NCCARF
National
Climate Change Adaptation
Research Facility

Climate change impacts factsheet:

3. Water resources and freshwater biodiversity

Fresh water is essential for virtually all forms of life and human endeavour. But a significant imbalance between water supply and demand — the times and places we need water compared to where and when it is available — means our planet faces a water crisis. Human health, the environment, agriculture, energy and mining are all challenged by issues of water quality and quantity. While population growth and rapid economic development are partially responsible, a variable climate is a significant driver, and a changing climate is likely to strongly impact on freshwater resources in the future. The resulting change in freshwater availability will continue to challenge all aspects of human society and natural ecosystems.

Climate and water resources

Australia has one of the most variable rainfall climates in the world. In any 10-year period, we average three good years and three bad years. A major cause of these fluctuations is the climate phenomenon called the Southern Oscillation. This is a major air pressure shift between the Asian and east Pacific regions - its best-known extreme is El Niño. This strongly influences the availability of freshwater needed for cities, irrigation, industry and the environment. The impact of water availability on society was highlighted by the protracted drought in eastern and southern Australia, known as the 'Big Dry'. Lasting from 2001 to 2011, this led to the lowest recorded inflows to the Murray River. The breaking of the drought was followed by extreme rainfall and widespread flooding in 2010/2011. The social, economic and environmental costs of these events have been catastrophic.

Increased and competing demands for freshwater, mainly for drinking water and irrigation, have in places been accompanied by long-term and persistent reductions in supply. In south-western Australia, winter rainfall has declined significantly since the mid 20th Century and runoff and inflows to reservoirs, local groundwater and wetlands have all declined dramatically (see Figure 1). In addition to growing demand, other environmental and socio-economic stressors affect water resources and freshwater biodiversity including dryland salinity, land clearing, river regulation, over-allocation and inefficient use.

Future climate trends

Climate models mostly project a 2–5% decline in mean annual rainfall across Australia by 2030. Reductions in winter rainfall in south-western and southern Australia are likely, although some models suggest rainfall may increase, particularly during northern Australian summers. Reductions in the extent and duration of snow falls are highly probable.

Temperatures are projected to increase by 0.7–1.2ºC by 2030. Surface and groundwater hydrology is likely to change as a result of these climatic drivers, and coastal freshwater ecosystems are highly likely to be affected by rising sea level and salt-water intrusion

Climate change impacts and vulnerabilities

Projected future climate trends on hydrology are likely to have significant implications for water security and freshwater ecosystems, especially in southern and eastern Australia. The availability (or lack) of water has flow-on effects for many sectors in Australia. Some of the sectors most vulnerable to future trends include:

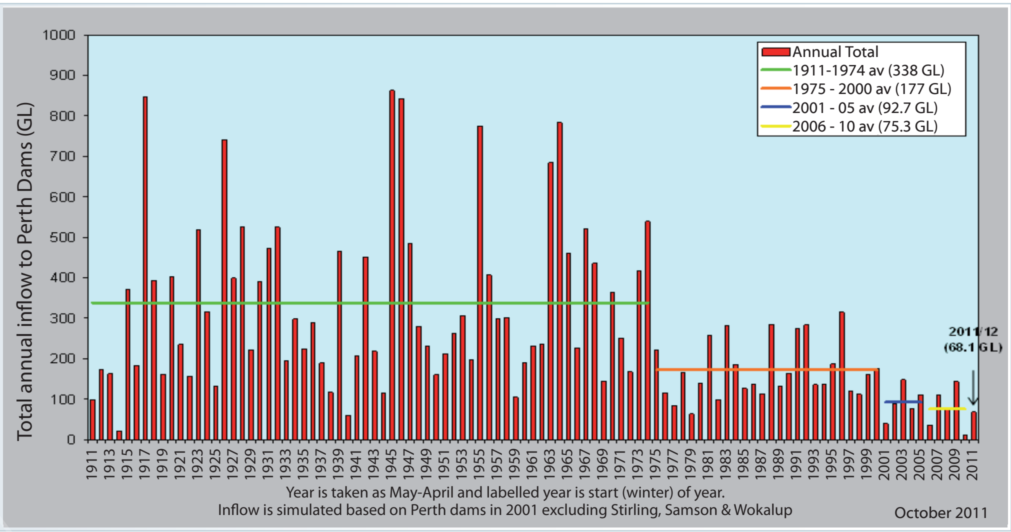
Agriculture – Water available for irrigation is likely to be significantly reduced with high demand industries particularly at risk. In some areas, pasture growth may also be negatively impacted by rainfall decline and altered flooding patterns. Substantial shifts in farming are likely to result, especially in marginal farming lands in semi-arid and arid regions.

Biodiversity – Declines in river flows, increased drought and extreme flooding events, and salt-water intrusion are all

Figure 1. Inflows to the Perth water supply

In south-western Australia, winter rainfall has declined significantly since the mid-20th Century and runoff and inflows to reservoirs, local groundwater and wetlands have declined dramatically

Source: Water Corporation



very likely to result in changes to the composition, structure and function of freshwater ecosystems. In addition, existing stresses on freshwater ecosystems (e.g. altered hydrology, habitat loss, invasive species, etc) will be aggravated by climate change, increasing the risk of species extinctions and shifts in the provision of ecosystem services.

Human health – In addition to threats to water supplies for drinking and hygiene, the extent of mosquito-borne diseases, e.g. Ross River and Dengue Fever, may expand due to the impacts of fewer but heavier rainfall events on mosquito breeding. Projected changes to surface water hydrology may also lead to more frequent and prolonged toxic algae blooms.

Infrastructure – Increases in the frequency and intensity of extreme rainfall, flooding events and tropical cyclones will increase pressure on floodplain levees and urban drainage systems with an increased risk of failure of these systems.

Social and economic impacts

Responding to the growing imbalance between water supply and demand has driven changes in water governance, in particular water allocation, by governments in Australia.

There is also likely to be further pressure on individuals and private organisations to alter their water use patterns and accept significant changes to the quality and quantity of water provided for different purposes. Policy, infrastructure and social changes are likely to be necessary to facilitate adaptation to water scarcity in urban areas. Recent efforts to address water shortages in southern Australian urban areas include installation of desalination plants, and use of recycled water from effluent.

Changes in the structure and function of rivers, estuaries and wetlands will affect the ecosystem services they provide, with far-reaching social and economic implications. For example, in rural areas, declines in agricultural productivity and shifts in farming are very likely and salt-water intrusion into estuaries and wetlands may affect coastal fisheries, recreational fishing and tourism (e.g. in the iconic Kakadu National Park).

Adaptation: practices, options and barriers

Adaptation strategies for protecting water resources may be supply-side (e.g. water recycling, seawater desalination, installation of rainwater tanks), demand-side (e.g. water restrictions), or both. Barriers to the implementation of these measures can include technical limitations of water distribution systems, costs, inflexible institutional arrangements and community resistance. In some cases these obstacles may be overcome by incentives, such as rebates on rainwater tanks.

Expansion of water markets and water trading are often recommended as a means of increasing water-use efficiency, as are improvements to irrigation infrastructure.

In the case of freshwater biodiversity, adaptation strategies that maintain well-functioning ecosystems are pivotal. This is achieved through enhancing resilience, removing or managing existing stressors, and maintaining diverse and well-connected mosaics of ecosystems (i.e. aquatic, riparian and terrestrial components) across the landscape.

Surface and groundwater resources are essential to freshwater biodiversity and aquatic ecosystem processes. Appropriate management is critical. Over-allocation of water resources represents a major obstacle to implementing suitable adaptation strategies for protecting freshwater biodiversity.

Research priorities

For biodiversity:

- investigating the effects of climate drivers on poorly understood species and communities;
- understanding how to incorporate climate change adaptation into water resources and freshwater ecosystem management to maintain ecosystem services;
- studying the indirect effects of climate change on freshwater resources (e.g. soil acidification, sea level rise);
- determining how to increase the resilience and connectivity of areas that provide refuges to freshwater organisms, e.g. through the design of reserve systems.

For water resources:

Understanding:

- the interdependencies of the water sector with other infrastructure sectors, e.g. reliance of the supply system on uninterrupted electricity supply, and reliance of electricity generators on water for cooling;
- the pressures on water availability from competing users - domestic, agriculture, commercial - under climate change;
- where the weak points lie in the water supply system, e.g. the locations of boreholes, pumping stations and purification works which are vulnerable to flooding;
- the potential impacts on hydrology and freshwater biodiversity of climate change adaptation and mitigation actions in other sectors.

Costs

The costs of adaptation measures to protect water security, such as changes to water supply infrastructure and environmental water allocations, are likely to be large. However, investment in adaptation measures will in the long term be small in comparison with the costs associated with threatened water security and key ecosystem services.

About the Network

The Water Resources and Freshwater Biodiversity Adaptation Research Network, convened by the Australian Rivers Institute at Griffith University, brings together Australia's top water scientists and managers with interests and skills in water resources and freshwater biodiversity and the implications for these of climate change. The Network has a regional node in each State and Territory and is supported by over 20 partner research institutions. Network activities aim to facilitate collaborative, cross-disciplinary research, build research capacity through supporting and mentoring early career scientists, and synthesise and communicate relevant knowledge to give water and biodiversity managers the best chance of coping with an uncertain climate future. For more information visit www.nccarf.edu.au/water