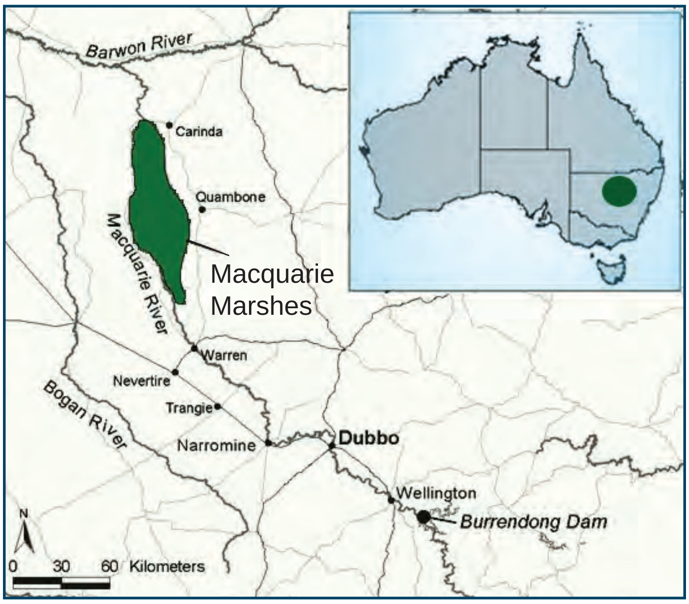
Limits to adaptation

NCCARF
National Climate Change Adaptation Research Facility

Climate change adaptation in floodplain wetlands: the Macquarie Marshes

Introduction

Adaptation is essential to address climate change impacts. However, the capacity of natural and human systems to adapt is limited, either by the severity of the climatic perturbation, or by vulnerabilities in the system. This is one of six regional case studies of the limits to adaptation that explore the underlying causes and potential to transcend these limits.



Context

Geographic

The Macquarie Marshes is an iconic floodplain wetland, occupying about 200,000 ha in central western New South Wales. Flows to the Macquarie Marshes come primarily from the Macquarie River, fed by five major tributary rivers. Around 10% of the Marshes is protected in the Marshes Nature reserve. The reserve and nearby Wilgara Wetland are listed under the RAMSAR convention due to their international significance, including for waterbird breeding.

Climatic

Located in the arid zone, the Macquarie Marshes receives less than 500 mm rainfall annually. Mean monthly temperatures range from 26.5°C in January to 12°C in July. The highest recorded temperature is 48.9° C and the lowest -4.2° C. Droughts, extended periods of low rainfall and/or low flow, are severe and common.

Human: economic, social

The Macquarie Marshes was traditionally occupied by the Wailwan people, and was culturally significant for traditional ceremonies. In addition to supporting significant ecological values, the Macquarie Marshes, with about 90% of the land privately owned, is also home to an established community of graziers who depend on river flows for their livelihood. There is an irrigation industry mostly upstream of the Macquarie Marshes.

Current stresses

The Macquarie Marshes are severely impacted by regulation that has reduced flooding volumes (by about half) and extended the inter-flood interval from 1-2 years up to 10 years last decade, to the point where the ecological character of the Ramsar site has changed. More than half the area of semi-permanent vegetation is degraded, being replaced by terrestrial plants. As a consequence organic matter and total carbon stores are declining and fundamental cycles at the base of the food web are shifting from dominance by respiration to primary productivity. In the current Marsh, waterbirds seldom breed and their communities contain reduced diversity and densities. Dormant microorganism eggs and acquatic plant seeds are reduced in areas that remain dry for periods longer than 10 years. Grazing productivity is significantly reduced, with long unproductive dry spells, and many families have moved away from the Marshes. Recent floods have resulted in a significant response in most biota, including waterbirds.

Climatic or flow variable	Scenario 1 median	Scenario 2 dry	Scenario 3 wet	Scenario 4 2070 [1]	Natural	Current
Temperature °C	+ 1.03°C	+ 1.6°C	+ 0.45°C	+ 4.0°C		
Mean annual rainfall	-2 %	-13 %	+ 11 %	n/a	544 mm	547 mm
Mean annual runoff	-6 %	-25 %	+ 30 %	n/a	35 mm	33 mm
Mean annual water availability	-8 %	-25 %	+ 25 %	-44 %		1567 GL
Average Inter Flood Interval (IFI)	+ 10% 5.2 yrs	+ 24% 18 yrs	- 25% 3.5 yrs	n/a	2.2 yrs	+ 114 % 4.7 yrs
Maximum IFI	n/a	+ 20%	n/a	n/a	7 yrs	15 yrs
Mean winter-spring flood volume/yr	-16 %	-38 %	+ 21 %	n/a	118 GL	75 GL
Mean winter-spring flood volume/event	-5 %	-6 %	+ 5 %	n/a	278	322

Future climate scenarios

Scenarios of a 2°C and 4°C warmer world

This table (left) shows the scenarios underpinning this discussion.

'The primary adaptation that will transform the Macquarie Marshes ecosystem from its current state of decline is the return of adequate environmental water'.

Impacts of future climate change

With a business-as-usual scenario the future Macquarie Marshes sees a worsening of all ecological and social indicators by 2030 and a marked decline by 2070. This is counterbalanced by increased delivery of environmental flows as a result of purchase of irrigation licences by the NSW and Australian governments.

Based on long term averages, changes by 2030 should be small compared to those already observed with regulation. However, another drought like the 2000-2010 'big dry' would significantly harm already degraded and vulnerable ecological and social systems. Drought incidence is projected to worsen. Nevertheless, the climate change projection for 2030 is within the current range of variability.

By 2070 the combination of markedly increased temperatures and reduced rainfall would see core Marsh areas further reduced and the possible loss of all floodplain with a short IFI (1-2 years). A series of droughts between now and then may destroy all but fringing red gum vegetation. Carbon and dormant egg/seed storage would be comparable to infrequently flooded wetlands on the Darling River and Cooper Creek. Waterbird populations are likely to plummet with few opportunities for recruitment and exotic species will replace many native fish. The 2070 projections would likely lead to few landholders grazing the Marshes and sheep replacing cattle.

Adaptation: options and barriers

The study identified two autonomous adaptations, four physical adaptations, seven institutional/political adaptations and eight land management adaptations. Most of these actions are currently at varying stages of application to counter impacts of loss of flooding due to regulation. At a workshop, stakeholders identified 16 high priority adaptations and discussed their limits and implementation. Water buy-back and environmental flows are key adaptations, but developing an adaptive management plan, social capital, responsive institutional frameworks and preserving free-flowing rivers were also identified.

Landholders graze the Macquarie Marshes using a flexible approach to deal with variability in the system. They identified loss of flooding and loss of variability as key impacts of regulation that reduce their resilience. Landholders have developed many practices to adapt to the loss of flooding that will enable them to adapt to climate change projections at 2030.

The primary adaptation that will transform the Macquarie Marshes ecosystem from its current state of decline is the return of adequate environmental water to restore the short and moderate IFI floodplain. If this occurs in the next 5-10 years, the Marshes should be buffered against the 2030 increased temperature and reduced runoff projections, although the projected drought increase creates uncertainty.

This technological adaptation will not succeed if the following changes do not occur to the social institutions (behaviours).

1. a transformation of society to increase the value placed on the natural environment of the Marshes so that it chooses to restore the short to moderate IFI floodplain
2. a review of the water sharing plan (WSP), guided by and the Murray-Darling Basin Plan, to specify shorter durations for the IFI so adequate water is held in Burrendong to prevent the short to moderate IFI floodplain being dry for longer than 2-4 years. These changes will improve capacity to manage water during droughts
3. implementation of a strategic adaptive management plan that identifies and proposes solutions to adaptation limits in governance.

Improvement in regional scale modelling capacity, enabling high spatial resolution climate change scenarios to be run for increased environmental flows (including carry over and increased volumes under water buy-back) will enhance development of adaptation strategies.

Policy implications: Limits to adaptation

The Macquarie Marshes, like wetlands globally, has experienced significant declines in biodiversity and populations due to regulation, and hence is increasingly vulnerable to projected climate change impacts.

A major limit to adaptation is the lack of capacity of river managers to learn from problems during drought periods and implement water sharing plans that avoid similar losses if climate change increases drought intensity and frequency.

This study examined the types of adaptations that reduce the climate change-induced extension of the IFI for floodplain wetlands. To achieve and sustain this, it is necessary to remove the biophysical drivers and to change the behaviour that causes the biophysical driver. Examples of adaptations that alter the biophysical driver, but not the behaviour, are trucking triage water (buffering), buying back adequate volumes of water and increasing the outlet capacity. However, if the water sharing plan, the main document that governs management of flow for flooding and IFI, is not changed then adaptation is limited.

This document summarises key findings from the NCCARF report *'Limits to adaptation in floodplain wetlands: the Macquarie Marshes'* by Kim Jenkins, Richard Kingsford, Ben Wolfenden, Stuart Whitten, Hannah Parris, Claire Sives, Rob Rolls and Sylvia Hay. Available at www.nccarf.edu.au
Images: This page: Cameron Muir. Overleaf: Eyeweed, Cameron Muir.