivers that generate much of Australia's climate variability.[53] This will affect Australia's temperatures, rainfall and sea levels.[54] Some changes, such as sea level rise, will continue to occur over decades or even centuries.[55]

Extreme weather events, such as bushfires, floods and drought, have always occurred in Victoria. But as Victoria's climate changes, so will the climate change hazards Victoria faces. Extreme weather events will become more frequent, more severe and less predictable.[56]

Different climate change hazards affect Victoria's regions differently. For example, north-west Victoria is more exposed to extreme heat, bushfires and drought. Coastal areas are exposed to coastal inundation and alpine areas are more exposed to damaging winds and landslides. In the projections we use in this analysis, Victoria's exposure to climate hazards increases from 2030 to 2070.

Climate change hazards

There are many climate hazards.[57] Some do not occur often or at all in Victoria, such as tropical cyclones. In our analysis we considered the climate hazards that are most likely to affect Victoria's infrastructure. We looked at how these climate hazards will change under different climate scenarios. The climate hazards we used in our analysis are:

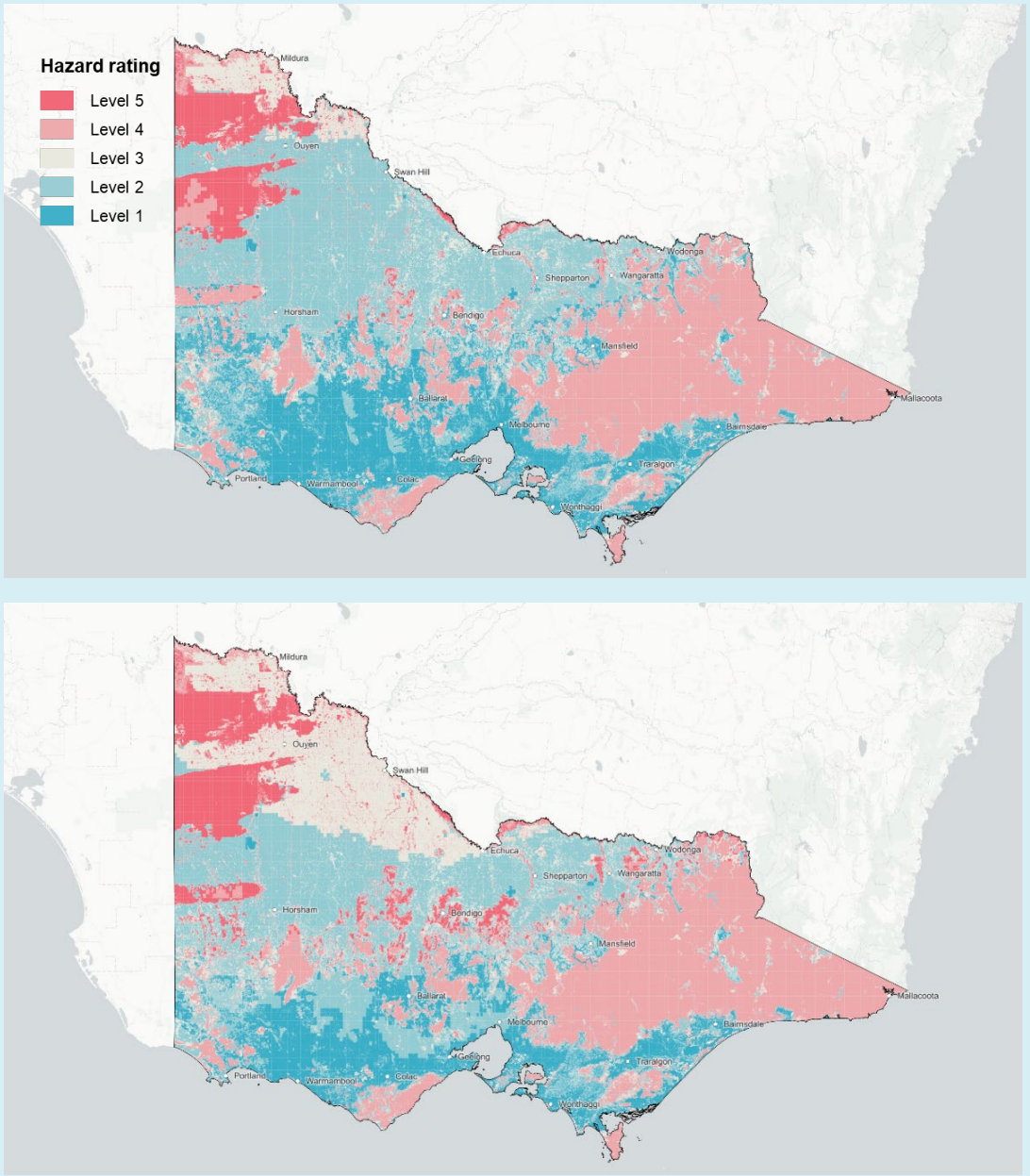
- bushfires
- drought
- coastal inundation
- damaging winds
- extreme heat
- flooding
- landslides.

Bushfires

Bushfires can impact infrastructure in many ways. They can destroy facilities and equipment. Bushfire heat can melt road surfaces. Smoke and ash can reduce solar power operations and reduce air quality inside buildings.[58]

Our analysis found parts of north-west Victoria have a very high exposure to bushfires in 2030. Areas of exposure extend further south by 2070 (see Figure 4). Parts of central and eastern Victoria and national parks such as Wilsons Promontory are also highly exposed to bushfires, driven by the high bushfire susceptibility and vegetation in these places.[59]

Figure 4: Bushfire hazard exposure in 2030 (top) and 2070 (bottom)



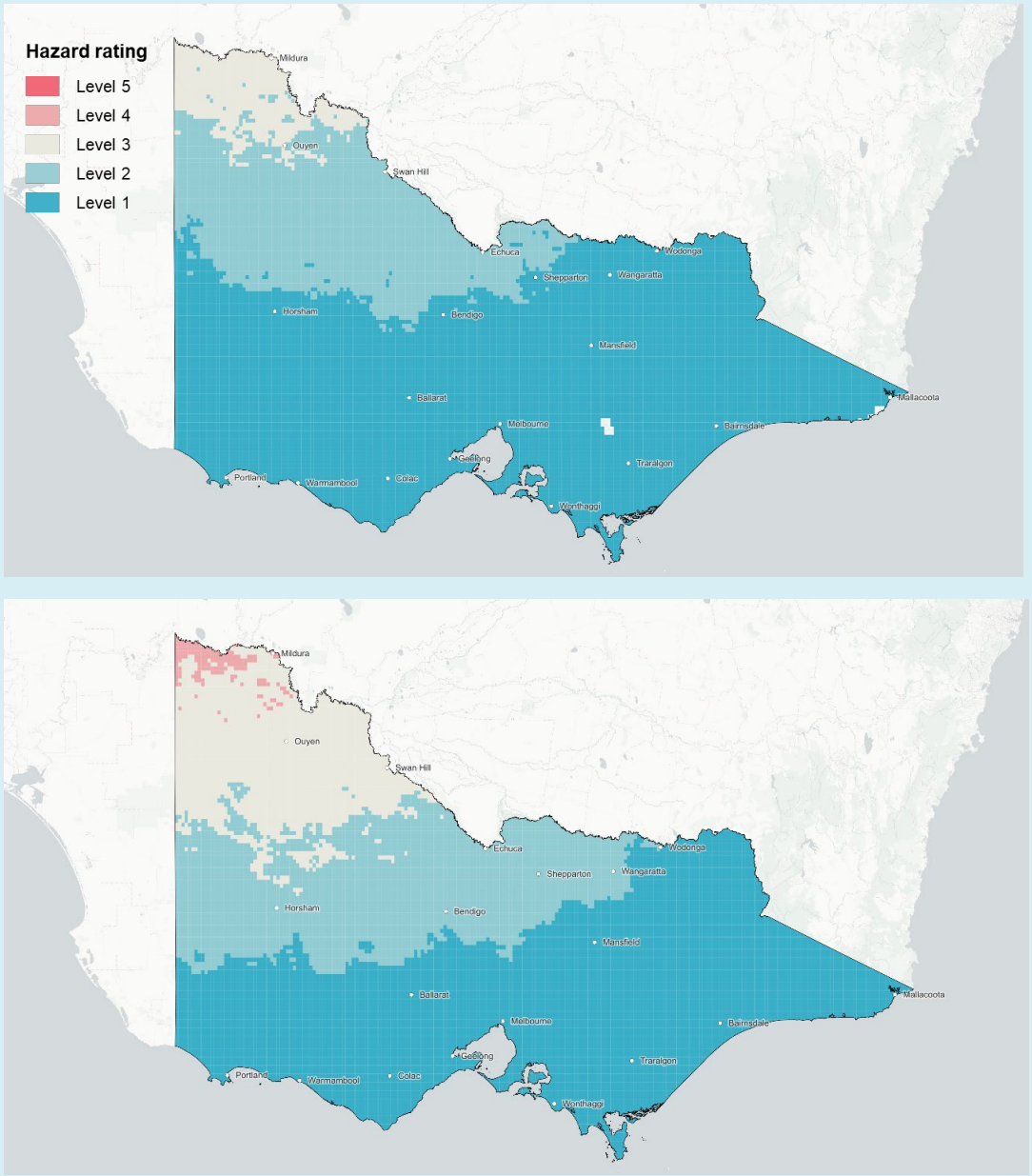
Exposure to bushfire in 2030 (top) in a low emissions scenario (SSP1-2.6) and 2070 (bottom) in a high emissions scenario (SSP3-7.0). A higher hazard rating indicates greater exposure to the hazard. Source: Arup, Victoria's climate risks to infrastructure, report to Infrastructure Victoria, 2026.

Drought

On average, the proportion of Victoria in drought has increased since 1900.[60] Future droughts are likely to affect communities for longer.[61] We found that parts of north-west Victoria are more exposed to drought than the rest of the state (see Figure 5). Areas affected by drought extend further south by 2070.[62]

Drought can affect infrastructure through soil shrinkage and ground movement. This can crack road pavements, damage rail track foundations and crack building foundations.[63]

Figure 5: Drought hazard exposure in 2030 (top) and 2070 (bottom)



Exposure to drought in 2030 (top) in a low emissions scenario (SSP1-2.6) and 2070 (bottom) in a high emissions scenario (SSP3-7.0). A higher hazard rating indicates greater exposure to the hazard. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

Coastal inundation

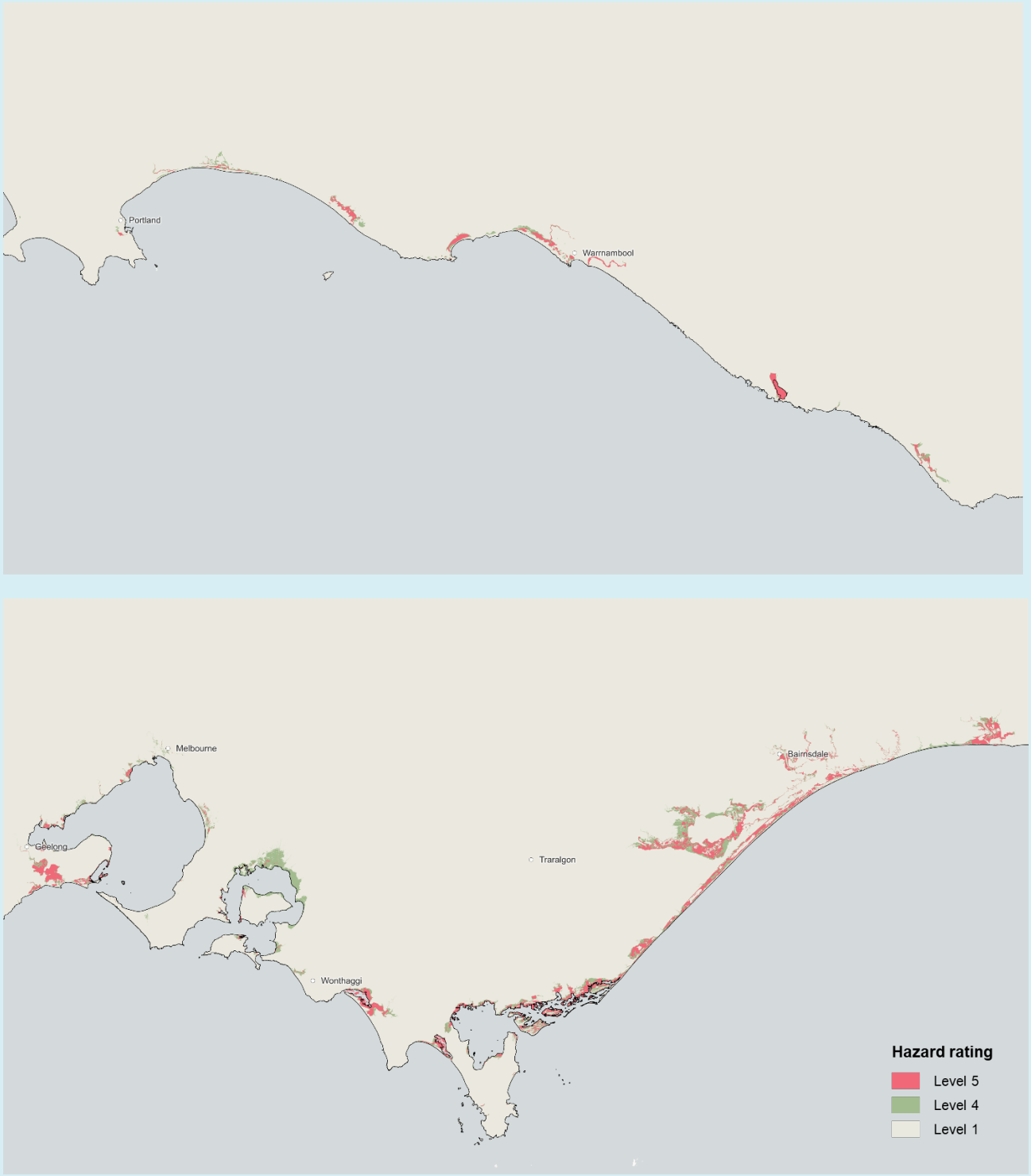
The average global sea level has risen by over 22 centimetres since 1900.[64] Sea levels will continue to rise over the next 100 years.[65] This is projected to occur in all emissions scenarios.[66] This will expose towns and cities along Victoria's coasts to coastal inundation.

We found parts of Melbourne, Geelong, Gippsland, south-west Victoria and the Bellarine Peninsula are exposed to coastal inundation in 2030 (see Figure 6). Figure 7 shows exposure to coastal inundation extends further inland under future climate scenarios, driven by sea level rise and storm surges.[67]

Figure 6: Coastal inundation hazard exposure in 2030

Exposure to coastal inundation in a scenario with 20cm of sea level rise in 2030. A higher hazard rating indicates greater exposure to the hazard. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

Figure 7: Coastal inundation hazard exposure in 2070



Exposure to coastal inundation in a scenario with 47cm of sea level rise in 2070. A higher hazard rating indicates greater exposure to the hazard. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

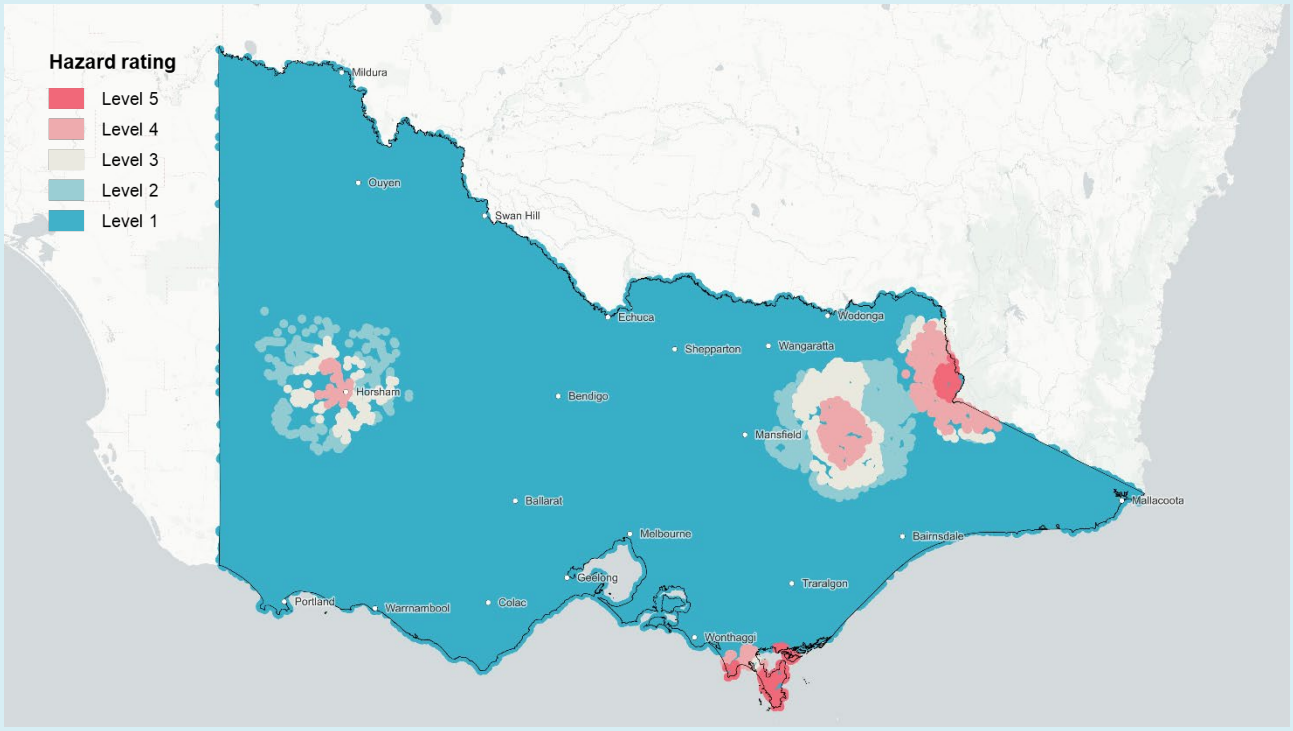
Damaging winds

Wilsons Promontory, areas near Horsham and alpine areas are more exposed to damaging winds than the rest of Victoria (see Figure 8).[68]

We defined damaging winds as the number of days with winds above 125 kilometres per hour. The Bureau of Meteorology issues warnings for destructive winds when wind gusts reach or exceed this speed.[69] We did not have data on how exposure to damaging winds will change in future climate scenarios.[70]

Damaging winds can have direct and indirect effects on infrastructure. Direct impacts can include wind farms shutting down, roofs coming off buildings and electricity transmission towers being knocked down.[71] Indirect impacts can include debris blowing onto structures like electricity lines or overhead rail lines.[72]

Figure 8: Damaging winds hazard exposure



Exposure to damaging winds under baseline conditions (2006–2023) using weather station wind data. A higher hazard rating indicates greater exposure to the hazard. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

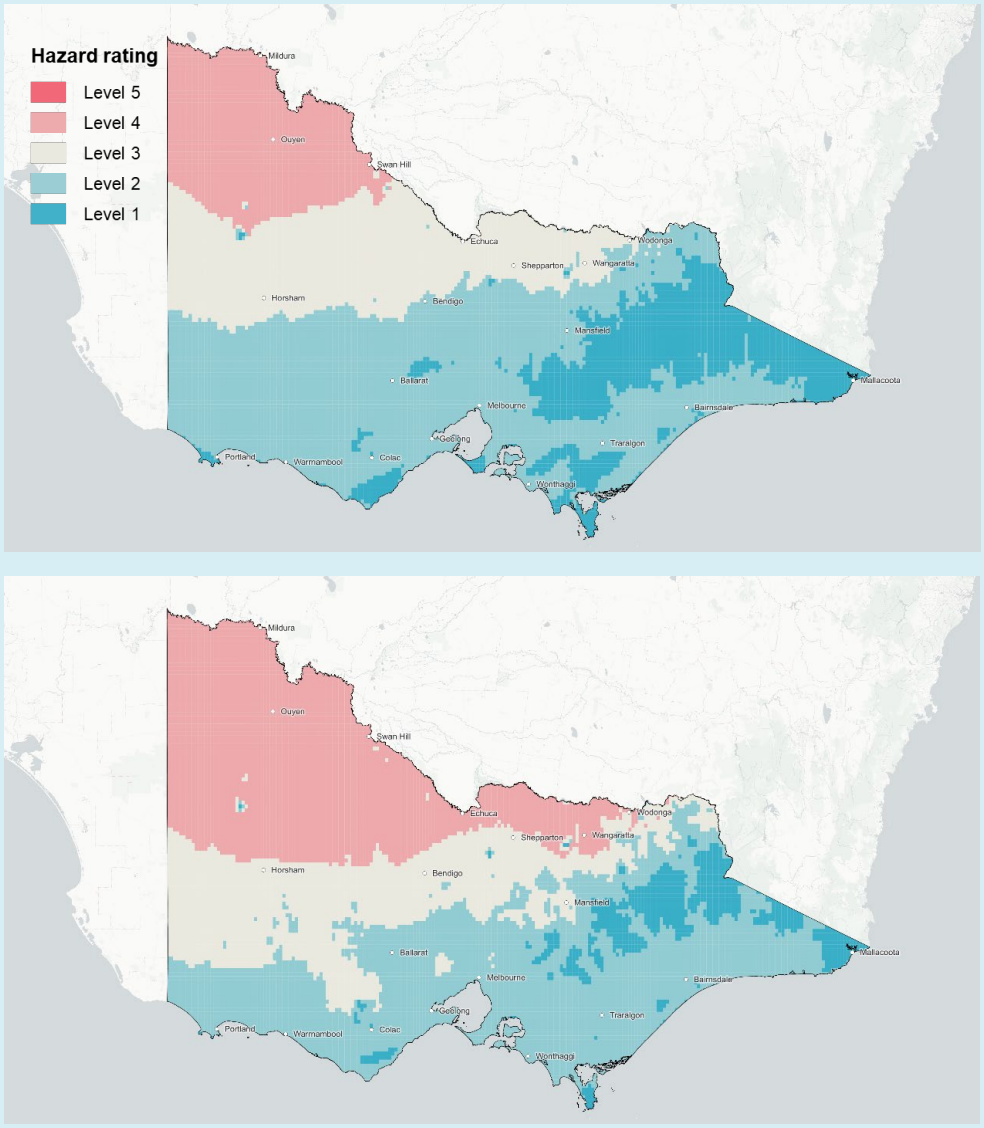
Extreme heat

Higher global temperatures mean Victoria will have more frequent, longer and more severe heatwaves.[73] Our analysis found that exposure to extreme heat is highest in north-west Victoria in both 2030 and 2070. Areas of high and medium exposure extend further south by 2070.[74]

We defined extreme heat as the number of days above 35°C. A high exposure to extreme heat means that between 10% and 20% of days in a year have a maximum temperature above 35°C.[75]

Prolonged extreme heat can damage infrastructure. Some direct effects include causing rail tracks to buckle or roads to soften, rut and crack.[76]

Figure 9: Extreme heat hazard exposure in 2030 (top) and 2070 (bottom)



Exposure to extreme heat in 2030 (top) in a low emissions scenario (SSP1-2.6) and 2070 (bottom) in a high emissions scenario (SSP3-7.0). A higher hazard rating indicates greater exposure to the hazard. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

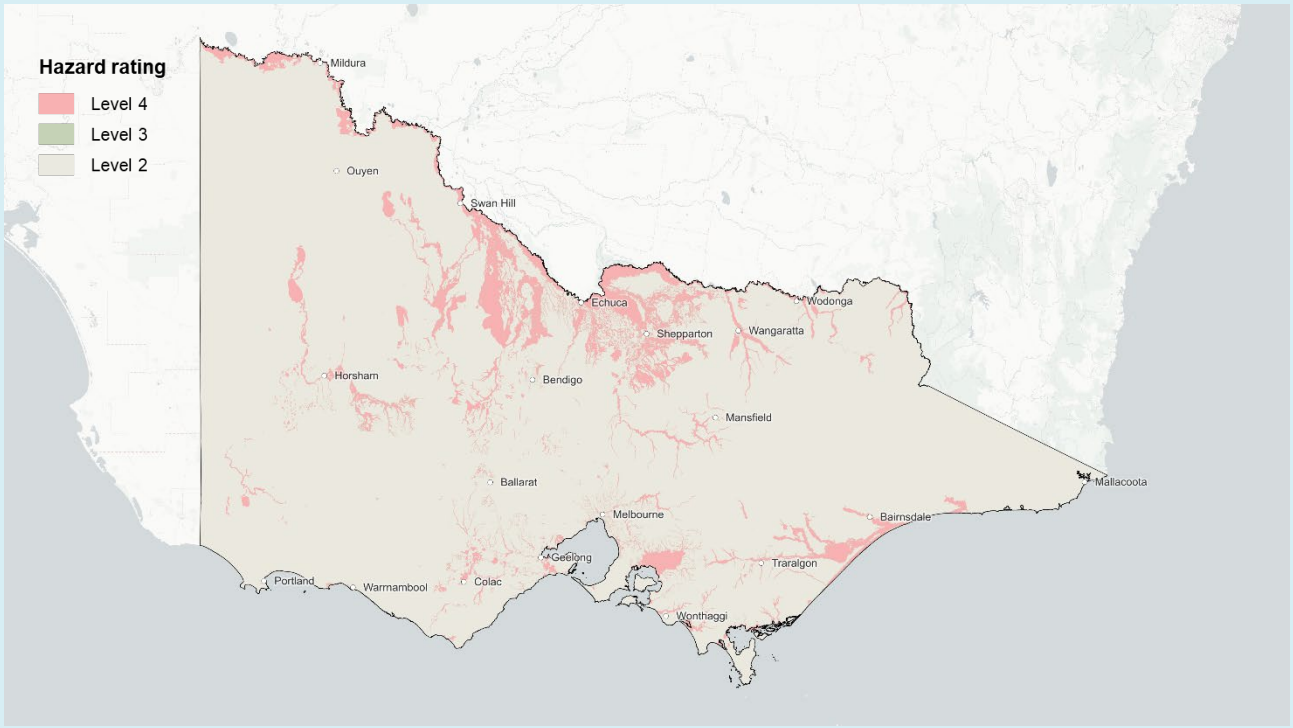
Flooding

Areas surrounding rivers, creeks and catchments are exposed to flooding. Our analysis found that parts of northern Victoria, Gippsland and Western Port already have a high exposure to flooding (see Figure 10).[77]

Our analysis of exposure to flooding was based on flood overlays, which generally reflect a historical one in 100-year flood event. We did not have data on how exposure to flooding will change in future climate scenarios.[78] The Victorian Government's Climate science report 2024 says that flood risks might double by the end of the century.[79]

Floods can cause extensive damage to infrastructure. They can damage culverts and drainage systems, erode rail track foundations and wash away road surfaces.[80] They can damage buildings and compromise the structural integrity of electricity towers. Floods can also cause corrosion in electrical and metal components, damage medical equipment and contaminate sterile areas in health facilities.[81]

Figure 10: Flooding hazard exposure



Exposure to flooding under baseline conditions (historical one in 100-year flood events). A higher hazard rating indicates greater exposure to the hazard. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

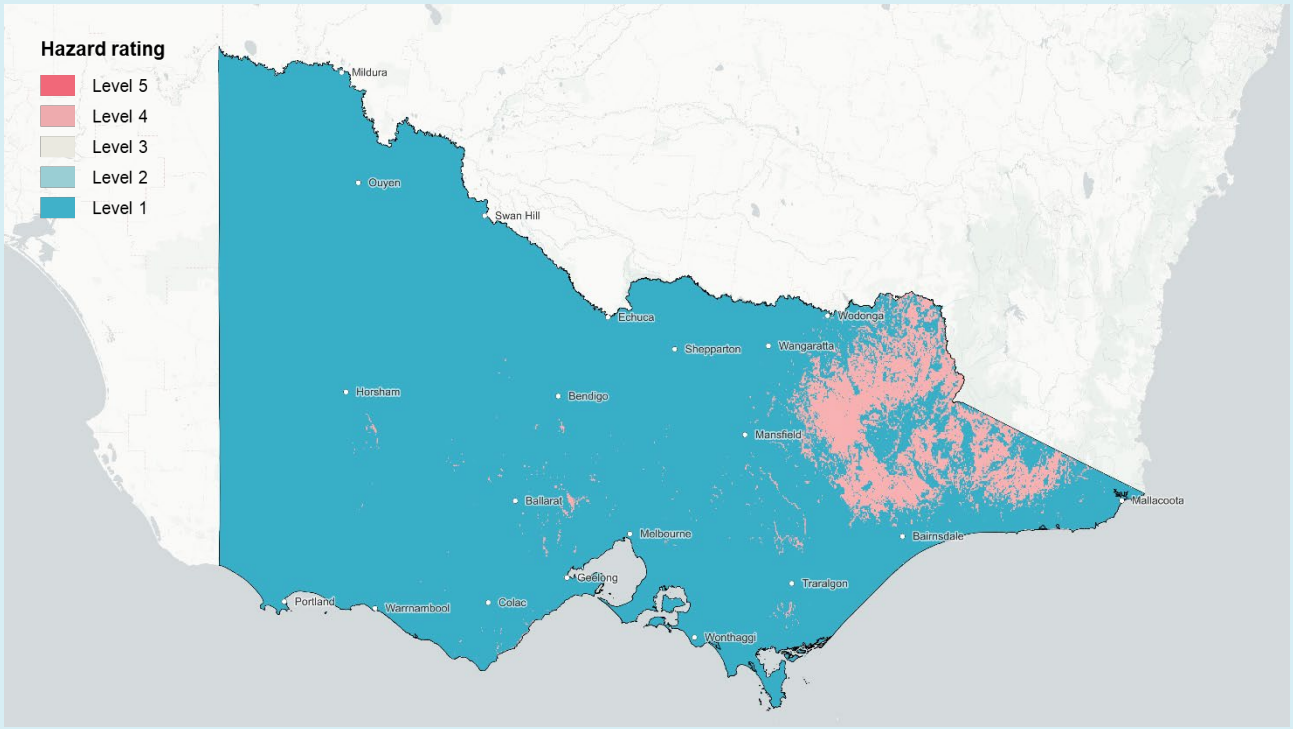
Landslides

Landslides occur in localised areas across Victoria. Our analysis found that Victoria's alpine regions have a high exposure to landslides (see Figure 11).[82]

We used a model of landslide susceptibility that considers rainfall as well as soil and ground conditions. We did not have data on how exposure to landslides will change in future climate scenarios.[83] However, rainfall is expected to change in future climate scenarios.[84] This might affect where landslides occur, their severity and their frequency.[85]

Landslide can directly damage infrastructure such as buildings, retaining walls, pavements and roads. Soil movement can also undermine rail track foundations and drainage systems. Landslides can also affect structures and utility connections such as pipelines, electrical systems and storage areas.[86] They can even cause displacement, tilting or collapse of electricity towers and poles.[87]

Figure 11: Landslide hazard exposure



Exposure to landslides under baseline conditions (using 1980–2018 rainfall data). A higher hazard rating indicates greater exposure to the hazard. Source: Arup, Victoria's climate risks to infrastructure, report to Infrastructure Victoria, 2026.

Climate change hazards have financial, environmental and psychological impacts

Climate change hazards will affect many parts of the economy, society and environment. Natural disasters, including floods and cyclones, cost the Australian economy $2.2 billion between January 2025 and June 2025.[88] The Australian Government spent an average of $1.6 billion each year on disaster recovery from 2012–13 to 2023–24.[89]

Victoria's ecosystems are also vulnerable to climate change. The Australian Climate Service says that climate change could lead to the loss of species and even the collapse of some ecosystems.[90] Heatwaves and bushfires threaten biodiversity in Australia's forests.[91] Droughts and floods threaten species that live in rivers, lakes and creeks.[92]

Climate change hazards already damage infrastructure. This damage causes large economic costs. Governments and communities might need to rebuild, repair or replace multiple assets after an extreme weather event. The Australian Local Government Association estimated it cost $3.8 billion to repair roads damaged during extreme rain and floods in Australia in 2022.[93]

The Victorian Managed Insurance Authority insures $255 billion in Victorian Government assets.[94] Since 1 July 2019, claims paid from climate events totalled nearly $135 million. Flooding represented just over half of these claims, followed by bushfires, then wind and storm events.[95]

Communities, businesses and homes will all be directly affected by climate hazards. The Insurance Council of Australia found that over the past 5 years insurers paid $4.5 billion each year to customers affected by extreme weather events.[96] This is higher than the 30-year average of $2.1 billion each year.[97] The Insurance Council of Australia say more frequent and severe floods are the main reason for this increase. These costs are passed onto consumers through higher insurance premiums.[98] The Productivity Commission estimate that extreme weather could cause up to $744 billion in damage to Australian homes by 2100.[99]

The consequences of climate hazards for communities can be severe and widespread. For example, the 2019–20 Black Summer bushfires damaged major roads and cut off entire towns in Gippsland (see Case study: Infrastructure destruction from 2019–20 bushfires causes long-term consequences for Mallacoota).[100]

Some people also experience long term negative psychological impacts after an extreme weather event.[101] For example, farmers can experience mental health challenges from losing their home, livelihood, livestock and assets.[102] The 2019–20 Black Summer bushfires destroyed 313 homes and caused $40 million in damage to agriculture buildings in eastern Victoria. These fires also caused the loss of 10,000 livestock.[103]

Research found that extreme weather events affect farmers' sense of identity and connection to the land.[104] A farmer recounting their experience of life after a bushfire stated:[105]

> "I mean it sort of broke me. I never used to be emotional at all, but now I'm just pretty much piss weak… But I've lost a bit of connection now. See before I wouldn't have thought about selling, but now, yeah, whatever."

Source: SR van der Kruk & KM Gunn, 'It sort of broke me': A thematic analysis of the psychological experiences and coping strategies employed by Australian fire-affected farmers

The Black Summer bushfires are also estimated to have cost Australia $2.8 billion in lost tourism.[106] Media coverage of the bushfires resulted in fewer international tourists, with an estimated $1.4 billion loss to international tourism in Victoria.[107] This included areas that were not directly affected by bushfires.[108]

In this research, we did not analyse risks to private property, the environment or other services from climate hazards. We also did not analyse how climate hazards will directly affect Victorians' health and wellbeing, such as from being exposed to more frequent heatwaves in poor quality housing. While these are important considerations for many Victorians, they are beyond the scope of this work. Other studies, such as the National Climate Risk Assessment, have explored the broader impacts from climate hazards.[109]

We undertook this analysis to expand on the available evidence on the size, type and location of climate change risks to Victoria's infrastructure. We focus on the damage or disruption climate hazards might cause to Victorian Government owned or regulated infrastructure.

We did not include water infrastructure because asset data was not readily available and because adaptation is already underway in the water sector.[110] For example, a climate risk assessment undertaken by South East Water identified a high risk of extreme rainfall impacting major catchments or treatment assets.[111] South East Water note they aim to complete a climate risk assessment for all critical assets in their climate adaptation action plan.[112] The Victorian Government is also funding climate action and disaster resilience as part of the water cycle adaptation action plan.[113] Local government infrastructure was also not in scope for this analysis. The Eastern Alliance for Greenhouse Action has commissioned analysis of the costs and benefits of adapting local government roads across Melbourne.[114] Many local governments have published their own climate action plans.[115]

Case Study

Infrastructure destruction from 2019–20 bushfires cause long-term consequences for Mallacoota

The bushfires of 2019–20 devastated Mallacoota, causing widespread damage and destruction to homes, businesses and parks. The bushfires destroyed more than 100 homes in Mallacoota. An abalone processing building in the town was also partially destroyed, leaving residents out of work for months.[116]

The bushfires also isolated the town during peak tourist season and leaving long-lasting social, economic, and environmental impacts. The fires struck during the summer holidays, the busiest period of the year, with road closures preventing people from returning after the immediate danger had passed.[117]Roads were closed for weeks, particularly the Princes Highway, Mallacoota's only major access route. This isolated the town during peak tourist season.[118] Hazardous trees and burned-out road surfaces needed clearing, with some routes remaining closed or restricted from December 2019 into February 2020.[119]

Many people found themselves displaced for months, and rebuilding was slowed by shortages of materials, accommodation and trades. Some residents are still in temporary homes, such as vans, boats and sheds, more than 5 years later because of the construction backlog.[120]Local businesses reported stock losses, cash-flow collapse, and found that they will need many years to recover. The subsequent impacts from COVID-19 made it even more difficult for businesses to recover due to the ongoing loss of tourism.[121]

National parks and coastal recreation areas suffered severe ecological damage. Over 463,000 hectares of parks and reserves burned statewide, including the Cape Howe Wilderness Zone and surrounding Parks Victoria estates. There was at least $30 million in damage to park infrastructure, including up to 1,024 items of park assets like walking tracks, toilets and jetties.[122] Loss of habitat, walking tracks, visitor facilities and scenic landscapes directly affected tourism, the primary economic driver for Mallacoota.[123] Burnt forests and slow environmental recovery continue to impact visitor numbers.[124]

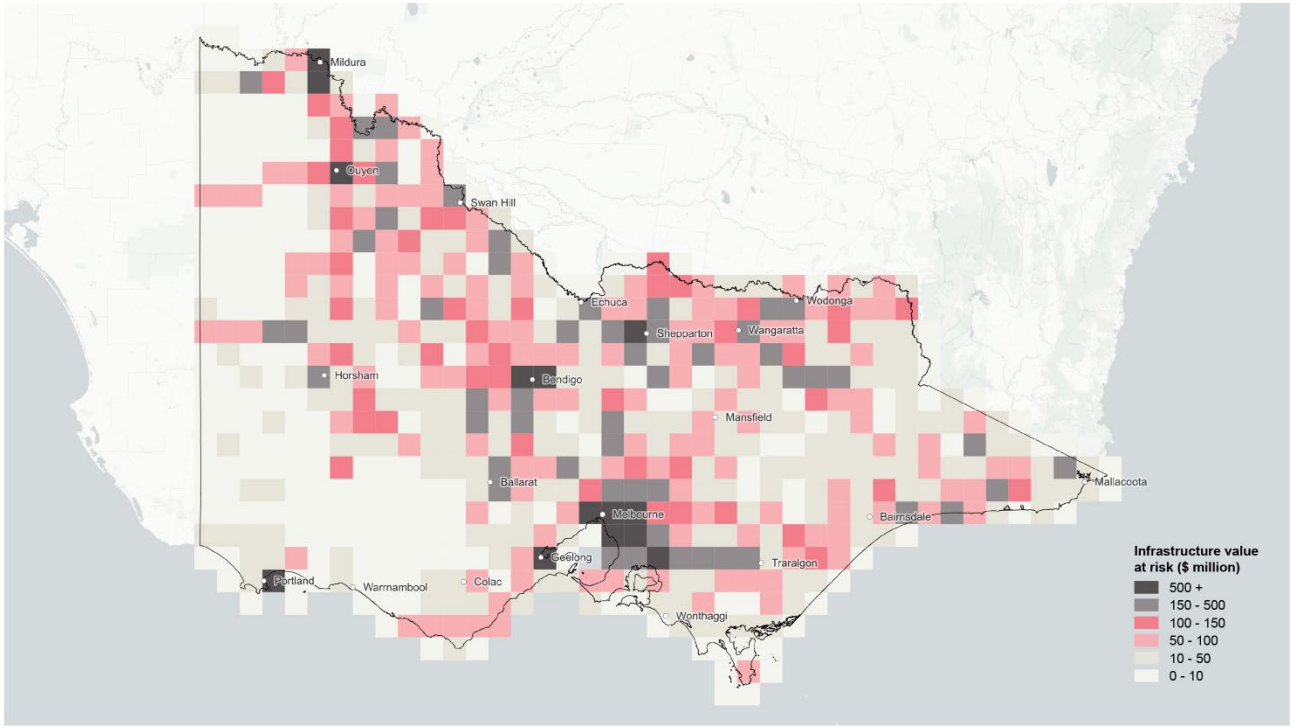
Beyond physical losses, the bushfires caused significant levels of distress and anguish with ongoing trauma for residents. This includes the significant toll on First Peoples, with the bushfires causing immense grief due to destruction to the environment, cultural heritage and wildlife deaths.[125]The social and economic effects continue to ripple through Mallacoota's businesses, families and environment. In January 2026, an out-of-control bushfire threatened Mallacoota again with residents told to keep themselves updated on evacuation warnings by the Country Fire Authority.[126]

Victoria's infrastructure faces many increasing climate change risks

We analysed climate change risks for $318 billion of Victorian infrastructure. We found more than $57 billion of infrastructure is at risk from climate hazards in 2030 in a low emissions scenario. This increases to over $71 billion in 2070 in a high emissions scenario.[127] We assessed infrastructure as at risk when it was at 3 or more on a 4-point risk scale.

Cities and towns generally have a higher value of infrastructure at risk from climate hazards (see Figure 12). The largest value of infrastructure at risk is concentrated around Melbourne. Regional cities with over $500 million of infrastructure at risk in 2030 include Geelong, Mildura, Shepparton, Portland and Bendigo.[128] Some smaller regional towns, such as Ouyen in Victoria's Mallee region, also have a large value of infrastructure at risk.[129]

Figure 12: The value of infrastructure at risk of damage varies across Victoria



Value of infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). 'At risk' means we assessed the risk at 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

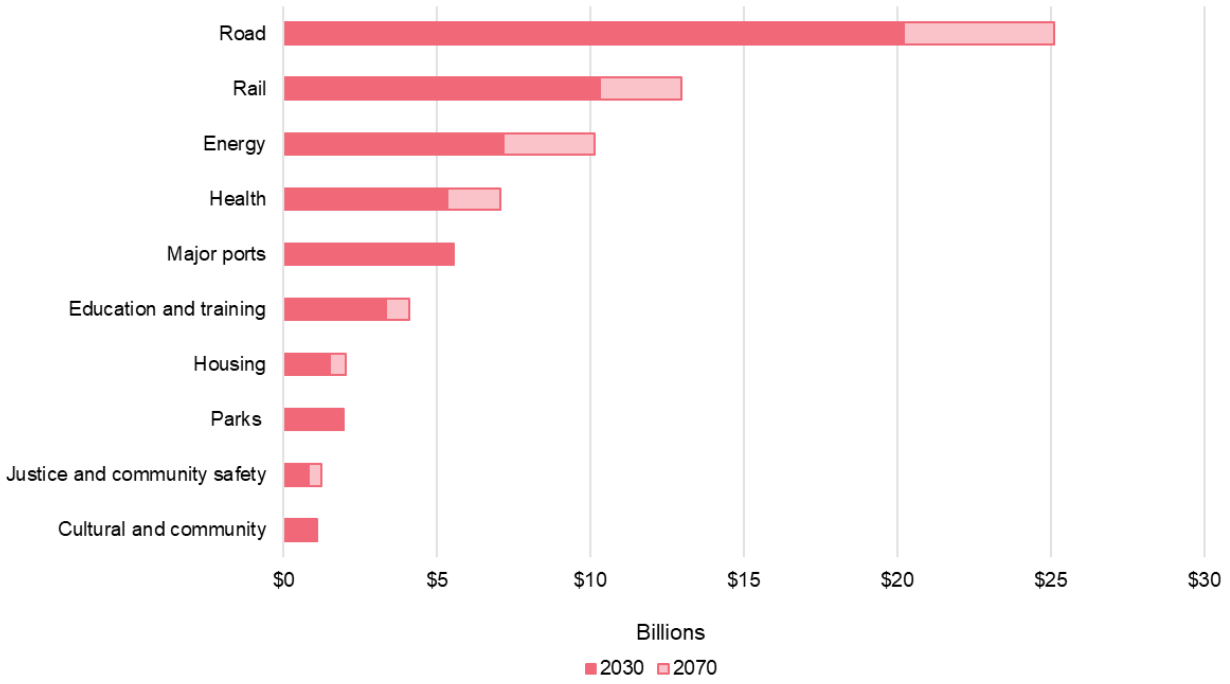
Different climate hazards drive these risks. Bushfires pose the greatest threat to Victoria's infrastructure in 2030, followed by floods and extreme heat. More than $23 billion of Victorian infrastructure is at risk from bushfires. Over $22 billion of infrastructure is at risk from floods and nearly $11 billion is at risk from extreme heat.[130] Many infrastructure categories are vulnerable to damage from these hazards, which contributes to the large value of infrastructure at risk (see Appendix 2).

Our analysis shows the hazards driving risks to Victoria's infrastructure will get worse. For example, by 2070 over $30 billion of infrastructure is at risk from bushfires and nearly $26 billion is at risk from extreme heat.[131]

A large value of road, rail, energy and health assets are at risk

The extent of climate risks varies for each infrastructure category. Road, rail, energy and health are the infrastructure categories with the highest value of infrastructure at risk (see Figure 13).[132]

Figure 13: Value of infrastructure at risk in 2030 and 2070



Value of infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6) and 2070 high emissions scenario (SSP3-7.0). 'At risk' means we assessed the risk at 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

We also identified the highest value risks to Victoria's infrastructure in 2030 (see Table 3). These include:

- floods and bushfires affecting roads
- coastal inundation affecting ports
- floods affecting health, rail and energy assets
- extreme heat affecting road and rail assets.

Table 3: Highest value infrastructure at risk to individual climate hazards in 2030

Infrastructure category	Climate hazard	Value of infrastructure at risk
Road	Flood	$9.3 billion
Road	Bushfire	$9.1 billion
Rail	Extreme heat	$5.9 billion
Major ports	Coastal inundation	$5.5 billion
Energy	Bushfire	$4.5 billion
Rail	Flood	$3.9 billion
Health	Flood	$3.3 billion
Rail	Bushfire	$3 billion
Road	Extreme heat	$2.4 billion
Energy	Flood	$2.3 billion

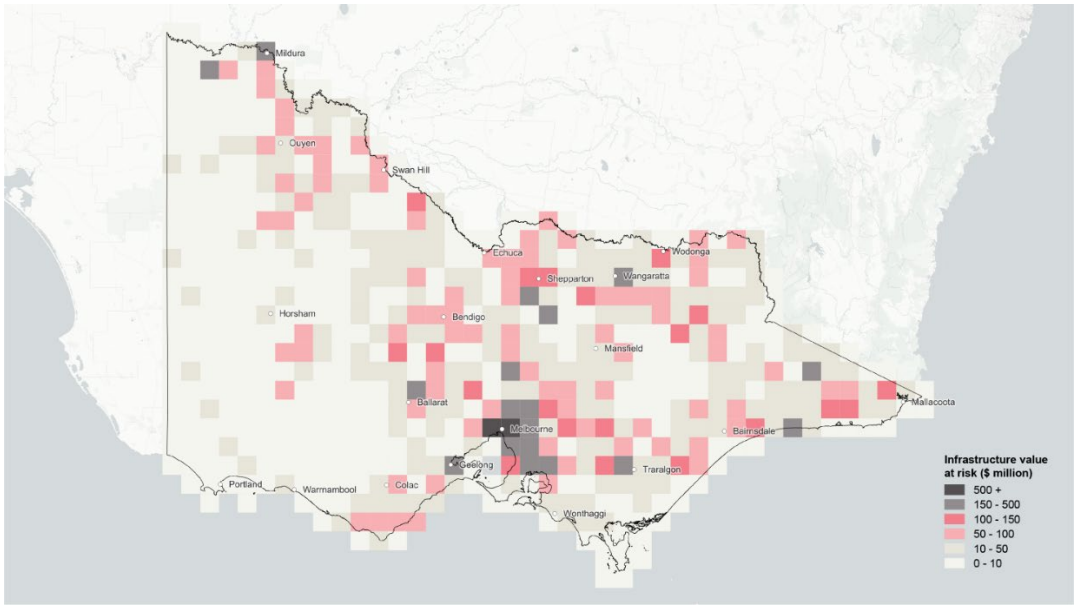
An asset might be at risk from more than one hazard, and 'at risk' infrastructure means infrastructure assessed at level 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

Floods and bushfires threaten Victoria's roads

In our analysis, roads have the largest value of infrastructure at risk. Around $20 billion of road assets are at risk in 2030.[133]

Figure 14 shows that the value of road infrastructure at higher risk is concentrated around Melbourne. Other areas of high risk follow major roads, such as the Hume Highway towards Wodonga and the Princes Highway to Traralgon.[134] Parts of northern and central Victoria also have a high value of road infrastructure at risk. The value of road assets at risk increases to $25 billion in 2070.

Figure 14: Distribution of road infrastructure asset value at risk of damage in 2030



Value of road infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). Note: 'At risk' means we assessed the risk at 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

Floods and bushfires are the largest risks to Victoria's roads. We found that floods and bushfires each threaten over $9 billion of road infrastructure by 2030.[135] The next highest risk is extreme heat which threatens $2.4 billion of road infrastructure in 2030.[136]

Deep and fast-moving floodwaters can wash away road foundations, erode embankments and damage drainage systems.[137] Floods can also force road closures because many vehicles cannot drive through floodwaters.[138] In October 2022, a flood event caused widespread damage and road closures in central Victoria.[139] More than 800 roads were closed across the Goulburn Murray region.[140] This severely restricted movement for people in Shepparton and nearby areas (see Case study: Road failures, community isolation and business disruption during Shepparton's October 2022 floods).

Floods can also have cascading impacts on other climate hazards. For example, heavy rain and floods cause soil saturation which can contribute to the risk of landslides.[141] Our analysis found that around $1.7 billion of road infrastructure is at risk from landslides.[142] When roads are damaged by landslides, shops might be cut off from customers and from suppliers. In some cases, entire communities can be cut off from tourists. The landslides and heavy rain that damaged sections of the Great Ocean Road in 2016 forced tourists to cancel trips to Wye River and Separation Creek.[143] Wye River was also affected by flash flooding in January 2026 and bushfires in 2015.[144] This demonstrates the multiple climate change hazards some communities face.

Adapting road infrastructure will help make it more resilient for future flood events. Our previous work included an economic analysis to identify which adaptation measures would be the most

beneficial to protect road infrastructure.[145] We found that preventive maintenance and foamed bitumen stabilisation produced the highest returns on investment, in both current and future climate conditions, as an option to adapt the road network for flooding.[146]

Bushfires can destroy roadside electrical systems, signs and safety barriers.[147] Around 1,500 road signs were damaged during the 2019–20 Black Summer bushfires.[148] The heat from bushfires can degrade or even melt road surfaces.[149] Bushfires can also cause prolonged road closures.[150] Trees that have been burnt during a bushfire are at a higher risk of falling and must be assessed before public access to roads is safe.[151] Over 1,400 kilometres of arterial roads and 5,000 kilometres of local roads were closed in eastern and north-eastern Victoria because of the 2019–20 bushfires.[152]

In current climate conditions, our previous research found programmed drainage clearing and vegetation management produced a return on investment of over $5 for every dollar spent as a road network adaptation option for bushfires and bushfire-induced landslides.[153] This increases to over $11 for every dollar spent in future climate conditions.[154]

Even minor damage to transport infrastructure can quickly cause problems in other sectors.[155] International research finds that even minor disruptions to roads can make access to healthcare services significantly reduced.[156] This damage can severely disrupt services, as medical and emergency staff and vehicles need well connected transport networks to respond to emergencies quickly.[157]

Case Study

Road failures, community isolation and business disruption during Shepparton's October 2022 floods

The October 2022 floods in Greater Shepparton were among the most severe in the region's modern history. They were driven by intense rainfall, saturated catchments, and inflows from both the Goulburn and Broken Rivers.

Rainfall of 34.6mm on 13 October and 46.6mm on 14 October caused high releases from Lake Eildon as reservoir levels peaked.[158] The Goulburn River ultimately reached 12.06 metres on 17 October, exceeding the historic 1974 peak by one centimetre when measured at the same gauge location.[159]

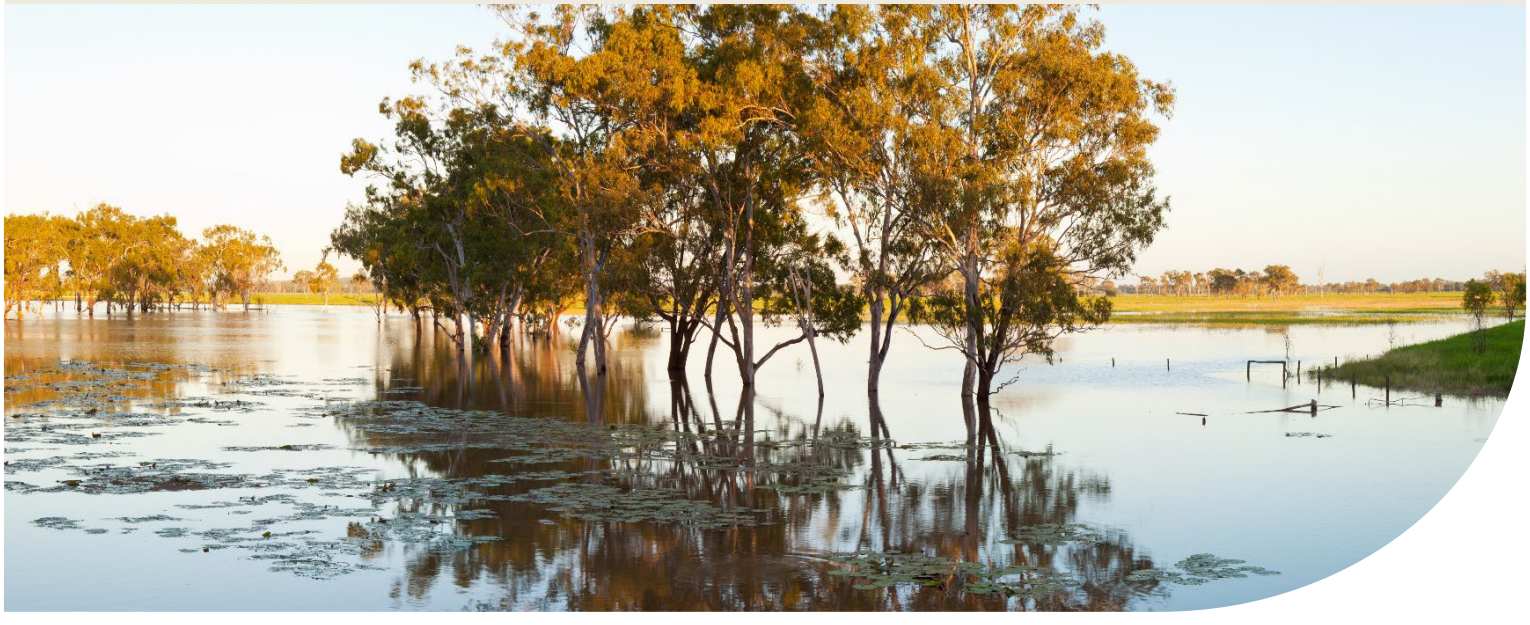
Flooded roads in the Greater Shepparton area caused significant and systemic problems. Road closures created isolation for communities in Shepparton, Mooroopna, Bunbartha, Undera and surrounding rural areas. Many properties on the floodplain remained dry but inaccessible by road for days. Residents reported being cut off from emergency services, health care, food supply, and evacuation routes.[160]

Road closures also disrupted critical freight and workforce mobility. A lack of real-time updates of road closures meant residents and local businesses relied on informal communication channels to navigate changing road conditions, including critical roads such as the Peter Ross Edwards Causeway. This hindered food transport and business continuity.[161]

> "Why was the causeway closure brought forward with no explanation or warning? It is a critical access point and key piece of infrastructure."

Local resident, Greater Shepparton[162]

Road closures due to flooding caused significant impacts to the operations of the Bega Group (Tatura Milk). More than 50% of staff were unable to access the site for 9 days. This prevented milk from being collected and delivered to the factory. In combination with loss of power to the site, this resulted in transport and communication disruptions, forcing local processors to dump milk, halt operations and divert perishable goods to other regions.[163]



Extreme heat, floods and bushfires threaten Victoria's rail assets

Over $10 billion of rail assets are at risk from climate hazards in 2030.[164] Rail assets in our analysis include train stations, rail tracks, tram tracks and stops, and maintenance facilities and depots.[165] The value of rail infrastructure at risk is largest in Melbourne, Geelong and along regional rail corridors (see Figure 15).

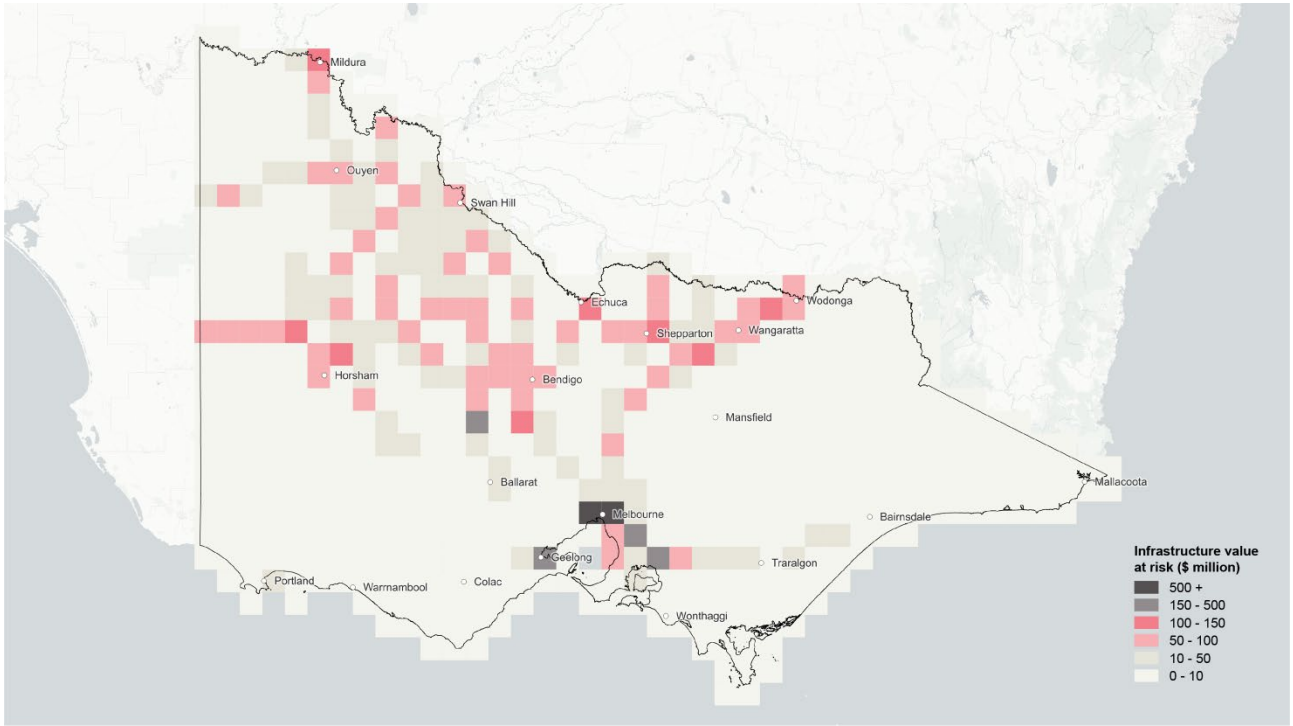
Rail was the infrastructure category in our analysis with the largest value of infrastructure at risk from extreme heat. Nearly $6 billion of rail assets is at risk from extreme heat in 2030. This increases to over $9 billion by 2070.[166]

Rail assets are vulnerable to both damage and disruption from extreme heat (see Appendix 2 and Appendix 3). Extreme heat can cause signalling and control equipment to stop working. High temperatures can cause rail tracks to expand or buckle.[167] Managing rail temperature, for example, by painting tracks with white reflective paint, can help keep the railways operating on hot days.[168]

Extreme heat can also trigger mandatory speed restrictions, resulting in delays and service cancellations.[169] The speed limit is reduced to 70 kilometres per hour for all trains on the Metro network when Melbourne's temperature is forecast to reach 42°C or higher.[170] Extreme heat can also disrupt the movement of goods and affect freight supply chains. This might worsen in future if more goods and supplies are transported by rail freight, as the Victorian Government plans.[171] Ensuring the ballast shoulders on railways are in good condition can help stop buckling on tracks due to extreme heat.[172]

Rail assets are also at risk from floods and bushfires. In 2030, $3.9 billion of rail assets are at risk from floods and $3 billion are at risk from bushfires.

Figure 15: Distribution of rail infrastructure asset value at risk of damage in 2030



Value of rail infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). Note: 'At risk' means we assessed the risk at 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

Energy assets are at risk from bushfires and extreme heat

Energy assets in this analysis include large-scale generation assets, substations, and electricity transmission and distribution lines. Our analysis showed over $7 billion of energy infrastructure is

at risk from climate hazards in 2030. Bushfire is the main risk to energy assets in 2030. By 2070, a large value of energy infrastructure is also at risk from extreme heat.[173]

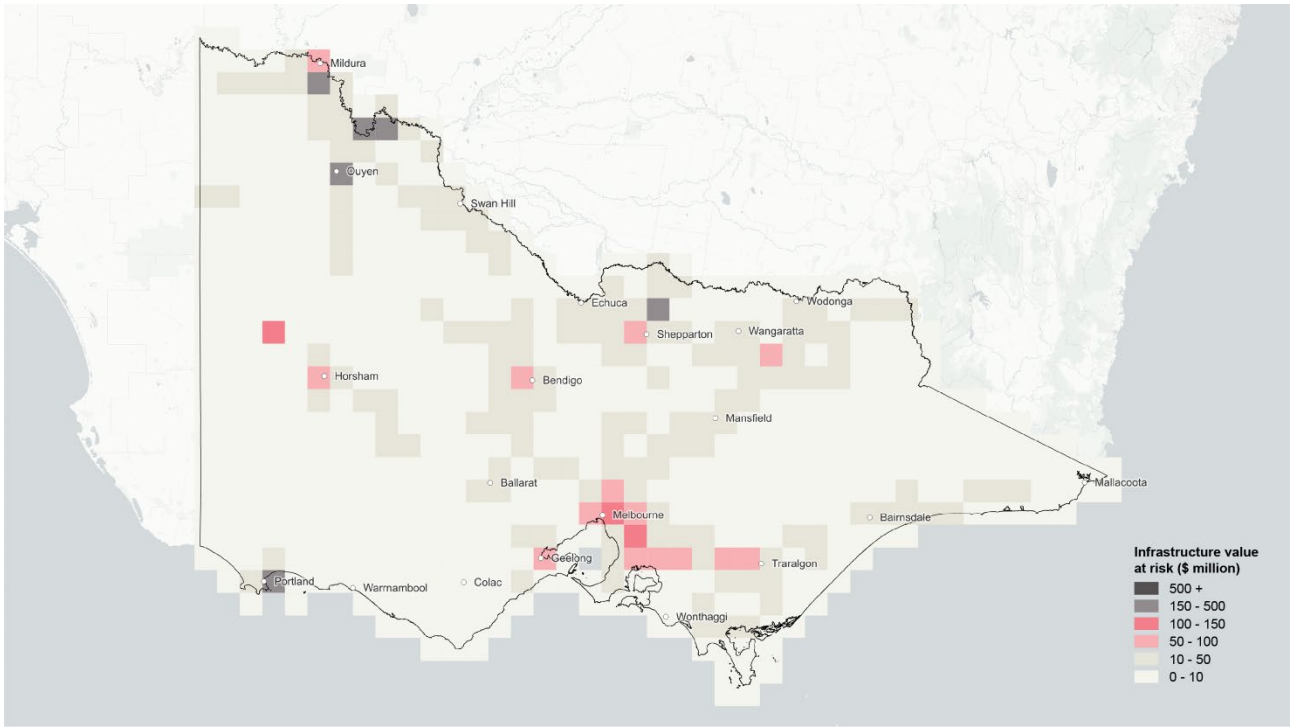
Bushfire poses a risk to $4.5 billion worth of energy infrastructure in 2030, growing to nearly $6 billion in 2070.[174] Energy infrastructure is highly vulnerable to bushfire as bushfires can directly damage assets (see Appendix 2).[175] During the Victorian bushfires in January 2026, around 3,400 bushfire-affected properties were without power in AusNet's service area.[176] At least 5 bushfires damaged Powercor's network infrastructure, affecting more than 3,000 customers.[177] Both companies worked with emergency services to gain safe access to assess and repair damaged infrastructure.[178] Vegetation management, including clearing branches, tall plants and grasses under powerlines, is a common practice in Australia to reduce the likelihood of bushfires damaging energy assets.[179]

Damage to electricity infrastructure can also affect homes and businesses not directly damaged by the climate hazard. For example, extreme wind and heavy rain across Victoria damaged electricity distribution infrastructure and caused power outages in June 2021.[180] Over 25,000 homes lost power. Some households were told they would be without electricity for up to a month.[181] Power outages can also disrupt business operations. For instance, supermarkets were forced to discard perishable stock during power outages in February 2024.[182] We previously found insulated cables can minimise damage to electricity distribution networks during high wind events.[183]

Over $5.5 billion of energy assets are at risk of damage from extreme heat by 2070.[184] Extreme heat can damage equipment and increase faults through overheating. It can also cause electricity lines to sag and, in some cases, it can cause towers to buckle.[185]

Geographically, there are pockets with a large value of energy assets at risk in various places across Victoria. Figure 16 shows that at risk energy infrastructure is located around Melbourne and extending east to the Latrobe Valley, in Portland, and up in the northwest of the state near Ouyen and Mildura.

Figure 16: Distribution of energy infrastructure asset value at risk of damage in 2030



Value of energy infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). Note: 'At risk' means we assessed the risk at 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

Even without physical damage, energy infrastructure is vulnerable to disruption from extreme weather. Damaged energy infrastructure also has significant flow on impacts. During the 2019–20 Black Summer bushfires, telecommunications outages meant some communities were cut off from emergency communications.[186] A review found that most of the outages were caused by power outages, rather than direct fire damage to telecommunication facilities.[187]

Victoria's health assets face risks from floods, bushfires and extreme heat

Around $5.3 billion of health assets are at risk from climate hazards in 2030. Health assets in this analysis include hospitals, community health centres, rehabilitation centres and cemeteries. These assets are in many communities across Victoria. This means the value of health infrastructure at risk from climate hazards is similarly dispersed. Figure 17 shows that a large value of health assets are at risk in Bendigo, Swan Hill, Mildura and south-east Melbourne.[188]

Floods are the largest risk to health infrastructure. Over $3 billion of health infrastructure is at risk from floods. Floods can damage health buildings and medical equipment. For example, the October 2022 floods inundated and caused extensive damage to the Rochester and Elmore District Health Service.[189] It took over 2 years for the facility to reopen.[190]

Floods can also disrupt the operation of health infrastructure. Floods can force health facilities to close because of unsafe conditions, reduced water supply or interrupted electricity supply. Floods can also force road closures, reducing staff and emergency service access.[191] Many adaptation measures can be taken to protect health assets from floods. Previous research in *Weathering the storm* and from the Australasian Health Infrastructure Alliance suggest upgrading stormwater and drainage systems to account for more rainfall or elevating critical mechanical and electrical equipment.[192]

In 2030, our assessment finds nearly $1.7 billion of health infrastructure is at risk from bushfires and around $700 million is at risk from extreme heat.[193] Health infrastructure is highly vulnerable to disruption from extreme heat (see Appendix 3).[194] Extreme heat can cause hospital cooling systems to fail. Hospitals may also experience power outages during heatwaves.[195]

Extreme heat also increases demand for health services.[196] This means more people may need to access health services when the infrastructure is least able to provide them. There are options to reduce the likelihood of extreme heat causing cooling systems to fail, such as developing strategies to reduce operational energy use or increasing the capacity of building heating, ventilation and air conditioning systems.[197] Vegetation or shade structures can also reduce heat exposure for buildings and equipment.[198]

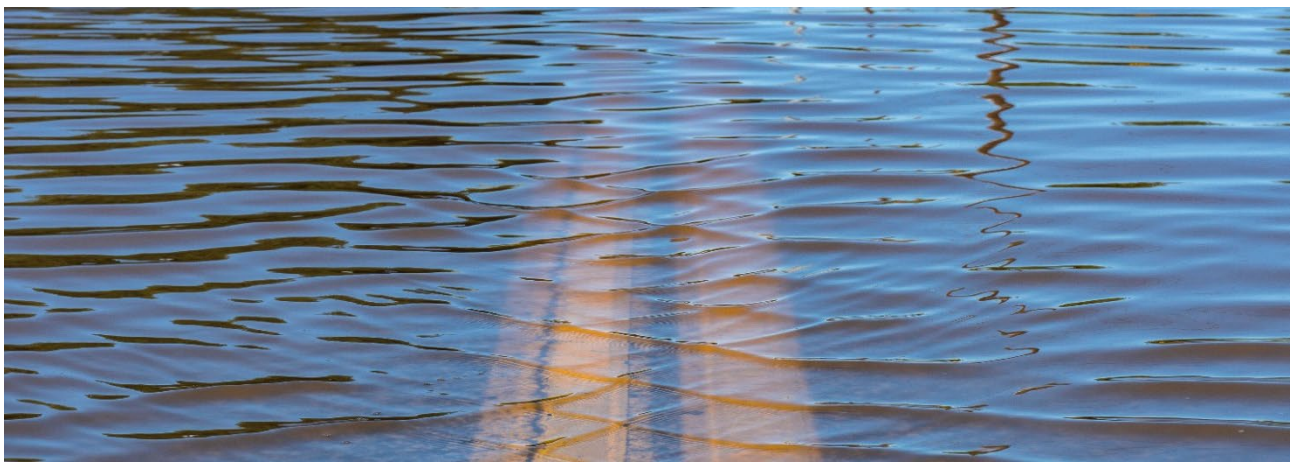
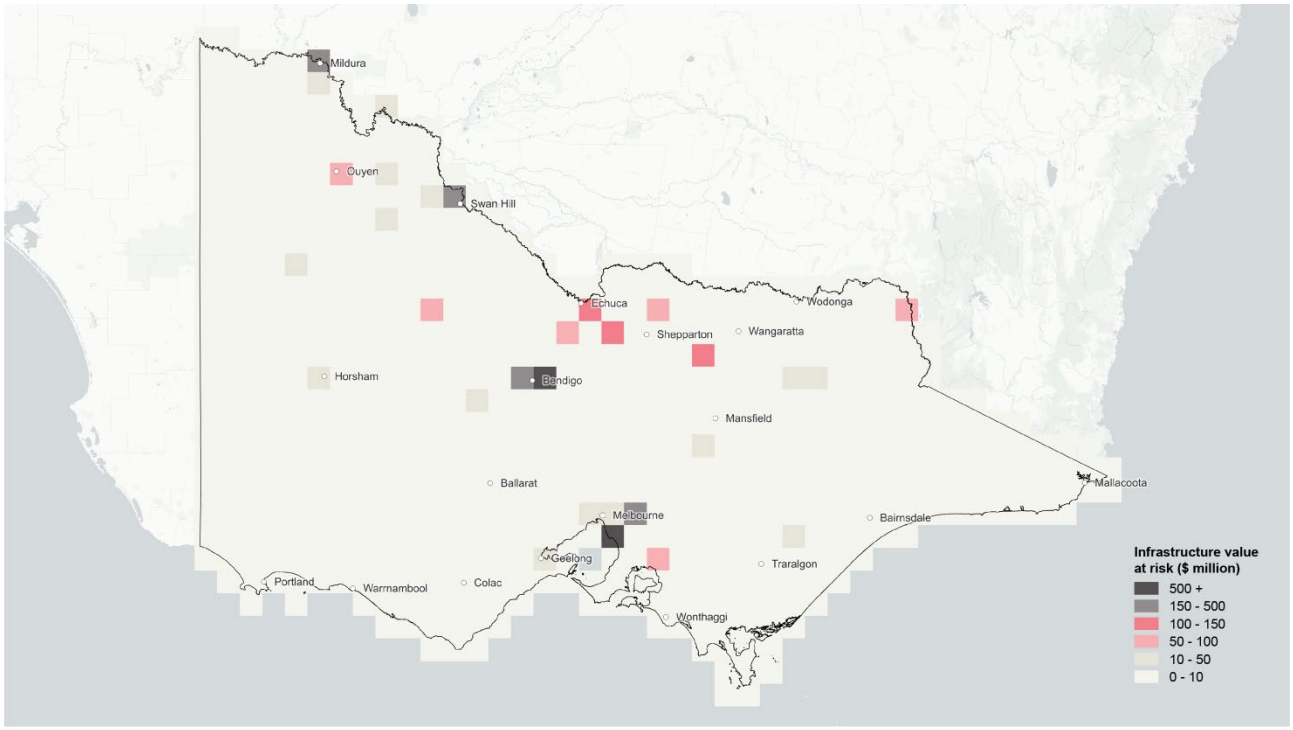


Figure 17: Distribution of health infrastructure asset value at risk of damage in 2030



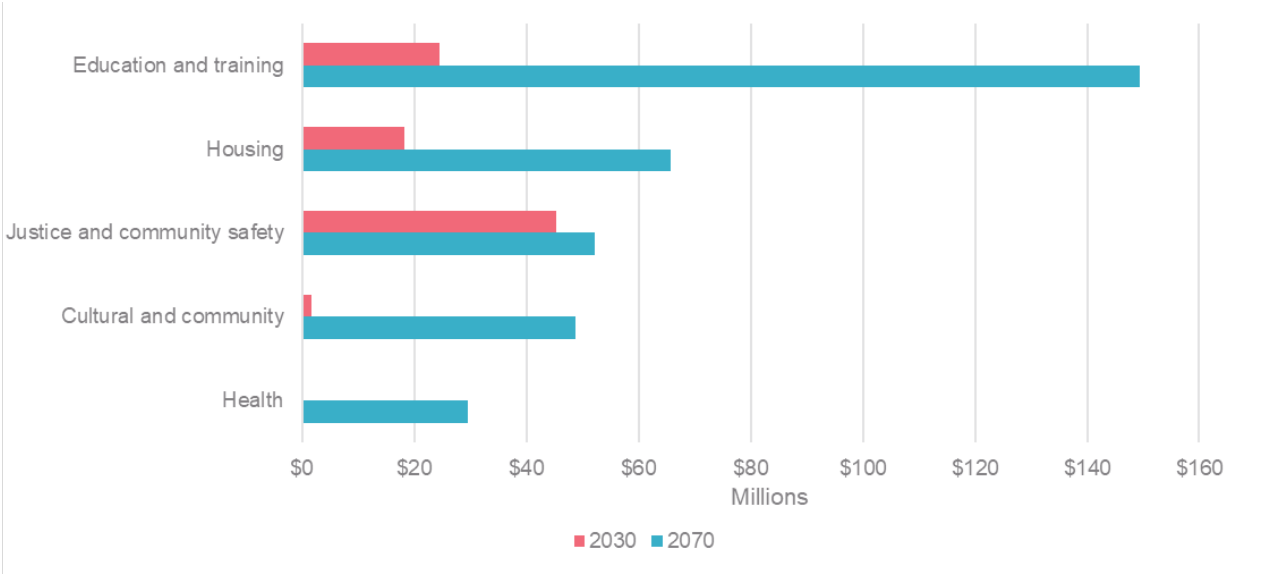
Value of health infrastructure at risk of damage in a 2030 low emissions scenario (SSP1-2.6). Note: 'At risk' means we assessed the risk at 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure*, report to Infrastructure Victoria, 2026.

Coastal inundation is a growing threat to social infrastructure

All infrastructure categories in our analysis are vulnerable to damage and downtime from coastal inundation (see Appendix 2 and Appendix 3). Coastal inundation presents a risk to all infrastructure categories and presents a growing threat to social infrastructure. Social infrastructure includes cultural and community, housing, health, justice and community safety, and education and training infrastructure. We found the value of social infrastructure at risk from coastal inundation rises from around $90 million in 2030 to nearly $350 million in 2070.[199] The education and training sector has $150 million at risk from coastal inundation in 2070.[200] Figure 18 shows how the value of social infrastructure at risk from coastal inundation increases from 2030 to 2070. Social infrastructure in Melbourne, Gippsland and the Bellarine Peninsula is at risk from coastal inundation in 2030.[201] More social infrastructure in south-east Melbourne is at risk by 2070.[202]

Social infrastructure is largely comprised of buildings that deliver services to the community. Coastal inundation can destroy building foundations, erode protective barriers and disrupt essential services.[203] Sea level rise means that, without intervention, some land areas will be permanently underwater in the future. Buildings near shorelines can become compromised as water depths of 50 centimetres or more can cause structural damage to walls and foundations.[204] Saltwater can also damage electrical, IT and plumbing systems within buildings.[205] It might force infrastructure managers to close or stop using some assets.

Figure 18: Value of social infrastructure at risk from coastal inundation



Value of infrastructure at risk of damage from coastal inundation in a scenario with 20cm of sea level rise in 2030 and a scenario with 47cm of sea level rise in 2070. Note: 'At risk' means we assessed the risk at 3 or more on a 4-point risk scale. Source: Arup, *Victoria's climate risks to infrastructure,* report to Infrastructure Victoria, 2026.

Coastal inundation creates unique challenges for coastal communities and infrastructure management. Past and future planning decisions will affect the vulnerability of coastal communities.[206] For infrastructure, limited options are available to prepare for and reduce damage from coastal inundation. It might be impossible or too expensive to restore some infrastructure. In some cases, relocating an asset might be the only feasible adaptation option.[207] *Victoria's resilient coast – adapting for 2100+* program provides guidelines on how to support coastal hazard risk management.[208] The *Adaptation actions compendium* is a resource to help land managers and asset owners adapt to inundation and protect infrastructure.[209] In *Victoria's infrastructure strategy 2025–2055*, we recommended regular updates to flood maps and future projections using the latest scientific data.[210] Integrating flood maps into planning schemes can help minimise building in areas at risk of flooding and coastal inundation.[211]

Extreme heat, drought and bushfires can also disrupt infrastructure use

Damage during an extreme weather event is not the only risk to infrastructure. Infrastructure operations can also be disrupted, even if it is undamaged.[212] For example, extreme heat reduces the capacity of electricity lines meaning they cannot carry as much electricity.[213] For energy generation assets, heat can reduce how much output a wind turbine can produce.[214] During drought, limited water availability can reduce the use of the water-cooling functions used in thermal power plants. This could result in reduced capacity of the power plant to operate normally.[215]

Climate hazards can also increase the demand for the services that infrastructure provides. Communities might also need these facilities for a range of services after a climate hazard, disrupting the normal services provided. For example, communities might use community centres as an emergency shelter during and after a climate hazard event.[216] Cultural and community assets have a moderate or high vulnerability to downtime from all climate hazards (see Appendix 3).[217]

We only considered downtime risks that arise from direct infrastructure damage due to an extreme weather event. This does not consider other consequences from climate hazards, such as the impacts on people who use infrastructure. For example, some buildings might become too hot for people to use safely and comfortably. This includes social housing.[218] Social housing residents are vulnerable to the effects of climate change.[219] Some homes do not have air conditioning.[220] Residents that have air conditioning in their home may not use it because of energy costs.[221] We

recommended the Victorian Government encourage household energy efficiency and electrification in *Victoria's infrastructure strategy 2025–2055*.[222] This includes completing social housing energy upgrades, such as electrification and solar panels.[223]

Climate hazard events can also displace people from their homes. This can lead to more demand for social housing.[224] Over 2,000 people were housed in temporary accommodation after the October 2022 floods.[225]

While these are important considerations, we focused on physical impacts on the infrastructure itself. This means some infrastructure categories may not have a large value of infrastructure at risk of damage or downtime, even when climate change might severely affect the lives of people using this infrastructure.

Governments can adapt infrastructure to support community resilience

Infrastructure damage affects some communities more than others

Damage to infrastructure from extreme weather events will affect many Victorian communities. But how communities respond, repair and recover will vary. This could be because of their location. It could also be because of social, economic, environmental or historical reasons. For example, communities with residents who have pre-existing health conditions or elderly people are more vulnerable to heatwaves.[226] Communities where residents have fewer transport options are more vulnerable to climate hazards as they are less able to leave and avoid harm.[227]

Communities without nearby emergency or health services are likely to be less resilient.[228] Regional communities often have limited access to services.[229] People in these communities also often rely heavily on infrastructure for their livelihoods.[230] The distance to services and the lack of alternative infrastructure mean they are more susceptible to impacts from climate change.[231]

Areas with higher unemployment, homelessness and lower household incomes are more vulnerable to the effects of climate change.[232] Some communities might also have limited or poor quality infrastructure.[233] The Australian Climate Service report the risk to health from heatwaves is influenced by urban greening and access to transport.[234] The Victorian Council of Social Services found people experiencing disadvantage are more likely to live in areas where buildings and roads trap heat.[235]

Understanding local circumstances, vulnerabilities and capabilities of rural communities can help build resilience. Resilient communities can recover and adapt quicker and more effectively.[236] But even resilient communities will face challenges. Repeated extreme weather events can wear down the ability of communities and infrastructure to survive further events.[237]

Communities are more vulnerable when climate hazards damage many types of infrastructure

Climate hazards can damage different types of infrastructure at the same time. A flood could damage hospitals, roads, schools and water treatment infrastructure. If this occurs, communities might be unable to access many essential services. Damage to multiple infrastructure assets can make it more difficult for communities to respond, repair and recover from climate hazard events.[238]

This occurred in October 2022 when floods damaged infrastructure in Victoria.[239] For example, Rochester's sewerage network, hospital and roads were all damaged.[240] The widespread damage made it difficult for the community to quickly recover from the flood event. Over 70% of Rochester residents were still not able to live in their homes 7 months after the flood.[241]

Climate change will also trigger new combinations of climate hazards events.[242] This includes cascading and compounding events.[243]

Compounding events means multiple climate hazard events occurring at the same time or in short succession. This can produce combined effects that are worse than the individual consequence of each event.[244] The 2023 Gold Coast storms show how consequences from multiple climate hazards compound (see Case study: Storms and heatwaves trigger multi-sector failure and Christmas chaos in Southeast Queensland).

The Australian Climate Service found there is increasing evidence of climate hazards compounding.[245] For example, drought can compound the impact of flooding because drier soils are less able to absorb water. This increases the vulnerability of infrastructure to flooding.[246]

Cascading events are when a climate hazard event triggers even more impacts.[247] For example, extreme heat has a cascading effect on bushfires as they are more likely to spread on hot, dry and windy days.[248]

Case Study

Storms and heatwaves trigger multi-sector failure and Christmas chaos in Southeast Queensland

On Christmas Day 2023, tornado-strength thunderstorms hit the Gold Coast, Scenic Rim and Logan regions in Queensland. Wind gusts exceeded 150 kilometres per hour. More than 1,100 powerlines came down, leaving over 130,000 people without power supply.[249] Seven people lost their lives in southeast Queensland.[250]

The power outages triggered a chain of failures across transport, communications, water and health services. Roads and rail were disrupted, mobile and internet networks went offline, and water supplies failed in several communities, showing how loss of electricity can quickly escalate into service breakdowns across many sectors and cause public health risks.

Hundreds of roads were blocked by fallen trees, landslides and live powerlines. Some roads were closed for several weeks.[251] Telecommunications repair crews and emergency services were hampered by road conditions, which slowed down the recovery efforts and repairs to electricity and transport networks.[252]

> "This is the first time we have seen a storm so intense that it has taken down concrete power poles." [253]
> Former Queensland Premier, Steven Miles [ABC News, 2023]

Power loss also has an impact on water supply and public health. Communities reliant on electric pumps for tank water in places like Tamborine Mountain needed emergency supplies of bottled water and portable toilets.[254]

A severe heatwave arrived three days after the storm, with temperatures reaching 38°C, 8 degrees above average. Around 50,000 people were still without power. Electricity demand reached 9,800 MW, close to the state peak.[255] Hospitals recorded a 30% increase in admissions, including heat stress and admissions related to medical devices failing from the power loss.[256] Some aged-care facilities without backup generation also lost power.[257]

More storms came through the region on 30 December, cutting off 51,000 landlines and NBN internet access. More than 100 mobile network sites also went offline. Businesses reliant on EFTPOS could not operate, and people could not receive emergency messages.[258] The Insurance Council of Australia reported 18,174 claims and more than $2 billion in losses.[259] The infrastructure damage was so great that recovery operations continued for several weeks into January 2024.[260]

Adapting infrastructure can support community resilience

Resilient infrastructure allows essential services to keep operating.[261] This includes water, energy, waste, telecommunications and healthcare.[262] Resilient infrastructure also helps communities recover and get back to normal as soon as possible.[263]

Planning for resilient infrastructure can significantly reduce the cost of extreme weather events.[264] Investing in more resilient infrastructure can be a cost-effective way to reduce the effects of climate hazards on communities.[265] Research from the Global Commission on Adaptation shows that resilient infrastructure can deliver up to $10 for every dollar invested.[266]

Adapting infrastructure does not need to be expensive. There are many types of infrastructure adaptation. Our previous research, *Weathering the storm: adapting Victoria's infrastructure to climate change,* explored different adaptation options. That report found adaptation is not a one-size-fits all solution and early adaptation can reduce the risk of damage and cost of recovery. Adaptation measures we considered included lower-cost measures, higher-cost investment options, maintenance and hazard management.[267] We found that that lower-cost adaptation options can produce a higher return on investment than more expensive measures under certain conditions.[268]

In *Weathering the storm,* we found that there is a compelling case for infrastructure managers to invest in adaptation measures when direct, indirect and intangible costs and benefits are considered together.[269] We developed a methodology to test the potential return on investment of different adaptation measures.[270] This methodology can help infrastructure managers assess whether different adaptation measures are cost-effective.

Adaptation measures can support community resilience. But the needs of each community will vary. What works in one location might not work in other places. Our analysis shows that different regions and different types of infrastructure face different risks.[271] Infrastructure managers must consider local conditions, and specific community needs, to decide which adaptation measures are appropriate.[272]

Some adaptation action is underway, but more is needed

Victoria is committed to climate action. It has a legislated commitment to net zero emissions by 2045, supported by interim emissions reduction targets, including reducing emissions by 75% to 80% below 2005 levels by 2035.[273]

The *Climate Action Act 2017* sets out the processes for Victoria to transition to net zero emissions and manage climate risks.[274] It requires the Victorian Government to develop a climate change strategy every 5 years. *Victoria's climate change strategy 2026–2030* was published in November 2025.[275]

Victoria's climate change strategy 2026–2030 details the next steps in reducing emissions and building climate resilience.[276] It notes the key role of infrastructure in building resilience.[277] The climate change strategy presents a vision for a climate resilient Victoria in which 'Victoria's infrastructure and settlements can withstand climate impacts.'[278]

The *Climate Action Act 2017* also requires the Victorian Government to publish adaptation action plans for vulnerable or essential systems.[279] Government published adaptation action plans for the built environment, education and training, health and human services, natural environment, primary production, transport, and water cycle systems in 2022.[280] The government also published 6 regional adaptation strategies.[281] These plans set out adaptation actions across the spectrum of government activity, not just infrastructure. Many of the 2022 adaptation action plans identified energy as critical to services in other sectors.[282] We previously recommended the Victorian Government publish an energy sector adaptation action plan in *Weathering the storm* and *Victoria's infrastructure strategy 2025–2055*.[283]

The 2022 adaptation action plans focused on developing climate-risk management and capacity building to improve climate change adaptation. The Victorian Government has made some progress in this area. For example, the Department of Jobs, Skills, Industry and Regions is improving its understanding of how climate change will affect TAFE buildings and infrastructure (see Case study: Risk assessment will guide adaptation for TAFE infrastructure).

The Victorian Government will publish new adaptation action plans in 2026.[284] These present a once in a 5-year opportunity to take a step forward, and prioritise and fund infrastructure adaptation. The findings in this report can help government identify where it can adapt Victoria's infrastructure so it can withstand current and future climate change impacts.

This report is the largest climate risk assessment of Victoria's infrastructure that we know of. By examining different infrastructure categories, locations and climate hazards, this research can help government prioritise adaptation. It shows where climate change risks to infrastructure are largest. This report provides further evidence that infrastructure adaptation is urgent, as over $57 billion of Victoria's infrastructure is at risk from climate hazards in 2030.[285]

We also know that sustained investment in infrastructure adaptation is needed beyond 2030. More than $71 billion of Victoria's infrastructure is at risk from climate hazards in 2070.[286] This may underestimate the extent of climate change risks in 2070 as we did not have future projections for floods, damaging winds or landslides.

Government needs to prioritise infrastructure adaptation action

In *Victoria's infrastructure strategy 2025–2055*, we recommended the Victorian Government better prepare infrastructure for climate change.[287] This includes funding high-priority, cost-effective infrastructure adaptation when the climate adaptation actions plans are updated in 2026.[288] In *Weathering the storm*, we made 7 recommendations to help the Victorian Government better assess and prepare infrastructure, and better plan for and adapt to climate change.[289]

Our risk analysis can help the Victorian Government prioritise areas for investment in infrastructure adaptation in both the short and longer term. We found:

- road infrastructure is at risk from floods, bushfires and extreme heat, with a large value of road assets at risk located in Melbourne, along major roads towards Wodonga and Traralgon, and across northern and central Victoria
- rail infrastructure is at risk from extreme heat, floods and bushfires, with at risk infrastructure located along regional rail corridors and in Melbourne and Geelong
- bushfire, floods and extreme heat threaten energy assets, with at risk infrastructure located in northern Victoria, Portland, Melbourne and towards the Latrobe Valley
- health assets across Victoria are at risk from floods, extreme heat and bushfires, with at risk infrastructure located in south-east Melbourne, Mildura, Bendigo and Swan Hill.

Government and infrastructure managers should consider these risks as they make decisions about when, where and at what cost to adapt infrastructure. But proactively adapting other assets will also benefit the communities that use them. Adapting significant community or social assets can ensure the infrastructure that benefits local communities, such as schools and health centres, can continue to operate. It can also reduce the need to rebuild or repair social assets after extreme weather events. This can help reduce costs for government.

Case Study

Risk assessment will guide adaptation for TAFE infrastructure

A goal of the Education and Training Climate Adaptation Action Plan (2022–2026) is to help deliver strong infrastructure and learning facilities. Action 14 is to have 'Targeted activities with the TAFE sector to improve understanding of the impacts of climate change on TAFE buildings and infrastructure.'[290]

To address Action 14, a climate risk assessment of TAFE buildings was completed by the Office of TAFE Coordination and Delivery (Department of Jobs, Skills, Industry and Regions). It looked at how rising temperatures, droughts, bushfires, storms, heavy rain, and sea level rise could affect TAFE infrastructure across Victoria. This information will help guide decisions about where to invest in adaptation or sell TAFE assets, and how to plan and design future building projects.[291]

Making sure TAFE buildings and properties are protected against climate change will support government initiatives to expand TAFE training in Victoria.[292] TAFEs can provide people with the skills and training that is needed in areas like construction, healthcare and energy. These sectors are already facing workforce shortages.[293] It is important that existing and new TAFE infrastructure is climate resilient so they can expand vocational education to address worker shortages and meet future skills needs.

Appendix 1: Climate data for 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	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 Prone Areas and Bushfire Management Overlay	VicPlan	Extent aligned to overlays	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	Proportion of time exceeding wind threshold (17m/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	Arup modelling	Extent aligned to inundation overlay	×	20cm and 47cm	Arup modelling[294]

Climate hazard	Hazard data description	Data source	Gridded dataset resolution	Baseline data	Scenarios available	Timeframes available
Rainfall-induced landslide	Landslide susceptibility	Global landslide hazard map, published by World Bank Group and developed by Arup [295]	1km	Based on 1980-2018 rainfall data No future projections		

Appendix 2: Vulnerability to damage

	Bushfires	Drought	Coastal inundation	Damaging winds	Extreme heat	Flooding	Landslides
Road	Moderate	Low-moderate	High	Low	Moderate	High	Moderate-high
Rail	High	Low	High	Moderate	Moderate - high	High	Moderate
Energy	High	Low-moderate	High	Moderate	Low-moderate	Moderate	Moderate
Major ports	High	Low	High	Moderate-high	Low	Moderate	Moderate
Health	High	Low	High	Low	Moderate	High	Low-moderate
Education and training	High	Low	High	Low	Low	Moderate	Low-moderate
Culture and community	High	Moderate	High	Low	Low	Moderate	Low-moderate
Housing	High	Low	High	Low	Low	Moderate	Low-moderate
Justice and community safety	High	Low	High	Low	Low	Moderate	Low-moderate
Parks	High	Low	High	Low	Low	Moderate	Moderate

Source: Arup, Victoria's climate risks to infrastructure, 2026.

Appendix 3: Vulnerability to downtime

	Bushfires	Drought	Coastal inundation	Damaging winds	Extreme heat	Flooding	Landslides
Road	High	Low	High	Moderate	Low-moderate	High	Moderate
Rail	High	Low	High	Moderate	Moderate-high	High	Moderate
Energy	High	Moderate-high	High	Moderate	Moderate	Moderate-high	Moderate
Major ports	Moderate	Low	High	High	Low	Moderate	Moderate
Health	High	Low	High	Low	High	High	Low-moderate
Education and training	High	Low	High	Moderate	Moderate	Moderate	Low-moderate
Culture and community	High	Moderate	High	Moderate	Moderate	Moderate	Low-moderate
Housing	High	Low	High	Low	High	Moderate	Low-moderate
Justice and community safety	High	Low	High	Low	Moderate	High	Low-moderate
Parks	High	Moderate	High	Moderate	Moderate	Moderate	Moderate

Source: Arup, Victoria's climate risks to infrastructure, 2026.

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