



Scenario Planning for an Innovative Response to the Water Challenge in the Murray Riverina Region

Scenario planning review

Regional Development Australia Murray, Regional Development Australia Riverina and Trade & Investment NSW

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Scenario planning

Introduction

Scenario planning is a strategic tool to help planners develop robust future strategies for their organisations and/or regions, particularly in complex and uncertain decision-making or operating environments. Scenarios are not the plans or strategies themselves, rather they describe plausible alternative futures within which strategies can be developed and tested or implications and risks assessed [1]. Unlike some other planning tools, they make no pretence about either predicting or significantly influencing future conditions [2].

Scenario planning is most useful when the future is uncertain, or when strategic uncertainty prevails. This situation is becoming increasingly common as major drivers like climate change having substantial uncertainty associated with them and others, like technological innovation, are occurring at increasingly rapid rates [1].

Since there are infinite possible futures, it is important for scenarios to focus on issues of critical importance to the future of the organisation or region. To achieve this, the first steps in scenario formation are a situation analysis and identification of important trends and drivers that will shape the future of the organisation or region [1].

The situation analysis aims to clarify the key features of the region being considered, what issues are currently being encountered, and how it came to be this way. The analysis of key trends and drivers is forward thinking, and

draws out those factors which are most important to but also most uncertain about the future [1].

This initial analysis can be used to build several kinds of scenarios, including:

- Narrative scenarios – in which scenarios are written as stories or narratives about the future. They describe situations which may emerge if current or projected trends or change drivers play out or shocks intervene. As storylines about the future, narrative scenarios typically include little technical information, although they should be backed up by a sound evidence base. Scenarios are presented in this way to engage a wide group of participants in thinking about and planning for the future.
- Aspirational scenarios – are forms of narrative scenario which describe desired future states for an organisation or region. They differ from other forms of narrative scenario in that the trends and drivers of change are directed towards particular beneficial or sought after outcomes. They are of most use in contexts where planners, their organisations or stakeholders have significant influence over at least some of the key change drivers.
- Numerical scenarios – which describe the future in numerical terms rather than as a non-technical narrative. Numbers and numerical models are used to explore the influence of critical change drivers and uncertainties. Such scenarios are widely used in climate change impact assessment and in support of adaptive planning.

- Option evaluation – a single scenario is developed in narrative and/or numerical format. Variants of the scenario are developed by adjusting one or a small number of critical drivers or uncertainties.

Forms of each of the above types of scenario planning have been used in the Murray and/or Riverina Regional Development Australia (RDA) regions of southern New South Wales or nearby regions of Victoria to assist in strategic planning in response to climate change, water and other natural resource issues. The remainder of this paper provides a summary of these various scenario planning activities and their implications for the *Scenario planning for an innovative response to the water challenge in the Murray Riverina region* project.

Narrative scenarios

Developing narrative scenarios [3]

Narrative scenarios are used to tell a story of the future that incorporates various socio-economic, environmental, technological and policy influences, which may not be readily expressed in common numerical terms. The use of storylines and avoidance of numbers and other highly technical information ensures the scenarios can be engaged with by stakeholders who do not have strong science or engineering backgrounds.

There are four main steps in developing narrative scenarios for adaptive planning (Figure 1), as follows. Similar processes could apply for aspirational scenarios.

Define – in which the scope of the scenarios is defined, the current situation facing the region or system of interest is analysed and trends and future drivers of change identified. Analyses of current status, trends and change

drivers should consider social, economic, environmental, technological and policy (STEEP) aspects. Broadly similar analyses would be

Explore – critical uncertainties in trends and drivers of change are identified and ranked. Scenarios are often based on the most important-most uncertain drivers. Foreseeable shocks to the system (e.g. global financial crisis) are considered for incorporation into one or other scenarios.

Build – a scenario logic is chosen to assist in storyline development. A 2x2 matrix based on the two most important-most uncertain change drivers is commonly used. An alternative scenario set is one framed around one key driver and which includes a business as usual scenario (which is not a continuation of current or historical conditions) and much better and much worse scenarios. The storyline elements are then developed and the narrative written. Draft scenarios are tested with stakeholders to ensure they are logical, consistent and plausible.

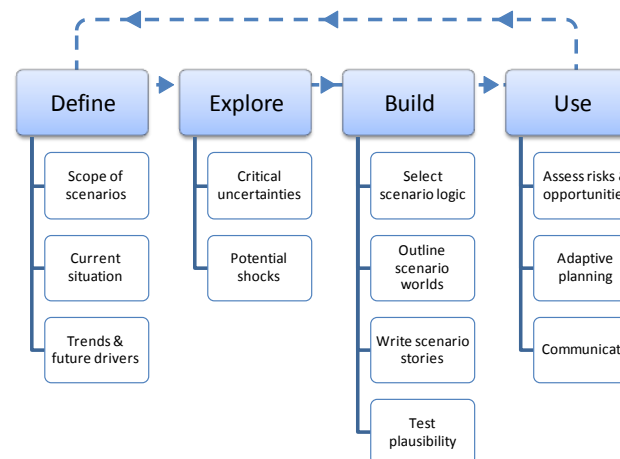


Figure 1 Steps in development and use of narrative scenarios in adaptive planning

Use – scenarios are then applied to adaptive planning tasks, including risk and opportunity assessment, communication with stakeholders, options development and assessment and strategy formulation.

Storylines typically commence with the current situation and extend through the planning period. Conditions in intermediate points, as well as the transitions to them, may be described. Storylines would typically be 2-4 pages in length, but may also be summarised into a single paragraph or table for communication.

Strengthening Riverina Irrigation Communities [3]

Narrative scenarios were recently developed for the Strengthening Riverina Irrigation Communities project managed by the Griffith City Council for a consortium including themselves and the Carrathool, Leeton, Murrumbidgee and Narrandera Shire Councils. The scenarios were developed as part of a project to help the Councils plan for a future with less water – particularly in response to climate change, water trade and environmental water recovery.

Scenarios were constructed from an analysis of key trends and drivers of change at regional to global scale. While there was a strong focus on climate and water-related issues, a wide range of other social and economic forces were considered to be driving change in the region (Table 1). Three scenarios were developed (below), which took water and climate as the critical uncertainties.

- Rejuvenated Riverina – in which the rains of 2010 heralded a return to a climate regime that while slightly warmer, ensured abundant irrigation water supplies and environmental flows, apart from during the

occasional, short-lived drought. Economic growth in China and India and population growth across the developing world created strong demand for food and beverages produced in the region and resulted in the long-term downwards trend in farmers’ terms of trade reversing. Environmental water recovery targets under the MDBP were well within a manageable range. The region’s economy prospered, people were attracted to the region from crowded metropolitan centres and the exodus of young people was slowed.

Table 1 Key drivers of change influencing Riverina Irrigation communities [3]

Local-regional scale drivers	State-national scale drivers	International or global scale drivers
Uncertainty/sentiment about future conditions Technological innovation & adoption in key local industries Investment in marketing the region Population retention &/or attraction	Seasonal irrigation allocations Trade in water allocation and entitlement Murray-Darling Basin Plan Environmental water recovery investment ICT infrastructure, including high speed broadband. Population growth, congestion and housing affordability in major Australian cities. Strength of Australian mining sector Interest rates Government and industry investment in regional economic development initiatives	Climate & climate change Economic growth in China and India, rate & extent of economic recovery in US & Europe Global population growth Global patterns of supply & demand for agricultural produce Oil price Currency exchange rates International policy responses to climate change. Global food security

- Resilient Riverina – in which the drought breaking rains of 2010 heralded the end of the ‘Big Dry’ and gave relief to hard-pressed dryland farmers, irrigators and water companies. Climate returned to its typical cycle of ‘droughts and flooding rains’, although there was an inexorable trend towards warmer and drier conditions under the influence of climate change. The MDBP proposed significant reductions in diversions for irrigations in the Murrumbidgee and Lachlan valleys, but allowed time for adjustment and did not mean an end to irrigation. Nonetheless, there was some serious restructure in irrigation industry. The Commonwealth Government worked collaboratively with regions and invested to reduce MDBP transitional impacts. While there was less irrigation water and lower rainfall than historical averages, agriculture successfully adapted and maintained production. Economic growth in China and India and expanding global populations helped to sustain the Australian economy. Food prices were sustained at strong levels. While the Riverina experienced significant challenges, the population was stabilised and its economy remained resilient.
- Ruinous Riverina – in which the drought-breaking rains of 2010 provided welcomed, but only short-lived relief from a ruinous climate. Drought soon remerged, although the near full storages of 2010 sustained irrigation for some time. Global climate systems turned out to be much more sensitive to greenhouse gas emissions than was originally thought. This meant that prolonged, intense droughts became the new norm for the Riverina. The 2007-09 global financial crisis (GFC) was repeated on an even larger scale, triggered by sovereign debt crises in EU countries. Domestic economies faltered and international financial markets collapsed. Recovery from the double dip recession was painful and slow. Economic growth in China and India helped to support the Australian economy, however commodity and equity prices were well below the

2000s. The MDBP proposed major reductions in irrigation water availability, despite widespread concern about socio-economic impacts. The decline in irrigation infrastructure and irrigation farming precipitated a crisis in the community’s confidence and resulted in a rapid and seemingly irreversible decline in population. Smaller rural Councils became unviable and were amalgamated, although this only compounded the challenges of service provision.

The *Resilient Riverina* scenario was considered to represent ‘business as usual’. The key features of this scenario are summarised in Table 2.

Table 2 Key elements of the Riverina Irrigation Communities business as usual scenario, *Resilient Riverina* [3].

Local-regional features:
Recovery from Big Dry, but region remains a land of drought and flooding rains. Conditions become drier and warmer, but only relative to historical average, not the Big Dry
Population loss (including young people) curbed, but remains dependent on the strength of agriculture
Irrigation infrastructure restructured and modernised, continual improvement in agricultural technology
Renewable energy investment
Economy resilient, but contracts somewhat and remains strongly dependent on agriculture and related manufacturing, services.
State-Murray Darling Basin-national features:
MDBP with significant SDL reductions for Murrumbidgee and Lachlan, does not spell end of irrigation
Environmental water buy-backs limited in each valley to irrigation systems and industries not pushed beyond viability tipping points. Water trade otherwise fully freed up.
Government investment in telecommunications, water and transport infrastructure

Major cities crowded and unaffordable, regional areas relatively attractive
Mining boom continues, helps to sustain Australian economy
Carbon markets accessible to agriculture. Price for carbon in Australian economy

Global features:

China and India emerge as dominant global economies. With rapid global population growth, with decreasing food security there remains strong demand and price for Australian minerals and food
Some concerted global action, but dangerous climate change not avoided.

The higher priority risks for the region under the business as usual scenario includes:

- Climate and water - drought returns rapidly and/or climate change more rapid or worse than expected.
- Water policy - MDBP leads to major reduction in irrigation water availability for regional irrigators.
- Rapid population decline - resulting from economic contraction and loss of confidence by local residents and business.
- Workforce contraction - inability to attract/retain skilled labour due to limited or unreliable employment opportunities and/or lack of “second job” opportunities for partners.
- Agricultural research and development (R&D) – underinvestment in agricultural R&D and low rates of adoption.
- Local governments become unviable - as a result of cost/service shifting by other levels of government, declining population and rate base.
- Water trade - MDBP accelerates water trade from region.

If realised, these risks would lead to significant reductions in the value of agricultural production, reduced employment, deterioration in economic infrastructure, divestment by business and potentially terminal decline in rice and other general security dependent irrigation industries. If this occurred, the region would be depopulated, especially of young people. Social services and infrastructure would be lost, as would confidence in the region’s future.

Most of the risks were less pronounced or not applicable under the best case scenario (*Rejuvenated Riverina*), but would be more severe under the worst case scenario (*Ruinous Riverina*).

The scenarios and risks are broadly applicable across the irrigation-dependent communities of the Murray and Riverina RDA regions.

Goulburn-Broken Region Irrigation Futures [4]

The Goulburn-Broken Irrigation Futures project was undertaken to help irrigation industry stakeholders develop a vision and strategies for irrigated agriculture over the next 30 years. The project was undertaken in 2007 response to the uncertainty faced by the Goulburn-Broken region as a result of drought, low irrigation water availability, water trade and the vagaries of international agricultural commodity markets. Scenario planning was used to help manage the uncertainty associated with such a long planning horizon.

Four scenarios were developed (below), with climate, water, land use and international markets for agricultural products used among the critical uncertainties. Scenarios also include ‘shocks’, such as disease, step changes in oil price and the loss of particular markets.

- Moving on - the cost-price squeeze continues to drive the development of agriculture. The phasing-in of bilateral free trade agreements with the US and ASEAN creates both export opportunities and strong competition.

Climate change results in less rainfall and a reduction in chill hours. Fire blight decimates pome fruit production in the region. Agricultural businesses adapt to declining terms of trade by increasing farm sizes and developing highly controlled production systems. Multinational corporations takeover the region's processing facilities. The number of lifestyle properties continues to grow slowly. Conflict arises over appropriate land management practices. Irrigation water delivery infrastructure is privatised and rationalised. The population of the region continues to grow steadily. The community is less willing to volunteer forcing the consolidation of community services and groups. The region remains economically prosperous.

- New frontiers - Demand for lifestyle properties in the region increases substantially as communication technology improvements enable residents to telecommute. Small blocks of land near towns and adjacent to forests and water become the focus of lifestyle developments. Trade with Middle Eastern countries collapses, increasing the price of oil and reducing markets for agricultural products. Governments increase regulation of agricultural practices and introduce a new wave of water reform. Environmental flows are increased through improving the reliability of water entitlements for irrigators. Agricultural industries struggle to adapt to pressures imposed by new regulations and loss of markets. The introduction of synthetic food production changes the face of agriculture, creating demand for grain as a feedstock. Significant volumes of water are traded out of the region due to the limited availability of large land parcels suitable for cropping. A small niche of authentic food production remains. Throughout this scenario the regional community and economy continue to strengthen, however the contribution of agriculture decreases significantly.

- Pendulum - A green influenced government commits to improve environmental flows in the Murray River. Government purchases all medium reliability water entitlements and some high reliability entitlements. Land and infrastructure is restructured to manage the social impacts of water purchase. The confidence of agricultural industries plummets and investment declines. Fish and aquatic bird populations flourish and attract fishermen and ornithologists from all over Australia. Conservative parties win a federal election and immediately assume control over the management of water resources, reallocating substantial volumes to agriculture. Government auctions water entitlements and rebuilds irrigation infrastructure in partnership with irrigator cooperatives with the auction proceeds. A wet climatic sequence causes floods to occur in successive years. Agricultural export opportunities improve as the dollar weakens, due to the floating of the Chinese yuan, and consumers seek GM free produce. As agriculture in the region expands and diversifies, labour shortages become apparent. The region slowly regains its former economic prosperity.
- Drying up - A recession in the United States and the emergence of China as a horticultural exporter causes Australia to lose export markets. The region is hit by a severe drought with water allocations of less than 100 percent for 5 consecutive years and as low as 30 percent in the worst year. Agricultural producers struggle to make ends meet, many selling assets and relying on government assistance. Irrigation infrastructure deteriorates due to the inability to afford maintenance costs. Aquatic biodiversity declines, as minimum environmental flows are not delivered. An exodus of young people slows population growth to a minimum. As the drought moderates, the global economy grows strongly. Export opportunities improve in the increasingly affluent Asian and South American countries due to Australia's GM free status. Agricultural

industries expand and intensify, with support from governments and private investors, but the availability of labour and skills restricts the rate of growth. The economic and environmental wellbeing of the region slowly recovers.

Implications of the scenarios were analysed by stakeholders and strategies developed to manage key risks. The key risks for which strategies were developed related to:

- Land, water and infrastructure for agricultural production;
- Maintaining a viable agribusiness sector;
- The resilience and adaptive capacity of the community;
- Protecting environmental assets;
- Maintaining institutions that help communities to adapt to change.

These scenarios are broadly consistent with those developed for the Riverina Irrigation communities in NSW, although do not consider a worst case scenario as severe as the *Ruinous Riverina* scenario. Again the scenarios and strategies developed in response to them are broadly applicable to the irrigation-dependent communities across the Murray and Riverina RDA regions.

Aspirational scenarios

Resilient agribusiness for the future of Sunraysia [5]

Scenario planning was used to enable irrigated agricultural industries in the Sunraysia-Riverland areas of Victoria, NSW and South Australia to make better decisions about how they respond to emerging challenges, such as

climate change and drought. The scenarios, which were developed (in draft form) in 2007 are narrative scenarios which include aspirational (or utopic) elements – in which storylines about a desired future are created. Dystopic scenarios, in which the future diverges markedly from the desired future, were also developed. Four scenarios were developed with storylines of how the region changed to 2018, as described below.

- 2018 Utopia (the preferred future) – Important water policy decisions are taken that bring stability and equity to water management in the Murray-Darling Basin and efficient water markets. The environment is allocated its own share of the water – 5% of all water entitlement – which the government buys from irrigators. Five years of above average rainfall means that irrigation water security improves dramatically. Commonwealth government expenditure on irrigation infrastructure is brought forward, planned well and rolled out in an equitable manner. Non-viable farm businesses exit the industry and remaining business consolidate and grow. Investment in research and development ensures the industry is able to adapt to climate change and emerging market opportunities. The region's food and wine sectors support an expanding tourism and export industry. An internationally-linked emissions trading scheme (ETS) is introduced, which supports a local solar energy industry and carbon sequestration business opportunities in dryland regions growing mallee scrub. The region's population grows strongly, young people are retained and local education and training strengthened. Food security issues in Australia lead to growing political influence of the nation's key food production regions.
- 2018 Making an effort – stability and equity in water policy is achieved. The government seeks to buy 15% of water entitlement for the environment, but only succeeds in buying about 10%. Efficient and well-

regulated water markets are used to good effect by irrigators to spread their risks and improve profitability. Investment in irrigation infrastructure proceeds, but only in parts of the region. Consumers demand water-efficient food production and receive retailer and government backing. Climate change begins to affect production, with a shift to increased summer/spring rainfall contributing to increased disease pressures. Research to adapt to new climates and markets continues, but is funded through new public-private partnerships. New markets are opened up for regional produce. Farm business numbers continue to decline. Property consolidation takes place and some irrigation assets are stranded. Reduced irrigation water availability leads banks to review their lending policies and results in a tightening of financial pressure for some irrigators. Younger producers begin to exit the industry to find more secure employment in other sectors. Food security issues gain prominence in Australia and food production is increasingly politicised. Regional population continues to grow, placing pressure on service provision, rental markets and residential land availability.

- 2018 Status quo – State and Commonwealth governments are unable to agree on water policy and trade remains fragmented and inefficient at the Basin scale (but not locally). Water supply problems worsen, with a continuation of drought and lack of consistency in allocation policy. In response to low allocations, irrigators increasingly turn to opportunistic, short-term crops from perennial horticulture. The industry declines significantly and painfully during drought years, with significantly fewer producers and many stranded irrigation assets. Reduced local grape production results in competition between processors, which supports prices to irrigators with water. As the drought eases towards 2018, the industry recovers, but only slowly. China and Russia emerge as economic

superpowers and recession hits the western world hard. China begins to dominate global horticultural markets, which destabilises prices for local producers. Horticulture's decline leads to loss of population and decline in social infrastructure, including education, and research and development investment. Property values decline and poor and socially disadvantaged people are attracted to the region. Health and other social issues increase, but there is insufficient capacity to meet needs.

- 2018 Dystopia: modern Mungo – Water supply issues worsen with continued drought. Allocations for irrigation decline by 10% overall and for the environment by 44%. Low river levels lead to the activation of acid sulfate soils and the acidification of water across large areas of the Basin. Water policy and markets are uncertain and dysfunctional. States begin to subsidise water purchases by irrigators. With the ongoing drought, new irrigation infrastructure remains unused and the resulting backlash from perceived wasted investment leads to large cuts in government funding for agriculture. Low water availability in the region tarnishes the region's reputation with local and international markets. Irrigation allocations fall to zero in 2015/16, leading to the loss of almost all perennial plantings. Wine grape production shifts from Sunraysia to regions more favoured by climate change. Input prices increase rapidly, the dollar moves well past parity with the US dollar and interest rates increase, all of which compound financial pressures on irrigators and the region from low water availability. Competition from international food producers and non-agricultural food sources (produced using nano-technology) pushes prices down. With prices for grains, such as rice, increasing rapidly, horticulturalists struggle to compete with rice producers for what water is available. The regional economy and population decline rapidly. Housing prices fall, which attracts poor and

socially disadvantaged people to the region. Social and health issues develop, but are poorly serviced.

These scenarios are again broadly relevant to irrigation-dependent communities across the Murray and Riverina RDA regions. The scenarios pose a similar set of risks to the Sunraysia region those identified in the Riverina Irrigation Communities scenarios described above.

Numerical scenarios

Planning by water resource management agencies in the Murray-Darling Basin (MDB) is typically structured around numerical scenarios for water supply and, potentially, water use or demand. The former reflects the widespread acceptance of climate change as a driving force in water resource availability and uncertainty associated with climate change projections. While long-term climate and water supply records are used in planning, it is recognised that by themselves they may be an unreliable guide to future conditions.

Adaptive planning in response to climate change for issues other than water resource management may also be based largely on numerical scenarios. Specific numerical changes in climate and related phenomena (e.g. temperature, rainfall patterns, evaporation, bushfire danger, water availability, wind etc.) are used to identify and assess risks to a region's or organisation's assets or service provision capacity. Priorities from such an assessment then form the basis for strategy development.

Murray-Darling Basin Sustainable Yields Project [6-8]

The MDB Sustainable Yields project (MDBSY project) was undertaken by CSIRO to provide the Australian and Basin State governments with a robust

estimate of water availability for the entire Murray-Darling Basin (MDB) on an individual catchment and aquifer basis, taking into account climate change and other risks. While the project did not undertake any planning, it and more recent updates to the modelling it undertook were critical inputs to the MDBP.

The MDBSY project was framed around four scenarios, reflecting different climate states and levels of water resource development, as follows.

- Scenario A: Historical climate and current development – In which future water resource availability throughout the Basin reflected the mean state and variability included in the long-term historical record. Future spatial and seasonal patterns of consumptive water uses would also reflect the current level and structure of surface water and groundwater resource development and river regulation.
- Scenario B: Recent climate and current development – in which future water resource availability is based on climatic conditions over the 10 years from 1997-2006, which has been among the driest across the MDB, particularly its southern reaches. At the whole of Basin-scale, rainfall would be 8% below the long-term average and run-off would be 21% lower than the long term average, but with significant variability between catchments. Water use patterns would, as with Scenario A, reflect current development.
- Scenario C: Future climate and current development – in which future water resource availability is based on climatic conditions projected using global climate models that account for human-induced climate change. Three variants of this scenario were developed, considering a best estimate of climate change and high and low levels of global warming (to 2030). Under the best estimate, water resource availability for the MDB would fall by 12% by 2030. Under the dry extreme, water resource

availability across the Basin would fall by up to 37%. Under the wet extreme, water resource availability would increase by 7%. Water use patterns would reflect current development, as per scenarios A and B.

- Scenario D: Future climate and future development – in which the three climate change scenarios included in scenario C describe future climate, but water resource availability is affected by changes in catchment interception (by new forestry plantations and farm dams in particularly catchments) and groundwater resource development.

The effects of the four scenarios on water resource availability in the three catchments included in the Murray and Riverina RDA regions is summarised in Table 3. Scenario B was not modelled for the Lachlan River as the high interannual variability in climate mean that there was no statistical difference in rainfall for the period 1997-2006 and the long-term record. Changes in catchment interceptions and groundwater use projected to 2030 had no significant effect on water resource availability at the whole-of-catchment scale. Impacts were likely to be significant in sub-catchments in which catchment interceptions were significant (e.g. upper Murrumbidgee).

Table 3 Summary of projected changes in water resource availability in the MDB catchments included in the Murray and Riverina RDA regions. Scenario A is taken as the baseline state [6-8].

Scenario	Murray-Lower Darling	Murrumbidgee	Lachlan
Scenario A	0	0	0
Scenario B	-30%	-30%	Not modelled
Scenario C			
- Dry	-41%	-28%	-30%
- Mid	-14%	-9%	-11%

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- Wet	+7%	+13%	+6%
Scenario D			
- Dry	-41%	-28%	-30%
- Mid	-14%	-9%	-11%
- Wet	+7%	+13%	+6%

The MDBSY project includes results from water resource modelling to show the effect of the scenarios on availability of water for various products (e.g. NSW high and general security water), for groundwater use and non-consumptive uses, including environmental flows. The MDBP is based modelling of Scenario Cmid over its 10 year life.

RAMROC Cluster Group 1 Stage 2 studies [9]

Scenarios were recently developed for the Strengthening Basin Communities project managed by the Albury City Council for a consortium including themselves and other local governments in the Riverina and Murray Regional Organisation of Councils (RAMROC) Cluster Group 1 (Corowa, Greater Hume and Urana Shire Councils). Like those for the Riverina Irrigation Communities (above), the scenarios were developed as part of a project to help the Councils plan for a future with less water – particularly in response to climate change, water trade and environmental water recovery.

The scenarios developed for the project incorporated both narrative and numerical elements. Trends and drivers of change were assessed prior to scenario development. These were broadly similar to those identified in the Riverina Irrigation Communities (Table 1) and included:

- Climate change – which followed the scenarios from the MDBSY project;
- Water policy – under national, MDB and NSW jurisdictions;

- Water management – by local government and irrigation water providers;
- Land use patterns – particularly agricultural uses;
- Economic development;
- Population and demographics;
- Non-water areas of government policy;
- Society’s attitude to environmental management;
- Changes in best practice natural resource management;
- Landholder goals;
- Terms of trade for agricultural producers.

Four main scenarios were described, incorporating three from the MDDBSY project (Cwet, Cmid, Cdry). A high climate change scenario, incorporating a continuation or worsening of 1997-2009 conditions (similar to MDDBSY scenario B) was also included. Scenarios included two forms of regional response to the climate and water resource availability conditions:

- Do nothing – where the regional community makes no attempt to adjust or adapt to a future with less water;
- Proactive response – where appropriate and possible adaptations are carried out.

Narratives were then developed to describe the outcomes of the climate scenarios and regional response (summarised in Table 4).

Tables assessing outcomes against social, economic and environmental criteria were also prepared.

The key risks associated with the scenarios included:

- Loss of population, industry, services and workforce;
- Closure of the West Corugan irrigation district;
- Further reductions in groundwater and surface irrigation entitlements;
- Decline in asset condition.

Table 4 Summary of narrative describing Cluster Group 1 scenarios [9]

Criterion	Do nothing response	Proactive response
Social		
- Population	Albury & surrounds grow, but population declines in rural areas. Liveability compromised in rural centres.	Albury and Corowa continue to grow, based on influence of tourism, manufacturing, education and agriculture. Rural communities’ populations stabilise. Access to high security water maintained
- Community assets	Gradual decline in amenities, which is greater for drier scenarios.	Continuous improvement in facilities by maintenance and reinvestment. Liveability improves.
- Infrastructure	Gradual decline in long-term.	Continuous improvement as population and industries grow. Influenced by

Criterion	Do nothing response	Proactive response
- Road & sewer	Steady decline.	state and national government. Continuous improvement in larger centres, as above. Influenced by state and national government.
- Reticulated water supply	Gradual decline in long-term.	Continuous improvement. Drought/climate proofing of urban and rural stock and domestic supplies. Improved recycle-reuse.
Economic		
- Agriculture	Steady decline, and reduced viability. Rationalisation of population and services.	Improvement in all but driest scenarios. R&D essential. Stock and domestic supplies climate/drought proofed.
- Agribusiness	Declines with agriculture, rationalisation, loss of service and competition.	Agricultural prosperity.
- Irrigation	Accelerated decline, but less impact in Corowa and Albury City because of limited irrigation.	Potential through technology, information etc. to keep ahead of climate and other changes, with possible exception of driest scenario. R&D and West Corugan PID strategic plan critical.
- Industry	Non-agricultural and low-water dependency industries may grow under all scenarios. Corowa highly exposed. Mining has significant potential.	Steady improvement as population grows and agriculture prospers. Industry grows.
- Tourism	Accelerating decline as amenities deteriorate.	Continuous improvement in amenities, cohesive promotion. Results in accelerated growth. Influenced by external conditions (e.g. GFC).
Environment	Steady state in short term, decline under drier scenarios.	Continuous improvement in public and private land environmental condition. Recycle and reuse/capture rainfall.

Significant opportunities were also considered to become available if the region responded proactively to the futures encompassed by the scenarios. They included population growth, improvement in agricultural productivity and profitability, expansion of the tourism sector and development of new industries such as mining.

This scenario analysis highlights the differences in future risks and opportunities between small, agriculturally dependent communities and larger population centres, such as Albury. Unlike the smaller rural centres, their more diverse and

less agriculturally dependent economies have significant growth opportunities even if climate and water policy lead to (at least modest) decline in irrigated and dryland agriculture. Wagga Wagga and, to a lesser extent, Griffith are in a similar situation. However, most of the region's communities are highly agriculturally dependent.

Option evaluation

Option evaluation as considered here is only loosely a form of scenario planning. Option evaluation describes situations in which variants of a single scenario or critical change driver are considered. Three regionally important examples are provided below.

Murray-Darling Basin Plan

The MDBP, as described in the recently released Guide [10], contains a single broad narrative around water resource management for the Murray-Darling Basin. The narrative's critical uncertainty is the volumetric reduction in water diversions for consumptive uses such as irrigation and the corresponding increase in water provided for the environment. The Guide describes three options for environmental water recovery (ranging from 3000-4000 GL of mean annual flow) that would achieve environmental outcomes specified by the Commonwealth *Water Act 2007* without undue socio-economic impacts. The amount of water proposed to be recovered in each of the Basin's catchment varies (Table 5), in part based on assessment of the economic efficiencies of water purchase.

Table 5 Proposed reductions in water course diversion for the NSW Murray, Murrumbidgee, Lachlan and Lower Darling catchments, specified in the Guide to the Proposed Murray-Darling Basin Plan [10].

Catchment	Basin water recovery target		
	3000 GL	3500 GL	4000 GL
NSW Murray	28%	32%	37%
NSW Murrumbidgee	32%	38%	43%
Lachlan	15%	19%	23%
Lower Darling	29%	33%	38%

The Guide describes the expected ecological and environmental flow benefits from each level of environmental water recovery. Socio-economic impacts

associated with each of the scenarios are described in a companion document [11].

Wentworth Group of Concerned Scientists report on Sustainable Diversions in the Murray-Darling Basin [12]

The Wentworth Group of Concerned Scientists' (Wentworth Group) report considers a single broad narrative like that of the Guide to the Murray-Darling Basin Plan. The critical uncertainty for the narrative is the provision of water to meet the needs of key Basin ecosystems by reducing water diversions for consumptive uses such as irrigation. A single option is considered: that the current Cap on diversions be reduced by about 40%. The report considers several options for how this change would be considered and proposes the spatial distribution of water recovery (Table 6). The distribution is partly based on their assessment of the economic efficiency of water recovery in the various catchments.

Table 6 Proposed reductions in water course diversion for the Murray-lower Darling, Murrumbidgee and Lachlan River catchments, specified in the Wentworth Group's report on sustainable diversions in the MDB [12].

Catchment	Basin water recovery target
Murray-lower Darling	39%
Murrumbidgee	65%
Lachlan	<1%

Judith Stubbs report on the Social and Economic Impacts of Reduced Irrigation Water [13]

The Stubbs report is based on a single broad scenario, encompassing various levels of environmental water recovery under the proposed MDBP. The report considers three simple options (10, 25 and 50% reductions in irrigation water

entitlement) and assesses the socio-economic consequences of those changes for the Basin and several specific communities, including the Griffith local government area (LGA). The report found that the greatest socio-economic impacts (e.g. in terms of employment and population) would be experienced in smaller, more remote and more agriculturally dependent communities. Of the southern Basin LGAs considered, impacts were projected to be greatest in Griffith LGA. They could be even greater in other LGAs that are similarly remote, but do not have the population or food manufacturing base of Griffith (e.g. Hay, Carrathool, Murrumbidgee LGAs).

Discussion

A wide range of scenario planning work has been undertaken for or is relevant to the Murray and Riverina RDA regions. This work shares a common set of drivers and critical uncertainties, mostly around climate change and water (resource availability, policy, trade and management). It is most pertinent to agriculturally-dependent (particularly irrigation-dependent) communities and economies of the Murray and Riverina. It is less pertinent to the region's two larger and less-agriculturally-dependent communities, Albury and Wagga Wagga and to its dryland farming and forestry-dependent communities, particularly in the east.

Some examples of the scenario planning consider critical change drivers and uncertainties beyond those relating to water. These consider, among other things, global economic forces, climate change policy, environmental, trade or socio-political shocks and technological developments in agriculture and food production.

Given the coverage of scenario planning work for the region, there appears little need to derive a whole new set of scenarios for the current project. However, it is recommended that existing scenarios be supplemented through

consideration of trends and key drivers of change and their effects for the forestry dependent communities in the region's east and the region's two major population centres, Albury and Wagga Wagga. This work would consider climate change issues, but also focus on national-global scale social-economic, technological and political influences on these areas and the potential outcomes. The analysis need not be developed into a full narrative, but rather highlight key change drivers and best through to worst case outcomes.

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