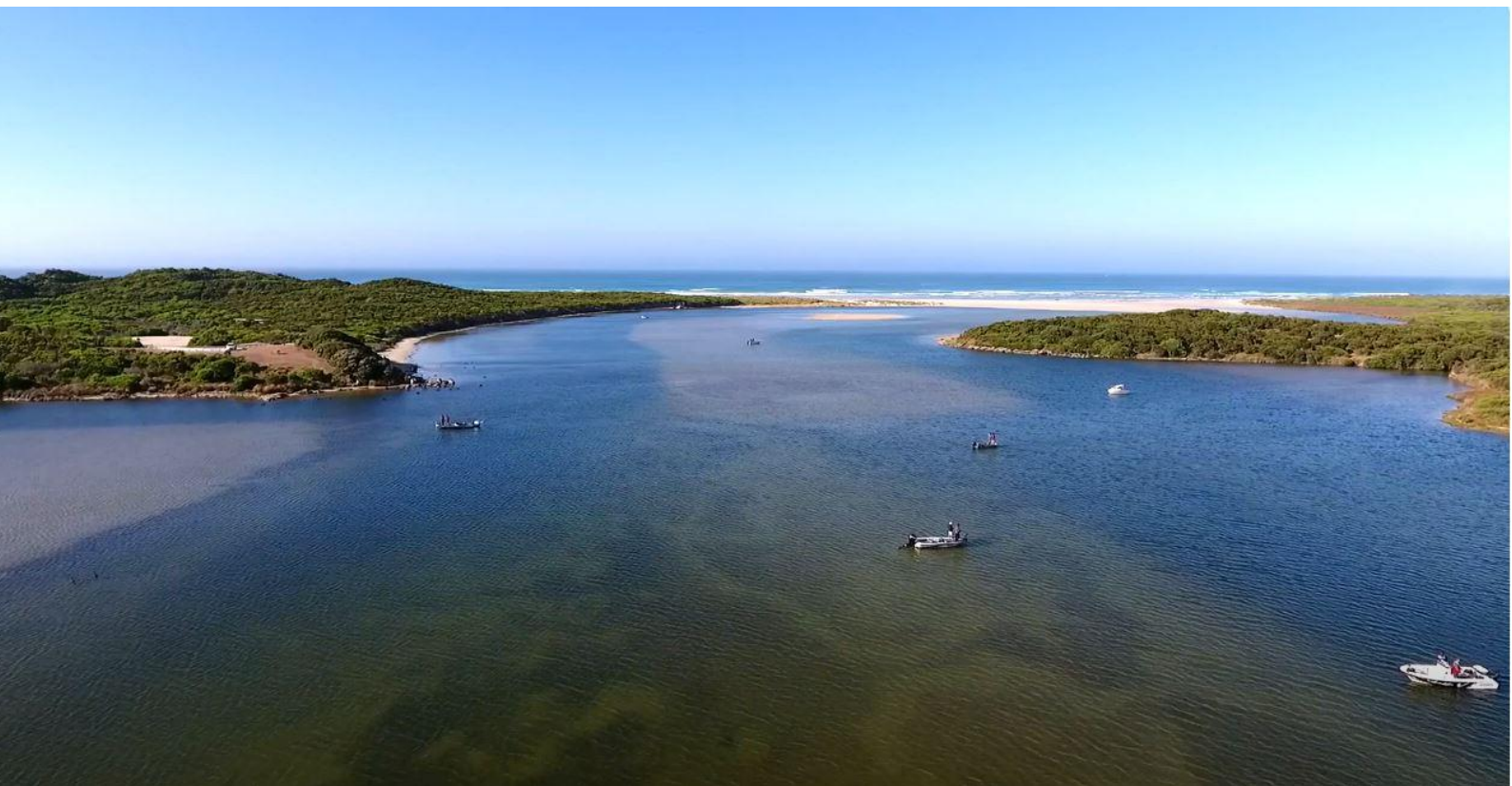


Glenelg Hopkins Climate Impacts Paper

Planning for the waterways of the Glenelg Hopkins region under a changing climate



Prepared by Glenelg Hopkins CMA

December 2025



Contents

Planning for the waterways of the Glenelg Hopkins region under a changing climate 4

 Climate related impacts on our waterways include:..... 4

 Rainfall and runoff – Victoria’s changing hydrology 5

 Impacts of climate change and drought on the hydrology and geomorphology of rivers in the Glenelg Hopkins region..... 5

 Impact on environmental water entitlement 6

 Impact on estuaries 7

 Impact on urban areas..... 7

 What does this mean for how we care for the waterways of the Glenelg Hopkins region? 7

REFERENCES: 9

EXECUTIVE SUMMARY

The Glenelg Hopkins CMA is developing a Regional Waterway Strategy (RWS) to guide collaborative efforts in improving waterway health amid accelerating climate change. Climate change is already reshaping Victoria's hydrology and ecosystems, with observed trends including:

- **Temperature rise:** +1.2°C since 1910; hotter, more frequent heatwaves.
- **Rainfall decline:** >10% reduction in cool-season rainfall over 30 years; step-change reduction in streamflows.
- **Extreme events:** More intense short-duration rainfall, longer dry periods, rising sea levels, and increased bushfire severity.

These changes threaten waterway health, biodiversity, and community values. Key impacts include:

- Reduced streamflows and runoff (median projection: 14% decline under 1.5°C warming).

Increased algal blooms, invasive species, and estuary closures.

- Higher flood magnitudes east of the Grampians and severe erosion risks.
- Transformation of river flow regimes (e.g., perennial streams shifting to intermittent or ephemeral).
- Rising estuary salinity and acidification risks.
- Potential reductions in environmental water entitlements for regulated systems like the Glenelg River.

Adaptation is essential. The RWS will focus on three approaches:

- **Resilience:** Maintain and restore current ecosystems.
- **Transition:** Support gradual shifts to new states.
- **Transformation:** Manage irreversible changes with innovative solutions.

Healthy waterways are more resilient, supporting ecological, cultural, and recreational values. Management will continue core activities (revegetation, fencing, pest control) but adapt species selection, scale, and timing. Flexible, region-specific planning will be critical to address ongoing and future climate challenges.

Planning for the waterways of the Glenelg Hopkins region under a changing climate

The Glenelg Hopkins CMA is leading the development of a regional waterway strategy (RWS) to guide how we work together to improve the health of the region's waterways, even as our climate changes.

Climate change presents a critical challenge to the management of Victorian waterways, impacting their health, biodiversity and the communities that rely on them. We have already experienced the following changes in climate and hydrology:

- an increase in average temperature by 1.2°C since 1910 and by around 1.4°C since the pre-industrial era.
- an increase in maximum temperatures and frequency of hot days
- heatwaves are becoming hotter, more frequent and starting earlier
- a decrease in average rainfall in all seasons except summer
- a more than 10% decline in cool season rainfall over the past 30 years
- a step-change reduction (rapid decrease) in stream flows over the past 30 years
- a decrease in average annual rainfall with short-duration rainfall events becoming more intense
- more extended dry periods and changing flood patterns
- sea level rise of around 1.7mm/year since the early 1900s and 3.1mm/year since 1993
- an increase in bushfire frequency and severity

These changes pose significant challenges to our waterways, affecting their flow regimes, water quality and overall ecosystem health. This in turn impact the ability of our waterways to support other regional values and uses.

Climate related impacts on our waterways include:

- increased frequency of algal blooms and potential for fish deaths
- conditions favouring invasive species
- increased storm surges
- increasing size and height of estuary mouth berms
- increasing periods of estuary mouth closures
- lower groundwater contributions to stream flows and wetland levels in groundwater dependent systems
- increase in the number of larger floods, and accompanying higher water velocities, due to extreme rainfall events could impact ecosystems by removing instream habitat features
- decreasing surface runoff to rivers. Averaged across Victoria, the median projection is for mean annual runoff (or water availability) to decrease by 14% under 1.5°C global warming
- decreasing streamflows which could result in the loss of spawning cues for migratory fish species or expose more barriers (natural and artificial) to impede the movement of fish. This flow reduction, and subsequent slower water velocities, could also increase streambed deposition leading to a less diverse and possibly less healthy stream ecosystem (fish and macroinvertebrate communities) through habitat smothering
- increasing water temperatures that could impact fish migration where fish use temperature as a spawning cue
- increased risk of compounding events such as extreme rainfall following flood resulting in reduced water quality
- increased risk of estuary acidification. Climate change projections could result in more extreme droughts and floods, which could initially lower water levels (exposing Acid-Sulphate Soils to oxygen then releasing large amounts of acid into rivers, making them more acidic and potentially lethal to aquatic life
- increased streambed sedimentation. The more frequent and intense rainfall events under a changing climate could increase hillslope erosion and stormwater runoff, leading to greater sediment loads entering river systems, which in turn could cover and smother fine substrates

Given these long-term trends, waterway management must continue to be innovative, adaptable and region-specific. Waterways must be managed in a way that supports their biodiversity and sustains ecological function and communities, while continuing to provide for other values and uses.

Future projections indicate that these trends are very likely to continue. Victoria's climate is highly variable but getting warmer and drier on average. Our rainfall patterns are changing and will continue to change. Hot days and nights will become hotter and heatwaves will be more intense and last longer. Extreme rainfall events will continue to become more intense, and sea levels will continue to rise (DEECA 2024). Drought duration, intensity and the percentage of time spent in drought are also projected to increase.

Rainfall and runoff – Victoria's changing hydrology

Most of the rainfall and runoff in Victoria occurs during the cooler half of the year. The reductions in cool season (April–October) rainfall have a disproportionately large impact on water availability because this is the time of year when a larger proportion of rainfall becomes runoff. The increased intensity of short-duration, extreme rainfall events, is not expected to offset the water availability impact of overall declines in rainfall.

Average runoff has declined over recent times, largely due to rainfall declines and increases in evapotranspiration. Generally, a 10 per cent reduction in rainfall might lead to a 20–30 per cent reduction in streamflow (DEECA 2023). However, runoff reductions in some catchments are larger than expected from reduced rainfall alone. There was a change in the rainfall–runoff relationship in many Victorian catchments in the Millennium Drought (1997–2009). More than half of the Victorian catchments analysed experienced an extra 20–40% decline in their annual streamflow due to the shift in rainfall–runoff relationships. Despite some wet years, about one third of catchments have seen no recovery in runoff, this includes many of catchments within the Glenelg Hopkins region.

Shifts in the rainfall–runoff relationships were largely governed by catchment resilience or vulnerability to drought, rather than differences in drought severity. Groundwater–surface water disconnection is also an important feature of catchments with shifted rainfall–runoff relationship during the drought.

The current generation of hydrologic models do not replicate well the observed changes in the rainfall–runoff relationship during and after extended drought. Changes in regional hydrology and rural flooding will depend on the conditions in any given catchment.

Impacts of climate change and drought on the hydrology and geomorphology of rivers in the Glenelg Hopkins region

During the Millennium Drought most of the rivers in the Glenelg Hopkins region, experienced the decline in the rainfall–runoff relationship. This appears to have resulted in a step change with most of our gauged rivers are experiencing a decline of around 50% in average annual flow since 1997.

Whilst hydrological analysis is incomplete, analysis done to date by the CMA shows several key changes that are of ecological significance:

- An overall reduction in flow for all but a couple of near coast streams
- An increase in cease to flow and near cease to flow events
- A reduction in the frequency of small to medium-sized floods in almost all rivers
- A reduction in the magnitude and frequency of large floods for waterways west of the eastern side of the Grampians (Gariwerd) National Park
- Conversely, a clear increase in the magnitude and frequency of severe floods for waterways east of the Grampians (Gariwerd) National Park (since 2010).

The vulnerability of rivers to these climate change impacts was modelled for the GHCMA Climate Change Strategy 2016–2023 (Glenelg Hopkins CMA 2016) and indicates that on fenced, revegetated or protected public land, vulnerability is lower than in other areas. Rivers in the northern half of the region are particularly vulnerable and about a

third of waterways in the region have high vulnerability beyond 2070. Coastal wetlands are vulnerable to threats such as sea level rise and storm surge in addition to reduced freshwater inputs.

Bond *et al.* (2008) noted that it is critical to recognise that the natural capacity (both resistance and resilience) of aquatic ecosystems to cope with drought has been lost or much reduced in many regions, but particularly in those impacted by intensive land use, loss of riparian vegetation, barriers to movement and altered flow regime.

The increased magnitude and frequency of severe floods in the eastern portion of the catchment overlaps with a large area of the Dundas Tablelands, which has some of the most erosion prone soils in Victoria. Historically, gullying and bank erosion within this area was driven by inappropriate land-use practices (overstocking, insufficient groundcover, stock access to waterways), rabbits, clearing of vegetation etc. However, despite improvements to land-use practices, since 2010 there have been 3 significant floods leading to erosion events. The GHCMA has run flood recovery programs following each of these events but has found that engineering solutions that were previously effective for mitigating erosion (e.g. trickle pipes) are failing prematurely. This is believed to be primarily because the design capacity of these structures is being exceeded by the increased magnitude of rain and flood events.

There have been numerous impacts on waterways within the region including the transformation of Fiery Creek from a wet intermittent (cease to flow >1% but less than 25% of the time) to dry intermittent stream (cease to flow >25% but less than 50% of the time), whilst the upper Mt Emu Creek has transformed from a dry intermittent stream to an ephemeral stream (cease to flow >50% of the time). The Hopkins River at Ararat and Burrumbeet Creek seems to be supported by groundwater inflows and the Hopkins River at Wickliffe remains a wet intermittent stream despite a significant drying from 9% of days cease to flow to 22%.

The increase in near to cease to flow events indicates that further future drying of the catchment could have the potential to initiate additional transformational change and with cease to flow events becoming more frequent and lasting longer. If a similar drying step change was to occur between now and 2065, speculative states of the waterways might be:

- Hopkins River at Ararat transforms from a perennial river to a wet intermittent river
- Hopkins River at Wickliffe transforms from a wet intermittent river to a dry intermittent river
- Fiery Creek at Streatham undertakes a second transformation from a dry intermittent river to an ephemeral river
- Mt Emu Creek at Mena Park may remain an ephemeral river, but with increasing frequency of zero flow years (currently 2006 and 2015 are the only 2 years with zero flow, and another 3 with less than 100 ML for the year).
- Burrumbeet Creek – Possibly transitioning towards a wet intermittent stream (though the development of land within its catchment for housing may have an influence on this).

Impact on environmental water entitlement

The Glenelg River is a regulated river system due to the construction of Rocklands Reservoir in 1951.

Although all water in the river is a part of the environment, the timing and quantity of water released from Rocklands Reservoir as 'Water for the Environment' serves a specific purpose to keep our river healthy and clean. In drier times, this water release becomes a vital resource to help manage salinity and create streamflow, ensuring water is available for plants, animals and people that depend on the river when they need it most.

Water for the environment is water that's set aside and can be release in times of need. It helps to maintain and improve waterway health but maintaining or improving connectivity, water levels and water quality.

The seasonal watering plan is a state-wide plan outlining where, when, and why water for the environment can be delivered throughout Victorian waterways.

The water entitlement available for use in the Glenelg River could be negatively affected by climate change. Under severe climate change the allocation for the Glenelg could drop significantly (HARC 2025), this would have severe consequences for nature and cultural uses.

Impact on estuaries

Low-lying coastal wetlands and shallow wetlands rely on rainfall and are affected by saltwater intrusion from the sea. Increased drought frequency and intensity, decreases in freshwater inputs, rising sea levels and increases in coastal storm surges will increase wetlands and estuary salinity. These conditions are likely to change the character of coastal wetlands through a reduction in size and/or a shift from one wetland type to another (e.g. brackish to saline).

Most of the estuaries within our region close from time to time (referred to as Intermittently Closed Salt Wedge estuaries) following the formation of a sand bar at the estuary mouth. With the decrease in stream flow and an increase in the height of the berm, our estuaries are becoming more likely to close and stay closed for longer. In the longer-term, sea-level rise and storm surge could significantly alter our estuaries increasing estuary opening periods due to high water levels. If coastal wetland communities are not protected and allowed to migrate inland, then they are likely to be lost to sea level rise (South West Climate Change Portal, n.d.).

Impact on urban areas

The impact of climate change on urban areas in the Glenelg Hopkins region is covered by Central Highlands Urban Water Strategy (2022), Wannon Water Urban Water Strategy (2022) and Glenelg Wimmera Mallee Water Urban and Rural Water Strategy (2022). It is anticipated that much of the impact of climate change on waterways in urban areas will be on social and economic values and that urban development will continue to put pressure on environmental values.

What does this mean for how we care for the waterways of the Glenelg Hopkins region?

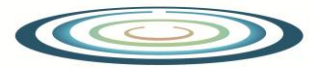
The natural environment has some capacity to adapt to climate change, but its ability to do so varies across ecosystems and species. Waterways that are already degraded and subject to significant ongoing threats are likely to be least resilient to the impacts of climate change and vulnerable to transformations (to a new type of system) once an ecological threshold is crossed.

The social, economic and cultural values of waterways will also have varying levels of resilience to climate change. For example, extreme events may repeatedly impact cultural sites or particular infrastructure through flooding or coastal erosion. Sites highly valued for recreation may no longer support water based activities due to lack of water or water quality issues.

Adaptive approaches are crucial for setting regional outcomes through the RWS, as they consider all factors affecting waterway values and conditions and allow for flexible solutions with multiple benefits.

There are 3 categories of adaptation approaches that can be used to help inform the planning and management of waterway values

1. **Resilience** – the ecosystem/value will be impacted but has the capacity to recover to its previous state i.e. the key river processes and structures that support the ecosystem or value can be returned. Management involves minimising the impacts of threats and supporting existing waterway values to be maintained or improved (persist or restored in their current locations).
2. **Transition** – the ecosystem/value will be impacted and will not recover to its previous state. Waterway values can change in structure or composition. Management involves supporting existing waterway values/systems to incrementally move to a new state by maintaining the integrity of ecosystems and processes.
3. **Transformation** - Transformation – the ecosystem/value will be impacted when a step change or tipping point is reached and will not recover to its previous state. This may result in new waterway values and new



management outcomes. Waterway values and systems may need to be managed in novel ways to address the root causes of vulnerability. This is especially important for those undergoing rapid and significant transformation, or those that have already reached a tipping point and changed irrevocably, such as following an extreme event.

The better condition our waterways are in the more resilient they will be to the changing climate and extreme events. As such it is essential that we continue and build upon the important work that has already been done in improving waterway health. Resilient waterways also support the range of other values including fishing, boating, kayaking and swimming. Healthy and resilient waterways also provide water quality suitable for a range of agricultural uses and provide cooler greener environments in urban areas providing a refuge from urban heat and benefiting mental health and wellbeing. We also acknowledge and respect the continuing and strong links between the health and wellbeing of first nations people and healthy waterways.

The range of programs and activities in waterway management are unlikely to change – revegetation, fencing, weed and pest management will all continue. However, where these activities occur, the range of species we may plant or target may change and the scale at which we work may change. There are also opportunities for innovative new approaches. Flexible implementation planning for the delivery of the RWS will assist with ensuring the right approaches are applied, in accordance with season and long-term climatic conditions, budgets and resourcing and regional knowledge.

References:

Alluvium. 2025. *DRAFT Summary of Current and Future Streamflow: Glenelg Hopkins CMA Region*.

DEECA. 2023. 'Climate Change Impacts'. Environment, Environment. <https://www.environment.vic.gov.au/natural-environment-adaptation-action-plan/climate-change-impacts>.

DEECA. 2024. *Victoria's Climate Science Report 2024*. <https://www.climatechange.vic.gov.au/victorias-changing-climate/Victorias-Climate-Science-Report-2024.pdf>.

Glenelg Hopkins CMA. 2016. *Climate Change Strategy - Responding to Climate Change in the Glenelg Hopkins CMA*. https://www.ghcma.vic.gov.au/wp-content/uploads/2017/05/FINAL_Climate_Change_Strategy.pdf.

HARC. 2025. 'Adapting To Climate Change-Stage2'. VEWH.

South West Climate Change Portal. n.d. 'Coasts and Estuaries'. Accessed 27 November 2025. https://www.swclimatechange.com.au/cb_pages/coasts_estuaries.php.

