

The Avon River Basin in 2050: scenario planning in the Western Australian Wheatbelt

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Abstract. Scenario planning was used to identify issues and drivers of change that are relevant to community efforts to improve regional prospects in the Western Australian Wheatbelt. The region, some 20 million hectares in area, is under pressure to respond to a variety of environmental (salinity, erosion, acidification, biodiversity decline), economic (declining agricultural terms of trade), and social forces (rural decline, isolation). Regional strategic plans have been increasingly seen as the means of achieving sustainability in the face of these challenges, but until recently typically had single-activity outlook and timeframes of up to a decade into the future. Systematic futures-based research has been used in various regions to avoid reliance on business-as-usual as the default strategy, and to identify opportunities and challenges not presently apparent. The Avon River Basin, the central region of the Wheatbelt, was selected as the geographic focus of the project, and the time horizon was set at 2050. The project was developed by a group of 50 stakeholders from the basin, with expertise and strategic interests across a wide range of economic, social, and environmental themes. Through a series of workshops the stakeholders identified critical issues and their attendant drivers, then documented relevant past trends. Four regional scenarios, Saline Growth, Grain and Drain, Landcare Bounty, and Harmony with Prosperity, were developed based on positive and negative combinations of 2 clusters of uncertain and important drivers: environmental change and access to new markets. Common opportunities, threats, and critical success factors for the Avon River Basin region out to 2050 were also identified. We also found that the stakeholders have a tendency to strive for positive outcomes despite negative initial conditions. This resulted in 4 scenarios that were superficially similar due to the regional scale of analysis and the continuation of agricultural industries as significant shapers of economy, society, and environment. However, each scenario represents profoundly different outcomes for the residents and communities of the Avon River Basin in 2050. The triple-bottom line outcomes for the Avon River Basin in 2050 were estimated to be in the range 4.9–9.7 Mt of wheat (currently 4.0), 46 000–66 000 people (currently 43 000), and 10–30% of farmland salinised (currently 6%). The application of these results to other regions in Australia is discussed.

Additional keywords: Water for a Healthy Country flagship, grainbelt, community planning.

Introduction

The Western Australian Wheatbelt, a region of some 20 million hectares, is under immense pressure to respond to a variety of environmental (salinity, erosion, acidification, biodiversity decline), economic (declining agricultural terms of trade), and social forces (rural decline, isolation), many of which have emerged over the past 50 years. Regional strategic plans addressing economic, social, and environmental issues are being developed by local and state governments, regional natural resource management groups, and individual industries (Weigall 1996; Avon Catchment Council 2004;

Grains Research and Development Corporation 2004). Systematic futures-based research has been used in various regions to avoid reliance on business-as-usual as the default strategy, and to identify opportunities and challenges not presently apparent. There are several important by-products that can be beneficial to a region in the medium to long-term, including encouragement for stakeholders to think laterally and 'outside the box', and the provision of a vehicle for strategic dialogue between stakeholders that typically have a single economic, social, or environmental mandate. We used scenario planning to investigate how community efforts

could improve regional prospects in the Western Australian Wheatbelt in the future.

The Avon River Basin 2050 (ARB2050) project aimed to:

develop an understanding of the critical issues and attendant drivers of change that may be relevant to community efforts to improve the regional prospects for present and future generations of the Avon River Basin between now and 2050.

Improving regional prospects was defined as any regional configuration that improves the triple-bottom line — the assessment of new development according to combined economic, social, and environmental benefits — although it may not necessarily represent optimal/maximal settings of any one of the benefits independently. Regional prospects might be advanced by a combination of improved income, investment, rearrangement of assets to improve benefits, efficiencies and outputs, increased participation in or control of decision-making processes that effect the region, and expanded capacity to be more resilient to changes and decisions over which there is little control within that region. Prospects can also be improved through appreciation of the links with other regions, nations, and the global economy and development of a regional identity through branding.

A set of plausible futures for the Avon River Basin (ARB), part of the Western Australian Wheatbelt, was developed using scenario planning, a structured approach by which companies, regions, and nations can learn about the uncertainty in the key driving forces that influence their goals, plans, policies, and strategies (Schwartz 1996; de Jouvenel 2000; Schwartz *et al.* 2000).

Stakeholders identified key drivers and elements that must be common to all future robust strategies for the regions, identified opportunities and challenges not apparent from current trends, and contributed to the development of a 'future-aware' culture in the region. A method for applying scenarios to strategic planning was introduced to the stakeholders, and possible future applications of the project results were outlined.

Location

The Avon River Basin in the central Wheatbelt of Western Australia, an area twice the size of Tasmania that produces nearly 20% of Australia's wheat crop, was selected as the geographic focus of the project (Figs 1, 2). A river basin was selected as the boundary because of the importance of water and salinity management to the region's future. Key historical environmental, economic, and social trends, and current status are summarised below.

Environment

The Basin comprises 3 surface water catchments, the Avon, Yilgarn and Lockhart, and is $\sim 120\,000\text{ km}^2$ in area. From

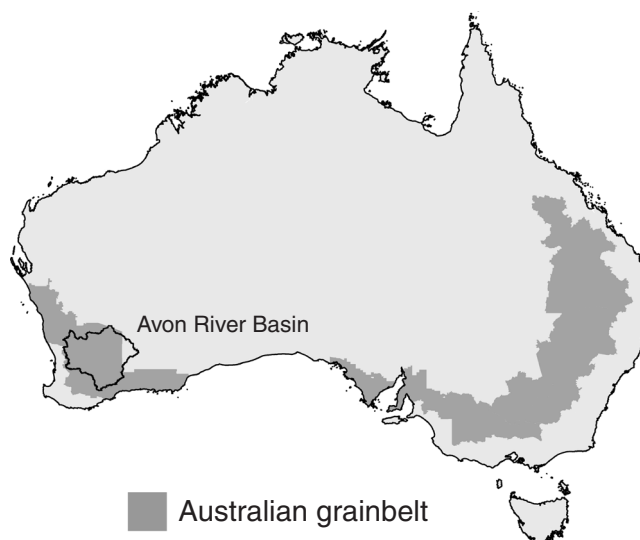


Fig. 1. The location of the Avon River Basin within the broadacre grainbelt of Australia (shaded). The shaded area includes cropping and non-cropping land. The figure incorporates spatial data kindly provided by the Australian Bureau of Agricultural and Resource Economics.

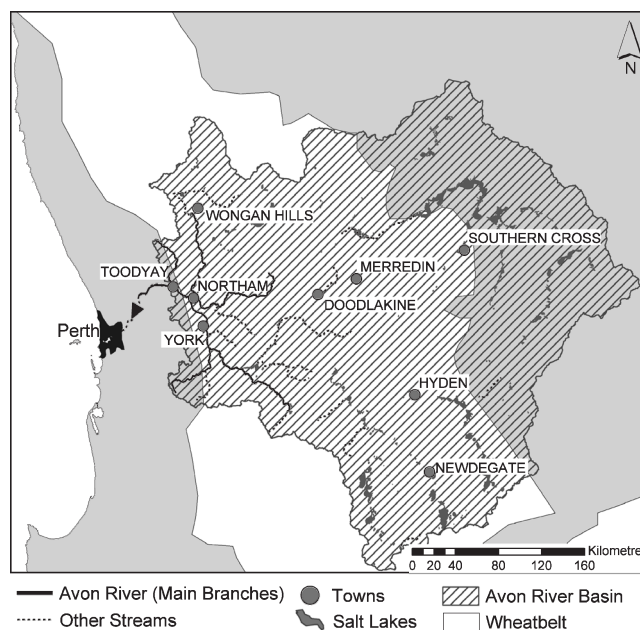


Fig. 2. The location of the Avon River Basin within south-western Australia. The Basin is drained by the Avon River, which is renamed the Swan River (line with arrowhead) as it flows through the capital city Perth and into the Indian Ocean. The region includes a substantial part of the Wheatbelt of Western Australia.

west to east, rainfall decreases from 750 to 200 mm per year. Through the upper part of the Basin, which remains extensively vegetated, chains of salt lakes connect up in extremely wet years (Viney and Sivapalan 2001). Since 1900, some $80\,000\text{ km}^2$ of native vegetation have been

cleared for agriculture in the lower reaches around the Avon Valley out to the Rabbit Proof Fence where rainfall is ~250–300 mm per annum (Avon Catchment Council 2004). Long sections of the lower Avon were retrained in the 1950s (Water and Rivers Commission and Avon River Management Authority 1999). Secondary salinity was first noticed ~1897, but remediation was limited until the early 1980s. Today, 6% of agricultural land is affected by salinity, predicted to grow to 30% by 2050, and two-thirds require some treatment for soil acidity (Avon Catchment Council 2004). The lower Avon exports 360 GL of salty water into the Swan River annually (Viney and Sivapalan 2001), influencing the salinity of Perth's estuary. State governments began to actively promote soil and water conservation in the 1950s at the height of agricultural land clearing in the Basin, and Landcare groups were first established in the region by the mid-1980s. Since 2000, the Avon Catchment Council has had the task of coordinating landscape management in the Basin (Avon Catchment Council 2004). The south-west of Western Australia, including the Basin, has been identified as one of 25 global biodiversity hotspots due to its high degree of endemism undergoing exceptional threat (Myers *et al.* 2000). An estimated 400 plant species are at risk of extinction due to salinity spread (Keighery *et al.* 2001).

Economy

Agricultural production in the Basin was valued at \$1.4 billion in 2000, of which over 70% was exported (Wheatbelt Development Commission 2001). Production is dominated by rain-fed crops, predominantly wheat (76% of tonnage), barley (13%), lupins (7%), oats and canola, together with wool and meat production from sheep and cattle. Between 1950 and 2000 the average wheat yield rose from 0.9 t/ha to 1.8 t/ha. In seasons of above-average yield the Avon River Basin may deliver nearly 20% of Australia's wheat crop. Large-scale land clearing for agriculture continued until the early 1980s. Value-adding and diversification is increasing in the form of tree crops (e.g. oil mallees for biomass harvest, olive oil, and sandalwood), aquaculture, and flour milling (The West Australian 2003). Non-agricultural sectors include eco- and indigenous-tourism, air sports and air training, and mining of gold, nickel, and iron ore. Mean annual economic growth between 1996 and 2001 is estimated to have been 4.4% (Australia URS 2003). Distribution infrastructure networks for television, telephone, electricity, and water supply have all received major extensions since the 1950s.

Society

There are 43 local governments and some 150 communities across the Basin. Many social indicators have declined since 1950, such as population and average age, driven by farm amalgamation and drift to coastal cities (Avon Catchment Council 2004). Immigrant camps in places such as Northam

and Cunderdin played a part in facilitating population increases during the 1950s. Over the past 2 decades, population has decreased by 8% to about 43 000. In the same period the proportion aged 45 or older rose from 21% to 36% of the population. Some 40% of the population reside in only 4 towns: Northam, York, Toodyay, and Merredin. The first 3 of these lie within the western fringe of the Basin, which forms a large part of what has become known as the Avon Arc, the rural shires adjoining the northern and eastern boundaries of the capital city Perth (Fig. 3). A recent State Government study predicts a rise in the population of the Basin by 2031 as Perth's population overflows into the Avon Arc encouraged by better connections to Perth through expanding commuter train services (Government of Western Australia 2002). The other formal aggregation of shires that overlaps the Basin is the North East Wheatbelt Regional Organisation of Councils (NEWROC) (Fig. 3). The Basin covers the traditional country of the Ballardong, Galimaia, and Nyaginyagi groups (Tindale 1974). Aboriginal people, not counted in the Census until the mid-1960s, are today a growing proportion of the Basin's population, having risen to nearly 5% in 2001 from 4% in 1991 (Australian Bureau of Statistics 1996, 2001).

Method

Project establishment

The Avon River Basin 2050 project was initiated in the first round of the CSIRO Water for a Healthy Country flagship projects in

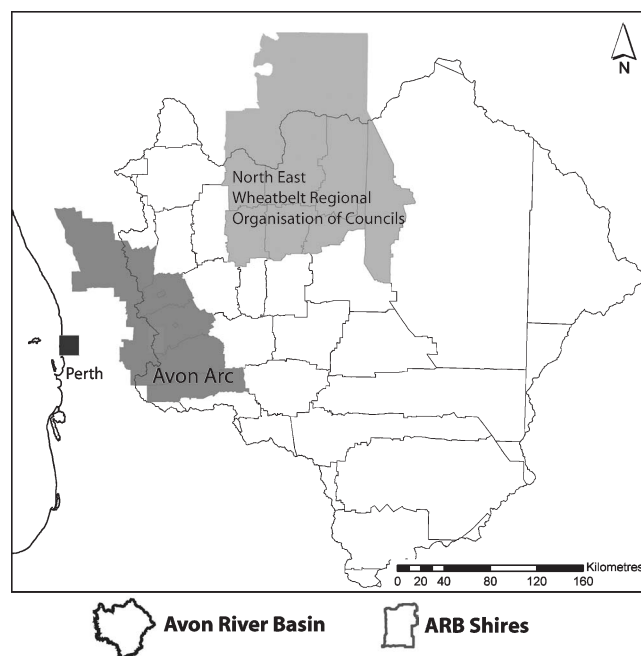


Fig. 3. The two shaded areas are subregional zones — the Avon Arc and North East Wheatbelt Regional Organisation of Councils (NEWROC) — that significantly overlap the Avon River Basin. They are significant elements of recent trends and the Avon River Basin 2050 scenarios.

December 2002. A working group was formed with staff from CSIRO, the Avon Catchment Council, the Wheatbelt Development Commission, the Department of Agriculture Western Australia, and the community through the convener, Mike McFarlane, a landholder at Doodlakine in the central Avon River Basin. Dr Don MacRae of APT Business Services Pty Ltd facilitated the scenario planning process.

Focal question and stakeholders

The Avon River Basin 2050 project was guided by the following question:

what critical issues and attendant drivers of change are relevant to community efforts to improve the *regional prospects for present and future generations* of the Avon River Basin to 2050?

This question guided 50 stakeholders, strategic thinkers, and investors invited from across the region to represent economic, social, and environmental interests. Organisations represented included the Avon Catchment Council, Australian Association of Agricultural Consultants, Australian Wheat Board, Bird-Cameron, Conservation and Land Management, CSIRO, Country Womens Association, departments of the Government of Western Australia (Agriculture, Conservation and Land Management, Environment, Health, Local Government and Regional Development, and Planning and Infrastructure), Elders Rural Bank, Grain Pool WA, Heartland Regional Branding Group, Heartland Regional Tourism Association, Indigenous Land Corporation, Merredin Senior High School, Member of the Legislative Assembly for Merredin, TAFE Western Australia (Challenger and C.Y. O'Connor campuses), Telstra Countrywide, Western Australian Farmers Federation, Water Corporation, Western Power, Western Australian Local Government Association, WDC Transport Advisory Group, Wheatbelt Area Consultative Committee, and the Wheatbelt Development Commission. The project time was from the present, taken to be 2000 for rounding purposes, until 2050.

The project was conducted as a series of 3 workshops, each dealing with a different stage in the scenario planning process (Table 1). Each workshop aimed to generate particular outputs that could be provided as input to subsequent workshops. The Critical Issues Workshop developed the foundation and context, the Scenarios Creation Workshop led to the creation of 4 scenarios, and the Strategies Response Workshop generated a set of strategic elements that will be relevant to a wide range of Avon River Basin futures.

Foundation and context

The framework for scenario development was created through 2 analytical tasks. The foundation for the scenarios is a detailed analysis of the geography and past and present attributes of the region. Scenario context is provided by (a) assumptions about the future, in order to limit the final number of scenarios by eliminating plausible futures not relevant to the focal question, (b) drivers and issues that are aspects of the regional prospects that are likely to be relevant in the future, and (c) two drivers subsets: shared drivers (common to all scenarios), and critical drivers (uncertainties that characterise each scenario).

Table 1. ARB2050 Workshop series details

All workshops were held in the Muresk Hall, Curtin University of Technology, near Northam, WA. A total of 53 people attended, representing 36 different organisations

Workshop Title	Duration	Date	Attendees
Critical issues	Half day	17 October 2003	38
Scenarios creation	One day	20 February 2004	37
Strategies response	One day	26 March 2004	30

The analyses that provided the foundation for the scenarios — characterisation of the region, historical trends, and current state — were initially developed by the working group and then expanded in consultation with the stakeholders. Prior to the Critical Issues Workshop the Working Group identified an initial set of 12 regional drivers and documented trends in associated critical issues between 1950 and the present, taken to be the year 2000. At the workshop, stakeholders considered a list of additional issues that could affect regional prospects. The new and existing issues were assigned to one or more 'future impact' themes that we termed drivers (e.g. land, water, plant industries, and marketing the Avon River Basin), and expanded by the addition of details about past trends and future prospects. Historical trends were investigated at whole-of-region scale, and expressed as maps, graphs, and tables wherever possible. These data and analyses provided with a snapshot of the region that served as the common starting point for all 4 scenarios. In addition, the snapshot identified and enhanced understanding of the relationship between each stakeholder's strategic interests and the geography of the Avon River Basin.

Environmental data were readily extractable for the Avon River Basin; however, the collection units for social and economic data were typically Local Government Areas (hereafter 'shire', although technically, one of the local governments in the Basin is a town) that have varying degrees of overlap with the Basin. A method was developed to collect and resample shire statistical data to fit the ARB boundary using a Geographical Information System and a relational database (O'Connor *et al.* 2004). Relevant historical statistics for the 43 shires that overlap the Avon River Basin were extracted in 5-year time steps starting at 1951. Sources included the Statistical Register publications of Western Australia, the WA Year Book series, Australian Bureau of Statistics publications, local histories, reports, and agricultural production data compiled by the Department of Agriculture, Western Australia. Additional historical trends were researched in response to new drivers contributed by stakeholders in the Critical Issues Workshop. Subsequent additions and deletions were aimed at building a more comprehensive and relevant data resource for use in building and understanding the ARB2050 scenarios, and in future scenario building and strategic planning activities (see O'Connor *et al.* 2004).

Before the Scenarios Creation Workshop, an overseer for each scenario driver revised its issues list and then ranked them in order of importance. Stakeholders were then asked to score at least two of the scenario drivers for their importance and uncertainty, as follows:

Importance → *how significant is the likely impact (positive or negative) of the Scenario Driver on the region*

1, *least important* up to 10, *most important*

Uncertainty → *how well understood is the impact of the Scenario Driver on the region?*

1, *least uncertainty* up to 10, *most uncertainty*

A further requirement of stakeholders was to ensure that they assigned at least one 10 and one 1 for importance regardless of how many more drivers were given importance scores. Any number from 1 to 10 could be assigned to the remaining drivers. This scoring style was then repeated for uncertainty. Most stakeholders ranked all 22 drivers in this way. The average importance and uncertainty scores for each driver were calculated and plotted.

Scenario development

Prior to and during the Scenarios Creation Workshop, the stakeholders analysed the uncertainty–importance graph to identify 2 clusters of the most uncertain drivers. The uncertainty was interpreted as a future possibility that these 2 driver clusters could independently become more positive/open/high or more negative/closed/low by 2050. The 2 future conditions of each driver cluster in 2050 were placed at opposite ends of separate axes, that when intersected at right angles defined the boundaries of 4 scenarios. A third cluster, the most important and most certain drivers, was identified from the graph and interpreted as the common core of all 4 scenarios.

The stakeholders were divided into 4 syndicates of approximately equal skills and knowledge of the aspects of the region. Each syndicate was assigned the task of creating 1 of the 4 scenarios. For the remainder of the Scenarios Creation Workshop the syndicate groups explored relationships between drivers by constructing feedback loops and influence diagrams, and then assembled creative story lines to link together plausible chains of future events. The scenarios were further developed by their syndicates after the workshop. The working group and driver overseers audited each scenario for its plausibility, internal logic and conformity to the parameters of its critical driver clusters. Each syndicate contained one high-school student who wrote an imaginative retrospective about their scenario, looking back from 2050 over the previous 50 years. Economic, social and environmental summaries and a set of ‘on-track’ indicators for 2010, 2025, and 2050 were also developed for each scenario.

Common strategic elements

At the Strategies Response Workshop, each syndicate analysed their scenarios for opportunities, threats, and critical success factors. In plenary the stakeholders extracted from the syndicate analyses a regional set of common opportunities, threats, and critical success factors. The final plenary session scored these common strategic elements for their relevance to future regional prospects in the ARB2050 scenarios, using elements from 3 regional strategic plans to illustrate the application of this approach. The list of most relevant strategic elements is preliminary as they are based on strategic plans either mid-way through implementation or currently under development. The working group summarised the findings, and identified future actions that could build on the ARB2050 project results.

Foundation and context

The outcomes of the project fall into 3 categories that are described in this section and the two that follow: foundation and context, the 4 scenarios, and common strategic elements. The foundation outcome is a detailed characterisation of trends over the past 50 years, and the context outcome is made up of assumptions about the future, drivers, and issues relevant to improving regional prospects, and the sets of shared and critical drivers that shape each scenario.

Trends from 1950 to 2000

The key Avon River Basin environmental, economic, and social trends of the past half-century are described in the Location section above. To reiterate, the Basin of the 1950s was a region of population growth, local education and healthcare, imperial measurement and currency, production quotas, land clearing, and valve-based electrical technology, in which economic, social, and environmental activities were often considered in isolation. The Basin today has

a lower but stable population, a higher level of externally obtained education and healthcare, decimal measurement and currency, advanced production systems, a cessation of land clearing, network digital technology, and a more integrated appreciation of the region is evident in planning processes. These gradual changes are at once well understood and taken for granted, yet also surprising and easily forgotten. Beyond providing a simple background to the scenarios, the documentation and illustration of historical trends demonstrated to ARB2050 stakeholders that a ‘business-as-usual’ future through to 2050 is improbable and the type of strategic thinking that will be counter-productive to full involvement in scenario planning, and therefore to improving regional prospects.

The completed set of Avon River Basin trends covered 46 aspects of 14 subjects associated with economic, social, and environmental themes (Table 2). This range of data types should be readily accessible for many Australian regions with relatively modest investment. The complete set of ARB2050 trend data was published in O’Connor *et al.* (2004), and with further investment could be the basis of a Basin-wide ‘atlas’ to support knowledge sharing and future strategic planning. The planning atlas recently compiled for Willamette Basin in north-western United States (Hulse *et al.* 2002) is an example of what could be achieved for Australian broadacre regions such as the Avon River Basin.

Assumptions about the future

In ARB2050 the number of scenarios was kept to a manageable level by making assumptions about global, national, and state trends, many of which will be inevitable or highly likely through to 2050 because of their inherent momentum, absence of any evidence of change, physical constraints, or the unavoidable lag between human action and effect. The stakeholders were clearly interested in futures in which human society is still present in the ARB, thus scenarios incorporating war, famine, pandemic, or catastrophic asteroid strikes were not considered.

Global trends

Globally, the 4 scenarios were assumed as having unfolded in a future of developed nations continuing the push for globalisation, even though there are great uncertainties in the final endpoint. Although there should remain a market for ARB agricultural products and scope to develop new markets, global forces will continue to set prices and make the rules (Australian Business Foundation 2000). Whether or not carbon trading markets and instruments are established, the total global energy and materials consumption is predicted to rise until at least 2050 (Harper 2000), the possible point of peak global population of ~9 billion (Cocks 2003). Current reserves of fossil fuel supply are seen as likely to be insufficient, leading to a push for alternative fuels well before 2050. The global biosphere effects most relevant

Table 2. Historical trends (1950–2000) and/or current status (2000) documented for the Avon River Basin during the ARB2050 project

Theme	Subject	Aspect of historical trends/current status
Environment	Water	Catchments, stream monitoring infrastructure, water assets defined in the State Salinity Investment Framework
	Soils	Agricultural subregions and soil types
	Vegetation	Pre-European types, history of land alienation, remnant vegetation, and reserve distribution
	Landscape	Extent of land resource threats, salinity increases, risk of salinisation, and the Rural Towns Program
	Biodiversity Climate	Defined regions, mammal decline history, current species status Change in winter rainfall since 1975 for the Basin and 3 towns within it, annual temperature fluctuations
Economy	Plant and animal production	Land use types, areas sown to various grains, Basin wheat yields relative to state yields, historical changes in animal herds, diversification
	Mining	Past and present sites and production level
	Infrastructure	Water supply scheme, electricity distribution, road estate, grain receival point network
Society	Governance	Local government boundary changes, state and federal electorates
	Demographics	Population changes, age cohorts, indigenous population, distribution of population change
	Regional associations	Subregional councils, western margin growth zone
	Education	School population, school distribution, post-secondary qualifications
	Other	Indigenous language groups, household water services, multilingual speakers, annual town-based events

to the ARB's future are climate change and greenhouse gas emissions due to continued rise in resource use by developing countries.

Australian trends

The Australia of the ARB2050 scenarios was assumed to be a competitive nation ready to engage with the world to varying degrees. Regardless of whether it is a Commonwealth or Republic in 2050, it remains one nation on its own continent. It was assumed that the ARB's voluntary/involuntary participation in, and compliance with, national programs and international conventions would continue to be driven by both direct and indirect funding (Cocks 2003).

Western Australia trends

The Avon River Basin scenarios were based on the assumption that the Basin remained in the jurisdiction of the state of Western Australia. The state will participate in attempts to diversify Australia from resource-based dependency towards a knowledge-and-services economy that will be the mark of developed nations in 2050 (Western Australian Technology and Industry Advisory Council 2000). The state will most likely remain the arbiter of inter-regional issues, and continue to administer funding on regional infrastructure and social programs. The evolution of Perth into a coastopolis seems almost certain by 2030 (Government of Western Australia 2002), with ongoing positive and negative effects on the Avon River Basin through to 2050. The historically strong positive correlation between

demographics and levels of regional resources and services should continue, and increase or decrease in line with the economic fortunes of the region. Equity of resource allocation compared with more populous coastal areas of the state and nation is less certain. Projected increases in the Avon Arc population were assumed to be features of the ARB's future (Government of Western Australia 2001). This established trend will enhance the region's external links through residents who commute to Perth for work or have friends and relatives there.

Drivers and issues

Stakeholders developed a final list of 22 drivers with bearing upon the future regional prospects of the Avon River Basin (Table 3). The original 12 drivers proposed by the Working group were retained within the final list; however, the critical issues associated with each driver were expanded from 54 to 114 and their contents were significantly revised. Each driver was explicitly defined, statements of retrospect (what happened before 2000) and prospect (what could happen in the future) were added, along with details of the current status and prospect of each associated issue. Every driver was assigned an overseer from among the stakeholders to review and edit the material as it developed.

Shared and critical drivers

The stakeholder scores for importance and uncertainty of the 22 drivers were averaged and graphed (Fig. 4). Four plausible scenarios were built on a framework derived from the position of the 22 drivers on the importance–uncertainty

Table 3. Driver definitions and associated critical issues generated by the ARB2050 stakeholdersThe current status and future prospects of each issue are described in detail in O'Connor *et al.* (2004)

Driver	Definition	Critical issues	
1.	Alternative fuels	Alternative energy sources for transport and other economic essentials	Biodiesel, ethanol
2.	Animal industries	Production of meat from sheep, cattle, pigs, and goats, as well as milk and wool. Aquaculture is a niche enterprise in the Basin	Biodiesel, international context, single-product reliance, value-adding, disease-free status, Benefits of 'clean and green', new industries, risk management, genetically modified organisms
3.	Biodiversity	The variety of natural life within the Basin, whether it be individual species, populations, or communities	Extinction, loss of ecosystem function, decline in vegetation quality, hotspot status, economic drivers for biodiversity protection, perception and management, introduced species
4.	Capacity building	The attraction, development, and retention of individuals, organisations and resources necessary to develop opportunities that enhance the Basin	Capacity building, planning for the future
5.	Climate	The general trend towards drier, warmer conditions in the second half of the 20th Century seems set to continue. The relative contribution of natural variability and human-induced climate change to this process is uncertain	Warming and drying, variability and extremes, uncertainty and informed response, climate sensitivities and thresholds, greenhouse emissions
6.	Demographics	Population size, a measure of our hold on land-use and habitation within the Basin. The size of the human resource limits the scope for driving change	Population, ageing, indigenous population, social and cultural diversity, voices of youth, community survival
7.	Education	The ability of the Basin to provide education from primary to tertiary level to its residents, and to receive education funding that is equitable with more populous areas of Western Australia	Investment
8.	Emerging industries	New or revitalised economic activities that have the potential for significant contributions to its economy in the future	Education, aged care, value-adding, lack of capital, enabling change
9.	Infrastructure	The physical form of our presence within the Basin, the resources that support the range of activities in which we engage. In some activities the size and distribution of these resources limit the opportunity for further growth	Infrastructure development, computing, phone and internet access, transport, reticulated water, alternative sources of power supply, governance structures, standards, relevance and quality, urban and community resources
10.	Land	A fundamental resource with links to many of the other drivers being considered. How people use and value land varies widely across the Basin, and must continue to evolve in response to current and future trends	Secondary salinity, land use, productivity, soil changes, erosion, decision making, integrated landscape management, diversification, value-adding, intensified land use, indigenous access
11.	Manufacturing and other industries	Rural-based manufacturing includes non-agricultural activities such as flour milling, engineering works, cabinet and furniture making, brick works, and abattoirs.	Diversification, constraints
12.	Marketing the Avon River Basin	Activities and symbols that promote an identity for the entire Avon River Basin.	Regional and product branding, ARB image, perception of decline

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Table 3. (Continued)

Driver	Definition	Critical issues	
13.	Minerals and energy	Those minerals extracted for local use (e.g. gypsum) or export (e.g. salt, gold), and local renewable energy sources and imports of fossil fuel energy as gases, liquids, or electricity	Infrastructure ageing, renewable energy, energy access and development, greenhouse emissions, mineral production, biomass energy
14.	New large-scale industry	The development of industry extensive across much of the Basin, and internationally competitive or unique	Industrial crops
15.	Perth – metro-centricity	The bias in focus, services, and funding towards the population of Perth, the Western Australian capital	Urban-rural overlap, fly-in fly-out, reverse Perth-ARB telecommute
16.	Plant industries	Production that includes grains such as wheat, barley and oats, legumes and oilseeds, as well as hay production. Horticultural enterprises are included here	International context, productivity and sustainability, research and development, farm forestry, value-adding, investments, single-product reliance, niche-products, GMOs, disease-free status
17.	Policy and Governance	(a) The effect of policies by local, state, federal, and international bodies on the Basin, and (b) the local governance structures, particularly of local government areas.	Subsidies, regional governance, state sustainability policy
18.	Service industries	Seeking to define and improve the minimum level of service, development of critical mass communities, and infrastructure maintained and enhanced	Availability and distribution, tourism, health and aged care, education, microbusiness, family support services, professional services
19.	Society and culture	An ongoing driver that affects many other major drivers. It includes trends in the makeup of the Basin's society, its common activities, and engagement with the communities and organisations in WA, Australia, and internationally	Partnerships, external influence, east/west divide, community infrastructure, indigenous development, cultural diversity and awareness, amplification of Aboriginal place and meaning, social/cultural identity, mobility, electoral reform
20.	Telecommuting and work	The potential for the Basin to be promoted as an excellent place to live and work through telecommuting	Nature of work, Information Technology services
21.	Tourism	The development of events and sites that bring short- and long-term visitors to the region	Eco-cultural tourism, events and sites
22.	Water	The characterising element of the Basin. Human settlement is dependent on water piped in from coastal regions, and the landscape is widely affected by saline groundwater. The Basin has 3 separate subregions with different flow regimes	Salinity, global issues, drainage, quality, channel and floodplain changes, bank condition, scheme water, equity issues, making a virtue out of necessity, water storage/harvesting, economics and management

graph. In the upper-right part of the graph, 6 drivers were identified as being the most uncertain, and grouped into 2 critical driver clusters. The most important and certain drivers were termed the shared drivers. These 2 types of driver clusters exert different influences on the content of each scenario.

Critical drivers define the framework of the unique 'story' of each scenario. The following two clusters of critical drivers were selected from the upper-right quadrant of the importance-uncertainty graph (Fig. 3):

- **Environmental change:** climate, policy and Governance, water, and biodiversity.
- **New industry and markets:** New large-scale industries, manufacturing and other industries, policy and governance, emerging industries, and biodiversity.

Their high uncertainty suggested that the state of each of the critical clusters in 2050 could 'improve' or 'decline' relative to their condition today. The product of 2 future states for 2 clusters of critical drivers was four

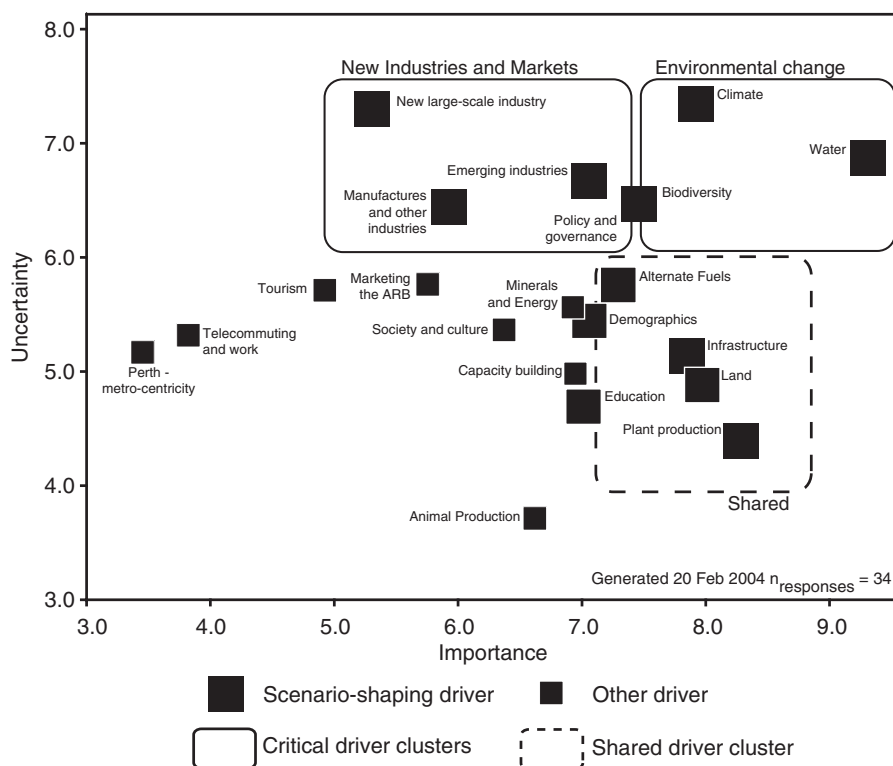


Fig. 4. Average importance–uncertainty values for the 22 ARB2050 drivers, of scores contributed by stakeholders during the Scenarios Creation Workshop. The large squares within the 3 boxes indicate drivers that were influential on the content and direction of the scenarios. The 2 critical driver clusters are indicated by solid-line boxes and the dashed-line box indicates the shared drivers that are common to all 4 scenarios.

ARB2050 scenarios (Fig. 5). Variants of this method can be used to create a lesser or greater number of scenarios, but 3 or more is generally recommended (Schwartz 1996).

During and after the Scenarios Creation Workshop, each syndicate re-checked their developing scenario against the scenario parameters. This was aided by detailed definitions of the meaning of ‘improve’ and ‘decline’ for each critical driver cluster.

(a) *Environment improving*: a slowing of decline to the minimum of current predictions, and a return to the long-term pre-1975 averages. The predicted effect of dryland salinity is revised through better modelling of hydrologic processes. When combined with other protection and enhancement activities, biodiversity is more readily conserved. Improvements in agronomic practices such as liming and tillage help to protect the land resource. Relevant local, state, and federal policy and governance support these changes.

(b) *Environment declining*: much drier and warmer conditions develop across the Basin, driven by climate change. Salinity eventually stabilises at 30% of the ARB

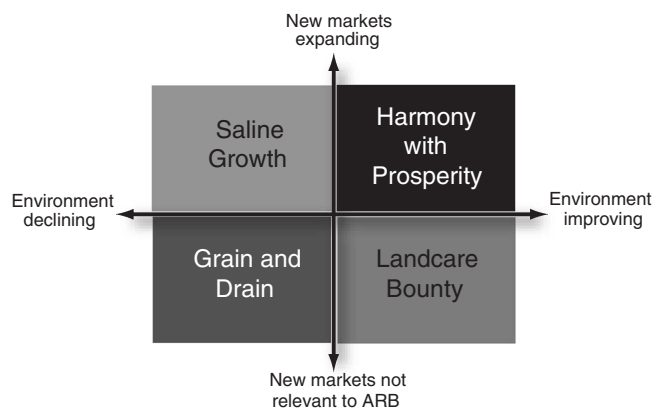


Fig. 5. The intersection of future values of 2 critical driver clusters (Environment and New markets) defines the boundaries for four ARB2050 scenarios. On the Environment axis ‘declining’ signifies reaching future levels of degradation near the current maximum predictions, and ‘improving’ signifies reaching future levels of degradation near the current minimum predictions. On the New markets axis, ‘expanding’ is diversification of the economic base from existing and new industries and ‘not relevant’ is essentially ‘business-as-usual’.

predicted in the 1990s, in part due to declining rainfall. Extreme weather events have become more frequent and unpredictable. Losses of species, populations, and communities are accelerated as a result of climate change. Unaffordable solutions to land degradation have led to areas of highly acidic soils that are unsuitable for agriculture. Policy and governance hinders or does not actively assist in tackling these issues.

(c) *New markets expanding*: the ARB diversifies its economic base and develops supporting industries and infrastructure. International and national policies, together with emerging market opportunities, favour the ARB's investors in efforts to develop new large-scale industries and a bigger range of diverse enterprises. Possibilities include industrial tree crops, biofuels, and value-adding to agricultural production, all of which are currently being investigated (Enecon 2001; Bartle and Shea 2002). The region's biodiversity has a role in driving this change.

(d) *New markets not relevant to ARB*: whether by choice or in a climate of unfavourable international and national policy, the ARB does not develop new opportunities in industries outside the traditional areas of agriculture and pastoralism. Declining access to liquid fossil fuels is remedied by new sources developed elsewhere, rather than biofuels from tree crops in low rainfall areas. Biodiversity either does not have a significant role in driving this change, or any gains by planting trees for alley farming are offset by losses of local biota. Changes to policy and governance at local, state, national, and federal levels either do not materialise or are ineffective and hinder this expansion.

In contrast, shared drivers are attributes of the region of the future that stakeholders judged would remain relatively certain and continually important in the Avon River Basin throughout the period to 2050. They reflect the inertia of current economic, social, and environmental drivers that resists substantial regional reconfiguration unless significant capital, people, or time are invested. Scenarios based solely on the shared drivers would read as variants of 'business-as-usual', the common assumption in formal and informal strategies that scenario planning is designed to eliminate. The shared drivers for ARB2050 were Plant industries, Infrastructure, Land, Alternate Fuels, Education, and Demographics. The 4 scenarios were checked for the inclusion of all 6 shared drivers, and that trajectories of particular future trends were consistent where they were incorporated into more than one scenario.

Four scenarios

Each syndicate developed their scenario in narrative and graphical terms. Each scenario is described below in terms of the overall progress by 2050. The following 'future histories' provide the flavour of each scenario.

Saline growth (Scenario 1)

In 2050, in a warmer, drier world, the Basin is a mix of vibrant, diversified, and sustainable zones around major centres, value-adding and specialist enterprise sites, surrounded by a broad expanse of more sparsely populated broadacre farming making a steady income from grains. The region has diversified its economic base: agricultural industries have incorporated more perennial plants that also drive value-added industries. There are expanding inland fisheries, indigenous eco-tourism enterprises, a world-class resort hotel, and a university focussing on disciplines associated with the industries, culture, and environment of the region. The remarkable turn-around in the Basin, from an area that was experiencing a constant decline in population and the threatened closure of many smaller towns by 2004 to a slow but inexorably rising population enjoying enhanced social conditions and infrastructure and significantly increased industrial diversification has occurred. However, the triple-bottom line that accounts for an improving environmental situation has remained out of the region's grasp, a failure of the global community to act on key issues and the inherent lag between global climate change and remedial action.

Grain and drain (Scenario 2)

The future options for the Avon River Basin in 2000 were clouded by many triple-bottom line uncertainties of a world intent on globalisation. The region has held onto its agricultural industries in spite of the challenges of nearly 5 decades of declining environment. Diversification outside agriculture was considered too risky and never really got started. The physical markets for industrial tree crop products failed to eventuate, and markets for ecosystem services (such as provision of fresh water and amenity) lacked the necessary policy and governance kick-start. In 2050 the region produces double the cereal harvest of 2000, and as such continues to make a contribution to the WA and Australian economies (agriculture is ~3% of GDP now and is likely to be less than 1% by 2050). However, the region is much poorer socially. As the average temperature climbed slowly and rainfall declined, people left. They were going anyway as phases of farm amalgamation reduced the need for agricultural labour and made many small rural towns unviable. As a result, traditional agricultural industries remained the dominant activity, and continued to grow in productivity. The drying trend of the 1980s and 1990s continued, while water quality fell due to salinity and increasing drainage; both of these added to the threats to biodiversity. Attempts to rationalise governance structures were defeated in referenda. This is a future that feels like an old couch: hard at times but comfortingly familiar.

Landcare bounty (Scenario 3)

This is the story of the ARB reaching a sustainable state (some define sustainable as triple-bottom line performance)

in 2050 built on local agricultural and landcare expertise. In the year 2000, solutions to the ARB's challenges were not entirely obvious, with a range of significant environmental, social, and economic challenges looming. The regional implications of global climate models, 1–5°C temperature rises, and 20–60% rainfall decline by 2050, never went much beyond the lower end of the range. As systems knowledge improved, so did the forecasting, and concerted action reduced the human contribution to global climate change. Risk management systems got fancier, commitment to hard-won 'green' sustainable credentials strengthened, and the Basin's farmers could still grow crops and herd animals to market at a profit. Attempts at diversification led to a significant number of micro-businesses but they never amounted to more than a few percent of the region's economic output. All through the first half of the 21st Century the ARB was driven by two slogans that bolstered state, national and global action: 'Think global, act local' and 'Partner or Perish'. Planning and commitment to the Basin paid off in developing sustainable agriculture, and it helped to retain and even increase the population. The region remained in step with national and global trends through the partnerships it made and kept.

Harmony with prosperity (Scenario 4)

In 2050 the world is only a little warmer and drier. Through half a century of concerted policy and governance efforts to achieve a more sustainable triple-bottom line, the Avon River Basin experienced a remarkable turn-around: from a declining resource base in 2000 to a diverse sustainable region in 2050. Markets for the ARB's diverse range of products were found in the sophisticated trading blocks of the 2020s and their successors, the decarbonated and dematerialised open global economy of 2050. Some smaller towns were abandoned in the relentless march of farm amalgamation, and a number were saved and even enhanced by the new industries dotted across the landscape. Although indigenous people have remained the growing cohort of the Basin's population, their health and educational disadvantages were not eliminated until almost 2030. Ownership, access to and use of land, and enterprises such as eco-tourism promoted indigenous culture and socio-economic development. In a post-fossil fuel global economy, alternative fuels (biofuels) are a necessary element and the ARB manufactures, consumes, and exports its own by 2050.

Scenario snapshots

The materials assembled by the scenario syndicates were reviewed several times by driver overseers and the working group to ensure that all scenarios described the future at the same level of detail, and were consistent with their own critical driver and other framework parameters. The project working group subsequently identified a need for

scenario snapshots, and textual and graphical summaries. The complete descriptions were summarised into single paragraph summaries of economic, environmental, and social trends and outcomes for each scenario over the next half-century (Table 4).

The historical trends and plausible future values of 3 headline indicators — one each of social, economic, environmental — were also graphed to form a snapshot of the broad possibilities for the Avon River Basin to 2050 (Fig. 6). These snapshots will provide stakeholders not directly involved in ARB2050 with an additional means of understanding the essence of each scenario. If further detail is required they can refer to the comprehensive descriptions published in O'Connor *et al.* (2004). In addition the snapshots are in a form that would facilitate their integration into large-scale scenarios (e.g. for the state of Western Australia, or for Australian broadacre agricultural regions).

Common strategic elements

The first step in developing strategic responses to the ARB2050 scenarios concluded the project activities. During the Strategic Response Workshop, each syndicate considered lists of the opportunities, threats, and critical success factors relevant to their scenario. In plenary, these scenario-specific strategic elements were summarised by the stakeholders into a set of common opportunities, threats, and critical success factors for the ARB region out to 2050. Common strategic elements were those that appeared in at least 3 or more syndicate lists, or were agreed to following further discussion in plenary.

Opportunities

In total the scenario syndicates generated 44 opportunities, ranging from 6 to 17 per scenario. This list was condensed to the following 6 common opportunities that were judged to be likely to contribute to improving regional prospects in most of the ARB2050 scenarios.

- (1) *Inwards migration*: the attraction of new people to the region as permanent residents or temporary residents such as post-secondary students.
- (2) *Natural resource management*: the adoption of technologies such as landscape design, catchment management, salt-tolerant cropping, and integration of conservation and production in the same landscape.
- (3) *Service industry benefits*: generated by the establishment of aged care, health care, and education to service the rising demands of the capital city; include new infrastructure, population increase, and local access to services that would not otherwise be available in the region.

Table 4. Summary of the social, economic, and environmental attributes of the Avon River Basin in 2050 under each scenario
Relative changes in attributes are expressed as the condition in 2050 compared with 2000. The 'All scenarios' row contains the attributes common to all scenarios

Scenario	Society	Economy	Environment
All scenarios	Indigenous people are the growing cohort of the Basin's population. On-farm population decline and several small towns abandoned. About 50% of farm businesses lost due to amalgamation and fly-in-fly-out farming	Farming remains profitable due economies of scale (farm amalgamation, improved productivity, plant breeding, and new market opportunities for traditional commodities)	Temperature rises and rainfall declines. Biodiversity remains under threat
Saline growth (Scenario 1)	New and different people: Population rise to 56 000, mostly after 2025 due to new industry and infrastructure near large ARB towns and environmental impacts in Perth.	New industries: Integrated tree processing based on native woody perennials. Exportable products include activated carbon, eucalyptus oils, biofuels, and grid-fed electrical energy.	Losses and gains: Tree planting and a biodiverse ARC offset some losses. Rise in annual average daily maximum temperature by 3–6°C. Salinity over 30% of Basin
Grain and drain (Scenario 2)	Declining & fragmented communities: Population is only 5% higher, at 45 000. Inequality between income and services in coastal cities and inland towns widens. The rise in the Avon ARC population not as large as predicted	More of the same: Cereal harvest had doubled to 8.1 Mt. Annual infrastructure repair costs for salinity damage are reduced by the unplanned drainage system but still costs \$500 million per annum	Continuing decline: Continuing pressure on native vegetation and rivers, due to drier hotter climate and salinity over 30% of the Basin. Extensive losses from this global biodiversity hotspot following lack of investment in regional, state, and national initiatives
Landcare bounty (Scenario 3)	Community optimism: Population rose by 24% over the half-century, to 52 000, much of it in the Avon Arc. This triggered improvements in adjacent areas to the east. The demographic gradient between Perth and the ARB remained but Perth-ARB links were enhanced	Green industry: Extensive woody perennial plantings of native species across 10% of the arable area in the ARB improved the sustainability of farming and the environment. New market opportunities arise for traditional commodities rather than plant-based energy and industrial products. Many micro-businesses but low impact on economic diversification	Slower decline: State, national, and global initiatives address the major environmental problems including salinity, biodiversity loss, climate change/variability, and greenhouse gas emissions. Climate change is at the predicted minimum
Harmony with prosperity (Scenario 4)	Diverse communities: Population rise by 45% to ~66 000 in 2050. Widespread investment in saving rural towns is based on a strategy to save the larger centres. Public funds put into some smaller towns to support new places of employment close to tree planting and harvesting zones	Diverse & integrated: Agriculture is enhanced by the slower-than-expected rate of climate change. Rising atmospheric CO ₂ sequestered by new industrial processing of extensive native woody perennial plantings (up to 10% of ARB). New products including activated carbon, eucalyptus oils, and grid-fed electrical energy, and biofuels	Biodiversity valued: State, national, and global policy shifts drive successful implementation of regional resource management plans, supported by investment from inside and outside the Basin. Climate change is at the predicted minimum and biodiversity losses were far fewer than the current level of prediction, an outcome of salinity reduction to 15%. Widespread replanting of suitable native species

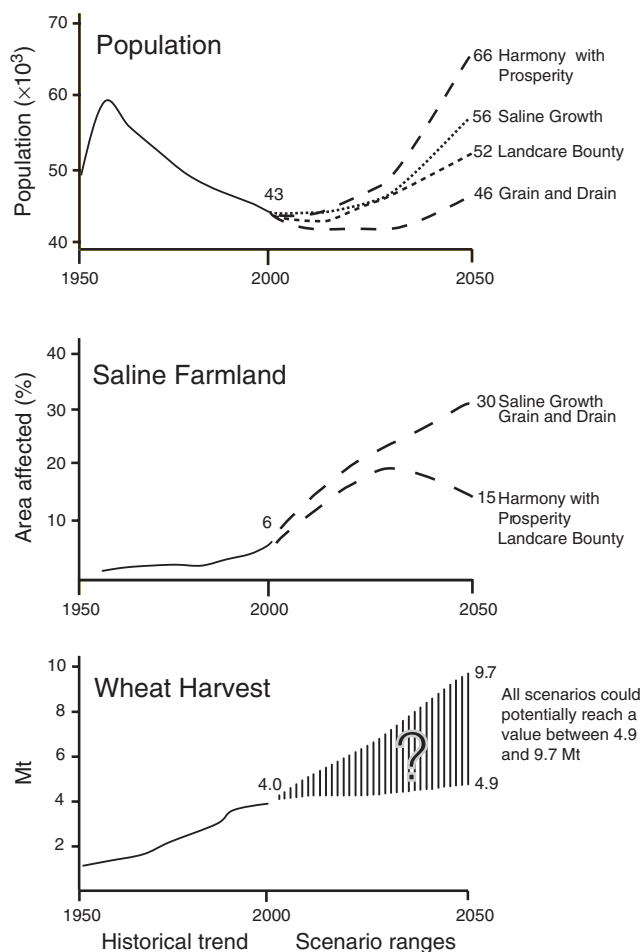


Fig. 6. A snapshot of past and future trends of 3 Avon River Basin headline indicators: economic (wheat production), social (population), and environmental (extent of saline farmland). Historical trends 1950–2000 are shown in the left half of each graph and plausible future values 2000–2050 are shown in the right half of each graph.

- (4) *Clean and green production*: of broadacre agricultural commodities will be a valuable marketing tool that can become returns to the region. It may require international standard quality assurance schemes that monitor the production chain and decisions about the introduction of genetically modified food.
- (5) *Trading on a positive safe lifestyle*: could be a means of attracting new residents. The Avon River Basin lifestyle was considered to be safe relative to life in capital cities, and in regions affected by international insecurities such as terrorism, and to urban issues such as overcrowding, air pollution and water quality.
- (6) *Animal-based farming futures*: an opportunity in which grain production is reduced in areas where it is clearly not sustainable, and in which the returns from generic and specialist animal-based products have potential to increase over time.

Threats

Beyond missed opportunities, there are threats that could potentially limit or eliminate improved regional prospects. These threats are risks to social, economic, and environmental investment and sustainability that must be addressed or at least assessed in regional strategies. From an initial set of 34 threats, the stakeholders identified the following 9 that are relevant to all or most ARB2050 scenarios.

- (1) *Infrastructure decline* in areas such as power distribution, water supply, roads, and public services were identified in the earlier critical issues analysis as an existing trend for which future remedies are uncertain. This trend, if perpetuated, could reduce the region’s opportunity to attract and sustain new people, investment, and industries.
- (2) *Disease and pest introductions* that reduce or destroy yield or increase costs of agricultural products could limit the future economy of the region. Biosecurity systems designed to counter these introductions are primarily in the province of state and federal governments rather than the Avon River Basin.
- (3) *Dependence on grain* as the major economic activity of the region has continued throughout the 20th Century. All scenarios except Grain and Drain (Scenario 2) address this historical reliance with the development of new industries and increases in animal production over the next 50 years. Even if this diversification reaches the maximum suggested in the scenarios, grain will remain a significant proportion of the regional economy in 2050, in an era of declining terms of trade for agriculture.
- (4) *Un-inspirational government policies* include state policies that are metro-centric (most services go to the capital city Perth) or antagonistic (incentives to develop farm water supplies are hampered by continuance of subsidised piped water), local government policies that have insufficient links to regional needs, and the potential for revision of policy every few years if a different political party is elected.
- (5) *Lack of political influence* could persist in the future as regional population declines as a percentage of state and national population, and if ‘one-vote one-value’ legislation is enacted. Unless the region undertakes activities to maintain and enhance its external profile and relevance, regional prospects will suffer.
- (6) *Lack of regional effectiveness* of government (all levels) is a by-product of the Avon River Basin as a natural region that overlaps two or more electoral and regulatory zones of local, state, and national governments. The threat to the region is a reliance on effective coordination between and across these government zones to attract partnerships with government that cover the entire Basin.

- (7) *Losing out to other regions* occurs when new resource distributions (e.g. infrastructure), population (e.g. moving to where work is available), and investments (e.g. processing plant or university campus) are skewed in distribution or wholly attracted to other regions of Western Australia in preference to the Avon River Basin. This could occur when other regions attract a greater proportion of state and federal government funding or major private infrastructure investment.
- (8) *Releasing investment capital for change* reflects a concern among stakeholders about the amount of capital tied up within regional agricultural enterprises, and the flow of profits and borrowing into investments outside the region. In a situation where external capital is lacking and the Basin's internal capital cannot be leveraged for the new development, future economic diversification may be limited. It should be noted that the exact nature of this capital and its flows has not been quantified for the Avon River Basin.
- (9) *Lack of human capacity to change* is the threat of social, economic, and personal inertia. Strategic and ongoing investment in community capacity building could meet this threat.

Critical success factors

Critical success factors are actions and acquisitions that must be achieved in order to improve and sustain future regional prospects of the Avon River Basin. Most of these factors are required in the short to medium term. They were devised by the stakeholders to maximise opportunities in their scenario while minimising threats, and then summarised in plenary into a list of factors relevant to all scenarios. From 31 scenario-specific factors, the following 5 common critical success factors were developed.

- (1) *Quality of governance* delivers the context in which the Avon River Basin stakeholders will strive to improve regional prospects and the partnerships that must be maintained in order to sustain a presence of value in future investment decisions.
- (2) *Research and development must be targetted and sustained*, responsive to the issues and opportunities of the present day and those likely to emerge in the future.
- (3) *Infrastructure resources to implement change* are critical to scenarios based on future agricultural production systems (e.g. communications technology for remote diagnosis), attraction and retention of new industries (e.g. reliable energy supply), and facilities that contribute to vibrant communities (e.g. recreation and schooling) that will be attractive places in which to live and work.
- (4) *Capacity to change* reflects the pressing need for education and training that maintains community capacity to identify, assess, and respond to opportunities

and threats, accept change as inevitable and revitalising, and accept the possibility of social, economic, and environmental futures unlike the status quo.

- (5) *Favourable international choices* are critical in their future effects on areas such as sustained partnerships (e.g. carbon trading), access to current and new markets for ongoing revenue (e.g. global trade agreements), remediation of global environmental problems (e.g. biodiversity decline and human pandemics), and conduits for migration (e.g. new residents able to move to the region).

Discussion

The way forward

Avon River Basin 2050 identified two pivotal elements of improving future regional prospects: relevant research and major (region-sized) investment. The first is inherently obvious in a project focussed on future unknowns and uncertainties. The second was the result of stakeholder concern that scenario planning would do nothing more than list the region's issues, an activity that has been conducted many times in the past.

By its inherent use of core drivers and critical but uncertain drivers, scenario planning points the way forward for research that will be highly relevant to improving prospects in regional Australia. This research must be relevant and applicable to improving regional prospects in the future regardless of whether any of the scenarios comes to pass. Research related to the set of core drivers will be important as they are likely to feature in the region's future. The identification of two clusters of critical (uncertain and important) future drivers neatly selects the other essential type of research that will be required. Some possibilities include research on managing climate change and variability, economic diversification options, and how to develop rural populations and infrastructure in agricultural regions where the trend is in the opposite direction. Future research focus should be a mix of commissioning new research at the region and subregion scale and maintaining awareness of relevant research conducted outside the region. Avon River Basin 2050 identified two research support tools that will be essential in supporting this research, and are not yet fully developed in regional Australia. First, the challenges experienced in characterising historical trends during the ARB2050 project demonstrate that regions need to invest in collecting, analysing, and disseminating data on past environmental, social, and economic trends. These data can also be valuable to future research and the enhancement of regional identity and allegiance. Second, many of the 'what-if' questions generated during and in response to scenario and strategic planning need to be modelled using specific regional data, often with a spatial component to identify subregional effects. We suspect that these research

support tools are only partly available in most regions of Australia.

ARB2050 also contained a 'generating investments' element that ran in parallel with the main scenario building activity. From an initial set of ideas, the top-10 preliminary investment initiatives were selected. Following the elaboration of these ideas into a set of 10 one-page briefs, the stakeholders determined that their preferred investment initiative was the initiation of the development of the Grainbelt Futures Co-operative Research Centre. This initiative is essentially a research-based centre that could bring together several of the research themes described above. The Co-operative Research Centre's research focus will be on sustainable business and community outcome. Three provisional research focal areas have been specified: (a) the development of integrated business systems for the grainbelt, (b) infrastructure provision, and (c) regional/community adaptation, by bringing together technologies, expertise, resources, infrastructure, and investment in new ways (see Appendix 6 in O'Connor *et al.* 2004).

Regional scenario building

Rural regional scenario planning presents several unusual challenges not typically encountered when conducting scenario planning within a single corporation, organisation, or industry. We found it necessary to reduce the project scope by stopping short of contributing to strategic plan revision (as typically happens in large-scale scenario planning activities), as there was a need to encourage stakeholders to participate in the process. Thus our project aimed to (a) increase futures thinking and activity in the region, (b) challenge 'business-as-usual' thinking, (c) increase awareness among stakeholders that their activities overlap the Basin's boundary, and (d) develop a dataset of past trends and present conditions to support the scenario planning and future activities. Hence regional scenario planning projects should begin by making an assessment of regional capacity to participate in the process.

We invited a wide range of regional stakeholders, mostly a single representative from each activity, organisation, or enterprise, in order to have the capacity to cover drivers and issues across the triple-bottom line. Unlike single organisation or single endeavour scenario planning, where participation is a management directive and scheduled activity, the resources and priorities of stakeholder organisations ultimately dictated participation in project activities at workshop events or between them. Seasonal factors and the annual farming calendar affected the availability of stakeholders to contribute, particularly between workshop events. Stakeholders were often knowledgeable across several areas, particularly in plant industries and nature conservation, which mitigated loss of continuity when the initial invitees were unavailable and then replaced by proxies. A related problem was that

a substantial minority was not aware that their activities overlapped the Basin, particularly those with a main activity focussed on economy or society. Some education along these lines was required in the early stages, using materials being developed in research on historical trends. Solutions to the disruption of continuity of participation we experienced in ARB2050 could include extension of the project to 2 years, a longer start-up phase, and increases in budget, number of participants, and project staff.

The results of ARB2050 suggested that the majority of participants in regional scenario building must be stakeholders that live and work within the region. The inherent loyalty and enthusiasm of regional stakeholders during the syndicate work led to more optimistic scenarios. Each syndicate viewed the challenges and difficulties of their scenario settings as an opportunity for creative problem-solving. Rather than extrapolate to a pessimistic endpoint it was evident that syndicates had independently proceeded with an unwritten goal of optimal continuance of human society in the Avon River Basin to 2050 and beyond. This outcome suggested that rural regional residents will probably develop a sense of ownership of the scenarios and any strategies based upon them, an outcome less likely if scenarios are developed and delivered by external experts. Those external to the Basin might conclude from the historical trends (Fig. 5, Table 2) that the region could struggle to achieve a more sustainable triple-bottom line by 2050 and may not be inspired to think laterally by the drive for survival.

Communication of the final scenarios is the most challenging aspect of the ARB2050 project, and one that is ongoing (CSIRO 2004). In regional scenario planning with stakeholders the quality of the scenario outputs is always uncertain, despite best intentions. This uncertainty arose from two concerns identified by the working group:

- the regional stakeholders, with their broad range of skills and varying levels of time and resources to commit to the project, might not be able to agree on the issues, and come to agreement on critical driver clusters;
- participation in the process might raise each stakeholder's preferred future to a level at which they would dismiss the scenarios as irrelevant.

Ultimately these concerns were mitigated by the pragmatic actions of the stakeholders, who saw the value to the region in producing a complete set of scenarios, despite the concerns they may have had about the emphasis on particular trends or issues. The shared set of important and certain drivers at the core of all 4 scenarios also brought communication challenges. At the whole-of-region scale the core set of drivers that are shared by all scenarios can make it difficult for scenario users to readily distinguish between the final scenario descriptions. Common techniques such as region-scale schematic illustrations of the future

may pose interpretation challenges, as each scenario would appear to have a similar pattern in the landscape. As with other aspects of human endeavour, the important differences are in the detail. We found the differences much easier to describe by using narratives of the nature and timing of scenario events, imaginative retrospectives looking back from 2050 to today, and summaries of key aspects of the triple-bottom line.

Relevance to other regions

Agricultural regions in southern Australia face a range of issues that will require near-term and mid-term strategic decisions and risk assessments (Grains Research and Development Corporation 2004). Many of these issues were also identified in ARB2050. They include the exclusion or adoption of genetic modification into plant and animal production systems, sanctioning of artificial drainage networks connected to natural drainage channels to provide a rapid reduction in salinised land, the attraction of major new large-scale industries that improve the sustainability of current land use while making a contribution to the revitalisation and growth of one or more rural towns, depopulation, the transition to new economically priced fuel sources as fossil fuel costs rise and availability declines in the decades prior to 2050, and whether to remain with the subsidised water supply schemes or develop local desalination or other sources. The project also highlighted several issues that require monitoring, political participation, and partnerships, including the outputs of research into climate change/variability, the emergence of global trade blocks and free trade agreements, and national and global carbon trading and environmental management systems. ARB2050 also demonstrated that many interdependent issues have not been adequately accommodated in strategic plans that have only an economic, social, or environmental jurisdiction. The relationship between economic change and socio-cultural development in regional Australia is particularly in need of further research, in order to identify settings that may be more beneficial for the region than aiming for the economic or social optimum.

The materials produced by ARB2050 — historical trend analysis, detailed compilation and analysis of critical issues, scenarios — are relevant to the aspirations and plans of agricultural regions in Australia and elsewhere in the world. Many of the post-1950 historical trends identified for the Avon River Basin reflect state, national, and global changes in agricultural industries, environmental change and outlook, and rural communities. Examples of these changes include the relentless decline in terms of trade, the declining share of agriculture in state and national economies, the end of large-scale clearing and emergence of landscape planning to integrate production with conservation, and the decline of population, infrastructure,

and whole communities in regional areas. On the basis that the Avon River Basin covers about 20% of Australia's southern grainbelt (Fig. 1), its issues and drivers are likely to be relevant to a significant area of southern Australia. For example, the obstacles to sustainable land use in the Murray–Darling Basin in eastern Australia include continued decline in water quality and ecosystem health related to past systems of natural resource management; increasing scarcity of water resources intensifying conflict between environmental, social, and economic users; difficult choices about protection of economic, environmental, and social assets; access to knowledge; and capacity building for communities (Murray–Darling Basin Commission 2001).

What then can other regions adopt from ARB2050? The most obvious is the method used during the project, from working group formation, through critical issues development and scenario building, to strategic response activities. This sequence of steps is typical of many scenario planning projects, whether intended for regions, urban centres, corporations, organisations, or individuals (Schwartz 1996). Most of the set of ARB2050's 22 critical issues encompass the economic, social, and environmental aspects of sustainability. These issue names could be adopted by grainbelt regions outside the Avon River Basin as a template for analysis of their own historical trends and future prospects. The historical trend data and maps assembled for ARB2050 highlighted the value in studying the enormous quantity of online and offline data to produce a view of the past and present that is specific to a region, rather than making assumptions that it has followed larger (statistical division, state and national) trends at all times. The scenarios are themselves quite specific to the region in which they were developed, but their documentation in the form of narrative, triple-bottom line trends, and story lines (see O'Connor *et al.* 2004) could serve as a template for structuring scenario descriptions in other regions. Examples of formats used in other regional scenarios in Australia and internationally were made available via links on the ARB2050 website (CSIRO 2004).

The most common objective of scenario planning is to make short-term and medium-term strategic planning more robust, i.e. more likely to withstand a wider range of future conditions. The representatives of regions that have defined their preferred future (sometimes labelled 'desirable future' or 'vision translated') are empowered in their strategic involvement with other regions, state and national governments and industry bodies, and corporations. Without a preferred future, regions can be captive to the visions and strategies of others. ARB2050 has already contributed to the region's long-term plan for natural resource management sustainability currently being finalised by the Avon Catchment Council. In contrast to early drafts, the plan now includes a section on scenarios, including a

description of ARB2050 drivers and a preferred future for the region.

Building on ARB2050

Scenarios provide regions with plausible futures, rather than predictions. What value then is an exercise such as ARB2050 in improving regional prospects, if the future will probably contain elements of all 4 scenarios as well as many uncertainties? Over the next 50 years the ARB will undergo considerable change in all manner of things important to its residents. The surprising nature of many changes since 1950 is proof enough that life in 2050 will be sufficiently different as to continually surprise those of us who live through the next half a century. Thus, scenario planning is building the capacity of the region to reject 'business-as-usual' as a mindset and a default future.

Conversely, the project revealed many trends and core drivers that will remain certain and important throughout the next 50 years. They are the cornerstones of the ARB's future, the daily business that must necessarily be excellently done. Over time this task will increasingly fall to the generation of the youngest ARB2050 stakeholder-participants, 4 students from Years 10 and 11 at Merredin High School. Should the region's prospects be stimulated by exercises such as ARB2050, there is every possibility that a greater number of their generation will still reside and prosper in the region in 2050.

Benefits from the ARB2050 scenarios will be generated if a more future-aware culture develops and persists among the region's strategic thinkers and investors, and if the project encourages them to build or revise strategies that are more robust in the widest possible range of potential futures. Equally important will be the attraction of substantial new investment in the region, for which the Grainbelt Futures CRC outlined above could play a significant role.

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References

- Australian Bureau of Statistics (1996) 'Census of population and housing.' (ABS: Canberra, ACT)
- Australian Bureau of Statistics (2001) 'Census of population and housing.' (ABS: Canberra, ACT)
- Australian Business Foundation (2000) Alternative futures for business in Australia to the year 2015: towards strategies. A report by GBN Australia for the ABF, Australian Business Foundation, North Sydney, NSW.
- Avon Catchment Council (2004) The Avon NRM strategy: the regional resource management strategy for the Avon River Basin. First draft version 9, Avon Catchment Council, Northam, W. Aust.
- Bartle JR, Shea SR (2002) Development of mallee as a large-scale crop for the wheatbelt of WA. In 'Private forestry sustainable, accountable and profitable: Proceedings Australian Forest Growers 2002 National Conference'. pp. 243–250. (Australian Forest Growers Association: Canberra, ACT)
- Cocks KD (2003) 'Deep futures: our prospects for survival.' (University of NSW Press: Sydney, NSW)
- CSIRO (2004) 'Avon River Basin 2050. Water for a healthy country: Research.' (CSIRO: Canberra, ACT [online: www.arb2050.com])
- Enecon PL (2001) Integrated tree processing of mallee eucalypts. Rural Industries Research and Development Corporation, Publication 01/160, Canberra, ACT.
- Government of Western Australia (2001) Avon ARC: Avon Arc sub-regional strategy. Western Australian Planning Commission, Perth, W. Aust.
- Government of Western Australia (2002) Western Australia tomorrow: Population projections for the statistical divisions, planning regions and local government areas of Western Australia. Government of Western Australia, Population Report No. 4, Perth, W. Aust.
- Grains Research and Development Corporation (2004) 'Towards a single vision for the Australian Grains Industry 2005–2025.' (Grains Research and Development Corporation: Canberra, ACT)
- Harper P (2000) The end in sight? Some speculations on environmental trends in the twenty-first century. *Futures* **32**, 361–384. doi: 10.1016/S0016-3287(99)00102-0
- Hulse D, Gregory S, Baker J (2002) 'Willamette River Basin Planning Atlas: Trajectories of environmental and ecological change.' (Oregon State University Press: Eugene, OR)
- de Jouvenel H (2000) A brief methodological guide to scenario building. *Technological Forecasting and Social Change* **65**, 37–48. doi: 10.1016/S0040-1625(99)00123-7
- Keighery G, Halse S, McKenzie N (2001) Why wheatbelt valleys are valuable and vulnerable: the ecology of wheatbelt valleys and threats to their survival. In 'Dealing with salinity in wheatbelt valleys: processes, prospects and practical options. Proceedings of the Wheatbelt Valleys Conference'. 30 July–1 August 2001. pp. 1–8. (Water and Rivers Commission: Perth, W. Aust.)
- Murray–Darling Basin Commission (2001) Integrated catchment management in the Murray–Darling Basin 2001–2010. Murray–Darling Basin Ministerial Council, Canberra, ACT.
- Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. *Nature* **403**, 853–858. doi: 10.1038/35002501
- O'Connor MH, McFarlane M, MacRae D, Lefroy EC (2004) Avon River Basin 2050: four regional scenarios for the next half-century. A report prepared for the partners of the ARB2050 project. CSIRO Water for a Healthy Country flagship project and CSIRO Sustainable Ecosystems, Canberra, ACT.
- Schwartz P (1996) 'The art of the long view: paths to strategic insight for yourself and your company.' (Richmond Ventures: Sydney, NSW)

- Schwartz P, Leyden P, Hyatt J (2000) 'The long boom: a vision for the coming age of prosperity.' (Orion Business: London)
- The West Australian (2003) Wheatbelt: heartland of WA [newspaper article]. 6 August 2003.
- Tindale NB (1974) 'Aboriginal tribes of Australia.' (Australian National University Press: Canberra, ACT)
- Australia URS (2003) 'Indicators of regional development in Western Australia.' (Department of Local Government and Regional Development: Perth, W. Aust.)
- Viney NR, Sivapalan M (2001) Modelling catchment processes in the Swan-Avon river basin. *Hydrological Processes* **15**, 2671–2685. doi: 10.1002/hyp.301
- Water and Rivers Commission and Avon River Management Authority (1999) River Recovery Plan Section 3 – Toodyay. Water and Rivers Commission and Avon River Management Authority, River Recovery Plan Series, No. RRP 1, Perth, W. Aust.
- Weigall F (1996) 'Shaping the future 1997–2010: an economic development vision and strategy for the Wheatbelt Region.' (Wheatbelt Development Commission: Northam, W. Aust.)
- Western Australian Technology and Industry Advisory Council (2000) 'Drivers and shapers of economic development in Western Australia in the 21st Century.' (Western Australian Technology and Industry Advisory Council: Perth, WA [online: www.wa.gov.au/tiac/drivers/])
- Wheatbelt Development Commission (2001) 'Wheatbelt economic perspective: an update on the economy of Western Australia's Wheatbelt region, July 2001.' (Department of Local Government and Regional Development and Wheatbelt Development Commission: Perth, W. Aust.)

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