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Lake Eyre Basin Ministerial Forum

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Cover Image: Arrabury Waterhole, Angus Emmott

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Introduction

This set of information papers has been prepared by members of the Lake Eyre Basin Ministerial Forum Scientific Advisory Panel in consultation with the Community Advisory Committee to inform community debate on how to best ensure the sustainable cross-border management of the water and related natural resources of the Lake Eyre Basin.

The papers cover a range of topics relevant to the Lake Eyre Basin Inter-governmental Agreement signed by the Australian, Queensland and South Australian Governments in 2001.

The Scientific Advisory Panel is working to ensure that decisions relating to the management of the Basin and its natural resources are made on the basis of the best available scientific information and, where appropriate, take account of local knowledge.

These information papers reflect the Scientific Advisory Panel's current state of knowledge and thinking about how the river systems and floodplains in the Basin function. These papers also highlight where further research is required to further improve our knowledge and guide future management action.

On behalf of the Scientific Advisory Panel I commend these papers to you.

Professor Peter Cullen
Chair
Lake Eyre Basin Ministerial Forum Scientific Advisory Panel
May 2004

Developing a Knowledge Strategy for the Lake Eyre Basin

Professor Peter Cullen

Introduction

The community of the Lake Eyre Basin (Figure 1) has been working together over the last decade to develop a Basin wide approach to managing their natural resources. Initial concerns were about possible listing as a World Heritage Area, and then about proposals to abstract water from Cooper creek to support irrigation. These issues helped the community realise that what happened in parts of their Basin could impact on the whole Basin, and that they needed to be pro-active in such matters. This led to the development of the Lake Eyre Basin Coordinating Group and several Catchment Committees to facilitate the development of plans and attract natural resource funding to the Basin to help achieve the outcomes desired by the community.

Development of any coherent catchment management approach across this vast and sparsely populated area has been a dramatic success. Those involved all have a deep commitment to the country and its future, and make a real commitment to involve themselves in meetings and other activities. The community appreciated that the State boundary between Queensland and South Australia was just getting in the way of sensible resource management, and established Committees that covered whole catchments, crossing the State border. To their credit, the State and Commonwealth agencies could accommodate and support this whole of catchment thinking and action.

One of many interesting challenges in this process is how to bring scientific knowledge of the Basin and how it functions to the community, and to incorporate this scientific view of the Basin with the local knowledge that rests with both the white and indigenous residents of the Basin.

This paper discusses this process and the challenges. It is as yet a journey only part completed.

The Governments of Queensland and South Australia have joined with the Commonwealth Government to establish the Lake Eyre Basin Ministerial Forum to assist with cross-border coordination. The Ministerial Forum has established a Scientific Advisory Panel comprising six scientists with expertise in freshwater ecology, hydrology, rangelands ecology and social science. The Chair of the Panel sits as an observer at the Ministerial Forum charged with informing the Forum on scientific matters. This itself is an innovative arrangement in natural resource management in Australia. There is also a Community Advisory Committee to ensure community views have similar access.

Knowledge and Natural Resource Management

Few would deny that we need knowledge to manage any natural resource. It is harder to get agreement as to what knowledge is reliable or relevant.

Figure 1: Map of the Lake Eyre Basin

Types of knowledge we need include:

- knowledge of the state of the natural resource (the soils, climate, hydrology, vegetation, wildlife) – this is inventory knowledge; and
- knowledge of how the resource will respond to pressures from human activities (pastoralism, tourism, mining) or other stress events (pest invasions, drought, climate change) – this is predictive knowledge.

Local knowledge and scientific knowledge are relevant to both of these types of knowledge. Local knowledge tends to be stronger at the local scale, and less likely to be as useful at the Basin scale. It may be strong on past changes, although these can be missed if they are gradual. It is strong on how the system responds in dry and wet conditions, and possibly on how it has responded to recent invasions of plants and animals.

Science has techniques of resource inventory that use systematic collection of data from ground survey or from remote sensing that allows inventory data to be collated at different scales. However, investment in such data collection has historically been poor and so we do not have good data sets. Remote sensing and new modelling approaches developed in the National Land & Water Resources Audit are helping develop this sort of inventory and predictive knowledge at Basin scales. Major challenges persist in deciding what inventory data is needed, how we collect it under the extreme of wet and dry conditions, who should collect it and who should pay for it.

Science seeks to be able to make predictions as to how resources will respond to various pressures, but in general our predictive capacity is patchy and not necessarily seen as reliable by those with local knowledge. Science is always contestable as better interpretations are developed and then tested against reality.

A Knowledge Strategy

We are seeking to focus on knowledge that will be useful. We have limited and patchy knowledge at present, and need to be clear as to what investments in knowledge will pay off for the community. We have new capacities in remote sensing and modelling, and in presenting data on the Web. But we need to be clear as to what are our priorities, who should collect and manage the data and who should pay for it. We also appreciate that in such a variable system we want to understand how the system functions under flood and drought conditions, not some mythical average.

Given the widespread agreement that knowledge is important to natural resource management, and that much of the knowledge we have coming from various sources is often hotly contested, it seems reasonable to think about our strategies for accumulating and managing knowledge. This is important for three key reasons:

- to establish priorities for investment in creating new knowledge;
- to enable knowledge from whatever source to be tested through examining evidence; and
- to ensure that the knowledge we do have is widely available to all those who would benefit from it.

Knowledge can be thought of an asset just like any other assets. Just like equipment that landholders are used to managing, knowledge can be new and full of promise as to what can be achieved with it. It can be established knowledge that we can trust or it can be old knowledge that we know its limitations. It can be discredited knowledge that we have found wanting and discarded. The knowledge assets we have might include data sets, maps or description of the natural resources. They might include formal predictive models developed by scientists or the understanding and predictive capacity of experienced local knowledge. We can even think of individuals as knowledge assets and consider what we might do if they were no longer available – would we seek to redevelop that knowledge asset or do we let if fade away?

We can think about six sorts of knowledge.

- What we know about an area – the knowledge assets we have
- What we think we know – our working assumptions that wait testing, but might be wrong
- What we need to know – key gaps that are to be filled; the knowledge assets we seek to create

- What we don't know that we don't know
- What we do not need to know – knowledge that we cannot use to make predictions or guide our management decisions
- What we don't want to know – knowledge that may be uncomfortable and we would rather not know about.

As well as identifying some of these sorts of knowledge, a knowledge strategy will identify:

- where the material is housed, updated and managed and how it is accessed;
- how we might go about getting new information (ie. Who are our suppliers and how can we influence them to invest in creating the knowledge we want?); and
- what knowledge do we need to discard as it is shown to be unreliable.

The Process of Developing the Strategy

The Scientific Advisory Panel started with a brainstorming session where each member talked about the Lake Eyre Basin they knew, and what they felt was important to its long-term functioning, and the threats to the Basin. Not surprisingly, each of us saw different aspects of the Basin, and the combining of these assorted mental models gave us all a much richer view of the Basin.

This series of theme papers encapsulate our present knowledge about various aspects of the Basin.

In developing these theme papers, it became apparent that there was a lot that we did not know about the Basin and how it functioned.

It was decided that we needed to concentrate on the issues that Governments and landholders could reasonable influence, and this provided a useful screen.

The Issues Challenging the Lake Eyre Basin

The sorts of issues that are important to the Basin at this time are:

- abstraction of water for mining or irrigation developments;
- biodiversity of the aquatic systems, including floodplains that may be impacted by water decisions or contaminants. (Are there biodiversity hot spots that act as important refuges for must be managed in a particular way?);
- impacts of pastoral activities, tourism and mining;
- management of waterholes – grazing, abstractions of water, groundwater linkages;
- management of floodplains – levees, road/rail links and their impacts on water flow across the floodplain;
- introduction of exotics and appropriate responses;
- impacts of groundwater management on surface water resources;
- management of mound springs;
- health of the rivers and catchments;
- salinity hazards and impacts of vegetation management on shallow groundwater; and
- impacts of climate change on surface water resources.

Angus Emmott

Strzelecki corellas

Key Elements of our Present Understanding

Rainfall in the Lake Eyre Basin is low and very variable, with higher rainfall in the north. The rain drives three elements, all of great importance to the Basin.

- Local rainfall affects soil moisture that determines plant and hence animal production
- Rainfall causes surface water flows, initially in channels to the waterholes and wetlands and eventually out across the floodplain
- Shallow and sub-artesian ground water supplies, and Great Artesian Basin water

There are three distinct hydrological elements of the Lake Eyre Basin.

- Tributary catchments, mainly to the north and east in Queensland, where slopes are significant and water flow is mainly channelised. These regions are dominated by pastoralism are the main areas in which tree clearing is occurring. They are the source of much of the water to the other downstream elements but from time to time have proposals to capture water or indeed divert it from the north side of the divide
- Distributary flood plain reaches in western Queensland, where the main rivers meander across vast plains, and main channels are principally locations where waterholes persist after floods have passed. The great black soil floodplains are an important intermittent pastoral resource,

but are also the location for major agriculture proposals. Water in this area comes from in-channel flows, overbank flows and from local rainfall

- Terminal ephemeral lake systems, especially in northern South Australia, which are fed also by local runoff but depend on major flushes down the whole Basin for their main fills. These lie mainly in multiple use conservation regional reserves, with continued grazing and some mining operations in the area.

Water is the key to life in the Lake Eyre Basin. The local rainfall and the periodic flood flows drive important production processes in the Basin:

- productive vegetation, particularly on the intermittently flooded floodplains, used for grazing;
- ephemeral aquatic production on the floodplains, that occurs only during flooding but is then a critical resource for water bird breeding (and probably for re-charging the fertility of these areas for subsequent terrestrial production);
- ephemeral aquatic production in the major terminal and side lakes, that are also essential for water birds and often identified as RAMSAR or other significant wetlands;
- waterhole re-charge that produces an array of short to long-lived waterholes that also carry critical biodiversity (including invertebrates, fish, reptiles and more waterbirds), as well as providing a focus for tourism and water supplies for the pastoral industry;
- specific unusual biota (both plants like the iconic ribbons of red gums lining the dry riverbeds, and animals, like some fish species restricted to isolated mound spring waterbodies) that depends specifically on ground water of one form or another, and is one of the drawcards for tourism into the region; and
- a number of these resources are of particular importance to the maintenance of indigenous culture and practices.

In addition to these values, there is the availability of ground or surface water for stock dams, community water supplies, possible agriculture and aquaculture developments.

The Lake Eyre Basin is characterised by remarkable "boom and bust" aquatic ecosystems that burst into life and create huge biomass eventually of fish and birds, before collapsing again as the system dries. The Aridflo project found fish up to 80 years old in some of the permanent water holes of the Basin, providing a clue as to how some parts of the biota hang on in the long dry periods. Within the turbid water holes, Bunn and his colleagues have demonstrated how algal production is concentrated at the shallow edge, where it is susceptible to pressure from stock watering.

Lake Eyre Basin Rivers Assessment

The Lake Eyre Basin Inter-governmental Agreement, passed by the Parliaments of the three Governments requires the Ministerial Forum to review the condition of all watercourses and catchments within the Area covered by the Agreement. The review is required to be carried out without unnecessary delay and be repeated on a ten-yearly cycle. The initial assessment is to provide a benchmark against which future assessments can be compared.

The SAP believes that the design of the Assessment requires a clear specification as to

the purposes the Ministerial Forum seeks to achieve from it. The emphasis, indicators and scales are driven by the sorts of questions that the assessment must inform. Some are obvious:

- major water development proposals to support agriculture, mining or even tourism developments;
- the cumulative impacts of minor water developments and diversions on the health of the waterways within the Agreement area; and
- the impacts of land uses in the catchments on the water resources of the Basin

One challenge facing us is to identify indicators that can integrate over reasonably large time scales, and perhaps spatial scales to help us handle the challenges of sampling such variable systems. Another is that there may be long lags between and action and when the ecological outcomes may become evident. In the MDBC the lag between clearing vegetation and dryland salinity become apparent has been 30-50 years.

Another challenge is we are seeking to measure the cumulative impact of what may have been many small decisions to build farm dams or divert a minor flood flow. Individually each of these actions might be minor, but their cumulative impact when repeated 100's of times may be significant, and irreversible.

We believe there are a number of ecological outcomes that may be important. We believe it is necessary to identify the important ecological assets that may provide a focus for the assessment.

Firstly, the condition of Ramsar wetlands, and other wetlands of national significance (already identified) are important due to the international rarity of desert wetlands. Secondly, much of the economic and cultural life of the Basin is focused around waterholes. There are few permanent waterholes on the Cooper system, and there are a number of waterholes that commonly contain water. These waterholes are an important focus for the assessment.

There are a number of national parks in the region, and rivers and waterholes in these areas are probably subjected to less grazing pressure than others, and so may be important benchmarks of ecosystem health.

Accessing Scientific Knowledge

The scientific work that has been done to date is dispersed across a variety of publications and is largely organised on a disciplinary basis – geology, botany and so on. There has been little attempt to integrate this disciplinary knowledge or to make it accessible to the community. One noteworthy effort to list the available information is the WISE project being undertaken by Kingsford and his colleagues for the Cooper Creek, and the work undertaken for the water resource management plan for the Diamantina catchment. These are important foundations.

Our experience has shown that community groups rarely want access to the scientific papers themselves, or even plain language summaries of each piece of work. What they seek in an integrated view of what all the science is saying about some aspect, not the various bits of knowledge that go together to make up this jigsaw. The scientific skills and resourcing to undertake this integration is not yet available, but may turn out to be a priority for investment.

The biggest challenge is to take our scientific knowledge out of the disciplinary silos where it is created, and to put it together to give a picture of how the whole Basin operates. This system understanding will identify what sorts of impacts we might expect. We can expect that land use

Angus Emmott

Vermont Creek in Flood

changes in the upper parts of the Basin will have impacts on the distributary and terminal parts of the Basin. It is hard to communicate these impacts to landholders when the impacts are a long way away in space, and possibly in time, and so it is important they be made obvious to Governments who are establishing policies for the Basin.

The Future

We have many opportunities in the Lake Eyre Basin. It is important that we harness the best scientific and local knowledge to ensure the decisions we as a community make give us a Basin that creates wealth and is sustainable in the long-term. All knowledge is contestable, and both the scientific and the local knowledge need to be supported by relevant and credible evidence.

We do know that avoiding degradation is about 100 times cheaper than trying to restore damaged systems, and we have proved elsewhere in Australia that treating symptoms without treating the cause of the problem is both futile and costly.

Developing the knowledge base to let us manage this important Basin is a challenge. We have limited resources, and need to be very strategic that the inventory data and predictive knowledge we invest in will be useful to the decision-makers of the Basin, and that we can deliver this knowledge to them in useful ways.

Acknowledgements

The ideas in this paper owe much to my colleagues on the Scientific Advisory Panel, Professor Stuart Bunn, Professor Geoff Lawrence, Professor Tom McMahon, Dr Steve Morton and Dr Mark Stafford-Smith. I also owe a deep debt to the many members of the Lake Eyre Basin Coordinating Group who have taught me so much about this wonderful Basin.

Integrated Catchment Management

Professor Peter Cullen

Introduction

The realisation that natural resources have natural boundaries rather than local or State boundaries has led to the development of catchment management in Australia. It is now the basis for Federal funding of natural resource management under the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust Phase 2. It has of course been well recognised in the Lake Eyre Basin with the development of catchment committees. Integrated catchment management (ICM) is the way we are able to bring economic, social and environmental aspects together to decide the sort of Basin we want.

We have already learned that we cannot just manage part of a basin. We need to understand and manage the whole system. The people of Lake Eyre appreciate that, and have had the foresight to establish catchment committees for the Cooper Creek and Georgina-Diamantina River systems that do cover the whole of these catchments, despite the State border that crosses them. If we degrade the lower sections of these rivers they are likely to become populated by pest organisms that will move upstream and damage the upper reaches as well.

It is the interaction between the natural resources of a catchment, and the aspirations of the people who live in the catchment that has led to the development of ICM. ICM is the process by which the various people with an interest in the area come together to learn about each other's activities, aspirations and their problems. It provides the opportunity to understand the natural resources upon which they all depend, and how those resources respond to the pressures we put upon them. It gives a chance for everyone to see how their activities fit within the bigger picture, and the sorts of impacts they might be having on each other. It provides the chance for early warning of problems so that corrective action can be taken while it is still possible to avoid a major disaster.

"Integrated"

Integrating means putting the pieces together. It means thinking about the impacts that upstream activities have on downstream activities. It means thinking about how pastoralism, mining, tourism and Indigenous values might interact. It means thinking about how local rainfall, flood flows and groundwater interact.

In the Lake Eyre Basin, we have to consider rivers, the waterholes and the terminal wetlands, in the context of their surface catchments and the groundwater systems that connect the bits.

What we do in one part of a catchment is likely to affect other parts of the catchment. If we clear vegetation in the upper parts of a catchment, we will increase the amount of runoff and hence stream discharge, and may well induce channel erosion and the bringing of salt in the landscape towards the surface where it can have detrimental effects.

By failing to understand these complex interactions in the landscape, we have caused major degradation in Basins like the Murray-Darling, and the damage we have caused has reduced the productivity and the value of some of these lands. Worse than that, degraded land might cause impacts thousands of kilometres downstream. For example, could pesticide spraying in western Queensland impact water quality in Lake Eyre?

"Catchment"

Catchments are therefore important units, and form the basis for the regional approach being adopted by Government agencies to focus funds and effort. Catchments are fundamental to managing water, and to water related processes like flooding. They may be less useful as management units for issues like weeds and feral animals, and with these issues we need to ensure we have effective cross catchment management.

Catchments tend to have a variety of climates, landforms, vegetation and land uses. They have different pressures on different parts of them, as people seek development opportunities. What is important is that as we develop and create wealth from the land, that we do not destroy the resource itself or damage the livelihoods of our downstream neighbours. This is obvious when the neighbour is next door and we see them frequently; it is more challenging when the neighbour is hundreds of kilometres downstream or upstream and we rarely see them.

"Management"

Management is about taking deliberate action to achieve some end. In the context of rural landscapes it is obvious that landholders all take a range of actions to manage their property in the way they believe is appropriate. Most landholders certainly want to be sustainable in the long term, although short term economic and climatic pressures can make this hard.

But there are some activities that need to be done at the catchment or Basin scale rather than at the property scale. Clearing management, weed control and feral animal control are obvious examples.

Interconnections

As we get to know and understand the country we live in, we start to see the connections that make the country work. Rain makes plants grow; plants support native and introduced animals that live on them. If country gets overgrazed, then wind or water can erode the soil. This may reduce the fertility of the soil, and the eroded soils may be deposited in some other place, where it may be a benefit or a nuisance. We know there is a lot of salt in the landscape of Lake Eyre; we have learned that it can be moved by wind action and by water, and be deposited in other places where it might restrict plant growth. Floods wash salt down into Lake Eyre, wind can blow it back on the surrounding landscape when the Lake dries. Ecology is the science of these interconnections in the natural environment. Our knowledge of these interconnections is limited. But our knowledge is sufficient to tell us that our activities may have an impact on the environment.

Ellar Creek entrance to Lake Toontawaranie – Coongies Lakes area

Developing a Shared Vision

An early task in the ICM process is to try and develop a shared vision for the Basin we would like to see in say 50 years. Do we seek to double the present population of the Basin? Do we seek to double the economic returns from the Basin? Do we just seek to keep on doing what we have always been doing without interference?

In discussions with the basin community it seems many seek a Basin with:

- healthy rivers, waterholes and terminal wetlands;
- healthy ecosystems and catchments;
- innovative, competitive and "clean and green" industries; and
- healthy regional human communities.

The challenge for ICM is to work out what we must do now to bring about such a Basin.

Catchments as Learning Communities

One of the exciting things about ICM is about how we can all learn from each other to gain a deeper understanding as to how the basin functions, and how it might be managed. Already through the activities of various community-based catchment committees we are all learning more about the Basin and how we might go forward. This learning is a special challenge in a remote and variable environment such as the Lake Eyre Basin and the Scientific Advisory Panel aims to make a contribution to this learning by helping to bring some contributions from science to inform discussion.

There has been limited scientific research in the Lake Eyre Basin and transferring knowledge from other environments in Australia maybe risky, although it is often all we can do. There are several challenges in managing and accessing the knowledge base.

- The scientific work that has been done is dispersed across a variety of publications and is largely organised on a disciplinary basis – geology, botany and so on. One challenge is to make sure we know what scientific work has been done
- Community groups may seek to access specific scientific information, but it is likely that they will want some one to read and interpret the information – to tell them what it means in plain language. They may want the information integrated. If they want to know about the geology of an area, they don't want to know what one particular scientific paper has to say. They want a broad view and seek new knowledge and how it relates to the old knowledge
- We need to explore situations where local knowledge and scientific knowledge differ. It may not be clear which is correct, but these differences provide an important start for the dialogue between science and local knowledge
- We need to work our where we should be investing in new knowledge. There is so much we could do, but we never have either the funds or sufficient people with a passion to explore all of the issues that seem important

Inspecting Bugs

What Needs to be in an ICM Strategy

Experience elsewhere has indicated that an ICM strategy needs to include the following information:

- a description of the Basin environment and resources;
- links to National and State strategies relevant to the basin;
- economic, environmental and social aspirations of all stakeholders in the basin;
- goals and measurable targets to be achieved by the strategy;
- assessment of current management strategies and the likelihood they will lead to achieving targets;
- planning and management changes needed in the basin;
- issues of concern and ways of working through them;
- priorities for on-ground actions by landholders and Governments;
- capacities needed to implement the plan (legal, financial and knowledge);
- monitoring and evaluation strategies;
- communication strategy to ensure effective and ongoing community involvement;
- legal and institutional framework in which the catchment operates; and
- identifying knowledge constraints on choosing appropriate actions and adaptive management.

Angus Emmott

Diamantina Waterhole

In the Lake Eyre Basin we seek to develop our communities so they respect the aspirations of others, and respect the knowledge that others bring to inform decision-making. ICM provides a meeting place for those who bring scientific knowledge with those who have local knowledge about the environments of Lake Eyre and how it responds to droughts and floods. It provides a vehicle where information can be provided to the community, and where the community can come to a view on particular issues and inform each other and Governments.

It is challenging for a community to take a hard look at the resources they have, and how they might support the community over the long term. The history of ICM in the South has been an inability for rural communities to face the realities of the land degradation they live with. Catchment plans often seek to live with the symptoms rather than remove the causes of degradation. Government support is often sought on the grounds that the individual farmer can't afford to manage land degradation, weeds or feral animals, and needs help from taxpayers. There are strong pressures to treat symptoms rather than address causes. We need processes to counter this natural tendency.

Thinking about the whole system in an integrated way is fundamental to achieving human and ecosystem sustainability in the Lake Eyre Basin.

Flow Regimes and Aquatic Ecosystem Health in the Lake Eyre Basin

Professor Stuart Bunn and
Professor Tom McMahon

Introduction

Rivers of the Lake Eyre Basin differ markedly from those in the temperate zones, particularly in terms of the unpredictable and highly variable nature of their climatic and hydrological regimes, and their associated physical, chemical and biological character. The combination of flow variability and geomorphic complexity creates a distinctive *boom* and bust ecology, characterised by episodic intense reproduction and high productivity by opportunistic plants and animals.

The physical nature of the rivers in the Lake Eyre Basin has been shaped by the interaction between flow and topography, soils and vegetation. Regional climate, especially the high rate of evaporation, is also a strong driver. At the catchment scale, this has given rise to the three broad functional zones: tributary catchments, distributary floodplain reaches, and terminal ephemeral lake systems. Each of these zones supports a distinctive aquatic and riparian/floodplain biota. Much of our current ecological understanding is restricted to the latter two zones, particularly within the Cooper catchment.

Waterholes – refugia during extended dry periods

Although some aquatic plants and animals can utilise ephemeral aquatic habitats, the larger waterbodies represent the only permanent aquatic habitat for much of the biota during extended periods of low or no flow. In the case of long-lived organisms like turtles (80+ years), very few waterholes appear to be sufficiently permanent to support mature populations. The aquatic biota is not particularly diverse, compared with other large rivers of the world, but there is a high level of endemicity. Several new cryptic species have recently been identified (e.g. freshwater mussels) and it is likely that more will be uncovered as research effort intensifies. Furthermore, many aquatic species with broader distributions are still common in the Lake Eyre Basin but have reduced distributions in more disturbed dryland river catchments (e.g. the Murray-Darling).

High turbidity is a natural feature of the waterholes, with light penetration required to sustain aquatic plant life often restricted to less than 30 cm. Despite this, waterholes often have a productive band of algae restricted to the shallow littoral margins. Recent work has shown that this *bathtub ring* of algae can be a major source of energy for the aquatic food web, sustaining large populations of snails, crustaceans and fish (Bunn *et al*. 2003).

It is worth noting that many terrestrial species that use riparian and floodplain habitats are also highly dependent on the waterholes.

Large floods

Rivers of the Lake Eyre Basin are renowned for their episodic floods that extend over vast floodplains. These undoubtedly have a major influence on floodplain soils, the composition and dynamics of vegetation communities, and pasture production. They also give rise to a boom of aquatic production, and inundation of

floodplains provides a rich source of food for aquatic species, as well as waterbirds. Many aquatic species have life history strategies that enable them to capitalise on these boom periods. There is evidence that 'clusters' of floods produce a cumulative response from the biota, and this pattern of flow may be of key importance for the persistence of aquatic populations during extended dry (bust) periods.

Lake Eyre Basin Rivers dramatically fluctuate between being highly fragmented with numerous disconnected waterbodies and highly connected with enormous tracts of inundated floodplain. High levels of physical connectivity (lateral and longitudinal) during floods allow widespread dispersal for many aquatic species. Little dispersal, if any, occurs between rivers and the catchment boundaries and Lake Eyre itself represent significant natural barriers to aquatic species. This is not the case for waterbirds, however, and variability in the timing of inundation of floodplains and filling of terminal wetlands across the Lake Eyre Basin provides a mosaic of available feeding and breeding habitat (Roshier *et al*. 2001).

Small flow events

Although we often emphasise the 'boom or bust' extremes of dryland rivers, we must be careful not to overlook the role of small floods and in-channel flows. The relative importance of groundwater and surface water to the persistence of waterholes and their associated aquatic biota is poorly understood. Similarly, we have little appreciation of the importance of surface flow (versus groundwater) inputs of nutrients to waterholes, and the implications of these exchanges on salinity. In addition to their effect on ecosystem processes, small floods and in-channel flows also may provide an important opportunity for dispersal for aquatic organisms.

Aquatic ecosystem health in the Lake Eyre Basin

Although our information base is poor, it is generally recognised that rivers in the Lake Eyre Basin are remarkably unscathed compared with those in the coastal regions of the continent and, especially compared with those in other arid regions of the world.

Lake Eyre Basin rivers are unregulated, with only minor alterations to the flow regime from small storages for towns and farms. There has been very little draining or filling of wetlands, as has occurred extensively on the wetter coasts, especially in the southern half of the continent.

There is little evidence of eutrophication, rising salinity or other contaminants and the native aquatic fauna and flora appear to be largely intact, with a low incidence of exotic plants and animals.

Furthermore, several wetlands are recognised nationally and internationally for their high natural values.

Threats to ecosystem health of Lake Eyre Basin rivers

Flow related threats

There is broad recognition by water scientists and managers that rivers and their associated floodplain and wetland ecosystems are legitimate 'users' of water (Richter *et al*., 1997; Naiman *et al*. 2002). In return, rivers and wetlands provide essential ecosystem services (e.g. Postel & Carpenter, 1997) and we are becoming increasingly aware of the real costs to society if these systems become degraded by human activity; i.e. when they can no longer provide the same level of service and the capacity to sustain economic activity (and human health) is diminished.

The environmental consequences of changing flow regimes are well documented (see Poff *et al*. 1997; Bunn & Arthington, 2002). Some lessons we have learned include:

- flow is a major determinant of physical habitat in streams, which in turn is a major determinant of the composition and diversity of aquatic plants and animals;
- aquatic species have evolved life history strategies primarily in direct response to their natural flow regimes;
- maintenance of natural patterns of longitudinal and lateral connectivity is essential to the viability of populations of many riverine species; and
- the invasion and success of exotic and introduced species in rivers is facilitated by the alteration of flow regimes.

Given this knowledge, there is little doubt that alteration of flow regimes (in the broadest sense – see Figure 2) poses a significant threat to ecosystem health of Lake Eyre Basin rivers. Although large-scale river regulation is unlikely, the effects of flow diversion from flood-plain harvesting of water, small on-farm storages and direct extraction will influence the extent and duration of wetland and floodplain inundation, as well as the interval between flows and the overall pattern of physical connectivity. Sustainable limits for water harvesting are unknown and current attempts to set them are high-risk.

Making river flows more predictable through interbasin transfers is likely to disrupt life history patterns of native species, enhance the spread and establishment of exotic species, change the physical habitat of the rivers and degrade water quality. Isolation of extensive floodplain areas, through levee construction or poorly designed roadways is also a significant threat. However, more difficult to appreciate are the cumulative effects of vegetation change in the upper catchment, through direct clearing, fire and grazing. This may also affect sediment regimes and influence the physical nature of the waterholes and floodplains downstream.

It is important to note that it will be the smaller flow events that are the most vulnerable to change from these kinds of activities. Rapid drawdown of waterholes (e.g. from direct pumping) is likely to expose productive littoral zones and reduce algal resources that sustain populations of fish and crustaceans.

"Non-flow" related threats

There are also several emerging threats that are not related to the alteration of flow regimes. Illegal fishing is widespread and intensive in some areas, and threatens long-term viability of aquatic species. Deliberate injuring and drowning of mature turtles caught in illegal nets is evident in some highly visited waterholes.

Degradation of riparian areas through overgrazing is a potential threat to some waterholes. Extensive use of waterholes by stock and particularly feral animals (e.g. pigs) may also trample productive littoral areas and reduce water quality. Harvesting of dead and living timber for campfires is unsustainable at some waterholes and the loss of logs and tree hollows is a significant threat to riparian biodiversity.

Bob Ashdown

Floodwaters

Deliberate or accidental introduction of exotic species of aquatic plants, fish (e.g. carp, tilapia) and crayfish (e.g. redclaw) is a significant risk, especially from ornamental ponds, recreational fishing using live bait and, more recently, aquaculture.

Intensive agriculture could introduce pesticides and herbicides into an area that until now has been largely free of chemical contamination. Chemical control of the plague locust may also pose a significant threat to the biota of waterholes.

Information needs and opportunities

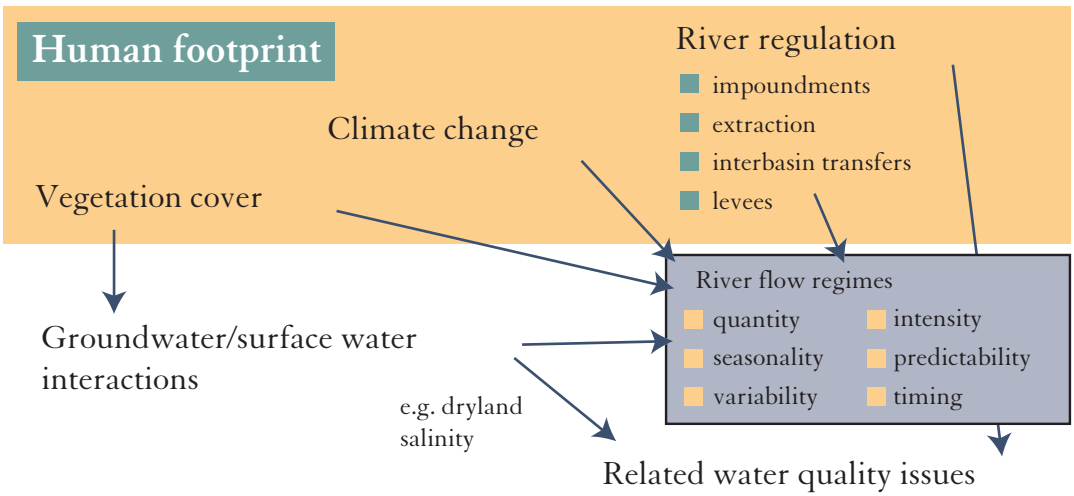
We currently have a poor capability to predict because of the limited database on Lake Eyre Basin rivers. Quantifying the likely hydrological responses of these systems to vegetation change or an increase in on-farm storages is characterised by a high level of scientific uncertainty, as are the consequences of climate change. An enhanced gauging network is required to adequately quantify rainfall and flow regimes in dryland river catchments.

Predicting the river health outcomes of flow change will be even more difficult. There is a need for more scientific information to identify which aspects of the flow regime are important for the maintenance of biodiversity and essential ecosystem services.

Given the high social, economic and ecological values of rivers and their associated floodplains and wetlands in the Lake Eyre Basin, the consequences of making poor predictions are not trivial. We currently have little broad acceptance as to what a healthy dryland river should look like, and what might be the appropriate suite of robust indicators that allow us monitor river health in the Lake Eyre Basin.

A robust and cost-effective ecosystem health monitoring program needs to be developed as a priority. It is worth remembering, however, that monitoring on its own is useful only for documenting declines. A monitoring program for Lake Eyre Basin rivers must be directly linked to clear management actions in order to achieve ecosystem health objectives and protect the natural values of the basin.

Figure 2: Conceptual view of the direct and indirect effects of human activities on flow regimes



Water in the Lake Eyre Basin

Dr Mark Stafford-Smith and
Dr Steve Morton

Introduction

The Lake Eyre Basin has surface and groundwater resources that support a range of social, economic and environmental values. River systems in the Lake Eyre Basin have extremely variable flows and are subject to minor and major flooding. Rainfall in the Basin is typically low and very variable, with higher rainfall occurring in the north. Rainfall is therefore important for providing:

- soil moisture, that determines plant and hence animal production;
- surface water flows, in channels, waterholes, wetlands and on the floodplain; and
- replenishment of shallow and sub-artesian ground water supplies, and Great Artesian Basin aquifers.

The Lake Eyre Basin River Systems

The river systems of the Basin can be divided into three distinct zones.

- The **tributary catchment zones**, mainly to the north and east in Queensland, where slopes are significant and water flow is mainly channelised. These regions are dominated by pastoralism, but there have

Lake Toontawarinie – Terminal Ephemeral Lake Systems Zone

Fran Sheldon

Stuart Bunn

Mayfield Cooper Creek – Distributary Floodplain Zone

been proposals to capture water or indeed divert it from the north side of the divide. They are the main areas in which vegetation clearing is occurring

- The **distributary floodplain zones** in western Queensland, where the rivers meander and break into many smaller channels across vast plains. These main channels are principally locations where waterholes persist after floods have passed. The great black soil floodplains are currently an important intermittent pastoral resource, but are also the location for major agriculture proposals. Water in this area comes from in-channel flows, overbank flows and from local rainfall events

- The **terminal ephemeral lake systems zone** especially in northern South Australia, which are fed also by local runoff but depend on major flushes down the whole Basin for their main fills. These lake systems lie mainly in multiple use conservation regional reserves, with continued grazing and some mining and petroleum development in the area.

Water Drives Production

Water is the key to life in the Basin. Local rainfall events and periodic flooding flows are vitally important for maintaining production processes, such as:

- productive vegetation, particularly on the intermittently flooded floodplains, used for grazing;

- ephemeral aquatic production on the floodplains, that occurs only during flooding but is then a critical resource for water bird breeding (and probably for re-charging the fertility of these areas for subsequent terrestrial production);

- ephemeral aquatic production in the major terminal and side lakes, that are also essential for water birds and often identified as Ramsar or other significant wetlands;

- waterhole re-charge that produces an array of short to long-lived waterholes that also carry critical biodiversity (including invertebrates, fish, reptiles and more

waterbirds), as well as providing a focus for tourism and water supplies for the pastoral industry;

- unusual biota (both plants, like the iconic ribbons of red gums lining the dry riverbeds, and animals, like some fish species restricted to isolated mound springs) that depends specifically on ground water of one form or another, and is one of the drawcards for tourism into the region; and
- a number of these resources are also of specific significance to the maintenance of indigenous culture and practices.

In addition to these values, there is the availability of ground or surface water for stock dams, community water supplies, possible future agriculture and aquaculture developments.

Paul Anderson

Cornish Creek – Tributary Catchment Zone

Water and Land Uses

The Lake Eyre Basin supports a range of land uses.

- Pastoralism - which uses water directly from stock dams and bores. Stock also graze on the floodplain resources and have local but at times intensive impacts on accessible waterholes. Stock can be a significant vector for weeds, although most pastoralists are very aware of this. In the upper parts of the catchments, particularly, significant vegetation clearing is continuing, to open up country to introduced pastures. Pastoralists are also the main creators of informal roads and fence lines, which can have significant impacts on overland water flow
- Tourism, which is focused around waterholes in the region, where fishing and firewood collection can have significant impacts. The sustained aesthetic values and sense of remoteness, as well as specific attractions such as waterbird breeding sites, are important parts of the attraction for visitors

Figure 3: Key elements of the LEB water-related system.

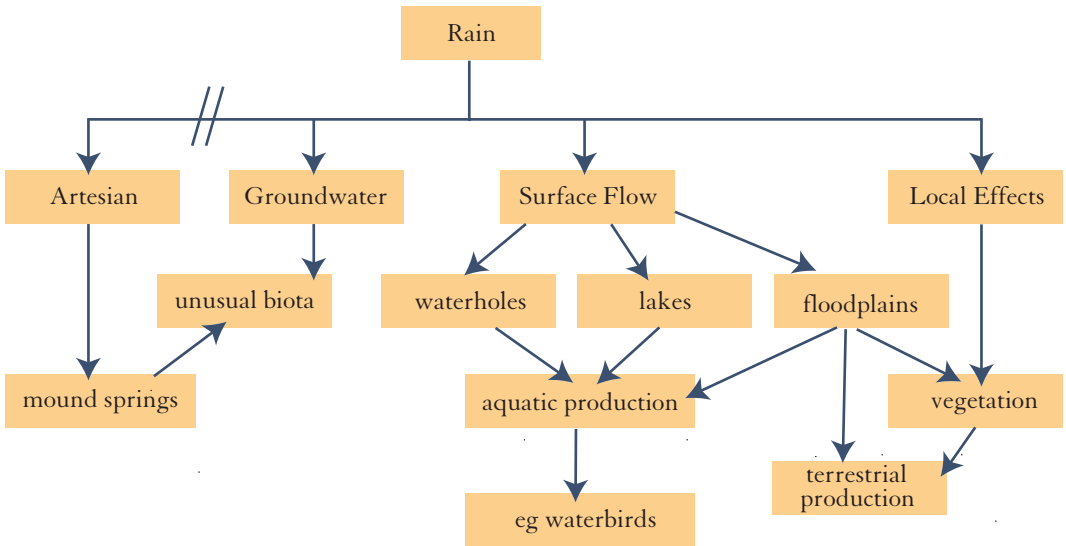
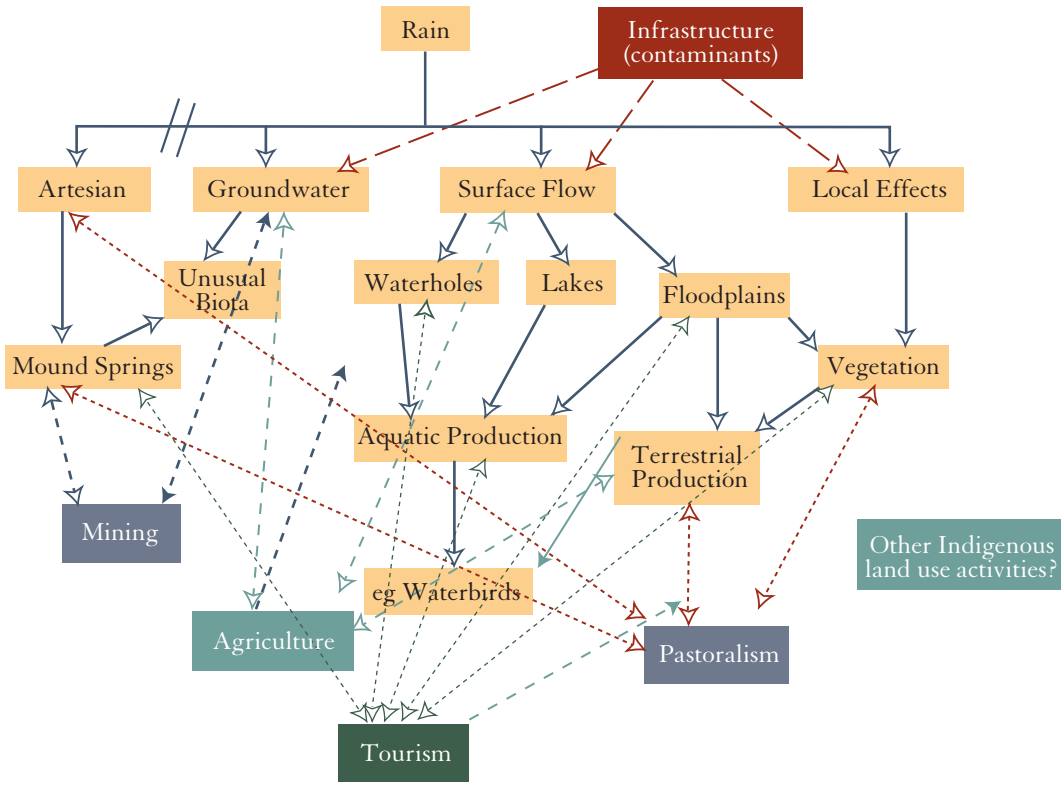


Figure 4: Effects of uses of the LEB water-related system.



- Mining, the physical impacts of which are mostly localised, except where use of groundwater draws down on a watertable. There have also been proposals to release surplus water from mining operations into rivers
- Agricultural development, which is still limited in the Basin, but there are likely to be an on-going series of proposals in the future. These usually propose to use significant water resources, and also, of course, may involve local vegetation clearing
- Aquaculture, which is a specific form of intensified production that could release nutrients and feral organisms if poorly managed
- Infrastructure development, which is driven by the needs of the above industries as well as access to conservation areas and indigenous communities, is another source of known and potential impacts. Most forms of infrastructure can have impacts on water flows, and some introduce risks of contamination from spills, etc.

Additionally, the Lake Eyre Basin is home to a number of small urban communities, which use water and are a principal local source of recreational activities. Some of these are aboriginal communities. Aboriginal people may engage in any of the above activities, but also value the Basin for other cultural reasons and undertake traditional and other activities that may have some effects on the system.

A Healthy Catchment?

It is impossible to talk of the vast arid zone catchment that is the Lake Eyre Basin without noting the importance that variability plays in sustaining its natural systems. The current low level of water resource development in the Basin allows it to function in a way that is globally unique. It is situated in a region with a particularly variable climate; it is that variability, rather than the average aridity, which provides its most special features. Variable systems experience extremes that allow some organisms (and management uses) to derive benefits that cannot be obtained from a steadier, average condition. For example, the ephemeral extremes of floodplain productivity in the Basin permit intermittent high levels of waterbird breeding which would not be possible in less variable systems. Such effects have real economic implications, in this case, being one of the reasons why tourists are attracted to the Basin.

In such a variable environment, when can we say the catchment is 'healthy'? It should be meeting the needs and goals of all its peoples, but of course people have a wide variety of different values and expectations. This can make setting targets difficult, not only for defining the level of health we want the Basin to have, but also how to also how to do this while maintaining socioeconomic vitality. There are trade-offs between different values, between environmental and economic outcomes, and between short and long term benefits.

There is no single, static 'ideal' condition, so our focus should be on taking a proactive rather than reactive approach to these trade-offs.

It is essential that good trade-off decisions towards a healthy Basin be informed by a good understanding of how the Basin functions.

Links to terrestrial environment

Dr Mark Stafford-Smith and
Dr Steve Morton

Introduction

This paper summarises the interactions between terrestrial and aquatic processes in the Lake Eyre Basin Agreement area focusing on biophysical processes rather than land use drivers and their implications.

Water and landscapes are intimately and systemically linked in the Lake Eyre Basin. Separating out specific interactions is therefore very artificial but helps to concentrate attention on what interactions are most important in different places or under different land uses.

Effects of aquatic systems on terrestrial processes

The direct effects of aquatic systems within the Basin are mainly restricted to adjacent landscapes, particularly floodplains. However changes in water tables and land use responses can create indirect effects across much larger areas of the catchment.

The key linkages here are:

- effects of flooding on floodplain terrestrial productivity,
  - for grazing eventually; but also some possible conservation or biodiversity value (ie. plant and animal diversity),
  - note that there are indirect effects on the 'back country' too, since lower floodplain grazing productivity could (at least in the short term) push more grazing pressure on non-riverine elements;
- effects of groundwater on vegetation, particularly the iconic river red gums down the river courses,
  - mounds springs also fall in this category, as would any other special zones such as any wetland terrestrial vegetation,
  - flooding may also have some significant effects on soil rejuvenation; and
- in relation to grazing and potentially cropping.

Effects of terrestrial system on aquatic processes

There are many ways in which changes to landscapes and landscape use may affect the aquatic systems, although how local changes compound to regional effects is poorly understood.

The terrestrial processes which may impact on aquatic processes include:

- effects of soil condition/infiltration, plant cover, and runoff parameters (gullying, etc) in catchments on overland flow quality and quantity, and on sediment loads into channels,

Paul Anderson

Cattle at Swanlea Station

- vegetation clearing, improved pasture planting, weed infestations, and grazing itself (whether domestic or feral/wild) all affect these parameters, directly and indirectly (eg. via changing vegetation composition). Weeds may also choke channels as well as affect overland flow,
- trampling by stock and any eutrophication effects in waterholes through defecation may also be factors;

- feral animals,
  - grazers may add to grazing/trampling effects,
  - predators may affect some aquatic faunas directly (fish, water birds?);

- pest control and other contaminant risks emerging from terrestrial systems may affect water quality,
  - grazing probably minor though widespread, mining focused though possibly intense, agriculture (including the uncertain effect of plague locust control) could be significant;

- tourism does locally affect vegetation with possible effects on flow regimes – removal of fire wood and trampling/informal tracks around waterholes, etc; this may be unimportant ecologically but very significant aesthetically; and
- direct use of water and waters,
  - for agricultural extraction as major diversions or smaller dams, or from bores,
  - also by tourists, mines, urban extraction, potential agricultural developments.

Scaling up

One of the most important problems with interactions in the Basin is the risk of "death by a thousand cuts". Many (not all!) of the interactions mentioned above are locally quite innocent, but if they happen everywhere can have massive emergent regional implications. This has been the problem with clearing in the Murray Darling Basin, just as water withdrawal, removal of riparian vegetation, or sedimentation of waterholes can all build from trivial local effects to major losses of values at a catchment scale. It thus becomes important to consider how these local interactions play out at broader scales.

River Gums at Arrabury Waterhole

Angus Emmott

Significant issues

Key catchment scale issues which require prioritising to determine whether there are research gaps to be filled, include:

- the effects of flooding on terrestrial productivity; and
- the effects of human (ie. vegetation change) and stock activity on infiltration and runoff.

These are likely to create the main concerns in terms of how to use or monitor the system. There may be special circumstances where other factors become critical locally.

Water Quality and Aquatic Ecosystem Health in the Lake Eyre Basin

Professor Stuart Bunn and
Professor Peter Cullen

Introduction

Measurement of the physical and chemical attributes of waterbodies has traditionally been used to define water quality, often with specific goals of setting criteria for stock and domestic use. However, there is growing acceptance that a more holistic approach to river health (ie. condition) assessment is required to adequately meet community expectations.

Ecosystem health is a relatively new field that brings together our biophysical understanding of how natural systems function with societal goals and human values (Rapport *et al*., 1998). Its central theme is the essential services provided by ecosystems that are vital to human welfare.

Water quality in the Lake Eyre Basin

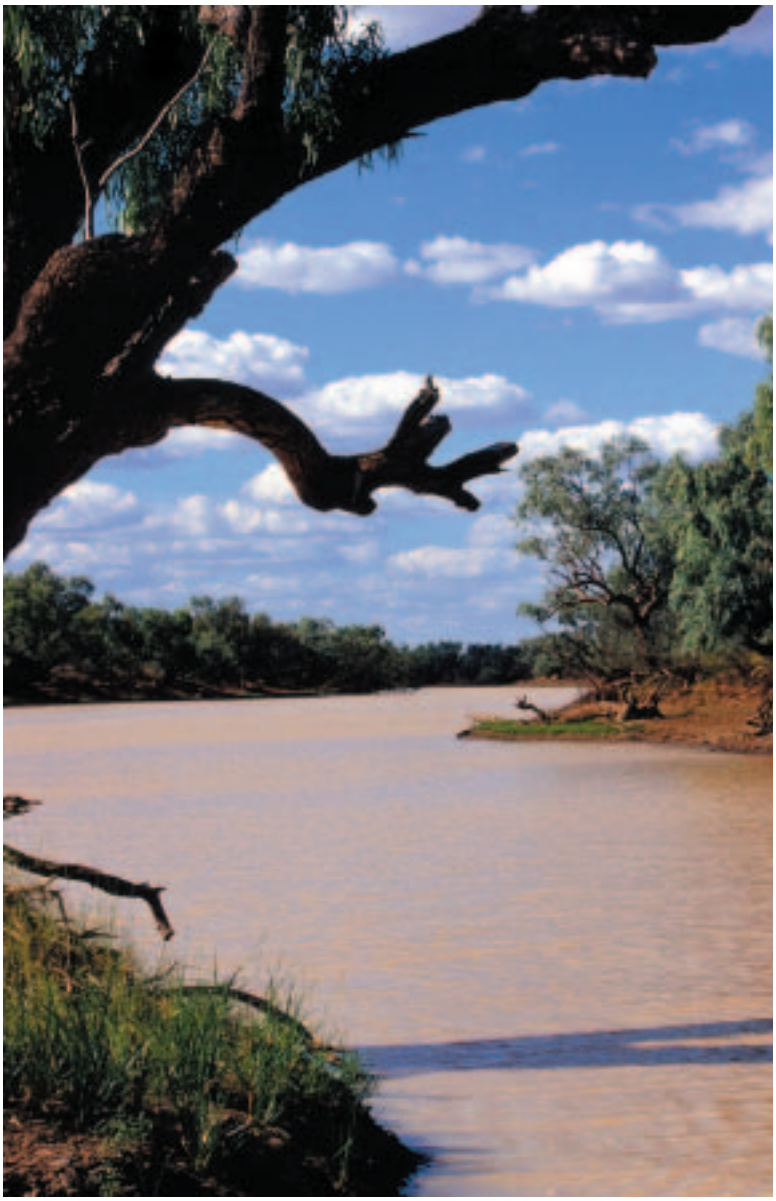
Several features of the Lake Eyre Basin give rise to marked differences in the physical and chemical attributes of surface water compared with the water quality of rivers and wetlands from more temperate systems. These include:

- the high temporal variability of flow and long duration of no-flow periods;
- the origin of rainfall and run-off within the catchments;
- high evaporation and transpiration rates;
- presence of shallow saline groundwaters; and
- the fine particle size distribution of the catchment sediments.

These factors in turn influence the structure and function of aquatic ecosystems and the quality of water for human use.

Waters of the Great Artesian Basin are also a significant feature of the Lake Eyre Basin, with a different origin (and age) to surface waters, and with quite distinct physical and chemical attributes. Water quality and ecosystem health attributes of groundwater and their dependent ecosystems (e.g. mound springs) need to be considered separately but not in isolation, as pressures on one can indirectly affect the health of the other.

Water quality in the Lake Eyre Basin is highly variable both temporally and spatially. This includes differences between the three broad functional zones of the river systems, for example, flood waters evapo-concentrate as their move down the system. There are also some marked differences among some of the catchments (e.g. the Neales and Finke are typically less turbid and more saline during low flows than the eastern catchments).



Angus Emmott

Thompson River

Turbidity

The fine-particle size of catchment sediments in much of the Lake Eyre Basin, means that surface water systems are naturally highly turbid and remain so even after extended periods of no flow (Note – levels would typically exceed ANZECC guidelines for surface waters in temperate Australia). Much of our information on spatial and temporal patterns in turbidity is based on local knowledge. The origins of runoff generated by rainfall events and the degree of floodplain vegetation cover both apparently influence the turbidity of floodwater and the resulting turbidity of waterholes. Intrusion of shallow saline groundwater or local run-off from saline wetlands can lead to marked decline in turbidity.

It is important to remember that turbidity is a major factor controlling the composition and production of algae (and other aquatic plants) in the rivers and wetlands of the Lake Eyre Basin. Accordingly, variations in turbidity have a major influence on ecosystem health (Bunn *et al*. 2003). Issues with respect to urban water supply include and effectiveness of treatment.

Salinity

There is considerable evapo-concentration of floodwaters as they move down the vast catchments of the Lake Eyre Basin. This results in significant increases in salinity, especially in the terminal ephemeral lake systems of the lower catchments. Saline wetlands and claypans are also widespread in the Basin and surface run-off from these catchments from local rainfall can lead to changes in river salinity.

Commonly, shallow groundwater is too saline for domestic use. With the exception of the western catchments of the Basin (e.g. Neales), there is little evidence of shallow (saline) groundwater inputs to waterholes.

Nutrients and algae

Some nutrient data are available for surface waters and suggest relative high concentrations of Nitrogen and Phosphorous. Much of this is likely to be associated with sediment particles and may not be readily bioavailable. Large populations of waterbirds periodically roost near particular waterholes. This can result in a significant increase in nutrients in these water bodies and is known to lead to algal blooms. Several species of blue-green algae occur in the phytoplankton of waterholes, however, we are not aware of any major outbreaks of toxic algae.

Human health indicators

Most properties draw domestic water directly from waterholes or rain tanks. Uncontrolled access of stock or feral animals (especially pigs) are a potential source of pathogens, as are waterbirds. Septic and sewage waste from small towns pose potential health risks unless appropriately managed.

Ecosystem health indicators

Some initial work has been undertaken to assess ecological measures of river health in the Basin. Given the low representation of aquatic insect groups in these rivers, standard AusRivAS assessments (Davies 1994) are likely to be inadequate on their own. Similarly, small numbers of native fish species and high temporal variability observed in populations may limit their utility as indicators. The low incidence of exotic species in Lake Eyre Basin rivers is one recognised indicator that these systems are in good health.

Threats to water quality of Lake Eyre Basin Rivers

Salinity

Given the climate and the presence of significant salt storage in most parts of the Lake Eyre Basin (in soils and shallow groundwater), salinisation of surface waters poses a significant threat. Potential drivers of change could include:

- extensive clearing of native vegetation in the upper catchments;
- rising groundwater levels associated with extensive irrigation;
- water harvesting and flow reduction;
- surface discharge of groundwater from oil drilling operations; and
- climate change.

Nutrients

Increasing nutrient inputs from rural towns has the potential to affect water quality at a local scale. However, this is probably insignificant on a catchment scale and especially compared with likely inputs from stock and feral animals.

What is a healthy dryland river?

There is general agreement in scientific circles that measures of ecosystem health should include aspects of organisation (e.g. biodiversity, species composition, food web structure), vigour (e.g. rates of production, nutrient cycling) and resilience (e.g. ability to recover from disturbance) (Rapport *et al*., 1998; Bunn & Davies, 2000).

Sediments and turbidity

Cumulative effects of vegetation change in the upper catchment, through direct clearing, fire and grazing pose significant threats to downstream reaches, through altered sediment regimes. Degradation of riparian vegetation due to grazing may lead to increased local erosion, and extensive use of waterholes by stock is also likely to influence re-suspension of sediments and turbidity. Increased salinity may reduce turbidity, increase light penetration and stimulate nuisance aquatic plant production.

Other contaminants

Intensive agriculture could introduce pesticides and herbicides into an area that is largely free of chemical contamination. The current widespread chemical control of the plague locust also poses a significant risk for aquatic ecosystem health.

Information needs

We have a very limited database on basic water quality in the Lake Eyre Basin. For both surface and groundwater systems, current ANZECC guidelines for water quality are likely to be inadequate and development of regionally relevant guidelines is a priority.

We currently lack a defensible and robust monitoring program to assess ecosystem health of rivers and groundwater dependent systems in the Lake Eyre Basin. Practical and cost-effective indicators of aquatic ecosystem health will be developed as part of the Lake Eyre Basin Rivers Assessment Program.

People and the Basin

Professor Geoff Lawrence

Introduction

Managing land, water and wildlife is as much a social issue as it is an economic or environmental one, particularly when the natural resource is limited, unreliable or both. Long-term management requires community agreement on the values, an understanding of existing problems and agreement on what to do about them. Some groups will be prepared to take responsibility and action. Any community-based project needs:

- clear goals;
- commitment;
- time;
- good relationships (trust);
- acceptance of cultural differences;
- representation of interests;
- skills and training; and
- opportunities for personal growth.

Given these principles and the considerable work that has already been undertaken by people with an interest in Lake Eyre Basin, what are the main social issues concerning the management of natural resources in the Basin?

Community meeting at Oodnadatta

Understanding interest groups and broader community values

The Lake Eyre Basin community is planning for sustainability. But communities are made up of mixed interests, often with quite dissimilar views about what changes are required, how improvements might be achieved, in what areas, and over what time. Is it possible to identify the sorts of values that the Basin community holds strongly and that might underpin future decision-making?

Alongside graziers and government officials, important new voices are being heard in regional decision-making – tourist operators, Indigenous groups, mining companies and environmental groups. These new players may have different values. The challenge is to reinforce the shared values and ideals, and find ways of balancing conflicts.

Some of the core values that have emerged in planning exercises include:

- appreciation of the worth of objective scientific research;
- the sustainable use of natural resources;
- conserving the biological uniqueness of the Basin;
- inclusiveness in decision-making;
- openness and honesty;
- empowerment of community groups;
- more knowledge of the impacts of human activity on the Basin; and
- simultaneously achieving vibrant communities, viable industries and environmental security.

There is also strong agreement on the ways forward. For example, it has already been agreed that an integrated planning approach be undertaken for the whole catchment; that there be fair representation across the Basin; that all natural resources (not only water) should be part of any long-term planning; and that community-based action address such things as soil, vegetation and water problems, biological diversity concerns, information management and networking.

Different aspirations can cause conflict that reduces the trust necessary to make decisions. Groups will need to articulate their positions, understand and empathise with other groups. Conflicts can be minimised through a better understanding of values and through workshops designed to revisit, rank and reinforce the long-term needs of the Basin and its inhabitants. Catchment management strategies will be a negotiated compromise.

Promoting community engagement

Community engagement is about citizen participation. In any society there will be groups which take an active role in decision-making, others which do so only at particular times and others which are reluctant to participate. Long-term harmonious outcomes do not emerge if participation is by a few active groups. Other, more marginal, groups need to be given a voice in decision-making. How is this to be achieved? Some groups do not have the power to get their views across. They may not have access to the human or financial resources to promote their views. Others do not have the time – especially where travel is either physically demanding, or costly and time-consuming, as it is in an area as vast as the Lake Eyre Basin. It is important to ensure that all

major interest groups are represented on decision-making bodies. Continuous engagement helps build trust. If – as is often the case with voluntary participation – commitment is limited by the cost or time of travel, then means must be found of ensuring representation, including the possible introduction of sitting fees or other incentives.

The capacity of communities to make decisions about their futures is achieved through fostering ownership of ideas and problems. Basin inhabitants need to feel that they belong to the catchment and that their activities will affect its environmental well-being; there are sustainability challenges and they must meet them. Community-based education and communication is important. The difficulty is that the Basin is not a small contained catchment, such as some of Australia's coastal catchments. It is vast, with low population density and a complex set of administrative borders and rules. Is it possible to connect those in the Georgina-Diamantina with those in the Western Rivers, or those from the Desert Rivers region with those from the southern region? The decision to build upon the knowledge and expertise that is located in the five catchments within the Basin is an excellent means of ensuring ownership at the local level. But the danger is that catchment plans might – in perhaps unintended ways – ignore whole-of-Basin issues. The development of a Basin-wide regional information service is one means of ensuring that information about the entire Basin is made available as a basis for improved decision-making. The latter might be highly desirable if the Lake Eyre Basin is to become a learning community.

There are at least eight important elements in effective relationships among those involved in natural resource management:

- awareness of problems, as well as vision and commitment;
- cooperative and team behaviour;
- the sharing of resources and outcomes;
- sound and effective consultation and communication;
- good meeting practices, governance and power structures;
- ownership of problems by the community;
- management ability and technical competence; and
- adequate support structures.

Managing cultural heritage

The Lake Eyre Basin is rich in history. Indigenous peoples have managed the resources of the Basin for at least 20–40,000 years. White explorers such as Eyre, Sturt, Burke and Wills have become famous for their attempts to find an inland sea, while the Duracks and Kidman helped to built the northern beef industry. The Birdsville track, along with the Birdsville races, are popular in the Australian imagination, and towns in the Basin (Longreach, Oodnadatta, Innamincka, Alice Springs and Winton – the latter claiming to be the birthplace of QANTAS and *Waltzing Matilda*) are famous in Australian folk history.

Buildings, industries, ideas and human activities are part of the area's cultural heritage. At a time in which Australians and overseas visitors are looking for authenticity and cultural experiences in tourism, the outback can gain an advantage if it preserves its cultural heritage. Tourism is a positive development in the Basin. Yet, there is already evidence that the impact of tourism on waterholes is causing environmental degradation. In the area of Aboriginal tourism much more could be done to ensure that

Aboriginal heritage remains protected. Aboriginal people could obtain better outcomes (including increased income from tourism and the sale of artifacts) and young Aboriginal people could receive training in the tourist, recreation, leisure and hospitality industries.

What constitutes Indigenous natural resource management? How can the ideas and insights of Aboriginal people be harnessed for better management of natural resources? The issue of land rights is central to the future of indigenous peoples of the Basin. The rights and responsibilities of those owning or leasing property must be considered when planning natural resource management. Who is responsible for doing what? Sustainable development in the Basin is subject to interpretations of laws, customs, power and knowledge.

Fostering institutional arrangements

The success of community-based natural resource management will depend on government support. The regional basis for catchment management cuts across local, state and federal boundaries and potentially challenges current structures of government. The Lake Eyre Basin is in three States and one Territory. Some say the regional approach goes beyond present legal structures and creates a fourth tier of government. Yet, the catchment and Basin levels are the most appropriate for natural resource management. Government can 'come behind' communities to:

- promote community understanding of the need for regional approaches to land and water management;
- encourage active participation in decision-making at the regional level, and support individual leadership;
- provide long-term legislative support for regional approaches – well beyond the life of any single parliament; and
- ensure that sufficient funds are made available to support the new regional structures – including funds for major works aimed at stemming environmental degradation and improving degraded lands.

Governance is ultimately about the acceptance – by community members and governments – of new processes of decision-making, and new interactions between people and governments. Civic engagement in rural Australia is no longer based upon the efforts of local governments. The main questions are: How can local governments combine to take on a more forceful role in natural resource management? How can the other new regional structures be enhanced? What social and institutional barriers prevent more effective decision-making? How can those barriers be removed? What constitutes the best means of community engagement?

Ensuring sustainable management

Land, water and wildlife management cannot be based on any straightforward scientific assessment of environmental problems. Natural resource issues are complex. There are connections between the environment, economic pursuits and social desires and needs that go far beyond scientific evaluation. Similarly, in geographical terms, what might be beneficial for upstream interests might not benefit those downstream. Science can

Paul Anderson

Scientific Advisory Panel Fieldtrip – Lake Galilee

contribute to decisions about such issues by showing how actions in one location can affect those in another. But science must be in partnership with communities – researching those communities' concerns and listening to local people. A strongly held value of Basin people is to respect and use local knowledge.

How do we implement desired change? Government involvement in identifying problems and funding change is widely accepted. But communities must be able to direct such funding into priority areas – without top-down control. Calculating the best mix of public and private interaction and investment is a crucial issue. There will need to be planning workshops, negotiated discussions and monitoring of actions taken. Lake Eyre Basin community leaders can help to ensure that governments and communities collaborate, and that the wider Basin community understands the partnership.

Given the sparse population and small settlements of the Lake Eyre Basin, how can services best be delivered in an efficient and fair way? How can all citizens of the Basin build sustainable livelihoods? Answers to these questions will be crucial to the future supply of energy, enthusiasm and commitment for natural resource management.

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