



International Centre of Excellence in
Water Resources Management

Response to Drought in South Australia: A Case Study in Adaptive Management

Proceedings of a workshop held on 7 December 2011

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Stranded boat at Goolwa. © MDBA ; Photographer John Kruger



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Executive Summary

The Millennium Drought is widely regarded as the worst on record for south eastern Australia. It impacted South Australia through unprecedented low levels of River Murray inflows, which reduced water held in upstream storages as well as flow to the state, and coincided with extreme low rainfall in the Mt Lofty Ranges.

The State's response to the drought, which concluded with summer rains in 2010/11, provides an opportunity to review an adaptive management approach on a large scale, recognising that the lessons learned are particularly valuable given future predictions of an increased frequency and severity of drought due to climate change. The first step in what may be a longer review process was conducted by means of a workshop on 7 December 2012 convened by the International Centre of Excellence in Water Resource Management under its Living Laboratories Program and supported by the South Australian Department for Water. The workshop was also motivated by the observation that the drought is of significant international interest and that a workshop would provide an opportunity to better understand common learnings from across government and research communities, and communicate the messages more widely.

In opening the workshop, the Minister for Water and the River Murray the Hon. Paul Caica noted that the State had faced a catastrophe - if action had not been taken to respond to the impacts of the drought acid sulfate soils would have impacted the environment of the Lower Lakes, Adelaide may have had to rely on bottled water and investment in irrigated horticulture would have perished. The former Minister for the River Murray and Water Security, the Hon. Karlene Maywald, also noted that the drought was hard to manage because it was a creeping natural disaster unlike floods or fires because there was no knowing whether it was close to the start, middle or end. The scale and nature of the challenge prompted a whole of Government response that resulted in the establishment of a governance structure with a Water Security Council advising the Minister which was supported by the Water Security Technical Working Group. This provided a forum for 11 state government agencies affected by drought conditions in the South Australian Murray-Darling Basin to work together.

There were key features that emerged from this whole of government response including:

- Direct communication and engagement, which involved (a) the Minister attending meetings regularly so the public had the chance to put questions directly to her, (b) appointment of well-respected community liaison managers to work with community groups and (c) attendance and involvement of departmental staff in frequent community meetings and forums;
- Evidence based, adaptive decision making, that while not always popular in terms of the measures that were implemented or plans developed (e.g. preliminary consideration of Pomanda Island Weir), was essential because there was no knowing how bad the drought was going to be;
- Major policy and on-ground achievements, such as Water for Good, helping to trigger the development of the Federal Water Act 2007, water level and flow regulating infrastructure interventions, and a range of bioremediation and revegetation projects around the Lower Lakes that saw 2029 tonnes of limestone applied by air and 130,000 seedlings being planted on higher ground around lakes, and the Lake Albert and Goolwa Water Level Management Projects.



Overall, the River Murray Drought Response Program is regarded as having successfully achieved its goals: water for critical human needs was made available at all times, water quality was maintained to a level suitable for potable use, acid sulfate soils were managed and the entire Lower Lakes did not acidify, the horticulture industry was assisted with purchased water enabling it to survive and riverbank collapse was managed as a state hazard. While goals were achieved, legacy issues remain: water quality issues persist in the Coorong and Lower Lakes, acid drainage from the Lower River Murray Irrigation Area continues and cracked levee banks persist.

Additional key lessons garnered from the workshop include:

- There is a lack of awareness amongst the broader community, including those in the water management sector, of the large amount of quality work that was done by the public sector in responding to the drought. This work was acknowledged at the workshop by those who were not directly involved with the Government's response;
- There are key eco-hydrological thresholds that emerged during the drought that if exceeded will cause significant degradation to the Lower Murray environment. For example, further degradation could be expected if levels in Lake Alexandrina were again to fall below sea level and the salinity level in the Southern Lagoon of the Coorong exceeds 100 g/L;
- It is essential that the time before the next drought is used to determine the priority for infrastructure spending, using an approach such as a full costs and impacts scenario analysis that considers hydrological events beyond historical experience (drought and flood) and potential future impacts arising from climate change; and
- Necessary approvals should be secured in advance with agreed triggers for implementation.

The workshop can be considered as the first step of what may be a longer process to fully document and establish the key learnings from South Australia's response to the Millennium Drought. Further work could include:

- More comprehensively documenting each of the major initiatives implemented during the drought into case studies that provide the learnings for a series of publications to be used for training and education purposes;
- Additional workshops on some of the themes and issues raised at the workshop, such as systematically reviewing what science is required to manage natural resources during drought events;
- Conducting an audit to determine the ecological recovery of the wetlands drained during the drought and to develop a framework for their future management and monitoring.
- Use drought learnings to inform River Murray operating rules and interjurisdictional water resource sharing arrangements to determine whether better outcomes are possible during drought conditions.

Audio and presentation materials from the workshop are available at:

<http://www.icewarm.com.au/page.php?pld=415>.



1 INTRODUCTION

1.1 Drought in South Eastern Australia

The past decade saw large areas of southern Australia subjected to the worst drought conditions in living memory. The drought has come to be known as the Millennium Drought and is widely regarded as having had a greater impact on communities and the environment than other long-term droughts such as the 'Federation' drought (1895-1902) and the 'Second World War' drought (1937-1945).

In South Australia, reduced rainfall created challenging conditions for dryland farmers and reduced run-off to major water storages in the Mt Lofty Ranges. In addition, there was low rainfall and runoff in important catchments in the headwaters of the River Murray in New South Wales and Victoria resulting in the worst inflows to storages on record. The result included:

1. River Murray flows to South Australia were drastically reduced;
2. Allocations to South Australia's irrigators were well below historical levels creating economic hardship for irrigation dependent communities along the South Australian Murray;
3. Water levels fell in many places, including the Lower Lakes where significant areas of lake bed were exposed; and
4. The environment became severely stressed from an extended period of low flow and a lack of floodwaters to rejuvenate floodplains and wetlands.

1.2 Living Laboratories

The Living Laboratories program commenced in 2007 as a joint initiative of the Department for Water (then the Department for Water, Land and Biodiversity Conservation) and uses large scale natural resource programmes as 'living laboratories' to:

- generate and document innovations and lessons learned;
- benefit researchers and water managers, from policy to implementation; and
- build the evidence base to inform policy development and implementation.

A workshop was convened on 7 December 2011 under the Living Laboratories program to review South Australia's response to the recent drought, focussing on the role of South Australian government agencies. Review of the drought was considered important because:

- The drought resulted in one of the largest ever whole of government responses to a natural resource management event in South Australian history, making it a significant Living Laboratories opportunity;
- It provided an opportunity to review an adaptive management approach on a large scale, recognising that the lessons learned would be particularly valuable given future predictions of increased frequency and severity of drought due to climate change; and
- The response to the drought is of significant international interest and the workshop provided an opportunity to better understand common learnings from across government and research communities, and communicate the messages more widely.



The goals of the workshop were therefore to:

1. Identify common learnings from across organisations and determine the keys to successful collaboration in responding to drought;
2. Determine effective means for Government to engage with the community during periods of high, collective community stress;
3. Identify outstanding high priorities for new research and/or policy to help respond to drought or equivalent natural resource stresses in the future;
4. Record and publish the lessons learned that may be of interest to other public administrators in Australia and overseas.

The workshop was structured in two parts (Attachment A): the pre-lunch session featured presentations from a selection of people including the former Minister for the River Murray and Water Security, government officers, a community representative (and former State Premier) and researchers to consider issues regarding the decision making process and the whole of government response that was put in place to direct South Australia's actions; the post-lunch session based on small group discussions on four themes (legislative change, policy and community engagement; role of science; environmental management; risk and infrastructure management).

These proceedings provide a summary of the information and opinions shared during what was only a one-day workshop and can be considered as the first step of what may be a longer process to fully document and establish the key learnings from South Australia's response to the Millennium Drought. There are also additional learnings that can be garnered from considering the Basin wide response to the drought, which may warrant future involvement of other jurisdictions from the Murray-Darling Basin (MDB).

There is some overlap in the information presented in the proceedings, which has been done to accurately reflect the topics covered by each of the speakers.

Audio and presentation materials from the workshop are available at <http://www.icewarm.com.au/page.php?pld=415>.



2 WORKSHOP PRESENTATIONS

2.1 Introduction to the Workshop

Speaker: Hon. Paul Caica, South Australian Minister for Water and the River Murray

The recent drought was unprecedented in terms of magnitude and duration. The significant low flow event in the Murray in 2006-07 was met with an expectation that drought would soon finish, yet there followed successive years of low flows in the Murray as well as low inflows in the Mt Lofty Ranges. As a result the quality of the State's metropolitan water supply was at risk because of salinity and acid sulfate soil issues emerging below Lock 1.

It was not an exaggeration to say that the State was facing a catastrophe and hence a whole of Government response was required. This led to establishment of the Water Security Taskforce and Water Security Technical Group, whose immediate goals were to maintain water for critical human needs as well as to provide a share of water for the needs of the environment and irrigation communities.

Specific actions in response to the drought included:

- Modification and lowering of major pumping offtakes for Adelaide's water supply;
- Pumping water into storages in the Adelaide Hills to provide a buffer against potential water quality issues;
- Securing a water reserve each year to provide for critical human needs;
- Building additional water reserves through market purchase;
- Commencing the Murray Futures Program, which included:
 - Construction of irrigation and stock and domestic pipelines around the Lower Lakes;
 - the Coorong, Lower Lakes and Murray Mouth program;
 - Riverine Recovery Program;
 - Augmentation of Clayton's water supplies;
- Assistance was provided to the Riverland horticultural industry by purchasing water to keep permanent plantings alive;
- Permanent wetlands were temporarily closed to save evaporative water losses and prevent high salinity and nutrient rich water from draining back into the river;
- Negotiations were undertaken through aboriginal agreements for a possible weir at Pomanda Island, disconnection of wetlands and required dredging processes;
- Fast tracking of the country water quality improvement program;
- Fast tracking of environmental approvals for dredging to enable navigation and dredging;
- Extending footings on ferries to allow them to operate at lower river heights;
- Monitoring for salinity, acid sulfate soils and riverine ecology;
- Goolwa Channel and Lake Albert water level management program;
- Investigations into levee bank cracking;



- Development of a State Water Security Plan that became Water for Good, which included the plan for construction of the desalination plant at Port Stanvac and investigations into the harvesting, treatment and use of stormwater;
- Encouraging water conservation through restrictions, rebates on low flow devices and rainwater tanks.

The South Australian Government's response was supported by good communication and engagement of a range of audiences, which was done through direct personal communications and engagement. This was led by the Hon Karlene Maywald (Minister for the River Murray and Water Security at the time) who met with large number of community groups and presented at public meetings and supported by the Hon. Dean Brown and Neil Andrew AO who were appointed as community liaison managers to provide a conduit between affected communities and government. This direct engagement approach was complemented by a range of written material that was made available through media releases and websites and in response to frequently asked questions.

Overall, the River Murray Drought Response Program successfully achieved its goals: water for critical human needs was met, water quality was maintained to a level suitable for potable use, acid sulfate soils were managed and the entire Lower Lakes did not acidify, no native or aquatic species were lost, the horticulture industry was assisted with purchased water enabling it to survive and riverbank collapse was managed as a state hazard. While goals were achieved, legacy issues remain: water quality issues persist in the Coorong and Lower Lakes and cracked levee banks persist.

Scientific advice suggests that the recent drought provided a glimpse of the future under climate change, whereby droughts like this will become more frequent and more intense. Lessons learned from the workshop will help put the State in a better position for the next drought and inform a united South Australian response to the Basin Plan and address the problems of over-allocation in the MDB.

2.2 Decision Making

The first session of the workshop was Chaired by Richard Hopkins, CEO of ICE WaRM who introduced the session by noting that it was important that we do not forget the lessons from this record drought which in reflection provides significant opportunity to look at what evolved as an adaptive management process. Further, it is important that we record the experience so that the next time similar circumstances arise we can see the signs and be ready to respond sooner. Finally, it was noted that this is the start of the process of reviewing lessons learned from the drought and not the end and that the workshop provides a focus on what happened in South Australia, even though there were significant relevant events upstream.



2.2.1 Departmental Perspective

Speaker: Mr Andrew Beal - Director, River Murray Operations, Department for Water; Chair, Water Security Technical Working Group; Principal Advisor, Water Security Council

Adelaide's water supply was historically considered to be secure with the Mount Lofty Ranges storages averaging 60% of supply and the River Murray providing the remainder. However, this level of water security was challenged by the drought and highlighted the fact that Adelaide has about 12 months storage capacity compared with 3-4 years storage in many other Australian cities. Reflecting on the drought was considered important as the next 25-50 years are expected to have more variable and reduced flows in the Mount Lofty Ranges and Murray-Darling Basin.

The early warning signs of the drought were observed in October 2002 when the mouth of the River closed. By the late 2000s the impacts of the drought were being experienced in various ways, including:

- historically low River Murray System inflows in 2006-07, 2007-08, 2008-09 and 2009-10 culminating in an extended period of low flows into South Australia, especially downstream of Lock 1;
- allocations to River Murray irrigators falling to historically low levels (Table 1);
- damage to levee banks below Lock 1 as a river levels fell leading to dewatering of the Lower Murray Swamps. In some instances this led to river bank collapse, and over 30 sites were identified between Lock 1 and Wellington with levee bank cracking, heaving and subsidence;
- serious degradation, desiccation, salinisation and acidification of permanently flooded wetlands below Lock 1;
- disconnection of many permanently flooded wetlands above Lock 1 to make water savings.



Dried out wetland at Swan Reach in October 2007. © MDBA ; Photographer Irene Dowdy



Flow downstream of Lock 1 1949-2011

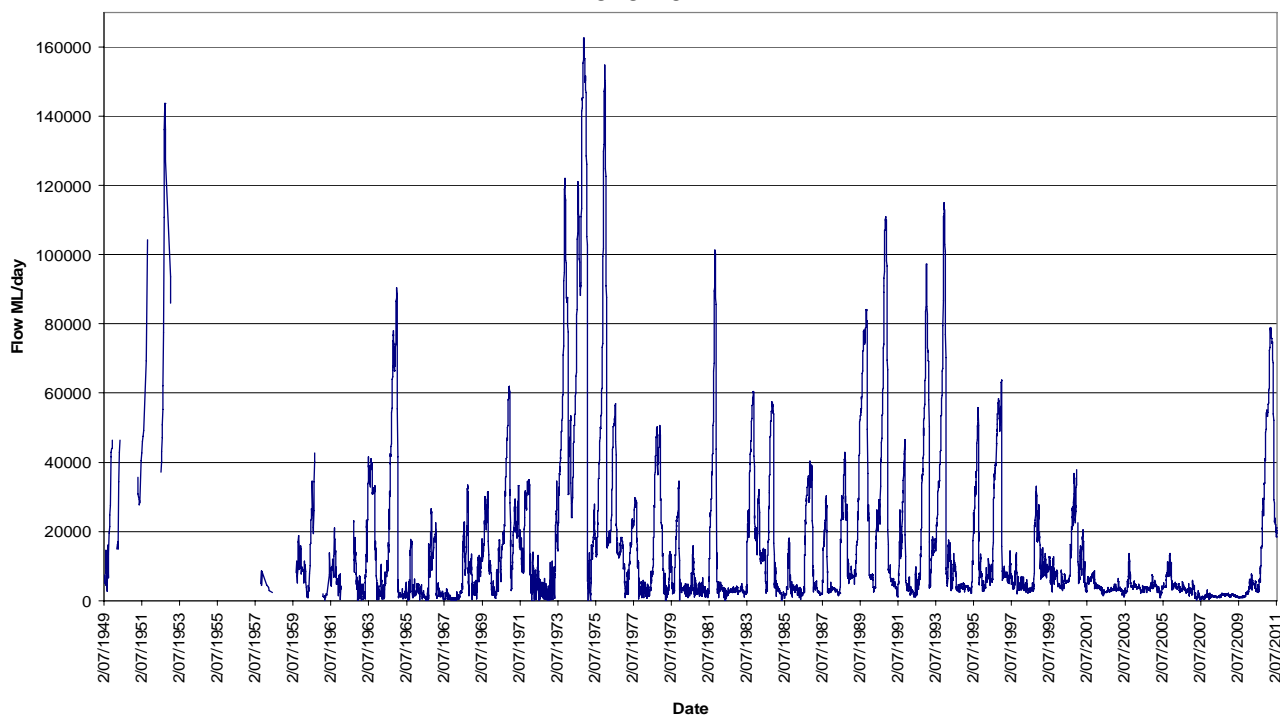


Figure 1. Flow downstream of Lock 1 from 1949 to 2011 showing record period of low flows from 2001 to 2009.

Year	Opening allocation %	Final Allocation %
2003-04	65%	95%
2004-05	70%	95%
2005-06	70%	100%
2006-07	80%	60%
2007-08	4%	32%
2008-09	2%	18%
2009-10	2%	62%
2010-11	21%	67%
2011-12	100%	100%

Table 1. Opening and closing irrigation allocations for the period 2003-04 to 2011-12.

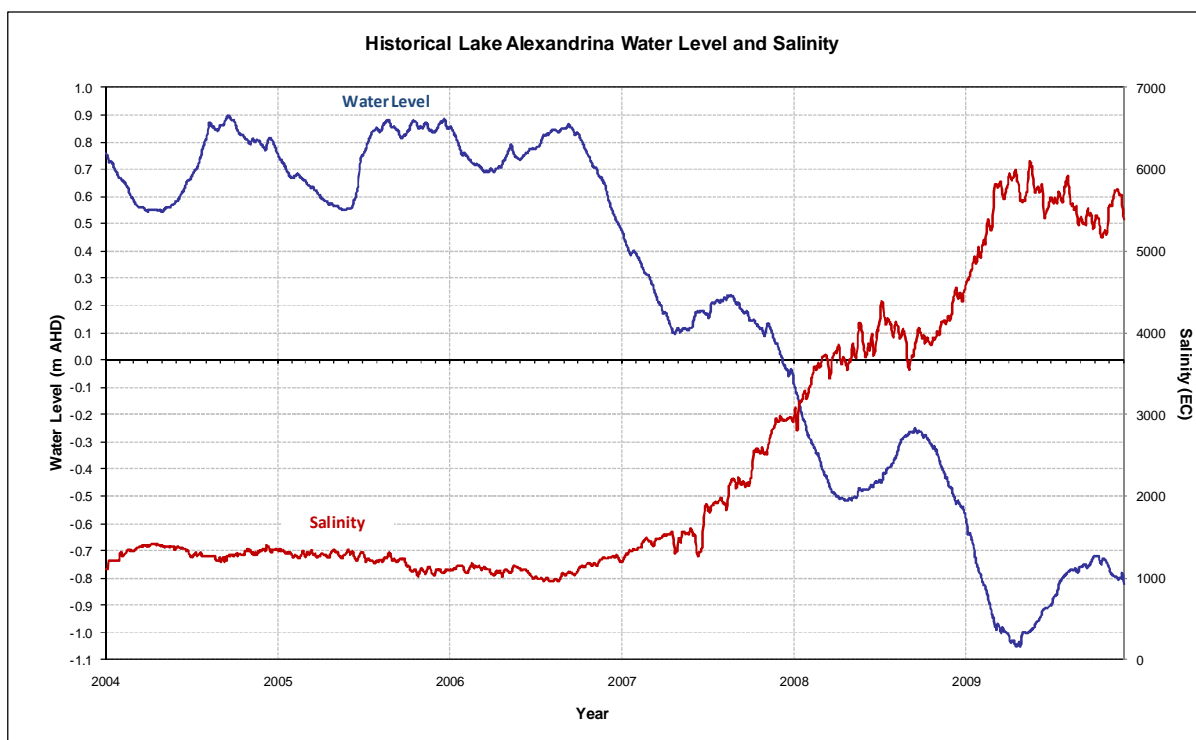


Figure 3. Floodplain Cracking, Heaving & Subsidence (LMIA Irrigation Bay Pompoota).
Photo courtesy of the Department for Water.



In response to the drought, the Minister for Water Security established the Water Security Council and reporting to it, the Water Security Technical Working Group. Together the Water Security Council and Technical Working Group developed a Drought Response Strategy which had the following goals:

- **Primary Goal:** To maintain the supply of potable quality water to meet the critical human needs of all South Australians living in the (River Murray) Water Security Zone, at all times, during the Water Security Planning Period.
- **Secondary Goal:** Once Critical Human Needs had been guaranteed for a given current year, additional River Murray flows were to be shared between:
 - a strategic reserve for critical human needs water the next water year;
 - the environment;
 - irrigation;
 - external domestic uses, and
 - to adjust any special accounting surplus / deficit.

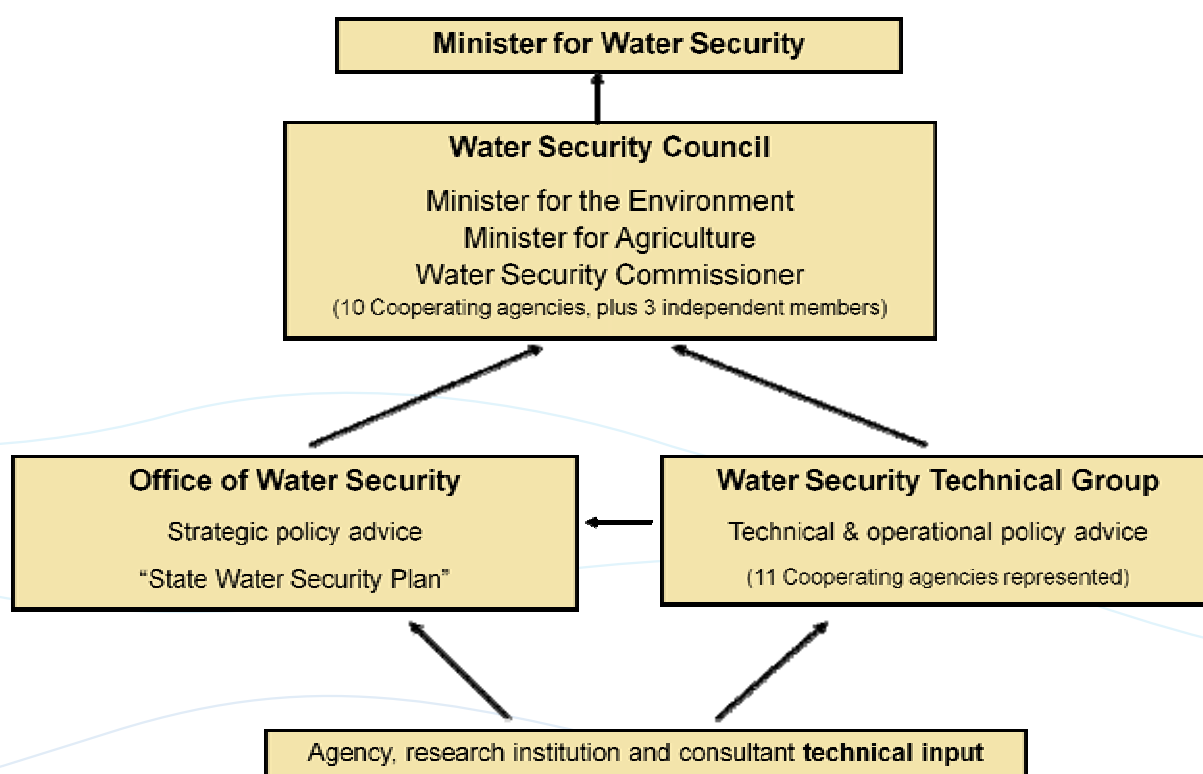


Figure 4. Water security Initiative governance, advice and coordination (A.Beal).



As part of the overall drought response strategy a Lower Murray Drought Contingency Plan was developed, which identified a series of triage actions which are outlined in Table 2. These actions included items that the Government commenced planning for, but which it hoped would not have to be implemented, such as the Pomanda Island weir or introducing seawater to prevent acidification of Lake Alexandrina if freshwater not available.



Water level – Trigger level (m AHD)	Triage actions
+ 0.3 m AHD	Augment water level & water quality monitoring and modelling
	Early pumping to Mount Lofty Ranges storages
	Implementation of urban water restrictions to minimise draw on River Murray
	Start modification to SA Water major urban supply intakes to cope with lower water levels
	Facilitate emergency dredging to provide continued access for private S&D and irrigation supplies
	Seal barrages to prevent seawater ingress with reverse head
0.0 m AHD	Initiate program to provide alternative urban supply for Clayton
	Commence modelling project to investigate acidification potential – identification of acidification trigger levels for each lake
	Commence investigations into acidification risk for wetlands between Wellington and Lock 1 - engaged CSIRO to undertake remediation trials
-0.4 m AHD	Implement Lake Albert Water Level Management Project to prevent acidification
-0.5 m AHD	Commence installation of Tailm Bend to Meningie S&D pipeline
-0.6 m AHD	Commence small-scale ASS bioremediation trials in Lake Albert
	Commence Goolwa Channel water level management project to prevent acidification of key wetlands and the Goolwa Channel
	Commence construction of Pomanda Island weir
	Commence construction of Jervois to Currency Creek irrigation pipeline
	Commence broad-scale bioremediation in key areas around lakes
-1.5 m AHD	Introduce seawater to prevent acidification of Lake Alexandrina if freshwater not available

Table 2. Triage action plan for different levels of Lake Alexandrina. Fully supply level is 0.75 m AHD (A.Beal).

In addition to the triage actions identified in Table 2, a large number of initiatives and projects were implemented during the drought, including the following:

- SA Water modified its major pumping stations to enable pumping to continue at levels of at least -2.2 m AHD. This included installation of low-lift pumps at Mannum;
- Acidification prediction studies were undertaken by the University of Western Australia, using bio-geochemical modelling to determine a Lake Albert acidification trigger of -0.5 m AHD;
- Lake Albert Water Level Management Project, which pumped water into Lake Albert to keep sediments submerged and saturated from May 2008 to June 2009 and then January to November 2010 at a rate of up to 1 GL per day and a cost of over \$14 million paid by the Murray-Darling Basin Authority;



- Goolwa Channel Water Level Management Project, which aimed to restore water levels in the Goolwa Channel and tributaries to manage the acid sulfate soil risk and provide an ecological refuge;
- A range of bioremediation and revegetation projects around the Lower Lakes that resulted in:
 - 2029 tonnes of limestone applied by air;
 - 1978 tonnes of limestone applied as barriers;
 - Approximately 6,580 ha of land revegetated either by machine seeding (air or land) and hand planting;
 - 130,000 seedlings being planted on higher ground around lakes.
- Lower Murray Reclaimed Irrigation Area (LMRIA) Acid Drainage project lead by a multi-agency working group (Environment Protection Authority, Department for Water, SA Water, SA Health, Primary Industries and Resources, and the South Australian Natural Resources Management Board) established to investigate the cause of acidification and develop management solutions. Outcomes included the Environment Protection Authority implementing a fast-tracked program of technical investigations to determine the extent and severity of acidification and to develop on-farm management solutions. At the time of the workshop 13 salt drains were confirmed as acidic (pH 2 – 4) and the presence of toxic metals confirmed (e.g. aluminium and manganese).

2.3 Decision Making Within Government

Speaker: Hon. Karlene Maywald – Minister for the River Murray and Water Security from July 2004 to March 2010.

The drought was seen as hard to manage because it was a creeping natural disaster: while floods or fires occur quickly and have a short duration and recovery can be immediately planned for, in the middle of the drought there was no knowing whether it was close to the start, middle or end. Historical data was of little use because there had been nothing like it on record since 1895. Because there was no precedence for the inflows observed, the Government had no way of knowing how deep the drought would go and it had to assume it was not going to end and be ready to take action at all times.

Interstate negotiations were important, with the then Prime Minister, Premiers and water ministers meeting on Melbourne Cup day in 2006 to confront the water management challenge presented by the drought. At this meeting CSIRO was charged with assessing the water resources in each of the MDB catchments and it was decided that the existing rules for sharing water could not apply because critical human needs could not be guaranteed.



Following this meeting a Senior Officials Group was established, which met regularly and through which SA was able to negotiate:

- access to space in upstream water storages so that the State could carryover water for critical human needs;
- 350 GL/year for flow past Wellington to carry salt through the system;
- access to water earlier than normal at the point of offtake to ensure sufficient water for critical human needs.

The negotiated water sharing arrangements prevented absolute environmental collapse and ensured critical human needs were met. Interstate negotiations were hard fought as it was understood that there was not enough water to meet all consumptive and environmental demands.

Within the state, the triage approach provided an important way of forward planning on the basis of “what if scenarios”. The Government had to weigh up issues on a daily basis with input from the Water Security Taskforce and Technical Working Group. This meant planning for actions that it was hoped would never be implemented, such as a weir downstream of Wellington or supplying bottled water to the residents of Adelaide.

In addition to triage planning and actions, the former Minister noted a number of major initiatives including:

- developing carryover water policy;
- appointing community liaison managers;
- establishing drought response centres;
- commencing work on the desalination plant;
- developing the Water for Good Strategy;
- installing water filtration plants in country areas to ensure water quality was maintained;
- purchasing water from upstream to meet critical human needs and protect permanent plantings;
- providing rebate schemes to encourage people to use less water; and
- holding science forums to ensure that the best available science could be brought to bear on the environmental and water quality challenges imposed by the drought.

The drought provided difficult management circumstances, as the Government and agencies were on crisis watch every day. If action had not been taken acid sulfate soils would have impacted the environment of the Lower Lakes, Adelaide would have had to rely on bottled water and investment in permanent plantings would have perished. Given that South Australia was able to avoid these negative outcomes means that important lessons can be learned and incorporated into the Basin Plan.



2.4 Decision Making and Community Engagement

Speaker: Hon. Dean Brown - former South Australian Liberal Premier and appointed by the Hon. Karlene Maywald as a Community Liaison Manager for the Murray below Lock 1 in late 2006. Also appointed as Special Adviser to Premier Rann on the drought.

In his role, the Hon. Dean Brown met with the Minister for the River Murray and Water Security every two weeks, liaised directly with Mr Paul Case, Chair of the Water Security Council and spoke with the Premier directly on drought issues.

The primary issues of the role became clear early (a) water levels were falling rapidly and were set to fall below historically low levels (+0.28 m AHD) and (b) there was a need to liaise with a community that was not aware of how bad the drought was going to get. The community engagement challenge was tackled by setting up a number of community groups to respond to local community issues.

For example, working groups were established with community representatives to consider issues such as:

- the impacts on the Mannum house boat industry of falling water levels;
- impact of falling river heights on levee bank cracking;
- access to water for pumping in Lake Albert and Lake Alexandrina. In the case of the Lower Lakes it was important to re-focus the group's discussion from concern about a possible weir downstream of Wellington to the need to provide access to water for about 150 pumping points around the Lower Lakes.

The strengths of the community engagement process were that the Minister attended meetings regularly so the public had the chance to put questions directly to the Minister about how the Government was responding. Also, and despite initial reluctance, departmental staff (Primary Industries and Resources SA, Environment Protection Authority, Department for Water, Department of Environment and Heritage, SA Water, Department for Transport, Energy and Infrastructure) attended meetings and participated in discussion which immediately set up dialogue with the community. Among the groups established was the Lower River Murray Drought Reference Group that was an interface between communities and the government and included about 35-40 community representatives.

The whole of Government response that was adopted was seen as essential. The work of the 17 government agencies was considered the best whole of government performance ever observed. The whole of government response was also seen as being vital in speeding up administrative processes. For example, emergency dredging of channels to bring water into pump-offtakes was sped up to 3 days.



Hon. Dean Brown also operated as an intermediary between banks and farmers who were facing financial hardship because of drought impacts. It was recognised that this framework was necessary to avoid banks appointing receivers or taking possession of properties, which would have plummeted property values. Negotiations were held for 72 properties in 2010-11 alone (in addition to more from previous years) of which none went on to bankruptcy. As part of this work, growers were helped to access exit grants and banks agreed to write off some debts (most debts written off were for \$500k to \$2 million).

Lessons to be learned from the drought were that:

- the quicker the Basin Plan is in place the more secure the future will be for South Australia;
- the water level below Lock 1 should not be allowed to drop below 0 m AHD (ideally not below 0.4 m AHD), because the negative consequences for the community are too substantial.
- sections of the community believed that Government was not consistent with respect to decision making (e.g. when making water allocations), yet many decisions were beyond the jurisdiction of the South Australian Government
- the slow response of the Australian Government cost communities dearly e.g. delays in building the Creeks Pipeline;
- adaptive decision making was essential because there could be no knowing how bad the problem would become; and
- during such events, every 3 months there should be a review to ensure that the level of government and community response is “severe” enough.



Digging Chain. Photo courtesy of the Department for Water.



3 CROSS AGENCY PARTNERSHIPS

Session 2 was chaired by Mr Andrew Johnson, Executive Director, Major Programs at the Department for Water who observed that while the first session was instructive about the extent of activities across government, the second session would expand on some of the elements of the whole of Government response. In this regard, while much of the attention during the drought was on the Department for Water Land and Biodiversity Conservation and SA Water's response to water issues, most government agencies were involved including from the health, transport, TAFE, education and primary industries sectors.

The period of the drought also saw major policy reform and achievements including:

- The Water Act 2007, with all of the jurisdictions agreeing to refer constitutional power to the Commonwealth;
- end of system flows and salinity and water quality became critical elements of the Basin Plan;
- trade increased from a base of \$100 million before 2006 to exceed \$1 billion within 18 months over the southern connected Murray-Darling Basin; and
- reform of irrigation legislation, some of which had been in place for over 100 years.

The whole of Government response that emerged during the drought has been enduring as demonstrated by the coordinated approach in responding to flood warnings that were issued over Christmas 2011.

3.1 Maintaining Service to Customers During the Drought

Speaker: Mr Paul Doherty, Manager, Water Security Strategy, SA Water.

Prior to the drought Adelaide's water supply had been considered as secure with water being supplied from the Adelaide Hills (storage capacity approximately 1 year's supply) and back up coming from Hume and Dartmouth Dams (via the River Murray). However, both supplies came under stress in 2006-07 and action was required to ensure supply was maintained to meet critical needs. Key issues for SA Water and its customers were rising salinity, water quality risks and falling water levels (especially downstream of Blanchetown).

A number of short term issues arose in responding to the drought, including

- the need to maximise water availability, through:
 - water sharing with other Basin states;
 - purchase of temporary allocations from willing sellers interstate;
- the need to make the best of what water was available, through water conservation / water restrictions;
- dealing with limitations on major pumping stations on the River Murray and ensuring their continued operation. This led to pump station designs that allowed for continued operating if water levels below Lock 1 were to fall by more than 1 metre;
- managing distribution system operations during restrictions; and
- water quality issues in the River Murray.



Water sharing with other Basin states focussed on providing sufficient flow to South Australia to keep salinity within drinkable limits and acquiring a water “reserve” that could be called on in an emergency to meet critical human needs.

The focus of water conservation was to conserve what was available to the State for as long as possible. In fact, water sharing arrangements with other States were conditional on restricted use within South Australia. A Drought Response Team was operated by SA Water and restriction levels were developed with a progressive increase in savings behind the conservation objectives. The Team was responsible for issuing permits, rebate payments and coordinating community engagement and communication and operated a 24 x 7 call centre for restriction and rebate inquiries, which peaked during the drought at 1000 calls/day. Water restrictions started in October 2006 at Level 2 and reached level 3 by January 2007. The response to water conservation measures was reduced consumption.

A number of water quality issues arose for SA Water, with low flows increasing salinity, especially in the Lower Lakes, and increasing the likelihood of blue-green algal blooms. In response SA Water:

- built drinking water pipelines on Narrung Peninsula;
- brought forward water quality improvement projects for small town supplies between Glossop and Mypolonga; and
- Clayton’s water supply was connected to the SA Water trunk main system.

SA Water also undertook works for other agencies like building irrigation pipelines to Langhorne Creek and Currency Creek and the temporary pumping station at the Narrung Narrows as well as analysing a range of other options.

Despite the hardship imposed on SA Water customers, surveys during and after the drought showed a high level of satisfaction with the way in which the drought was managed. For example, customers provided the following survey responses:

- An average of 4.5 out of 5 respondents said that “Water restrictions are a necessary response to drought”;
- An average of 4.1 out of 5 respondents said that “SA Water did well to maintain supply during the drought”.



3.2 Drought Impacts on Primary Producers

Speakers – Ms Helen Lamont, Director Sustainable Systems and Greg Cock, Leader Drought Response, PIRSA

Primary Industries and Resources South Australia (PIRSA¹) coordinated the whole of South Australian Government drought response from 2006 to 2011. As drought conditions worsened, the Cabinet issued instructions to PIRSA to:

- Coordinate a whole of Government response;
- Deliver evidence based and innovative support;
- Be responsive to regional needs and consistent with national exceptional circumstances policy and programs.

This led to adoption of a phased and adaptive approach, progressing through 14 phases from crisis to recovery to preparedness, with cross agency action and collaboration providing ready access to services and support. “Holistic support” was provided by combining farm business support, family and community support and employment and workforce support.

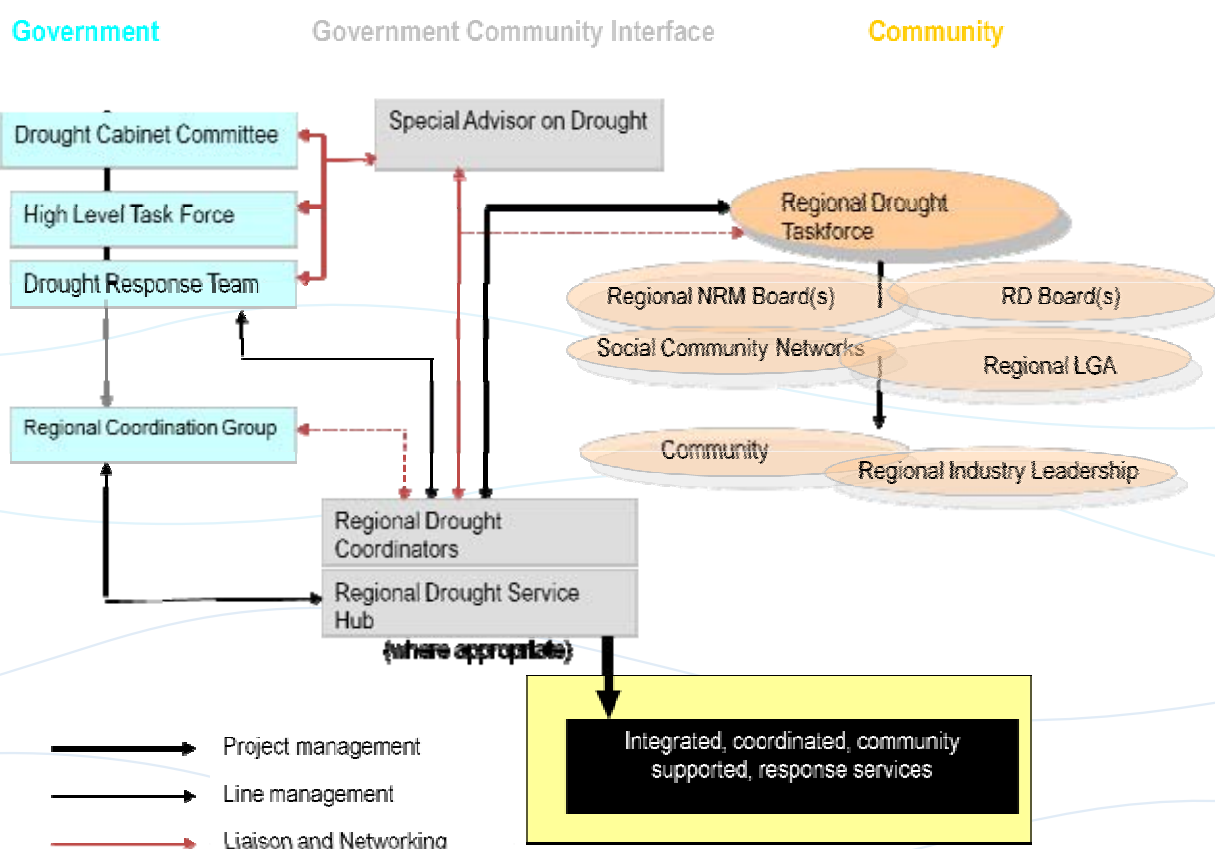


Figure 5. Government and community interactions for the statewide drought response.

¹ In late 2011 PIRSA became *Primary Industries and Regions South Australia*



The River Murray Corridor faced a unique set of challenges because despite low inflows, there was always water in the river upstream of Lock 1. Despite there being highly efficient irrigators a socio economic study in April 2007 indicated that growing conditions were unfavourable as a consequence of record low flows and restricted allocations.

This led to support being provided in a number of ways including technical support, Exceptional Circumstances declaration, assistance from the Premier's Special Advisor and establishment of the Riverland Horticulture Reference Forum and Lower Murray Drought Reference Group.

As a result of this support, a number of River Murray Corridor programs and actions were initiated, including:

- Interest rate subsidies;
- Relief payments;
- Exit grants;
- Professional advice and planning grants;
- Irrigation management grants;
- 'One Stop Shop';
- Financial counselling;
- Health and well being counselling and support;
- Alternative employment assistance;
- Critical water allocations; and
- Information and decision support.

These programs and actions supported the potential for rural communities to recover and build regional capacity. The programs were regarded as successful as they helped to mitigate impacts on the:

- state's agricultural food production;
- state's economy;
- fabric of rural communities; and
- environment and landscape.



3.3 Learning from Extreme Events

Speaker: Associate Professor Justin Brookes, University of Adelaide and leader of the CLLAMM Ecology project

The role of science in responding to drought is to inform policy and management. But how do we protect ecosystems given competing demands and uncertainty about future climate? This requires robust science (including economic and social science) to inform the debate on water use and identifies the need for predictive capacity regarding the climate, hydrology, hydrodynamics, water quality and ecological response.

The realities of the drought were that active storage levels were very low and flow to South Australia was well below average. This saw falling water levels and rising salinity in the Coorong, Lower Lakes and Murray Mouth, the traditional country of the Ngarrindjeri and a Ramsar listed wetland that supports irrigation agriculture, tourism and fisheries and that traditionally provided refuge for ~80% of aquatic birds in the MDB during drought.

During the drought a salinity gradient established along the Coorong with salinities more than doubling during the most severe times of the drought in 2007 (Figure 6).

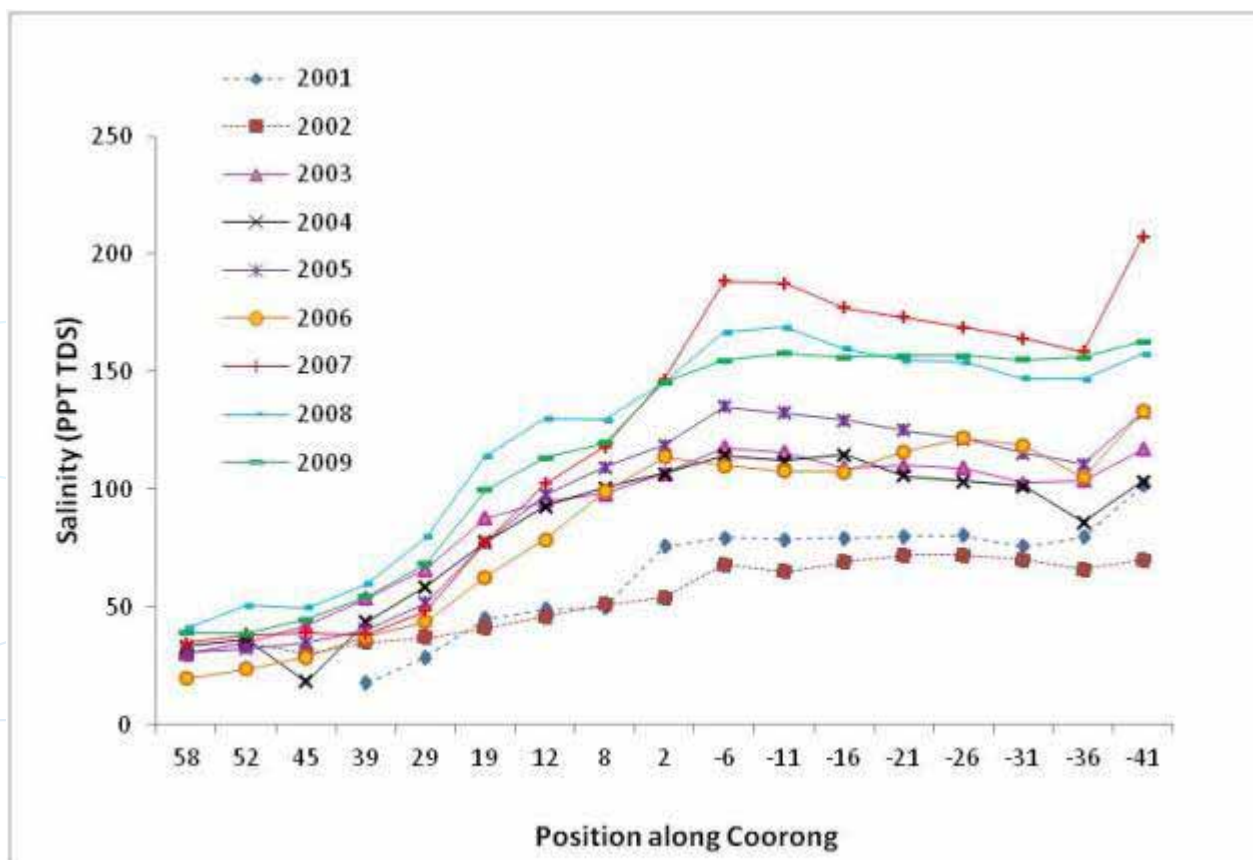


Figure 6. Salinity gradient at sites along the Coorong from 2001 to 2009 (J. Bookes).



The ecological impacts of increasing salinity during the drought became evident with decreasing numbers of invertebrate taxa further down the Coorong (i.e. heading southwards away from the mouth) associated with increasing salinities, such that in March 2007 there were no taxa recorded at the southern most sampling sites where salinity had risen to above 140 ppt. Further evidence of the impact of rising salinity in the Coorong came from changes in the abundance of *Ruppia tuberosa*, which virtually disappeared from the Coorong during the height of the drought (Figure 7). The impacts of rising salinity on food sources for larger birds could also be seen, with the abundance of Black Swans falling as the abundance of *Ruppia* declined and Fairy Tern abundance falling as fish density in the Coorong declined (Figures 7 and 8).

Experience from the drought has indicated that the target salinity threshold in the South Lagoon should be 100 g/L and that high flow alone has not flushed out the built up salt in the system. Degradation of the Lower Lakes and Coorong during the drought suggests that:

- new policies are needed to provide adequate flow to maintain the Coorong;
- mismanaging the past means we are now over-managing the future;
- running our ecosystems down leaves them vulnerable to further change;
- there is an imperative to conserve now, so that ecosystems are resilient and able to cope with extremes in climate
- a new investment in new science for tomorrow's challenges because we can't just assume that mining historical data will give us the answers we need



Bank collapse at Neeta. Photo courtesy of the Department for Water.

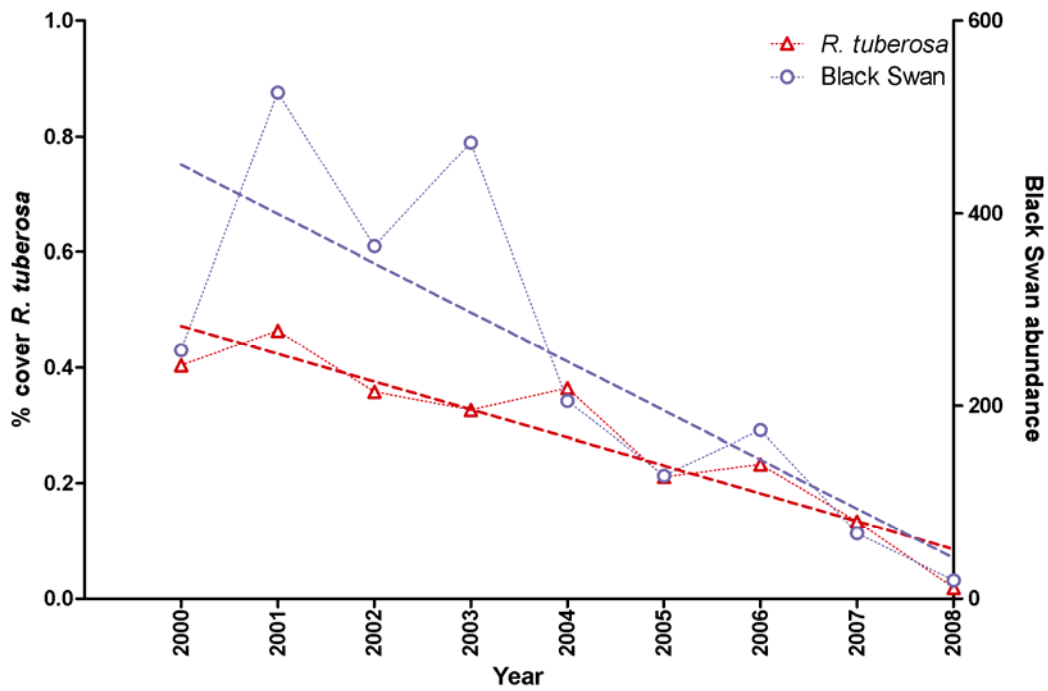


Figure 7. Links to Food: Black Swan (J.Brookes).

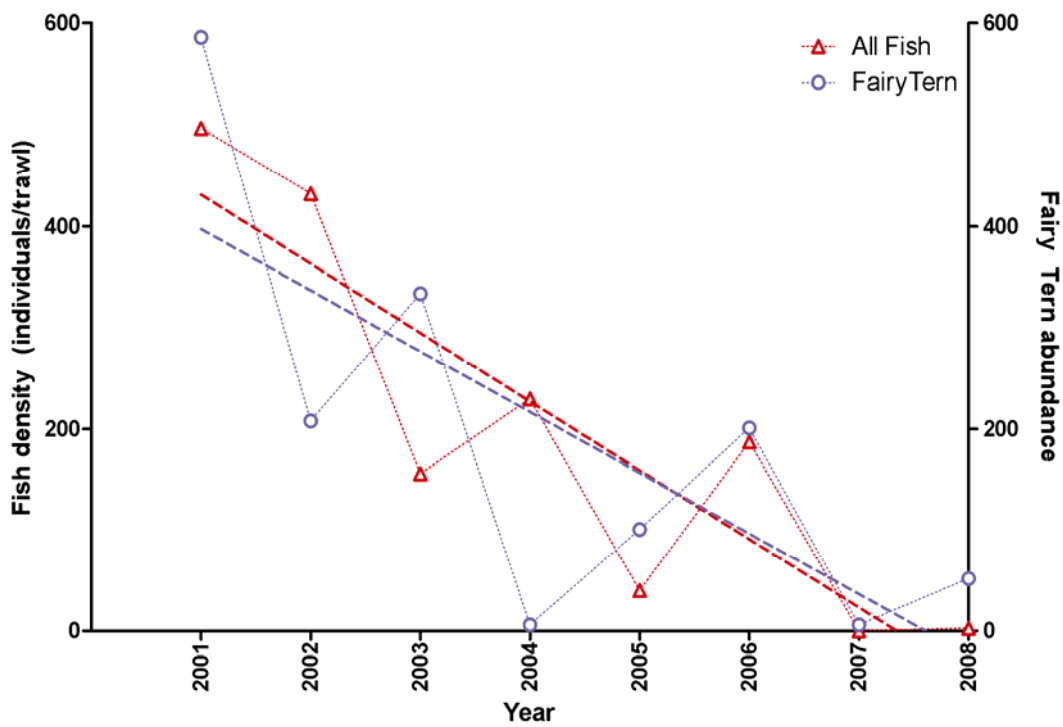


Figure 8. Links to Food: Fairy Tern (J.Brookes).



4 SMALL GROUP DISCUSSIONS

The second half of the workshop involved a series of small group discussions focussing on key themes that emerged during the drought. There were two discussions per theme (45 minutes each) enabling workshop attendees to contribute their thoughts to two discussion groups. Each discussion was led by a government agency representative (listed below) who had experience with the issue and the ensuing discussions were moderated by an ICE WaRM facilitator.

A detailed, edited list of the contributions made by participants during the small group discussions is provided in Attachment C. Key summary points from each theme were as follows:

Environmental Management

– led by Ms Kelly Marsland, SA MDB NRM Board

- Significant resources are required for sufficient monitoring to occur and data should be accessible;
- The EPBC Act has limitations in responding to a major natural resource threat like the drought;
- The decision making process for managing environmental water needs to be clarified for environmental managers;
- There is value in recording landholder experiences;
- It remains unclear as to whether there has been permanent environmental damage caused by the drought;
- It is uncertain as to whether the Basin Plan will address some of the environmental risks experienced during the drought;
- There is a need to plan for drought during non drought periods

Role of Science

– led by Mr Jason Higham, Department of Environment and Natural Resources

- Science provides knowledge that can act as a guide for management.
- While science contains uncertainty this should not be a reason to marginalise it in the decision making process. Instead the uncertainty needs to be noted as is the case for other information types (e.g. financial, social);
- Science interpretation is critical to political decisions and there is a need for scientists to become more proactive in communicating the results of their work;
- Scientists need to invest in building trust with decisions makers and the community;
- There is a need to systematically decide what science is required and how to get the most out of it;
- Lessons can be learned from the management of the recent drought in the Murray that demonstrate the value of taking a truly adaptive approach to scientific investigations to support management and not waiting until a crisis occurs. This is further demonstrated by operation and management of drainage scheme infrastructure in the South East of South Australia.



Infrastructure and Risk Management

– led by Mr Andrew Beal, Department for Water

- It is important to use the time before the next drought to determine the priority for spending money on infrastructure. This can be achieved through a fully costed scenario analysis;
- The Lower Lakes should not again be allowed to drop below 0 m AHD because significant infrastructure issues start to arise as a result;
- Capacity and corporate knowledge is diminishing rapidly due to staff turnover;

Legislative Change, Policy and Community Engagement

– led by Ms Julie Cann, Department for Water

- The importance of community engagement in informing policy was re-enforced;
- Focussed community engagement should be done at the same time as developing communications material;
- Community engagement became a positive mechanism during the drought for conveying information about how the state was responding and provided an opportunity to inform policy development;
- Each region is different and requires a tailored community engagement approach.



Dry lake bed at Goolwa, January 2008. © MDBA ; Photographer Arthur Mostead



5 DISCUSSION

The workshop provided a small window of time to focus on some major learnings from the Millennium Drought. Key people from a political to on-ground level were involved ensuring a cross section of views were expressed and discussed.

Key messages from the workshop were that:

- There is a lack of awareness amongst the broader community, including those in the water management sector, of the large amount of quality work that was done by the public sector in responding to the drought. This work was acknowledged at the workshop by those who were not directly involved with the Government's response;
- Cross-government governance structures were essential in the State Government being able to respond to the drought and integrated, environmental, health and safety, irrigation, drinking water and engineering considerations. An example of this was the Water Security Technical Working Group;
- The impacts of the drought are still with us (e.g. acid drainage from the Lower Murray River Irrigation Area, cracked levee banks) and communities are still re-building confidence, their livelihoods and economic activity;
- Community engagement was as key tool in communicating the reasons why new legislation and policies were required and that the community engagement processes that were run could be maintained and built upon where possible to further spread the benefit of the "social capital" that emerged during the drought;
- There is a need to systematically determine and agree on what science is required to manage natural resources during such events and how to obtain the most relevant knowledge to support decision making from the investment that is available. The recent drought demonstrates a suitable approach;
- There are key eco-hydrological thresholds that emerged during the drought that if exceeded will cause significant degradation to the Lower Murray environment. For example, further degradation could be expected if levels in Lake Alexandrina were again to fall below sea level and the salinity level in the Southern Lagoon of the Coorong exceeds 100 g/L;
- It is essential that the time before the next drought is used to determine the priority for infrastructure spending, using an approach such as a full costs and impacts scenario analysis that considers hydrological events beyond historical experience (drought and flood) and potential future impacts arising from climate change; and



- Necessary approvals should be secured in advance with agreed triggers for implementation.
- It is important that before the next drought “event ready” research and monitoring programs are prepared. This involves the design of research and monitoring based on an improved understanding of potential drought impacts informed by recent experience. This will contribute to the appropriate science being available to support decision making processes.

The workshop was presented as being the first step in what may be a longer review and documentation process, to ensure that the lessons from the drought do inform future management of such events. Next steps could include:

- Further documenting each of the major initiatives implemented during the drought into a series of case studies that could intum form the basis of an edited book, drawing on contributions from people involved with management of the drought. This would be similar to publications produced for the Colorado River below Glen Canyon Dam where an adaptive management program has been in place since 1997 and numerous publications produced (<http://www.gcdamp.gov/index.html>).
- Additional workshops on some of the themes and issues raised at the workshop, such as systematically reviewing what science is required to manage natural resources during drought events and identify the need for predictive capacity regarding the climate, hydrology, hydrodynamics, water quality and ecological response;
- Determining how best to adopt a South East type approach to adaptive management for River Murray wetlands, developed during normal rather than drought years;
- Conducting an audit to determine the ecological recovery of the wetlands drained during the drought and develop a framework for their future management and monitoring;
- Using outcomes from the drought to inform development of the Basin Plan, especially with respect to setting operational targets for river height below lock 1 and water quality parameters; and
- Use drought learnings to inform River Murray operating rules and interjurisdictional water resource sharing arrangements to determine whether better outcomes are possible during drought conditions.



ATTACHMENT A – WORKSHOP AGENDA

TIME	DURATION	TOPIC	WHO
9:00 am	5 minutes	Welcome	Hon. Paul Caica, Minister for Water and the River Murray
9:05 am	10 minutes	Introduction and Context. Why this is important?	Richard Hopkins
9:15 am 9:40 am	25 minutes 25 minutes	Decision making Decision making within Government Departmental perspective	Chair: Richard Hopkins Hon. Karlene Maywald Mr Andrew Beal, Director, River Murray Operations
10:05 am	30 minutes	PANEL SESSION - Decision making and community engagement	Hon. Karlene Maywald, Hon. Dean Brown, Andrew Beal Facilitated by Richard Hopkins
10:35 am	15 minutes	BREAK – MORNING TEA	
		Cross agency partnerships	Chair: Andrew Johnson
10:50 am	15 minutes	Drought impacts on urban water users	Paul Doherty, Manager, Water Security Strategy, SA Water
11:05 am	15 minutes	Drought impacts on primary producers	Helen Lamont & Greg Cock, PIRSA
11:20 am	15 minutes	Learning from extreme events	Assoc. Prof. Justin Brookes , University of Adelaide
11:35 am	45 minutes	PANEL SESSION	Facilitated by Andrew Johnson
12:20 pm	40 minutes	BREAK – LUNCH	
		Workshop session 1	<i>2 short presentations per topic to seed a facilitated group discussion</i>
1:00 pm	40 minutes	Environmental management Infrastructure and risk management Role of science Legislative change, policy and community engagement	Kelly Marsland, SA MDB NRM Board Andrew Beal, DFW Jason Higham, DENR Julie Cann, DFW
1:40 pm	20 minutes	ROTATE BETWEEN GROUPS	
		Workshop session 2	<i>2 short presentations per topic to seed a facilitated group discussion</i>
2:00 pm	40 minutes	Repeat of the workshops in the 1 pm session	As above
2:40 pm	20 minutes	AFTERNOON TEA	
3:00 pm	10 minutes	Summarising remarks	Andrew Johnson/Mark Siebentritt
3:10	10 minutes	Wrap – up and thank you	Richard Hopkins
3:20 pm	FINISH		



ATTACHMENT B – LIST OF ATTENDEES

Name	Organisation
Alrajhi Abdullah	Uni SA
Steve Adkins	SA Water Corporation
Faisal Ahammed	Uni SA
Michele Akeroyd	Water Quality Research Australia Limited
Kane Aldridge	Adelaide Uni
Laura Allen	Department for Water
Glyn Ashman	SA Water
Rene Basse	Fyfe Earth Partners
Andrew Beal	River Murray Operations
Graham Brook	Mount Barker Natural Resources Centre
Justin Brookes	University of Adelaide
Hon. Dean Brown	Lower Murray Community Liaison Manager, Special Adviser to the Premier on the Drought
Adam Chambers	Primary Industries and Regions South Australia
Greg Cock	Primary Industries and Regions South Australia
Yvette Colton	Department for Water
Barb Cowey	Business SA
Paul Doherty	SA Water
Jarrod Eaton	Department for Water
Elnaz Etehad	
John Ewers	GHD
Malcolm Fearn	SA Water
Lesley Fischer	
Adrienne Frears	Department for Water
Melanie Gale	Uni SA
Wayne Golding	Country Health SA
Wayne Henry	Business SA
Jason Higham	Department of Environment and Natural Resources
Richard Hopkins	ICE WaRM
Anne Jensen	The University of Adelaide
Andrew Johnson	Department for Water
Mohammad Kamruzzaman	Uni SA
Helen Lamont	Primary Industries and Regions South Australia
Sean Lasslett	SA Water
Sam LeRay	Department for Water
Dale Lewis	Primary Industries and Regions SA
Liam Mannix	Indaily
Richard Markevecius	Department for Water
Chris Marles	SA Water
Kelly Marsland	South Australian Murray-Darling Basin NRM Board
Hon. Karlene Maywald	Former Minister for the River Murray and Water Security
Dale McNeil	SARDI
Jonathan McPhail	SA Inland Fisheries Management



Name	Organisation
Cameron Miller	ICE WaRM
Bob Newman	Catchment Management Consulting Pty Ltd
Julie Peltz	Country Health SA
Trevor Pillar	ICE WaRM
Mostafa Razzaghmanesh	PhD Student
Ian Reid	ICE WaRM
Andy Roberts	Water Industry Alliance
James Robinson	Rabobank
Pauline Rooney	Waterfind
Tom Rooney	Waterfind
Ben Samy	Department for Water
Mike Seager	ICE WaRM
Ann Shaw Rungie	Ann Shaw Rungie Consulting
Mark Skewes	South Australian Research & Development Institute
Jonathan Sobels	Flinders University
Denis Sparrow	Rural Solutions SA
Ross Stevens	Parsons Brinckerhoff
Kristyn Swaffer	Department for Water
Debro Thaw	ICE WaRM
Tony Thomson	Waterwood Farm
Joel van de Peer	Department for Water
Bart van der Wel	
Joel Voortman	ICE WaRM
Cameron Welsh	South Australian Murray-Darling Basin
Darren Willis	Natural Logic Australia Pty Ltd
Peter Willmott	Primary Industries and Regions SA
Christopher Wright	SA Government
Qifeng Ye	SARDI



ATTACHMENT C – SMALL GROUP DISCUSSION SUMMARY

The following provides an edited list of the issues identified during the small group discussions at the workshop around 4 themes:

- 1) Legislative change, policy and community engagement
- 2) Environmental management
- 3) Role of science
- 4) Infrastructure and risk management.

Legislative Change, Policy and Community Engagement

Speaker: Ms Julie Cann, Department for Water

- A whole of Government response emerged
- Having a committed Minister was important
- Rapid feeding of information back through networks (sometimes reactive)
- No regrets decisions
- Reliance on a small number of staff
- How do you pass the knowledge on? Need to document decisions and processes
- Decisions were more bi-partisan than normal
- Need enough time to help people take a lead in the community
- Needed to ensure there was informed debate e.g. Stories about what is happening elsewhere on the river
- Drive for Water Act was a South Australian initiative
- Need to work out how to inform all relevant groups affected
- Hard to run a consultation process that makes the information transfer stick
- Each region is different – need a case by case engagement process
- There is a need to draw on the knowledge of people that might have moved on from their roles/employment during the drought
- A one stop shop was important for information sharing
- Negotiated storage rights were an example of policy changes in response to the drought
- Need consistency of information and clarity on decision making processes
- One of the key successes was distribution of information, especially frequency of information distribution
- Did not communicate the severity of the problem as much as we could have, in part because we did not believe the severity of the problem or comprehend it
- Do not attempt to convey information through a public meeting
- Organised bus tours proved useful
- Structured engagement through established groups
- Need to preserve social capital that emerged during the drought
- Tight timeframes often limited effective consultation.
- Dean Brown acted as the chair of 19 community engagement groups and thus provided for continuity of information
- Most groups were spontaneous, issue focussed
- Need time and funding to help continue to build social capital
- Continue to invest in engaging community networks
- Recognise that interest in engagement is driven by purpose
- Invest in community organisations where people are cooperating for a purpose



- Agencies engaged with the community in a way they would not have normally
- Need to avoid feelings of over consulting
- PIRSA needs to invest in regions
- No fault environment where it is ok to make mistakes
- Invest in people
- Invest in extension
- Recognising Stewardship as a pathway to information changes
- How to deal and communicate with people who do not get what they want
- Succession planning in the community is important e.g. who is the next Dean Brown
- Support people in roles in Government
- Suck it and see – make a decision
- How do you engage both sides of politics in a bi-partisan way?

Environmental Management

Speaker: Ms Kelly Marsland, South Australian Murray-Darling Basin Natural Resources Management Board

- It is okay to shut wetlands off during drought as a measure to save water but will this become the practice?
- Shutting down wetlands [closing regulators and drying out] under results in different outcomes for different wetlands
- Management of individual site future need to manage floods to build resilience
- Putting water back to wetlands should be built into management arrangements
- What was the process that decided that the environment didn't get any water?
- Environmental water for water quality purposes
- We describe critical human needs but where is "environmental needs?"
- Consistent criteria and agreed triggers in advance so that we can have options at the ready
- Wetland allocations differ during drought and other conditions
- No species lost during drought! Is this correct?
- Murray Cod – no increase - will we have a Murray Cod population?
- Timing of water delivery is crucial to the population growth/maintenance of some species.
- Environment regulators = explosion of carp
- With recovery through increasing flows it is important to capture outcomes
- Fresh water needed in Lake Albert.
- Must be understanding of hydrology of Lake Albert/Coorong
- Management choices to be made that communities will be interested in
- Toxins from flood plains ending up in river
- Crises over funds for water monitoring of toxins
- Shut down wetlands still need to be monitored e.g. for mosquitoes.
- There is so much information and stories need to be told. In times of crises the community needs to be kept informed
- Farmers need to know who to contact in times of crisis
- Need acid sulfate program to learn management techniques from farmers e.g. contouring to revegetate
- Resources are required for monitoring
- Water-critical and environment needs



- Clarify the decision making process
- What culture now exists around community and environment - how do we change/improve
- Land holder experiences around lower lakes should be documented
- Drought and flood management to build resilience!
- Wetlands were perceived as a waste of water by community
- The dry phase of wetlands was of no benefit
- It's unclear whether there are examples of irreversible damage
- It took at least 6 months for water quality to come back
- Studies are being undertaken to determine if there has been permanent damage to the Coorong
- Ongoing monitoring will tell if there is any permanent damage
- 30 – 40 wetlands that the board monitors can be used to create data maps and summaries
- Commonwealth provides no funding for monitoring during crises.
- Ongoing research needs to learn from drought impacts
- This was a very different scenario – river banks slumping etc.
- Next drought should not be as extreme
- We have never extracted as much water out of this system as we did during this drought
- Reserves need to be stored
- SA Government structures for responding to drought are very different to other states.
- Some NRM groups are better resourced than others.
- Ability to invest on the ground is very different for each state.
- Limited in what it will recognise e.g. species not listed.
- Ability to plan for drought during non drought periods is essential. Responding to drought not enough! (Victoria managed this well)
- Linkages between state and NRM important and to be acknowledged
- Better integration needed between departments/states etc.
- Contingency plans for different areas of drought and how they relate to each other (Victoria)
- Work out who owns responsibility for what in the environment departments
- A plan for the next drought. A long term view
- There is a risk that wetlands are now perceived as a water waster because of their closure during the drought to ensure water for critical human needs was available



Infrastructure and Risk Management

Speaker: Mr Andrew Beal, Director, River Murray Operations, Department for Water; Chair, Water Security Technical Working Group; Principal Advisor, Water Security Council

- Business Infrastructure
- Community Infrastructure e.g. Tourism, Education
- Regional 'Clumping'
- Additional water storages
- Desalination - Education on reliance on amount of River Murray water
- Ecological management of Murray water
- Water savings from wetland management (wet/dry cycles)
- Selling environment allocations in the market
- Lower Lakes
 - Water diversion
 - Evaporation
 - Dredging
 - Study Project?
- Policy debate - Socio economic models
- Triple bottom line

Role of Science

Speaker: Mr Jason Higham, Department of Environment and Natural Resources

- Needed to insure against acid sulfate soil
- Important to justify large capital expenditure
- Federal Funding was provided at a very slow rate
- Stranded infrastructure was caused by policy
- River recovery - how to manage for acidification?
- Design to manage for future acidification
- Must avoid lakes drying out
- Prepare designs and preliminary approvals
- Design for permanent structures rather than temporary community debates now – ready for the future
- Capital to avoid future dredging.
- Re-evaluate risks with new climate information
- Now know much more than 5 years ago: Must use now or lose it.
- South East infrastructure has been truly adaptive and not developed in crisis
- Federal government infrastructure junkies
- No OEM support
- Annual contracts. Externally funded, information generated over last 5 years



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