

Climate Change Adaptation Planning for Natural Resource Management in the Goulburn Broken Catchment

The Goulburn Broken Catchment Management Authority (CMA) coordinates natural resource management (NRM) in the Goulburn Broken Catchment in Northern Victoria, in collaboration with the community, all tiers of government, regional authorities and research and funding organisations.



The Goulburn Broken CMA has led the development of a Climate Change Adaptation Plan with its partners to help integrate climate change planning into NRM activities across the Catchment. The Plan identifies priority landscapes for climate change adaptation and carbon farming in the context of improving the resilience of natural resources and identifies management options for all groups involved in NRM to consider.

The Plan has been developed primarily for NRM planners (but may inform the work of researchers and implementers) to provide an initial prioritisation for climate change adaptation based on the vulnerability and values of natural resources – it is one important component of climate change adaptation decision-making but not the answer. Investigations to further understand the interactions between drivers of change in social-ecological systems and how key points of natural resource vulnerability may be overcome will continue.

The Plan contributes to strategic directions of the Goulburn Broken CMA's Climate Change Integration Strategy 2012-2015. The Strategy is one of several sub-strategies supporting the Goulburn Broken Regional Catchment Strategy (RCS). The RCS provides an integrated planning framework for managing land, water and biodiversity resources in the Catchment. It identifies 20 to 30-year objectives for these resources and outlines regional priorities and management measures to achieve these objectives.

The development of the Plan was managed by a multi-organisation steering committee and informed by extensive consultation with:

- Goulburn Broken CMA staff and Board
- Commonwealth, State and local government representatives
- representatives from regional NRM organisations across Victoria and the Murray Basin
- research institutions
- expert consultants
- community and industry representatives.

Influence of climate change on natural resource condition

Regional climate projections developed by the CSIRO for the Murray Basin (of which the Goulburn Broken Catchment is part) indicate that climate change will have the following impacts:

- average temperatures will continue to increase in all seasons
- hotter and more frequent hot days and longer warm spells
- fewer frosts
- less rainfall during the cool season by 2090
- increased intensity of heavy rainfall events
- a harsher fire-weather climate
- increased evaporation
- on an annual and decadal basis, natural variability in the climate system can act to either mask or enhance any long-term human-induced trend
- snowfall and maximum snow depth will continue to decline.

An analysis of the influence of climate change on the condition of natural resources has been undertaken using the Driver-Pressure-State-Impact-Response (DPSIR) model (see figure 2). Table 2 summarises the drivers and pressures with a high influence on natural resource condition that are expected to experience a change in influence under climate change.



Figure 2: The DPSIR model

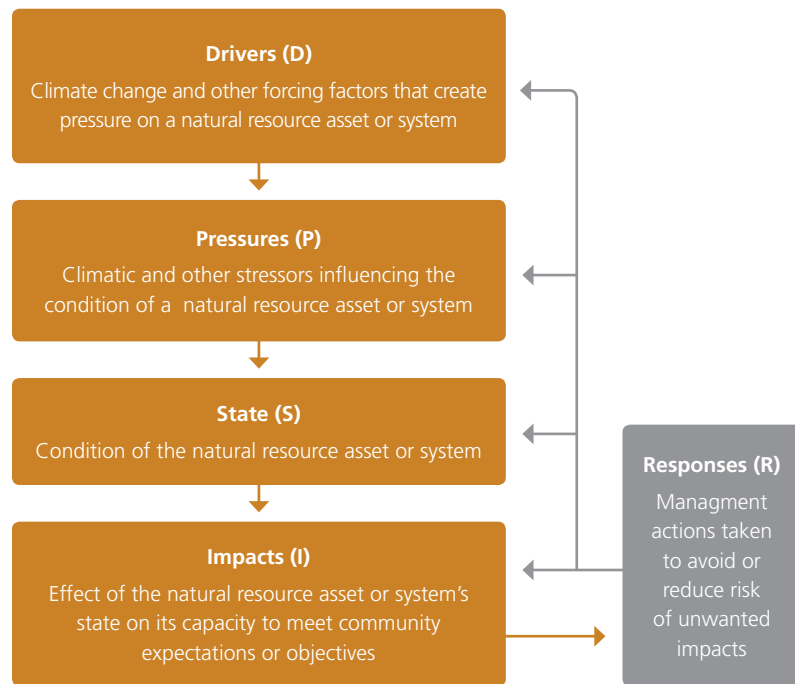


Table 2: Drivers and pressures with a high influence on natural resource condition that will experience a change of trend under climate change

Strongest drivers of and pressures on natural resource condition	Natural resource class	Trend in level of influence on condition under climate change
Drivers		
Climate variability and change	All	Increasing
Land use and management change	Land	Increasing
Water availability and policy reform	All	Increasing
Pressures		
Change in fire regime and management	All	Increasing
Change in rainfall regime	All	Influence high only under climate change
Cultivation, cropping, grazing, stock access	Land	Increasing
Extreme weather and climate events	All	Increasing
Increase in temperature	All	Influence high only under climate change
Infrastructure development	Water	Increasing
Invasive plants and animals	All	Increasing
Irrigation – regulation, drainage, diversion and storages	Land	Decreasing
	Water, Biodiversity	Increasing
Salinity	Land	Decreasing

Focus areas for climate change adaptation

Ecological change in response to climate change is unavoidable and will be widespread. Therefore the focus of climate change planning by the Goulburn Broken CMA is on adaptation strategies to maintain the resilience of social-ecological systems so they continue to deliver critical services and values for people and nature. A resilience approach recognises the need for adapting to drivers of change by countering risks and capturing opportunities they present.

A Spatial Assessment Tool was developed to assess the vulnerability of the Catchment's natural resources to climate change and identify focus areas for adaptation. The Tool can assist NRM planners to develop climate change impact scenarios based on spatial data with criteria able to be assigned different levels of importance.

The Tool is not an end in itself, but instead a means to assist NRM planners and decision-makers to understand the complex planning and decision-making environment.

The assessment of adaptation priority reflects four main attributes; exposure, sensitivity, adaptive capacity and value (environmental, social and economic) (see figure 1). A regional NRM planning framework review and the DPSIR analysis was used, in consultation with regional NRM planning stakeholders, to identify a set of criteria to assess adaptation priority (see table 1).

Using this assessment, eleven focus areas for climate change adaptation have been identified in two types of landscapes; each are of high value but differ in vulnerability under the climate change scenario for 2030:

1. Planned adaptation priority focus areas (see figure 3) have higher sensitivity and lower adaptive capacity and are of high value. Such areas should be considered first for developing and implementing management programs to address vulnerability to climate change.
2. Semi-autonomous adaptation priority focus areas (see figure 4) have lower sensitivity and higher adaptive capacity under current tenure and management and are of high value. Specific adaptation interventions may be not required above current management and tenure arrangement, however, given the high values present, a "watching brief" should be maintained to detect any changes in natural resource condition that suggests the need for adaptation.

Figure 1: The climate change adaptation prioritisation framework

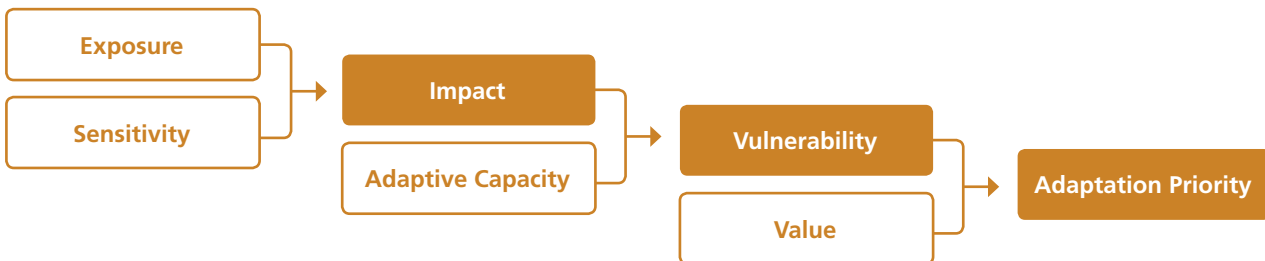
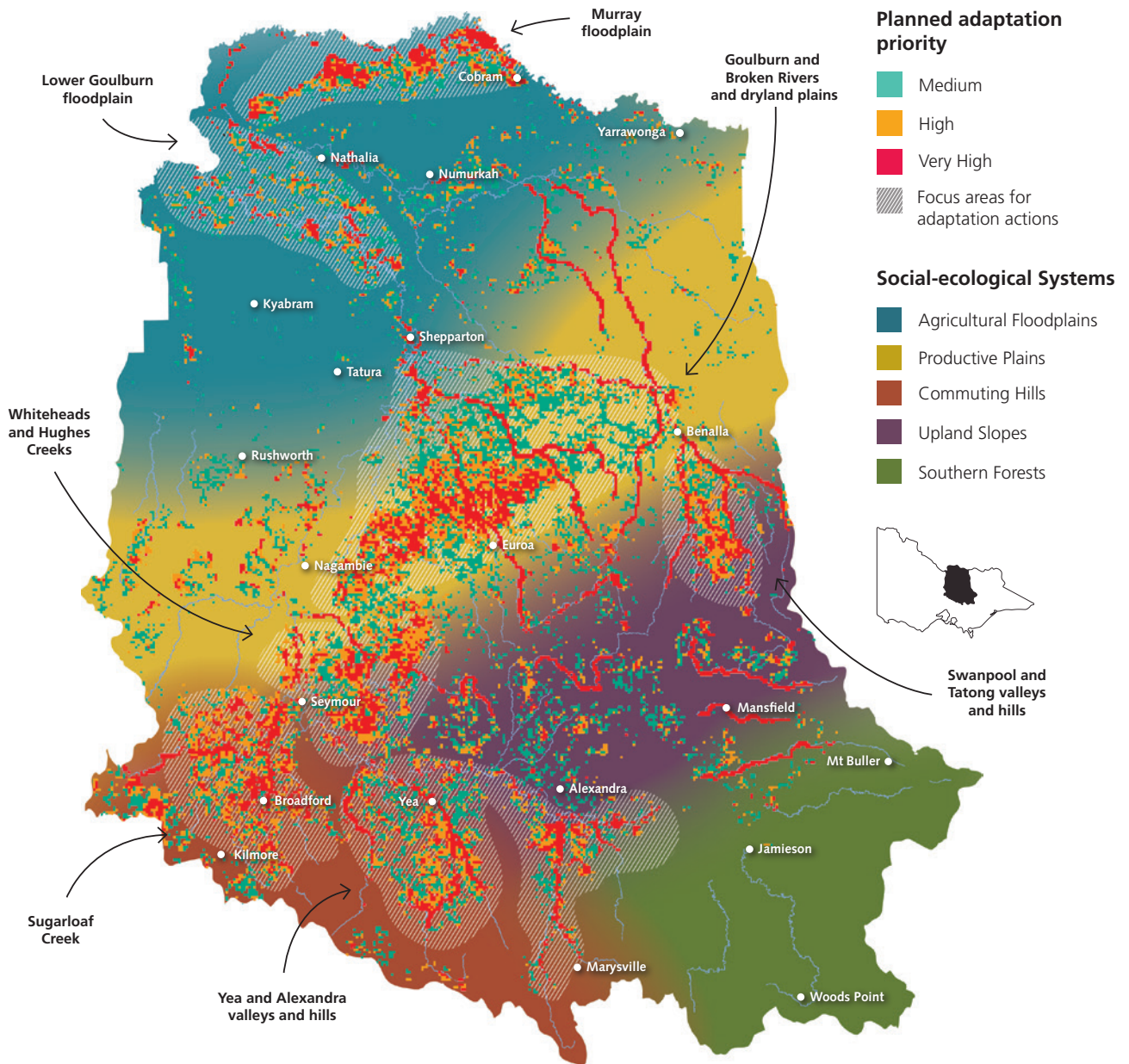


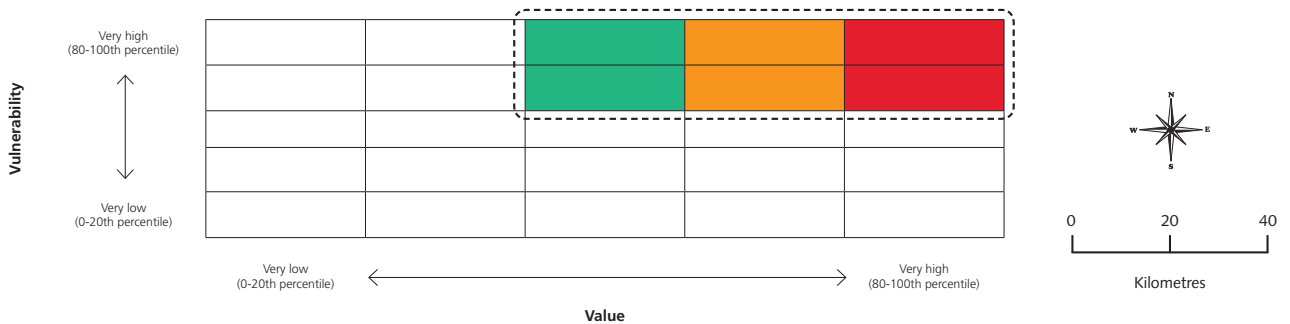
Table 1: Criteria for assessing adaptation priority

Exposure	Sensitivity	Adaptive capacity	Value
<ul style="list-style-type: none"> - Change in maximum annual average temperature - Change in average spring and autumn rainfall - Surface water yields - change in mean annual flow - Waterlogging and salinity – current shallow aquifer depth to water table - Area currently inundated in a 1 in 100 flood - Change in annual average minimum temperature 	<ul style="list-style-type: none"> - Native vegetation connectivity - Native vegetation condition - Index of stream condition - Native vegetation range under current conditions - Current land use - Land and soil health hazards - Proximity to wetlands 	<ul style="list-style-type: none"> - Tenure - Irrigation supply - Whole farm planning - NRM works 	<ul style="list-style-type: none"> - Biodiversity value - Stream reach and wetland value - Consequence of loss: <ul style="list-style-type: none"> - Environmental - Production - Infrastructure - Micro-refugia - Land value - Floodplain value

Focus areas for planned climate change adaptation



Planned Adaptation Priority Matrix (Clifton and Pelikan, 2014)



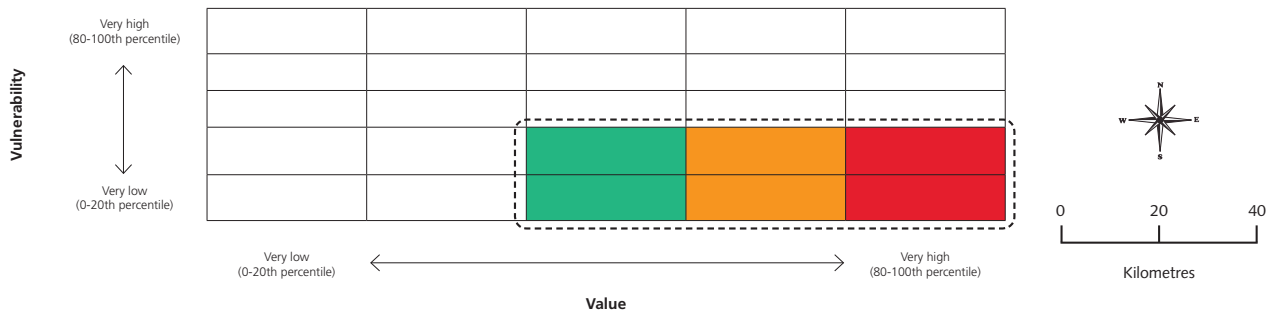
Please note: These maps are not intended to incorporate all decision-making elements but represent an initial prioritisation for climate change adaptation based on spatially-enabled criteria for vulnerability and value. Vulnerability is used to highlight locations and issues to focus further analysis, including risk assessment and management. These maps should be considered in conjunction with the Climate Change Adaptation Plan for Natural Resource Management in the Goulburn Broken Catchment, Victoria, 2016 in its entirety.

Figure 3: Priority areas for planned adaptation to climate change for natural resource management in the Goulburn Broken Catchment

Focus areas for semi-autonomous climate change adaptation



Semi-autonomous Adaptation Priority Matrix (Clifton and Pelikan, 2014)



Please note: These maps are not intended to incorporate all decision-making elements but represent an initial prioritisation for climate change adaptation based on spatially-enabled criteria for vulnerability and value. Vulnerability is used to highlight locations and issues to focus further analysis, including risk assessment and management. These maps should be considered in conjunction with the Climate Change Adaptation Plan for Natural Resource Management in the Goulburn Broken Catchment, Victoria, 2016 in its entirety.

Figure 4: Priority areas for semi-autonomous adaptation to climate change for natural resource management in the Goulburn Broken Catchment

Management options

The development of management options in the Plan represents only the first step in a process of detailed adaptive management planning for the Goulburn Broken CMA. Subsequent steps will include:

- engaging with stakeholders and communities
- continuing to investigate and understand the interactions between social-ecological systems and drivers of change and how key points of vulnerability to natural resources may be overcome
- assessing the feasibility and effectiveness of adaptation options to particular circumstances.

The process for developing management options draws on the vulnerability and adaptation priority assessment and the regional NRM planning framework review and considers the following five questions:

1. Adaptation to what?
2. Who or what adapts?
3. How are pressures and impacts currently being managed?
4. How effective are these responses anticipated to be?
5. What additional options could be considered?

Management options - Planned adaptation areas (see figure 3)

Modify the events

- Infrastructure construction to protect flood prone urban environments
- Develop and implement streamflow management plans (in catchments without them) to reduce impacts of farm dams and other forms of water interception on riparian, wetland and aquatic ecosystems
- Develop and implement groundwater management plans (in areas without them) to reduce impacts of groundwater use on groundwater-dependent ecosystems and drought refugia

- Perennial vegetation reinstatement in hill country to reduce flash run-off and flood, erosion and water quality impacts of extreme rainfall events (especially Yea River catchment)
- Address bushfire hazard in public land areas fringing the boundary of the Productive Plains, Upland Slopes, Commuting Hills and Southern Forests

Respond to the effects

- Strategic revegetation and native vegetation protection programs to:
 - identify and build the size and connectivity of key native vegetation remnants to nearby public land forest areas
 - strengthen water quality protection
- Strengthen native vegetation retention controls and planning to protect resilience features of high value remnant native vegetation patches and drought refugia
- Modify land use planning in flood zones of the Agricultural Floodplains focus areas to reflect projected changes in flood depth and extent with climate change
- Encourage revegetation and/or perennial grass establishment on hills to maintain groundcover and protect against erosion, salinity and flash flooding

Reduce the risk

- Reinstatement of floodplain function in the Agricultural Floodplains focus areas
- Retire highly flood-prone agricultural land from use in the Agricultural Floodplains focus areas
- Manage fire ignition risk e.g. electricity distribution lines, in areas with high risk from catastrophic bushfires
- Migrate residential and other flood sensitive land uses away from flood-exposed areas

Build adaptive capacity

- Research into the need and opportunity to introduce new species or provenances to maintain ecosystem function under climate change
- Peri-urban and lifestyle landholder natural resource management programs to encourage such landholders to engage in measures to protect soil health and remnant vegetation and to develop the skills and capacity for implementation; and to strengthen bushfire preparation and response capabilities

Management options - Semi-autonomous adaptation areas (see figure 4)

Reduce the risk

- Migrate settlements from interfaces with highest risk bushfire environment

Build adaptive capacity

- Research into resilience of alpine and restricted range species whose habitats are at high risk from climate change
- Research into long-term management of key fire sensitive environments under climate change
- Research into water resource impacts of climate change and potential implications for irrigation, environmental watering and urban supplies
- Monitoring of natural resource condition to detect trends indicative of climate change impacts to provide potential triggers for changed management



Australian Government

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