PLANNING TOOLS

Future scenarios and ecological risk assessments

NATIONAL PROGRAM FOR
Sustainable Irrigation

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About this NPSI Knowledge Harvest document

The NPSI Knowledge Harvest brings together information from across the National Program for Sustainable Irrigation (NPSI) projects, highlighting key findings and promoting wider understanding.

Key themes within the Harvest are:

- Irrigation Overview – facts, figures and key concepts about irrigation.
- Water Delivery Systems – the efficient storage and distribution of water for irrigation.
- On-farm Irrigation Essentials – principles for efficient irrigation.
- Recycled Water – recycling treated effluent and stormwater for irrigation.

This document is part of the Irrigation Overview theme. It explores issues likely to affect the future of irrigation in northern and southern Australia, especially those related to ecology and natural environments, and provides tools for planners to address them.

Other documents in the series may be downloaded from www.npsi.gov.au

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Preface

Rising global demand for food offers a positive outlook for irrigators, with potential for higher commodity prices. However, producers face increasingly competitive and volatile markets, compounded by the global financial crisis. There are also looming shortages of water, as cities increase their demands, water is reallocated to improve the environment and flows are affected by climate change.

These complexities and their implications are being researched by governments, businesses, industries and regional bodies across the world. The National Program for Sustainable Irrigation (NPSI) and its predecessor (the National Program for Irrigation Research & Development – NPIRD) have contributed by developing knowledge, tools and processes that shed light on issues affecting irrigation development and help people plan for the future.

NPSI and NPIRD have developed tools for:

- Scenario planning - foresighting and the production of future scenarios
- Assessing environmental impacts – via ecological risk assessments.

Both approaches are described briefly below, with examples of their application. Subsequent sections report on how both techniques have been applied to help shed light on the future of irrigation in northern and southern Australia.

For many irrigation areas in southern Australia there are overarching questions about renewal and survival; in the north, the questions relate more to the possible role of irrigation and any potential for growth. Water availability and environmental management will be critical to both.

NPSI has invested in scenario planning and ecological risk assessments in northern and southern Australia as input to the wider examination of those questions. The work produced by the projects discussed here can be accessed on the NPSI website, www.npsi.gov.au.

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Scenario planning

Alternative scenarios provide one way to explore the future.

Scenarios are a mixture of fact and information combined with alternative trends and social choices to create different perspectives of what the future could be. They help users understand the nature and possible impact of issues affecting the future – and to plan for them.

Scenarios present possible alternatives and should not be regarded as predictions.

The process begins by identifying key drivers of the future (e.g. climate change, demand for food, water availability and environmental protection) and concentrates on those that could have most impact and which are most uncertain. Themes or 'story-lines' are developed around the drivers and three or four scenarios are then developed weaving together alternatives. In some cases, it is possible to limit the investigation to two key drivers (such as environmental protection and profitable production) and develop four scenarios from them – based on the high and low projections for each.

Research priorities

An early project investigating sustainable irrigation and river health used three scenarios representing different trade-offs between production and the environment:

- Economic Growth: A scenario in which great importance is placed on production and government policies support growth.
- Conservative Development: A 'sustainable development' option, where policies seek win-wins for production and the environment.
- Post Materialism: Where the environment is the clear top priority and land and water are retired from production to improve the environment.

These three scenarios were used to plan the type of scientific research required to meet future challenges associated with irrigation and river health. They showed that environmental issues would be increasingly important. The promotion of ecological risk assessments (ERA) by NPSI is a response to that issue.

"Scenario planning provides a means to develop strategic options that will be robust across several perceived futures."

Derek Poulton, Goulburn-Murray Water

Ecological Risk Assessments

Irrigation has a number of well-defined impacts on the environment:

- It competes for water which rivers, wetlands, flood plains, forests and other natural ecosystems require to survive and thrive.
- It interferes with the natural flooding cycle of rivers by drawing water from them and 'regulating' them with weirs and dams.
- It can introduce contaminants into natural systems (e.g. salt, nutrients, pesticides, herbicides, sediment and excess water).
- Different production systems interact with the surrounding environment, including birds, fish and insects, and with local communities.

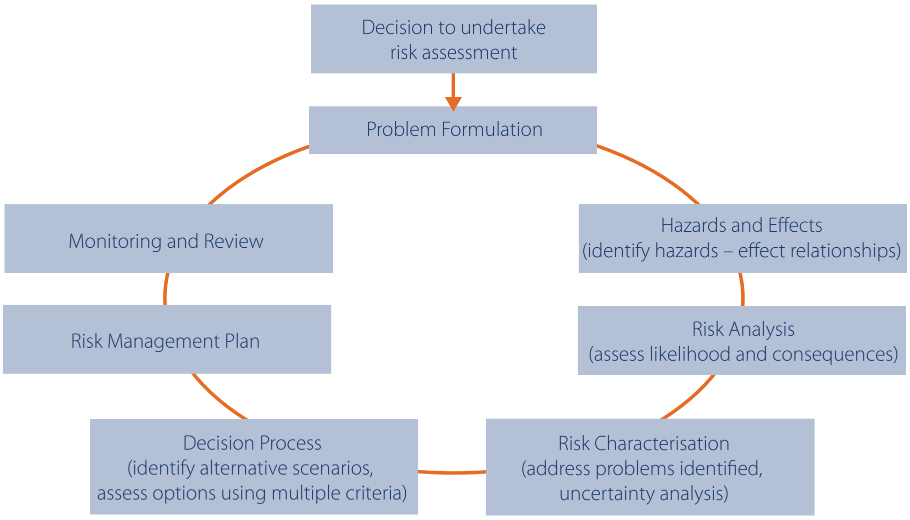
By developing ways to better identify and assess the ecological risks of irrigation, Australia has made significant progress in planning how to avoid or minimise these risks and has improved the sustainability of new and existing irrigation schemes.

ERA in action

An Ecological Risk Assessment (ERA) assesses the risk to ecosystems from stressors. Risk is the product of the probability (or likelihood) of a hazard occurring and the consequence if it happens.

Risk = Likelihood x Consequence

The process describes the links between stresses on the environment, their likelihood and consequences. All stakeholders should be involved in the process – especially the early phases – to ensure comprehensive outcomes and to avoid perceptions of bias. Conceptual models can help identify key interdependencies for analysis.



Northern Australia

- 40% of Australia's land-mass lies north of the Tropic of Capricorn
- Tropical rivers discharge 60-70% of Australia's freshwater.

It is no wonder there is interest in more irrigation development in northern Australia.

However, that water is already being used – to maintain the environment, for Indigenous and other cultural values, and economic activity (including off-shore fisheries). The question is not whether to develop 'unused' water resources for irrigation but whether to divert water from existing uses to irrigation and, if so, how, where and under what management?

Tropical rivers

Most tropical rivers are 'event-driven'. They are fed by storms and hence flows are highly variable within, and between, years. Rainfall is highly seasonal, driven by cyclonic depressions. Some of the highest daily rainfall intensities in the world are recorded there – with similarly high evaporation rates.

Different climatic zones in the tropics are typified by different flow regimes:

- Wet tropics – more perennial rivers
- Wet-dry tropics – few perennial streams; and those that are, are often due to groundwater inflows; giving rise to unique natural ecosystems
- Semi-arid, arid tropics – low groundwater recharge and discharge rates; but with potential for high yield flood events with implications for in-stream, estuarine, and marine environments.

Water storage

Building effective storages will be a challenge in many parts of northern Australia:

- Large dams would be required to harvest intermittent high flow events
- Large, relatively flat landscapes offer few opportunities to build large dams
- High evaporation rates would mean high losses from dams.

In addition, although poorly understood in detail, the links between surface water and groundwater appear to be very important in many areas; with groundwaters maintaining perennial stream flows and unique ecosystems.

Planning for sustainable irrigation

If irrigation were to be further developed in northern Australia, planning would need to be tailored to local situations and go beyond purely biophysical information.

There is often a shortage of environmental data and technical services providers in the north, but a wealth of traditional knowledge. With large areas of land under Aboriginal control, reserves or pastoral leases, planning needs to incorporate social needs as well as water budgets and the environment.

NPSI supported several projects that explored how to achieve that, including the development of a framework for Ecologically Sustainable Development and an examination of the potential for "irrigation mosaics".

Environment and society

A framework for Ecologically Sustainable Development (ESD) has been developed to consider ecological, social and economic issues. This will help communities and decision-makers deal with complexity and uncertainty in a comprehensive, transparent and inclusive way.

The framework uses a suite of tools, including:

- Sustainability indicators – to show relationships between factors and incorporate all stakeholder perspectives and knowledge (including traditional)
- Ecological Risk Assessments – subject to early agreement about their role and operation

"Probably the biggest take-home message is the complexity of the system and the need to manage that complexity."

Doug Hall, Irrigation Australia

- Modelling – e.g. Bayesian Belief Networks (see accompanying text), as a means of mutual learning
- Foresighting or visualisation – developing alternative future scenarios to help develop plans and responses to possible futures
- Local Social Framework – accommodating local social and statutory structures and processes
- ESD Component Trees (sets of issues and impacts connected in hierarchical trees) – to understand the positive and negative contributions of different components and activities
- Knowledge Platforms – to synthesise and share information and understanding, and help make debate and decision making mo re transparent (e.g. the web-based platform developed for the Lower Burdekin).

Bayesian belief networks

Bayesian belief networks can answer questions such as, "If state X exists, what are the chances of Y occurring?"

They begin with a graphic representation of the interactions between different factors (a conceptual model), and then incorporate knowledge and data (which is represented as probabilities), to understand the likely outcomes of different scenarios. They can be used to identify and prioritise the key influences on an outcome.

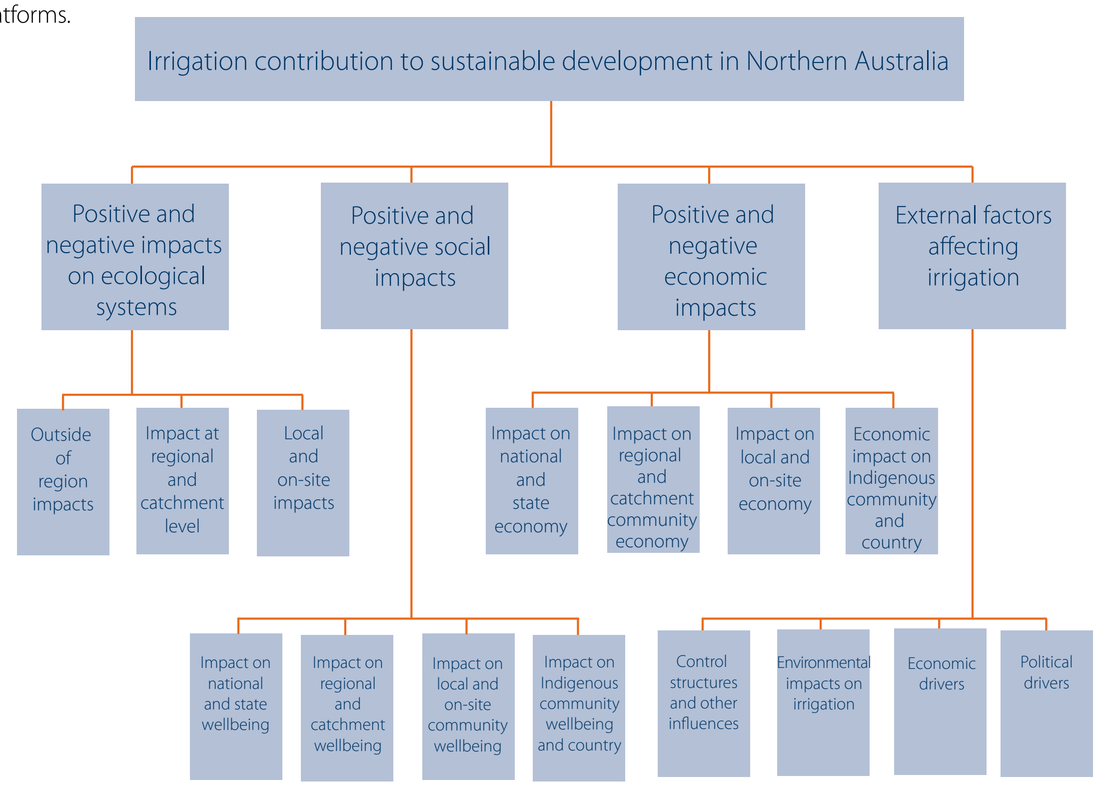
A major advantage of Bayesian belief networks is that they can use both quantitative data and qualitative information (e.g. expert opinion), which can be very useful in situations where detailed knowledge is limited.

Irrigation mosaics

Could irrigation mosaics (patches of irrigation distributed across the landscape) be effective in the north?

ESD Component Trees

ESD Component Trees, such as the one below, help build understanding and the management of risk. They may be a component within Knowledge Platforms.



Source: Story et al, (2008) *Frameworks to Support Irrigation Decision Making in Northern Australia.*

Given the environment in northern Australia and the needs of Aboriginal communities and pastoralists seeking small-scale diversification, patches of small-scale irrigation may be more appropriate than large contiguous developments.

Biophysical modelling and analysis tools were applied to test that thinking. The modelling found that irrigation mosaics could have positive and negative effects compared to large-scale contiguous irrigation.

Positive impacts

- Reduced watertable accessions, less salinisation and groundwater contamination, improved filtering of surplus nutrients, reduced erosion and less change to natural flows.
- Opportunities for farmers and small, remote communities to be directly involved in management and to supply local markets, with less risk of environmental and social impacts (e.g. displacement).

Negative impacts

- Higher evapotranspiration losses and more 'edge effects', increased operational losses and fewer economies of scale.
- May be more difficult to make representations to investors (e.g. Governments) and to attract support and services (technical and education) to the 'irrigation industry' as a whole.

The actual benefits will depend on the size of individual patches, the spacing between them and the capacity of intervening country to assimilate any off-site impacts of irrigation.

Ecological risks

In recognition of the importance of factoring the environment into future development considerations, Ecological Risk Assessments (ERAs) have been conducted as case studies for the Ord River (WA) and in the Fitzroy Basin (Qld), and in the Lower Burdekin (Qld) to assist the development of a framework for Ecologically Sustainable Development.

The emphasis in the Ord and Fitzroy was on the diversity of plants or animals (e.g. invertebrates) and on water contaminants (e.g. pesticides).

In both cases, the area occupied by irrigation is very small in comparison to the entire catchment. As a consequence, while local water quality impacts may be identified, it is often impossible to detect them at a catchment scale because of other factors. These factors include contaminants from other sources, additional flows diluting concentrations, sediments settling out and chemicals being adsorbed. However, changes in flow regimes, e.g. due to dams and reservoirs, may be far wider in their impact and have a catchment-wide effect on biodiversity.

Ord River

Northern (tropical) river systems are highly variable between seasons and between episodic flood events. Dams and weirs change that natural sequence. Changes in the quality, quantity and timing of flows affect the downstream ecology.

For example, flows in the Ord River are now regulated by the Ord Dam and the Kununurra Diversion Dam. Previously, the Ord would be reduced to isolated pools in the dry season, with raging floods in the wet. Now, with the Ord Dam providing water to generate hydro-electricity and for irrigation, there is a permanent flow below that point.

Studies have shown local flow rates to be significant in affecting invertebrates. 'Return waters' (drainage from irrigated lands) can create plumes of high turbidity (suspended sediments) and nutrient concentrations, which also affect local invertebrate communities. Pesticides were not detected, although they could be present episodically. However, these water quality impacts were localised and a related assessment of the impact of further irrigation development (Ord Stage 2) rated the risk of biodiversity loss as low for the majority of the river.

Fitzroy Basin

In the Fitzroy Basin, conceptual models of catchment processes were developed in consultation with stakeholders to identify factors that could affect the aquatic ecology.

Risk tables (reflecting the importance of any impact and the likelihood of it occurring) were then prepared, supported by environmental monitoring to gather additional data.

The ecological risk assessment concluded that:

- Irrigation had mainly local effects in the Fitzroy, e.g. contaminants affecting water quality were not detected more than three kilometres downstream from the Dawson Valley Irrigation Area
- Flow regulation is a major cause of ecological impacts, affecting the distribution and abundance (the

ecology) of many aquatic species, from invertebrates to fish

- Suspended sediments and associated nutrients affect algal growth, invertebrates (especially filter-feeders) and fish
- Pesticides were found in high levels at times, but little is known of their impact in turbid, tropical streams
- Nutrients and sediments resulting from existing irrigation have minimal, if any, immediate impact on coral reproduction and growth, as their concentrations decline away from the river's estuary. The possible effect of pesticides is less clear.

It should be noted that contaminants are often mobilised by flood events that may be missed by periodic sampling. A recent "scientific consensus paper" concluded that:

- Water discharged from rivers to the Great Barrier Reef is of poor quality in many locations, and
- Land derived contaminants, including suspended sediments, nutrients and pesticides, are present in the Great Barrier Reef at concentrations likely to cause environmental harm.

Northern opportunities

In assessing options for future irrigation development in northern Australia, it is essential to consider those aspects that make northern systems different to the south, for example:

- Difficulties associated with storages in flat terrain, with high volume but variable flows and high evaporation
- The often critical contribution of groundwater to base flows and the maintenance of ecological function, along with the importance of water quality in meeting ecological needs
- The cultural and social resources of the region, including traditional knowledge, technical skills and environmental data.

At the same time, lessons from the south must be heeded, for example:

- Preparing catchment-scale water, salt and nutrient management plans before irrigation development
- Setting quantity and quality targets for groundwaters in conjunction with surface water resources.

The investigations supported by NPSI helped develop and extend an appreciation of the characteristics of catchments in northern Australia. They led to an understanding that the full range of perspectives present in a community need to be incorporated for a thorough understanding of natural systems and that tools like ecological risk assessments were valuable contributors to that process. The ongoing success of groups like Lower Burdekin Water Futures is evidence of the value of regions taking responsibility for their affairs and the role of sound science.

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Southern Australia

The Murray-Darling Basin's future is clouded by the prospect of climate change, shifts in water allocation to the environment and cities, and the movement of entitlements between districts.

- What might future irrigation districts look like?
- How can irrigation reduce its impact on the environment?

These are typical of the questions to which the National Program for Sustainable Irrigation has responded. It has supported scenario planning in the Goulburn-Broken region (one of Australia's major irrigation districts in the south-east of the Basin) and the development of several ecological risk assessments as part of its contribution. The results have helped shape major changes in the region's water infrastructure.

Future irrigation scenarios – Goulburn-Broken Region

Drivers of change

The irrigation districts of the Goulburn-Broken region in northern Victoria are among the oldest gravity-fed irrigation systems in Australia. With their aged infrastructure due for renewal, it was timely for the National Program for Sustainable Irrigation to assist with experience in assessing future scenarios.

A collaborative program consulted widely with local communities and listed key drivers likely to affect the region's future. The drivers include:

- The need for renewal of irrigation infrastructure
- A variable and changing climate
- Declining terms of trade for agriculture
- Growing numbers of 'lifestyle' landowners
- Policies affecting trade, the environment, labour and water entitlements
- Future demands for food, including high-tech substitutes and advances in 'functional foods'
- Global trade and competition, e.g. China
- Technological developments, e.g. genetically modified crops, communications, and energy.

Alternative scenarios

The drivers were applied to develop four alternative scenarios of the future to see how they would affect the Goulburn-Broken;

- Moving on – The cost-price squeeze on farmers and climate change continue unabated; and governments rely on global market forces to govern production. Under this scenario, there would be fewer, larger farms - using high-tech (GM) systems. There would be high costs for water and more lifestyle properties in the region.
- New Frontiers – Advances in science drive the laboratory production of synthetic foods and communication technologies allow people to live in the country yet work globally, resulting in; an increased rural population, with many lifestyle blocks (buffered from high production farms); reduced agricultural production; more environmental regulations and less water due to water trade, climate change and increased environmental demand.
- Pendulum – Dramatic swings in policies as contrasting political agendas (alternatively favouring the environment or production at the expense of the other) hold sway. An environmentally based economy could result with strong environmental policies at the expense of agricultural decline – including the retirement of land from irrigation. This could be offset by opportunities to grow biofuels and sell carbon and biodiversity credits. Environmental health and recreation opportunities would arise at the expense of a declining regional

economy and the loss of younger generations.

- Drying up – Ongoing drought and a global recession; 'led' by the USA, with China dominant in markets for labour-intensive, high-value horticulture. Under this scenario, the region could focus on producing high-value 'fresh' or 'clean & green – No GM' produce or high-tech products such as nutraceuticals. Drought and reduced water allocations would affect the environment, recreation and tourism. Local communities would decline, with stronger divisions between the 'haves' and 'have-nots' and an exodus of youth.

To survive these alternative futures would require:

- Flexibility – building the ability to respond quickly and smoothly to change
- Adaptability – being able to detect change, assess options and make use of flexibility to respond.

Planning Implications

Considering alternative future scenarios and their implications provides clarity about key features that may be required for future prosperity.

Some conclusions follow with implications for governments, water suppliers, industries, educators, communities and individual irrigators. These factors will need to be accommodated in future plans for the region.

Land & Water

- Flexible irrigation infrastructure will be required to deal with the impacts of climate change and water trade. A 'handbook of technologies for flexible infrastructure' was subsequently produced, including "in- and off-channel storages", channel lining to reduce friction loss and short-life infrastructure.
- High levels of irrigation supply service will be important if more differentiated production systems and high-priced crops are grown.
- The construction of high-cost drainage assets could be delayed – as improvements in irrigation efficiency, climate change and reductions in water use result in less drainage.
- River flows could be managed for environmental advantage.

Agribusiness

- Irrigators may seek globally competitive advantages through high-tech, lower-cost production; innovative products aimed at market niches; or vertical integration (value-adding through more involvement in supply chains). Sophisticated production and business systems and highly developed technical skills will be essential.
- Better promotion of agriculture and the importance of irrigated produce may help retain access to natural resources and attract an agricultural workforce.
- Efficiency of production will remain crucial – to stay cost effective and to retain market and community sentiment (including access to natural resources, i.e. water).
- Sound on-farm management will be a prerequisite to avoid conflict with neighbours and maintain market access or advantage.

There is an inter-reaction between the security of water rights, the technologies and service standards applied for water distribution, and the irrigation requirements of the crops grown.

For example, a high cost perennial crop that is susceptible to stress would only be grown if the water supply was secure and the supply system was able to meet the specific needs of the crop.

Communities

- Active community organisations must be maintained; emphasising community collaboration and planning to avoid conflicts and optimise regional strengths. Encouraging transport, energy, communication and community infrastructure will help maintain healthy communities.
- All levels of government should understand the implications of policy options and any measures required to assist with changes to communities and production systems.
- Strong regional 'knowledge management' will help to share knowledge and deal with the possible loss of knowledgeable people, previously un-experienced conditions, and the demands of high-tech systems.

Ecological risks

Ecological Risk Assessments (ERAs) have been conducted in northern Victoria and southern NSW, in recognition of the importance of incorporating environmental management into future irrigation systems.

The ERAs assess the risks for ecosystems and environmental priorities from stressors arising from human activity and help design risk management strategies. This approach provides considerable insight about specific issues and enables highly effective, strategic responses to combat major threats to important ecological values.

ERAs have been widely promoted by the National Program for Sustainable Irrigation. Their success has influenced individual projects and developed capacity across Australia to undertake and understand such work. Case study projects have shown the importance of engaging stakeholders early and ensuring they understand the nature and limitations of the approach. Having a broad cross-section of community views and understanding is imperative to ensure the outcomes do not overly reflect the personal biases or understandings of those involved.

ERAs may not consider all environmental issues or incorporate economic or social information – although they can. They generally are a part of a sustainability assessment, not a sustainability assessment itself.

ERAs have been conducted for:

- Black box wetlands (Murray Irrigation Region, NSW)
- Grey crowned babbler (Lower Loddon, Vic)
- Native fish (Murray Irrigation Region, NSW and Goulburn River, Vic)
- Aquatic macro-invertebrates (Lower Loddon, Vic) and
- Blue-green algae (Goulburn River, Vic)

All studies involved consultation with stakeholders to select high-priority environmental assets on which to focus, the collation of qualitative and quantitative information as well as any existing models of ecological function, the development and testing of models (e.g. sensitivity analysis and validation against field data), and consultation regarding the model outcomes. Bayesian belief networks were used in the modelling.

Black box wetlands

The condition (canopy cover) and regeneration of these eucalypts was seen as an important ecological asset in the Murray Irrigation region of NSW. Sensitivity analysis using a Bayesian network showed:

- The wetting regime (flooding frequency) is the most important factor affecting tree condition and recruitment, with wetting between one in every five and ten years being optimal.
- Land management (fencing and grazing management) is important for effective regeneration.
- The condition of surface water, groundwater and soils were generally of less influence.

Grey crowned babbler

The grey crowned babbler – a threatened species of bird classed as 'vulnerable' – frequents box woodlands. Modelling of factors that would affect bird populations showed that:

- Habitat availability, food availability and biological factors (e.g. competition, reproductive success and predation) influence bird numbers.
- Reducing grazing by stock would increase the likelihood of achieving medium to high population levels.

Native fish

The Goulburn River is highly modified with numerous, and significant, weirs and dams that affect flows and the upstream movement of fish. Streams have been de-snagged, there are raised levels of turbidity and nutrients, and exotic fish species have been introduced (e.g. trout and carp). The ERA showed that:

- Native fish stocks are at most risk from barriers to migration, altered flow regimes, changed structural habitats, and low water temperatures (due to the release of water from the bottom of Lake Eildon)
- The relative importance of these factors varied in different parts of the catchment.

Aquatic macro-invertebrates

In the Lower Loddon River, modelling indicated that:

- Habitat variables (e.g. in-stream habitat, food availability, in-stream vegetation, turbidity, sedimentation, riparian vegetation, woody debris and roots, and bank erosion) had most influence on the diversity of macro-invertebrate communities, an indicator of aquatic health
- Reducing stock access was one means to generate significant improvement.

Blue-green algae

In the Goulburn River, blooms (or population explosions) of blue-green algae are driven by nutrients (e.g. from irrigated lands or urban centres), light and temperature (as shown in the conceptual model below).

Studies of the Goulburn Weir (Lake Nagambie) and Lower Goulburn River indicate that:

- Nutrient levels (specifically the level of 'filterable reactive phosphorus') are the main driver
- Both systems seem "resistant to the formation of algal blooms", although the risks are higher in Lake Nagambie and would be further increased in unusually warm summers.

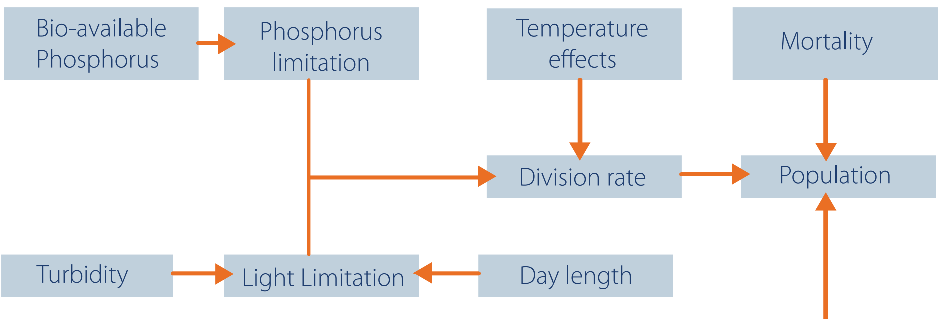
A shortage of data about algal blooms in the study sites made it difficult to validate the model developed in this study and hence there is a high level of uncertainty about the outcomes.

Environmental Risk Assessment conclusions

The ecology of streams in temperate Australia is affected by many factors, including changes in flow regimes, barriers to fish movement, riparian and in-stream management and nutrient levels.

Understanding the specific needs of priority components enables appropriate management responses to minimise the impact of irrigation and water management activities, e.g. installing 'fish ladders' or periodically wetting flood-plains.

ERAs have proven useful tools and have provided a focused way to consider environmental issues. They provide a better understanding of how irrigation may influence the environment and how potential impacts may be managed.



Conceptual Model of Blue-Green Algae Population Dynamics

Southern opportunities

Irrigation in the Murray-Darling Basin is under pressure. However, the Ecological Risk Assessments (ERAs) and Future Scenario work supported by the National Program for Sustainable Irrigation have shown that many of the associated issues are manageable.

In the interests of future regional communities, State and national economies, and the environment, it is essential that they are managed well.

An emphasis on water use efficiency (on the farm and in storage and distribution systems) and on specific environmental management measures (e.g. environmental flows) will be necessary. The National Program for Sustainable Irrigation has invested heavily in research to improve efficiencies in water use and the information is available via **www.npsi.gov.au**.

The work undertaken in the NPSI projects has had significant influence on the modernisation of irrigation within the Basin and methods such as scenario planning and risk assessment have been used on numerous occasions and in other irrigation regions. For example, Murray Irrigation Ltd is preparing scenarios as part of its assessment of options to upgrade irrigation delivery systems through the Australian Governments modernisation program; the Victorian Government is developing farming systems scenarios as part of its state-wide Climate Change Adaptation Program; and Catchment Management Authorities have used ERAs to better target investments for environmental improvement.

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About NPSI

The National Program for Sustainable Irrigation provides research and innovation to improve the environmental and productive performance of irrigation in Australia.

The program funds and manages research projects across Australia, working at the property level with farmers, at catchment level with policy makers and planners, and at scales that cross state and territory borders.

Our vision

Australian irrigation that is valued for its environmental, economic and social contribution.

Our mission

To invest in research, development and its adoption to improve the productivity and sustainability of irrigation in Australia.

Outcomes

- Improved irrigation water use efficiency and enhanced ability to respond to changing levels of resource availability over time.
- Reduced environmental impacts, more sustainable ecosystems and more prosperous communities.
- Improved skills, knowledge and decision making of end users, which leads to practice change, and more efficient and sustainable use and management of water.
- A national approach to irrigation related to R&D in Australia, which includes a strong focus on a skilled human resource base and enhanced R&D capacity and collaboration.

Our values and guiding principles

- Scientific innovation and excellence.
- Practical knowledge ready for adoption.
- Leadership, integrity and collaboration across the irrigation industries.
- Commitment to sustainable irrigation industries, communities and management of natural resources.

Partners

NPSI is a collaboration between 14 funding partners. Investment Partners include irrigator groups, water authorities, commodity groups, state government agencies, Research and Development Corporations, Cooperative Research Centres and the Australian Government.

- Cotton Research and Development Corporation;
- Australian Government Department of Environment, Water, Heritage and the Arts;
- Gacoyne Water Cooperative, Western Australia;
- Goulburn-Murray Water, Victoria;
- Horticulture Australia Limited;
- Harvey Water, Western Australia;
- Land & Water Australia*;
- Lower Murray Water Authority, Victoria;
- Ord Irrigation Cooperative, Western Australia;
- Grains Research & Development Corporation;
- Sugar Research & Development Corporation;
- South Australian Research and Development Institute; and
- SunWater, Queensland;
- Western Australian Department of Water.

* Land & Water Australia was a parner until the end of July 2009.

Resources

To view NPSI research reports and case studies, visit www.npsi.gov.au

NPSI's partners

Australian Government
Cotton Research and Development Corporation

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Gascoyne Water — Irrigating the Future

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