



Australian Government

Department of Climate Change, Energy,
the Environment and Water

Managing Ramsar wetlands under a changing climate



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Department of Climate Change, Energy, the Environment and Water

GPO Box 3090 Canberra ACT 2601.

Telephone 1800 900 090

Web dcceew.gov.au

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Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

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Introduction

Purpose

This report brings together current tools and information to help Ramsar site managers and agencies respond now and in the future to climate changes that will impact Ramsar wetland values.

Our experience and understanding of natural resource management under a changing climate is rapidly evolving and this resource is intended to be reviewed and updated as significant advances are made.

About the Ramsar Convention

Australia is a party to the [Ramsar Convention on Wetlands](#), signed in the Iranian city of Ramsar on 2 February 1971. The Convention aims to halt and, where possible, reverse the worldwide loss of wetlands and to conserve those that remain through wise use and management.

As a party to the Convention Australia must designate sites for the List of Wetlands of International Importance and promote conservation of its listed wetlands, and as far as possible the wise use of other wetlands in Australia.

The definition of wise use of wetlands is ‘the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development’ ([Ramsar Convention 2005, Resolution IX.1 Annex A](#)).

The Convention defines ecological character as the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time (Ramsar Convention 2005, Resolution IX.1 Annex A). This definition recognises that wetlands are complex systems and emphasises the links between the ecological components, their processes or interactions, and the benefits or services they support.

Climate change in Australia

The world's climate is changing as a result of anthropogenic warming and will continue to change in the future (IPCC 2021). Australia's climate has warmed by around 1.47°C since 1910 (CSIRO & Bureau of Meteorology 2022). This has led to an increased intensity and frequency of extreme heat events, longer, more intense fire seasons, changes to rainfall and streamflow, warming and acidifying oceans and rising sea levels. These climate trends and extreme events have caused major impacts for many natural systems, with some experiencing risk of irreversible change in Australia (IPPC 2022). [The Australian State of the Environment Report 2021](#) (Australian Government 2022) documents the ways climate change has already impacted water resources and dependent biodiversity, with dry years and low streamflow, together with water extraction in many catchments, impacting species such as waterbirds and fish.

Regardless of emissions reductions and other mitigation measures that are required to be taken now to keep future warming below 2°C, impacts are locked in for the coming decades because of past actions (Australian Government 2019).

The Australian Government Bureau of Meteorology and CSIRO monitor, analyse and provide information on observed changes in Australia's climate and future climate projections. Together these organisations produce a biennial state of the climate report.

State of the Climate 2022 (CSIRO & Bureau of Meteorology 2022) documented the following observed changes:

- warming of Australia's climate by around 1.47°C and an increase in the frequency of extreme heat events
- decreases in cool season rainfall in the southwest and southeast of Australia
- increases in rainfall and streamflow across parts of northern Australia
- increases in extreme fire weather and the length of the fire season, especially in southern Australia
- ocean warming of around 1°C as well as ocean acidification
- sea level rise and more frequent extremes leading to increased risk of coastal inundation.

Australia is projected to experience:

- continued increases in sea and air temperatures, with more hot days and marine heatwaves, and fewer cold extremes
- further sea level rise and ocean acidification
- decreases in cool season rainfall across southern and eastern Australia with more time in drought, but an increase in intense heavy rainfall events
- more dangerous fire weather
- fewer but more intense tropical cyclones.

Wetlands and climate change

Impact of climate change on wetland ecosystems

Wetlands are valuable ecosystems that support rich biodiversity. They provide important ecosystem services – sequestering carbon, supplying freshwater for human needs, supporting food production, purifying and filtering harmful waste and pollutants and providing protection from floods and storm surges (Ramsar Convention 2015). Wetlands also provide services related to climate change mitigation and adaptation. (Ramsar Convention 2021).

Under current and future emissions scenarios, it is expected that significant change to the character of existing ecosystems, including wetlands, is inevitable (Ramsar Convention 2021; IPCC 2014; Dunlop et al. 2013). Wetlands are among the ecosystems considered most vulnerable to the effects of climate change (Ramsar Convention 2012; Finlayson et al. 2017). They are sensitive to changes in rainfall and increased temperature and evaporation (Boulton et al. 2014). It is likely that aquatic ecosystems will degrade (Green & Moggridge 2021) and shifts in wetland values will occur.

As temperatures rise and evapotranspiration increases, permanent wetlands will become seasonal, and seasonal wetlands ephemeral; the composition of species in alpine wetlands will change as temperatures rise and snow melts; and as sea levels rise, intertidal wetlands will migrate inland, where this is possible. Wetlands in coastal regions may be further affected by sea level rise and more extreme storm surge events (Paice & Chambers 2016). Globally it is projected that between 20 and 90% of current coastal wetlands will be lost by 2100 especially where landward migration is constrained by topography or human modification of shorelines (IPCC 2019).

Climate change impacts are likely to interact with existing land use impacts so that ecosystems, including wetlands, already subject to anthropogenic impacts such as those resulting from water regulation and extraction, agricultural land clearing and urban, industrial and port development are less resilient and more likely to be significantly affected and less able to adapt (Gell, Mills & Grundell 2012; Finlayson et al. 2017; Lukasiewicz, Pittock & Finlayson 2016; Kingsford 2011). Separating the effects of existing anthropogenic impacts from those attributable to climate change is likely to be difficult (Finlayson et al. 2013). Climate change will also interact with natural variability and climate extremes will coincide to intensify impacts – for instance a drought that coincides with an extremely hot day or an extended heatwave.

Ecosystem changes attributable to climate change are already being observed including shifts in the geographic ranges, seasonal activities, migration patterns, abundance and species interactions of many terrestrial, freshwater and marine species (Groves 2012; IPCC 2014; Pecl et al. 2017).

Biodiversity loss, including loss of threatened species resulted from Australian bushfires of unprecedented magnitude that occurred between August 2019 and January 2020. These fires, exacerbated by hotter, drier weather attributed to climate change, impacted large areas of habitat and many plant and animal species (Australian Government 2020). The catchments of some Ramsar wetlands were extensively burnt during these fires and there may have been direct impacts on sites due to an influx of pollutants or hydrological changes. For example, the 2019-20 bushfires burned

870,000 ha in the Victorian Gippsland region including large areas in the catchment of the Gippsland Lakes Ramsar site, where water quality was impacted (Kirono et al. 2022).

These climate driven events highlight the need for conservation measures that account for the increasing impacts of projected climate change including extreme events. These could include fire and water adaptation planning and actions, targeted research to fill knowledge gaps and transitioning ecosystems to a state that will suit future conditions.

The uncertainties about multiple possible futures under a changing climate, exacerbated by limited knowledge about how species and ecosystems will respond to climatic changes, need to be considered in planning adaptation responses (Rissik, Boulter & Doerr 2014).

As climate change progresses, further changes are likely to occur. For Parties to the Ramsar Convention, who are required to maintain the ecological character of listed wetlands, this is a particular challenge.

Ramsar wetlands and climate change vulnerability

Many of Australia's 67 Ramsar sites are likely to be at risk of change in ecological character associated with climate change in combination with other anthropogenic impacts. Already, changes to ecological character resulting from climate change have been documented for Australian Ramsar sites. For example, Muir Byenup wetland system in Western Australia has experienced a reduction in rainfall, resulting in reduced groundwater discharge and the drying out of the wetland and exposure of acid sulfate soils, leading to acidification. The Head of the Australian Ramsar Administrative Authority has published a [statement on climate change and wetlands](#) that recognises this situation and the work being done to address it.

All parties to the Ramsar Convention are expected to remain informed of any changes to the ecological character of Ramsar sites in their territory and to notify the Ramsar Secretariat at the earliest opportunity if the ecological character of a site has changed or is likely to change (Ramsar Convention 1987, Article 3.2; further clarified in Ramsar Convention, 2002, Resolution VIII.8, 2002b). Change in ecological character is defined as the human-induced adverse alteration of any ecosystem component, process and/ or ecosystem benefit or service (Ramsar Convention 2005, Resolution IX.1 Annex A). However, the Ramsar Convention has not provided guidance to Parties concerning how climate change induced impacts should be treated in the context of the requirement for formal notifications under Article 3.2. To date Australia has not made any formal notifications under Article 3.2 where climate change is the main driver of ecological character change.

To support effective management of Australia's Ramsar wetlands as our climate changes, guidance on how to consider, plan for and adapt to climate change is needed. This resource is one element in a suite of activity planned to build this support. It is the result of collaborations with government officials from across Australia's states and territories and Commonwealth government. Ongoing collaborative work programs will assess vulnerability and plan for adaptation at Ramsar listed wetlands in the Murray Darling Basin and nationally. Additional tools and activities to build capacity for adaptation planning for Ramsar and other high value wetlands, including in northern Australia are underway.

Resources for managing wetlands

Australian and international published research provides scientifically robust information that describes global and regional climate changes, projections of future climate and likely impacts on components and processes that support Ramsar values.

This section outlines some resources available to support knowledge and understanding of wetlands and climate change and to facilitate adaptation planning and actions to support the ecological character of wetlands. A list of resources is included at the end of this document.

International resources

The Ramsar Convention provides information to support wetland management in the form of articles of the Convention, Convention resolutions and published Ramsar technical guides and handbooks.

For example:

- The Ramsar Strategic Plan 2016–2024 specifically includes climate change mitigation and adaptation: for example, Target 12: Restoration is in progress in degraded wetlands, with priority to wetlands that are relevant for biodiversity conservation, disaster risk reduction, livelihoods and/or climate change mitigation and adaptation.
- Resolutions of Conferences of the Parties urge Contracting Parties to manage their wetlands wisely to increase their resilience to climate change (Resolution X.24) and to maintain or improve the ecological character of wetlands to promote the ability of wetlands to contribute to nature-based climate change adaptation (Resolution XI.14). Other resolutions refer to specific wetland types, including to encourage the restoration of coastal wetlands in relation to their role in disaster risk reduction (Resolution XII.13), Blue Carbon values (Resolution XIII.14); and the value of Peatlands as carbon sinks (Resolution X.24; Resolution XIII.12).
- Ramsar Convention publications that provide technical and policy guidance in relation to climate change include Ramsar briefing note 10 – Wetland restoration for climate change resilience and Ramsar Technical Report 5 – A framework for assessing the vulnerability of wetlands to climate change.

The Intergovernmental Panel on Climate Change (IPCC) prepares comprehensive Assessment Reports about knowledge on climate change, its causes, potential impacts and response options. The IPCC also produces Special Reports, which are an assessment on a specific issue and Methodology Reports, which provide practical guidelines for the preparation of greenhouse gas inventories.

National resources

The Australian Government invests in activities that provide information that is relevant to managing wetlands under climate change. The Australian Government Department of Climate Change, Energy, the Environment and Water has published a national climate resilience and adaptation strategy for 2021 – 2025 (Australian Government 2021).

Some of the most significant Australian work includes reports and resources developed by CSIRO, Bureau of Meteorology (BOM) and the National Environmental Science Programme (NESP) Earth Systems and Climate Change Hub.

Nationally, information and tools are available from Climate Change in Australia (CSIRO and BOM); and CoastAdapt (the former National Climate Change Adaptation Research Facility, Australian Government Department of Environment and Energy). Climate Compass is the Australian Government's framework for understanding and managing the risks from a changing climate to policies, programs and asset management (CSIRO 2018). The framework has been used in the development of this resource.

The CSIRO and Bureau of Meteorology web-based portal Climate Change in Australia provides climate science information, reports, data and climate projections for Australian NRM regions and subregions. For example, the Regional Climate Change Explorer provides a clickable map of regional clusters and sub clusters (according to NRM boundaries). Summary information is displayed on projected average temperatures, number of hot days, rainfall trends including extreme events, mean sea level rise and fire weather. Available tools range from the easy-to-use clickable map to detailed datasets requiring user training.

The Australian Government has also developed the methodology for analysing the vulnerability to climate change of Ramsar wetland sites (Dunlop & Grigg 2019), which is described in more detail in this document.

State-based resources

Australian state and territory governments have published climate change policies, projections and guidance that can be used to support wetlands vulnerability assessment and adaptation planning. There are many resources and they include:

Queensland – [Pathways to a climate resilient Queensland – Queensland climate adaptation strategy 2017-2030](#), and [the Long Paddock – Queensland Future Climate Dashboard](#), a web based resource providing down-scaled climate projections.

New South Wales - [NSW climate change policy](#) (Office of Environment and Heritage) and [AdaptNSW](#) a website providing information and climate projections.

Victoria – [Victoria's climate change strategy](#) and [Victoria's future climate tool](#) which provides regional climate projections and guidance on risk management.

Tasmania – [Climate Action 21: Tasmania's climate action plan 2017-2021](#) (a new action plan is under development), and the [climate futures for Tasmania](#) project which provides assessments of climate impacts and climate modelling.

Northern Territory – [Climate change response: towards 2050](#), and [Climate change in the northern Territory - state of the science and climate change impact](#).

Western Australia – Western Australian climate change policy, [and Western Australian climate change projections summary \(Department of Water and Environment Regulation 2021\)](#).

[South Australia – South Australia government climate change action plan 2021-2025 and Guide to climate projections for risk assessment and planning in SA 2022 \(Department for Environment and Water 2022\)](#).

Assessing climate vulnerability

Assessing vulnerability to climate change can help managers understand how projected changes in temperature, rainfall and other climate variables are likely to affect critical components, processes and services and therefore the ecological character of Ramsar wetlands. Understanding vulnerability can inform the development of effective adaptive management strategies. The vulnerability assessment methodology outlined here provides a flexible guide for site managers that could be integrated into existing management processes.

Ramsar site vulnerability assessment methodology

The [methodology for analysing the vulnerability to climate change of Ramsar wetland sites](#) (Dunlop & Grigg 2019), provides a standard method to help Ramsar site managers explore future changes to individual wetland sites, understand their vulnerabilities, and consider the consequences for management. The process helps build a collective knowledge base to underpin adaptation planning. This will help site managers communicate clearly with wetlands stakeholders about maintaining values in the face of climate and ecological change. While the method is expected to be used primarily by Ramsar site managers, it could also be used by natural resource management agencies and other stakeholders, including developers.

The methodology has 3 stages with steps to guide users through the analysis:

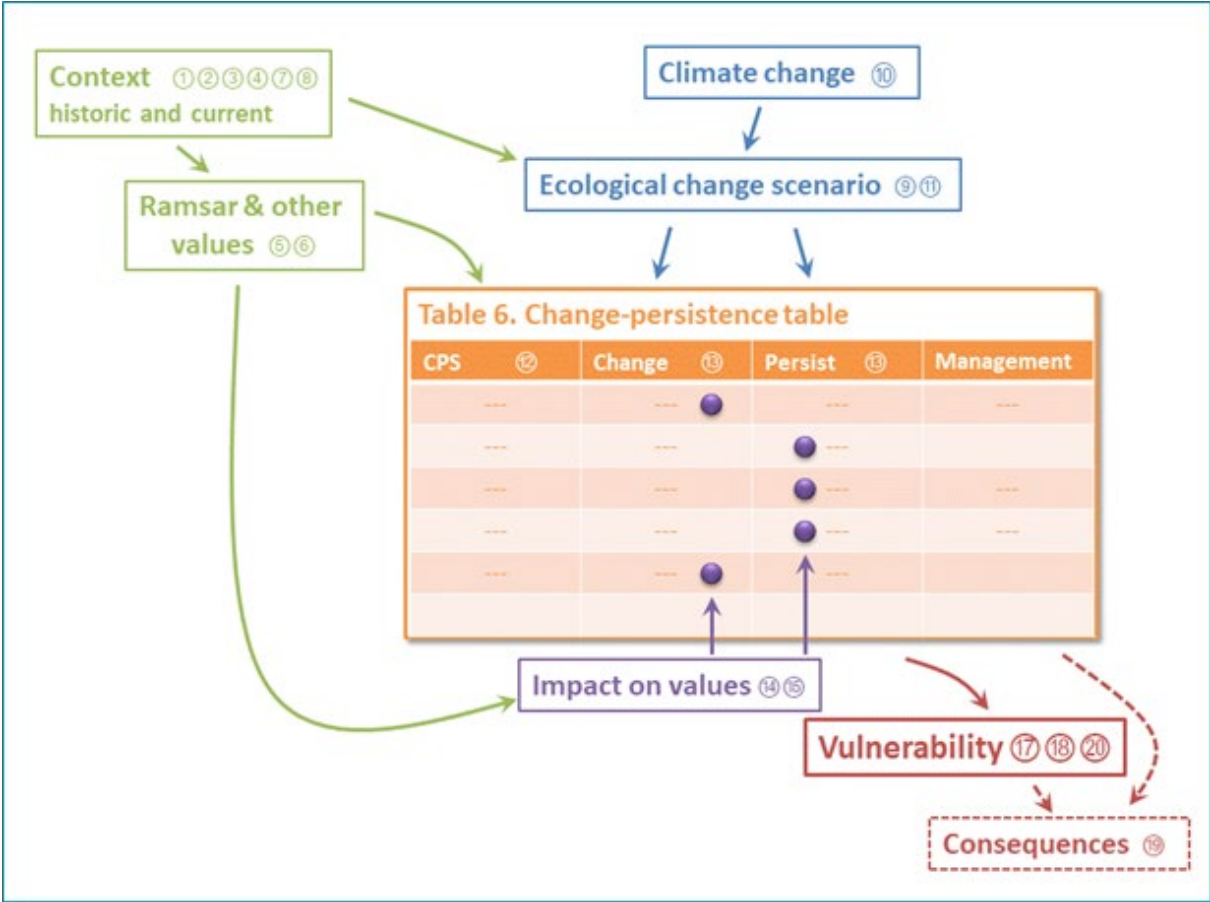
- **Stage 1** – Understanding context is about developing a shared basis for the analysis. Much of the context will be very familiar to site managers and documented in the Ecological Character Description and Ramsar Information Sheet. However, the methodology is a process of thinking differently about a site, and it helps to step back and explore the broader context, including the social and institutional setting and information from other stakeholders, to provide a foundation for the analysis.
- **Stage 2** – Scoping future impacts starts with initial concerns and known sensitivities about hydrological and ecological impacts, brings in climate change projections for the site or region, constructs a scenario of ‘greatest plausible change’ for the site, then constructs a ‘change-persistence table’ for the site. The change-persistence table documents understanding about how different features of the site might change and persist, then this is used to explore the consequences for Ramsar, and other values associated with the site, and some implications for future management and knowledge about the site.
- **Stage 3** – Interpretation guides the users through exploration of the results of Stage 2. It starts with a series of questions designed to facilitate deliberation among participants about the data collected in the previous stage. Guidance is then provided to elicit and document some key messages and conclusions about the vulnerability of the site. Users are also guided to document any insights or implications for policy or management that have been revealed, noting that structured adaptation analysis planning is beyond the scope of the methodology.

The methodology is consistent with the principles of the scan cycle in Climate Compass: a climate risk management framework for Commonwealth agencies (CSIRO 2018). The Head of the Australian Ramsar Administrative Authority recommends using the methodology for assessing the vulnerability

to climate change of Ramsar sites and other high value wetlands. The method has been applied at several Ramsar wetland sites, including the Gippsland Lakes Ramsar site in Victoria (Kirono et al. 2022).

Figure 1 summarises the steps that are undertaken to implement the vulnerability assessment methodology.

Figure 1 Workflow of Ramsar site vulnerability assessment methodology



Source: Dunlop & Grigg (2019)

Adaptation planning for Ramsar sites

Impacts to Ramsar values that are at least partly attributable to anthropogenic climate change have already been recorded at some Ramsar sites and this is likely to increase with projected climate change. This situation creates challenges for managing Ramsar sites to maintain ecological character in line with Ramsar Convention and EPBC Act requirements. Management approaches that incorporate a climate change adaptation planning process are likely to be more robust and realistic. Documenting and planning for climate impacts will maximise opportunities to build resilience and support wetland values as the climate changes. Adaptation planning will also support planning for restoration projects and environmental watering by improving understanding of long-term outcomes.

Climate change adaptation has been defined in the Australian Government's national climate resilience and adaptation strategy (Australian Government 2021) as “the process of adjusting to actual or expected changes in climate to reduce or avoid impacts or exploit beneficial opportunities”.

An adaptation planning process for a Ramsar wetland should include an understanding of climate change vulnerability or risk assessment. The methodology included in this resource can be used to build an understanding of the site's history, existing social and institutional setting and pressures, and relevant climate projections and the likely impacts on the critical components, processes and services of the site. Once a good understanding of site issues is gained, effective consideration of potential management actions can be undertaken. Outputs of the adaptation planning process can be documented in an adaptation plan, and this would ideally be integrated with existing adaptive management processes for the site.

Frameworks for adaptation planning and management

The basis for adaptation planning outlined in the previous section includes the identification of adaptation options. Documented experience in adaptation planning and implementation with respect to Ramsar wetlands is limited. However, frameworks for considering adaptation actions that managers can implement in protected areas and specifically for wetlands, including those referenced here, are available to assist decision-making. The [Climate change toolkit for World Heritage properties in Australia](#) (Lin, Melbourne-Thomas and Hopkins et al. 2022), is likely to be particularly useful for Ramsar site adaptation planning given the similarities between the two protected area types.

Adaptation actions can be categorised in different ways such as:

- management approaches that seek to prevent/avoid or accept changes brought about by a changing climate
- the scale at which actions may be undertaken – are they site based or at the landscape scale
- the time frame at which actions can be undertaken (now, soon or later?) – or do actions need to be undertaken in a particular order? (Tanner McAllister et al. 2017; and Finlayson et al. 2017).

Adaptation options may include actions that build resilience such as invasive species control, environmental watering or revegetating areas with species tolerant of hotter, drier conditions.

Other actions could include protection of refugia, translocation of threatened species and captive breeding programs.

Options such as hard engineering that aim to prevent change may be considered appropriate. These include examples such as providing shade for turtle nests or revegetation on riverbanks or building barriers to sea level rise. In some situations, significant hard engineering approaches might not be sustainable because of the scale of change anticipated and the cost of resisting change into the future as climate change progresses.

Adaptation actions can also be research activities, conceptual modelling, monitoring and evaluation programs, and other capacity building or community awareness raising activities. Monitoring and evaluation can inform a robust adaptive management approach – learning from experience and improving approaches through time. Investments in education and capacity building at various levels and scales can facilitate social learning and long-term capability building to reduce risk and enhance resilience (IPCC 2019).

Some climate change adaptation actions have co-benefits, for example actions such as restoration of vegetated coastal ecosystems including mangroves, tidal marshes and seagrass meadows (coastal ‘blue carbon’ ecosystems), could provide significant climate change mitigation benefits by storing carbon. Improved protection and management of degraded coastal habitat can also reduce carbon emissions from these ecosystems (IPCC 2019). Such actions that protect, manage and/or restore ecosystems to help address societal challenges (including climate change mitigation and adaptation) and provide benefits to biodiversity are sometimes termed nature-based solutions.

Principles for management under a changing climate

The following principles are based on the Australian Ramsar Management Principles and provide a framework for Ramsar site management under a changing climate.

Ramsar site vulnerability assessment and adaptation planning is:

- addressed in Ramsar management plans in a robust and defensible way using the best available science
- based on the Ramsar principles of wise use in order to maintain ecological character
- inclusive of a range of stakeholders and their values
- recognised as part of, and integrated into catchment scale natural resource management processes
- flexible
- integrates new knowledge and values iteratively through adaptive management
- acknowledges that current conservation frameworks may no longer be appropriate in the face of climate change impacts
- monitored, evaluated and reported on as part of adaptive management cycle.

Links to important documents

Links to documents referred to in this resource along with some other suggested sources are provided in this section.

Australian national wetlands tools and guidance*

- Policy statements which document the Ramsar Administrative Authority's position on key issues under the Convention (and national legislation).
 - [Statement on climate change and wetlands by the Head of the Australian Ramsar Administrative Authority](#)
 - [Australian Ramsar Management Principles](#)
- Convention guides – provide specific instructions for developing the site documentation required under the Ramsar Convention.
- Tools and other resources - provide suggested methodologies and practical examples for site managers.
 - [Climate change vulnerability assessment for Ramsar sites methodology](#)

* Web pages for Australian national wetlands tools and guidance are currently being developed. This section will be updated when development is completed.

EPBC guidance and regulation

- [Australian Ramsar Management Principles](#)
- [EPBC national significance Ramsar guideline](#)

Ramsar documents

- [Resolution X.24 – Climate change and wetlands \(2008\)](#)
- [Resolution XI.14 Climate change and wetlands: Implications for the Ramsar Convention on Wetlands.](#)
- [Resolution XIII.12 Guidance on identifying peatlands as Wetlands of International Importance \(Ramsar Sites\) for global climate change regulation as an additional argument to existing Ramsar criteria](#)
- [Resolution XIII.14 Promoting conservation, restoration and sustainable management of coastal blue-carbon ecosystems](#)
- [Resolution XII.13 Wetlands and disaster risk reduction](#)
- [Briefing Note 10 – Wetland restoration for climate change resilience \(2018\)](#)
- [Ramsar Technical Report 5 – A framework for assessing the vulnerability of wetlands to climate change](#)
- [Wetland Ecosystem Services Factsheet 10 – Climate change mitigation and adaptation](#)

Other information

- [IPCC reports](#)
- [Climate change in Australia](#)
- [Australian Government wetlands and climate change portal](#)
- [Australian Government climate change strategies](#)
- State agency climate change policies, programs and projections
 - New South Wales – [Taking action on climate change](#)
 - Victoria – [Victoria’s path to a net zero emissions and climate resilient future](#)
 - Tasmania – [Renewables, climate and future industries Tasmania](#)
 - South Australia – [Climate change](#)
 - Western Australia – [Western Australian climate change policy](#)
 - Northern Territory – [Climate change NT](#)
 - Queensland – [Climate action](#)
 -
- [National climate resilience and adaptation strategy](#)
- [Climate compass](#)
- [CoastAdapt](#)
- [National Environmental Science Program – Climate systems hub](#)
- [IUCN global standard for nature-based solutions](#)
- [Australian guide to nature-based methods for reducing risk from coastal hazard](#)
- [Climate change toolkit for World Heritage properties in Australia](#)

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