Ensuring Australia's urban water supplies under climate change

Eighty-five percent of Australians live in urban areas. Ensuring they have a safe and secure water supply will be a major challenge under climate change.

Key Points

South-west Western Australia (SWWA) is experiencing a long-term drying trend linked to climate change which is likely to persist. The water management response contains useful lessons for a nation likely to experience similar conditions in the future.

The average flow rate into Perth's dams has declined steeply: the 2006-2010 average was 57.7 GL/year compared to an average of 177 GL/year for the period 1975-2010.

The management response for public water supply has included developing more climate independent water sources. In 2005-6, half the public water supply was from surface reservoirs, and half from groundwater. By 2010-11, the effective supply from surface reservoirs had dropped to 22%; desalination supplied 20% and groundwater supplied the balance. As we write, at the beginning of 2013, approximately 50% of water is derived from desalination. At the same time, efforts are being made to reduce consumer demand.

Desalinated water is delivered at approximately $2.20/kL, compared to 20c/kL for water from surface reservoirs.

Findings relevant to Australian water policy include the need to: utilise all water sources from a portfolio of supply options; use fit-for-purpose water for appropriately planned and designed infrastructure and property developments; protect the ecosystems and biodiversity; encourage demand reduction and lower levels of outdoor use; inform the public and train workforces to enable adaptation. The needs of more vulnerable consumers for a secure low-cost water supply must be maintained. Water management should be integrated into land planning decisions. Under a changing climate, thresholds can be assigned to trigger management responses, infrastructure investment and/or shifts in supply sources.

NCCARF's evidence-based Policy Guidance Briefs address key challenges to effectively adapting Australia to a variable and changing climate, providing high level policy guidance designed for use by policy makers at Commonwealth and State level.

This Guidance Brief deals with the challenge of managing the urban water supply under climate change. The example location is south-west Western Australia (SWWA), which is experiencing a long-term drying trend linked to climate change that will likely persist. The water management response contains useful lessons for a nation likely to experience similar conditions in the future.

NCCARF is also producing Policy Guidance Briefs on Agriculture and on Infrastructure, which touch on water management under climate change.

1 The climate context

Rainfall in SWWA has reduced by around 15% since the mid-1970s (CSIRO, 2009). Autumn rainfall has declined by 15% since 2000 (IOCI, 2012). Average stream flow into Perth's dams continues to decline (Figure 1). The decline is attributed, at least in part, to climate change: typically, rain-bearing fronts cross SWWA from the Southern Ocean between autumn and spring; over the last 40 years, these fronts have been driven southward off the continent by a warming climate.

Relative to 1962-1999, models suggest SWWA is likely to experience a decline in rainfall of 8-33% by mid-century, and 17-46% by the end of the century, for an intermediate emissions scenario (IOCI, 2012).

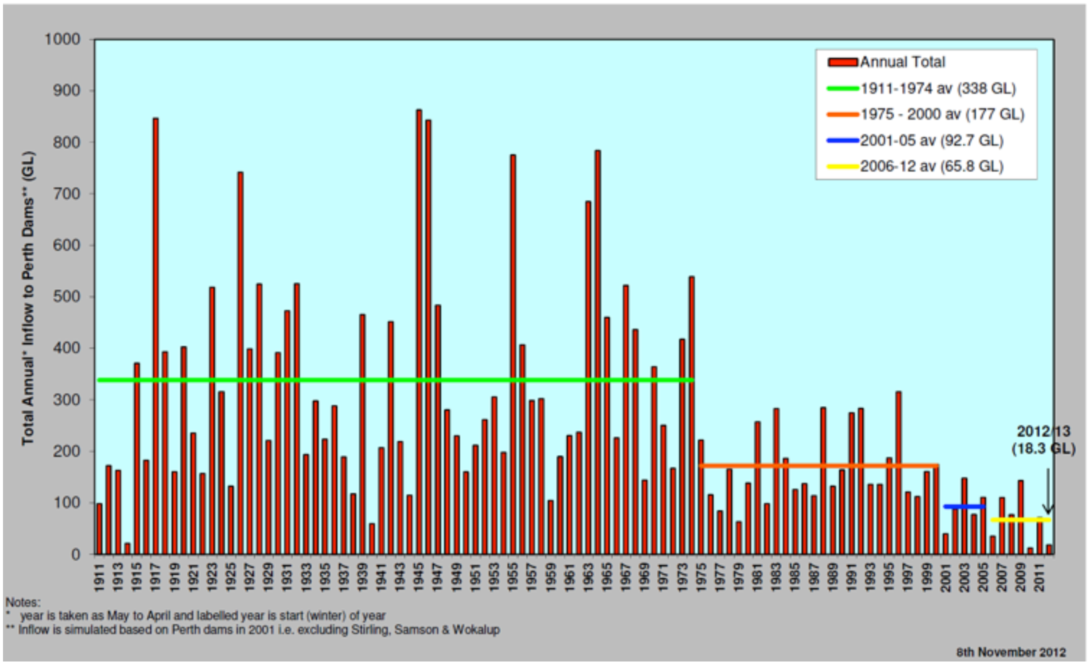

Figure 1: Historical annual stream-flows into Perth dams (GL/year).
Source: http://watercorporation.com.au/

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Current effects, impacts and issues

Water Supply: Historically, the water supply in SWWA was met from surface reservoirs and groundwater. In 2005-6, half the supply was from surface reservoirs, and half from groundwater (with a small recycled component, less than 2%). The average flow rate into Perth's dams has declined: the 2006-2010 average was 57.7 GL/year compared to an average of 177 GL/year for the period 1975-2010. The inflow in 2010 reached a historic low of 13 GL/year (see Figure 1).

Water supply planners are seeking to reduce dependence on less reliable surface water and environmentally sensitive groundwater sources by increasing use of seawater desalination, deep groundwater and wastewater recycling. In 2010-11, the effective supply from surface reservoirs had dropped to 22% and desalination supplied 20% (NWC et al., 2012). As we write, at the beginning of 2013, two desalination plants will be able to meet approximately half the piped water demand of the 1.8 million people serviced by the Integrated Water Supply Scheme (IWSS – primarily metro Perth) (Water Corporation, 2012).

Water Demand: Household consumption in Perth in 2005-6 was 268 kL/property/year, falling in 2011-12 to 250 kL/property/year. Demand management has included outdoor sprinkler rosters, annual water planning for high water use non-residential customers, tiered water pricing, encouraging more water efficient gardening, low-flow fittings, targeted household retrofits and education and awareness campaigns. Trials to reduce system pressure have been undertaken. There is scope for further reductions in water demand.

Ecosystems: Prior to the drying trend, ecosystems were already stressed by human activities, particularly land clearance followed by invasion of weeds and feral animals, challenging fire regimes, overgrazing and salinisation. Drying has imposed an additional stress, exacerbated by increased groundwater pumping to meet water supply needs in, for example, the Swan coastal plain. There has been higher than normal tree death in the Perth metro area and the Northern Jarrah forest. Some freshwater ecosystems are threatened by reduced inflows and groundwater recharge, disconnected river pools and, in coastal regions, sea-level rise. Cave fauna, including internationally-important species, are threatened with extinction.

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Future effects, impacts or issues

Public water supply and demand: A challenge in the next few decades will be maintaining security of water supply in SWWA regional towns and rural communities under the effects of climate change. To date, supply shortfalls have been met by increased groundwater pumping, temporary pipelines and tankering.

There is a considerable risk that demand will exceed supply under climate change in future. Recent Water Corporation modelling of demand for the IWSS compared to existing supply sources, taking into account projected rainfall trends, shows a deficit of 315 GL/year by 2060.

Ecosystems: Declining water levels in rivers and soils, increasing temperatures and changes in seasonal cycles are already causing and will continue to cause shifts in biological communities, and reductions in biodiversity and productivity. Some species will face extinction. Freshwater and estuarine ecosystems will continue to experience decreased flushing and evapo-concentration of nutrients, salts and pollutants.

Table 1: Water use statistics. Source: NWC et al. (2012) and Water Corporation (pers. comm.)

	05-06	06-07	07-08	08-09	09-10	10-11	11-12
Average annual residential water supplied (kL/property/year)							
Water Corporation (WA)	268	281	268	277	276	264	250
SE Water (Vic)	187	167	152	143	141	136	n/a

4 Adaptation: what this means for managing the sector

Shorter term (10-15 years) responses to declining water resources

Domestic water demand: There is scope to reduce water demand. Of large water utilities, Perth has the highest average household water consumption in Australia, due in part to long, dry and hot summers and sandy soils. Consumption in 2010-11 was close to double consumption in South East Victoria (see Table 1); note, however, that SWWA has faced water deficient periods over the last decade, whereas Victoria has moved from dry to wet conditions. Half the water supplied from the IWSS in SWWA is used for garden irrigation.

For SWWA, the Water Corporation has a planning target of 15% reduction in water use (from the IWSS) per person by 2030 compared to 2008.

Piped water supply: Desalination plants can continue to deliver a climate-independent water supply, but at a financial and environmental cost. Building a desalination plant that meets 15% of Perth's water supply costs of the order of $1 billion. Environmental costs lie in the large amounts of energy required which, unless renewable sources are used, will add to the atmospheric burden of greenhouse gases. However, local environmental impacts of more groundwater pumping are avoided.

Limited use is so far made of recycled water in the domestic supply, but this is a potential next step if community concerns can be overcome and options prove safe and cost effective. Pilot schemes are in place which pump treated recycled wastewater into aquifers that supply the IWSS with water.

To date, emphasis has been on meeting the needs of the metro region. The next step will be to address water security in rural and regional centres. To date, any shortages have been met through increased groundwater pumping, temporary pipelines and tankering. Delivering a sustainable water supply to regional communities under climate change will be challenging. Options include increased water use efficiency, expansion of deep groundwater sources and, for larger coastal communities, desalination. Regardless of water supply security, many of these communities risk significant economic pressure as declining rainfall challenges the viability of agriculture and forestry.

The keys to managing water supply under a diminishing resource are forward planning, integration and diversification of water sources, and community involvement. Together, these enhance resilience of the system and provide managers with more options and greater flexibility. Integration across SWWA has begun with the IWSS. A diversified supply utilises surface reservoirs, deep and shallow groundwater, desalinated, piped and recycled water together with demand management.

Longer term (decadal) responses to declining water resources

Further into the future, more innovative and more expensive solutions to declining water resources will be required if the Western Australia economy and population is to grow and prosper. Potential solutions include:

Demand management offers potential in future. To fully realize this potential, further use of regulation, pricing signals and smart metering may be required. The SWWA Water Corporation has a planning target of 25% reduction in water use (from the IWSS) per person by 2060 compared to 2008.

Wastewater recycling. Greywater recycling (non-toilet household water) on individual properties and buildings happens now, but is maintenance-intensive and can present operational challenges (for example, when occupants are not meeting maintenance requirements). Recycled wastewater and storm water at a district scale can be used, however its viability will be influenced by factors such as:

- Location of sewage treatment plants: for example, if recycled wastewater is to be a major non-potable water source, it may be appropriate to locate smaller treatment plants close to the developments receiving the treated water.
- Scope to use managed aquifer recharge for small-scale (district level) fit-for-purpose water (e.g. public open space) from local groundwater bores.
- Plumbing modifications to residential areas receiving recycled wastewater: for example, the 'purple pipe' which carries recycled water through a separate, clearly-identified and isolated system.
- The large training requirement to ensure plumbers work safely on these innovative systems.

Systematic large-scale wastewater recycling will require substantial up-front infrastructure investment and ongoing commitment to maintenance. The costs and benefits need to be carefully evaluated.

What this means for managing the sector ... continued

Long pipelines and use of remote sources. A pipeline from the Kimberley, which has seen a wetting trend in the recent past (although this has not been linked to climate change), is sometimes promoted as a solution to water shortages in SWWA. This would be an extremely expensive solution: a 2006 report (DPC, 2006) estimated the cost at around $9.7/kL (excluding the value of the resource), compared to present-day costs of around 20c/kL from surface reservoirs and $2.20/kL from desalination. Also, this solution would be energy intensive. However, a cost-efficient connection of treated water sources within a region (as in South East Queensland) to meet regional needs adds to the resilience of water supply schemes.

Throughout, the needs of ecosystems must be recognised. Native biota possess adaptations to survive drought and to make use of refuges in the landscape. One of the main concerns about climate change is the long-term exceedance of resilience and resistance capacities, leading to reduction and possible extinction of these source populations. Adaptation of water resources management to climate change must plan with the needs of ecosystems in mind.

5 Policy implications

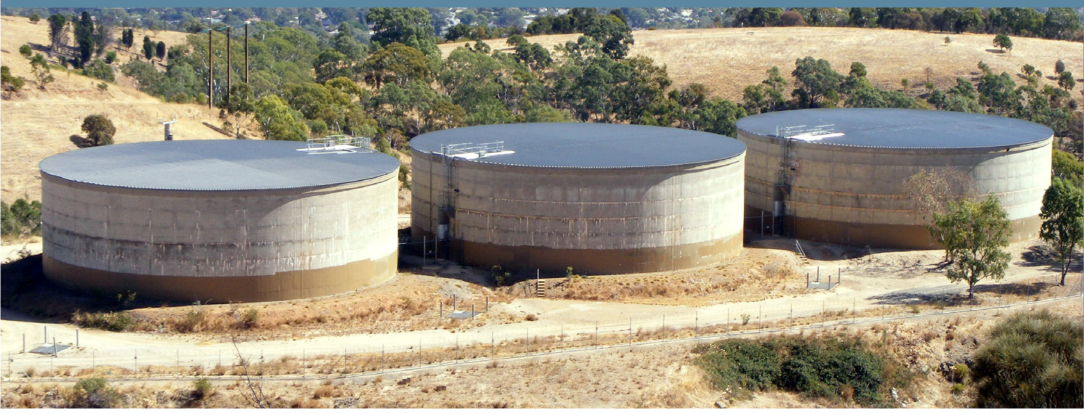
The experience of SWWA under declining water resources has lessons for policy development elsewhere in Australia as the effects of climate change are felt.

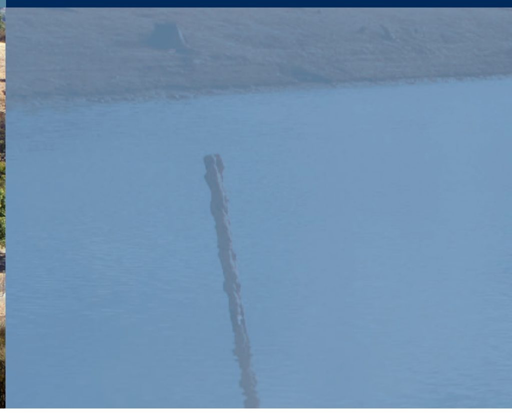
1. **All potential water sources need to be utilised to deliver a secure supply.** This includes surface, ground (shallow and deep), recycled, piped and desalinated water.
2. **Investment in new infrastructure and development needs to meet the challenge of delivering a secure water supply under climate change.** Incentives and stronger regulation of water planning may be required. Training requirements need to be addressed.
3. **Economic analysis** (including cost-benefit and real options analysis) can be used to demonstrate the optimal mix of supply and the next best source of supply at any point in time, while accounting for key social and environmental values. Under a changing climate, thresholds can be assigned which trigger infrastructure investment and/or shifts in supply sources.
4. **The needs of all consumers must be met, including those of regional communities.** Delivering a secure supply under climate change may be complicated by factors such as distance from the sea and competing demands (e.g. from agriculture and mining industries).
5. **Water management must be integrated into strategic planning decisions of government, households and businesses from drawing board to implementation.** This includes water sensitive design for all new developments, redevelopments and infrastructure, and full use of technological advances such as smart metering.
6. **Headroom exists to reduce demand** through approaches such as smart metering, programs to help households and businesses improve water use efficiency, promotion of low-water-use gardens, pricing signals and pressure reduction. Communities need to understand and support changes in water supply and demand management.
7. **Pricing is key** to ensuring decision making on investment in infrastructure and demand management is efficient and effective. Efficient pricing arrangements are vital to ensure waterusers and the water industry respond appropriately to increasing costs of water supply.
8. **Investment in renewable energy and low carbon technologies will enhance sustainability in a carbon-constrained world.** Manufacturing water by desalination or recycling, and pumping water long distances, are presently energy intensive.
9. **Policy implementation should be evidence based.** SWWA water policy, planning and management is currently built on research which unambiguously demonstrates an existing and likely continuation of a long-term drying trend (previous planning assumed long-term resource stability). To ensure policy is evidence-based, investment in research is essential.
10. **Water management must take account of the need to minimise impact on ecosystems and sustain biodiversity.** Key policy actions must identify and protect refuges to maintaining resilience, especially for freshwater- and groundwater-dependent ecosystems.

Approach

The policy guidance in this brief was developed based on a regional workshop held in Perth, Western Australia, and attended by policy makers and managers in the industry, representatives from state and local government, researchers from Murdoch University and CSIRO, Robert Kay (Adaptive Futures), and NCCARF staff.

NCCARF is producing a portfolio of twelve Policy Guidance Briefs in 2012–13 on critical climate change adaptation topics. For a complete list of available Policy Guidance Briefs, please go to: www.nccarf.edu.au/publications/policy-guidance-briefs





Further information and references

For further information, see NCCARF publications e.g.:
http://www.nccarf.edu.au/publications/research-portfolio-factsheet-water-resources
http://www.nccarf.edu.au/sites/default/files/attached_files/Impacts%20on%20Freshwater%20Biodiversity.pdf

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