RIPRAP
RIVER AND RIPARIAN LANDS MANAGEMENT NEWSLETTER

What are Ecosystem Services?

The functioning of natural ecosystems provide 'services' that are essential for human health and survival. Examples of the kinds of services we receive from nature include water filtration, maintenance of soil fertility, pollination, pest control, and cultural and spiritual stimulation. Despite receiving these benefits, however, the ecosystems that deliver them in Australia are in decline. We need look no further than the growing salinity problems, water quality issues, continuing tree clearing and increasing greenhouse gas emissions to see that many ecosystems are unable to function successfully.

The concept of ecosystem services has been seen as one way to address these issues. Instead of asking what do we have to give up in order to have a healthy environment, we ask the question, what do we have to gain by maintaining ecosystem function? This includes asking who benefits from the delivery of ecosystem services? and how can costs and benefits be fairly shared?

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RIPArian lands:

WHERE LAND AND WATER MEET

From the Editor

Welcome to our first edition of 2002! This edition is focusing on a much talked about, but possibly less well understood topic — Ecosystem Services. By working with Steve Cork and his Ecosystem Services Project Team, we have pulled together an edition of *RipRap* that provides an overview of what ecosystem services are all about, how different researchers are approaching the topic, and what projects are currently underway in Australia and overseas. I am sure you will find it extremely interesting, and a useful *RipRap* to 'dip into' whenever someone starts talking about ecosystem services and what it means to them. We also have plenty of information about upcoming courses, new publications and events. The Land & Water Australia **Rivers Forum** flyer is included and I hope you will be able to make what promises to be an interesting, fun and exciting event. If you want extra copies of the **Rivers Forum** flyer please do not hesitate to contact me. I hope you enjoy this edition, and I look forward to seeing you at the **Rivers Forum** in March 2002!!

What are Ecosystem Services?

(continued from page 1)

By Steve Cork

The concept of Ecosystem Services has been developing slowly around the world since about the 1950s. Over this time, ecologists have thought and written a lot about how nature is organised. This led to the concept of ecosystems, which are suites of living things (plants, animals, fungi, bacteria and others) interacting with one another and with their surrounding non-living environments. These interactions perform functions and produce outcomes that are above and beyond what would come from the species separately — the whole is greater than the sum of the parts.

Ecosystems exist everywhere — in wilderness areas, national parks, agricultural fields, suburban parks and gardens, and even (in a very limited way) on your kitchen table. Ecosystems are always changing, which makes it pointless to be too dogmatic about what is a "natural" state. However, we expect that the more an ecosystem is simplified by human activities, the fewer functions it will perform. Ecologists debate the extent to which humans and their activities should be considered as "natural" parts of ecosystems.

The concept of 'services' arose to acknowledge the reliance of people on ecosystems. Ecosystems perform functions that allow humans to live on earth and fulfil our lives in a variety of ways. The air we breathe and the temperature of the earth are maintained within the limits for human life by plants. The plants, animals, fungi and micro-organisms that make up soil ecosystems filter particles out of water and remove many toxic and disease-causing compounds and organisms. Soil and plant systems also absorb the wastes produced by humans. Plants in forests, grasslands and other systems protect us from floods and provide habitat for species that control pests, pollinate crops, and maintain the diversity of life that we value for its existence and for the recreational, cultural, spiritual and intellectual stimulation that it provides. And, of course, ecosystems are where our food, our fibre, our pharmaceuticals and most of our building materials come from.

The word 'service' has so many meanings in our modern world. It literally means "providing a benefit, doing a good turn, transforming raw materials into a valuable product". Ecosystems take natural assets like soil, water, air and living species and produce products that people benefit from and value in many ways, including financially.

But people are important in the delivery of ecosystem services too. People like farmers manage ecosystems and hence play a key role in sustaining and fulfilling human life. In the past, the role of land managers in providing food and fibre was recognised, but this is now expanding so that their roles in maintaining air and water quality, climate, flood protection, healthy rivers, pest control, pollination, biodiversity, and cultural, spiritual and intellectual values is also being recognised.

What are Ecosystem Services?

The concept of Ecosystem Services gives us a basis for discussing what benefits come from the environment, how our activities affect those services, who benefits from ecosystem services, who helps to provide them, and how we might fairly share both the costs and benefits of managing the environment in a variety of ways.

Why are ecosystem services getting so much attention?

At present, there are major initiatives on ecosystem services on every continent on the globe (although sometimes they go under a different name like "Multifunctional Landscapes", which is the term used in Europe). Some of these are reported in this issue of *RipRap* (see It's a Wrap pages 36–39). These initiatives are responses to a number of trends that emerged in the last few decades of last century.

There has been increasing evidence from national and international studies, that the world's ecosystems are changing dramatically under pressure from growing human populations and high levels of consumption of natural resources. The World Resources Institute in Washington DC, for example, concluded in 2000 that "If current trends continue, humanity will dramatically alter or destroy virtually all of the Earth's natural ecosystems within a few decades".

These studies have shown that declining ecosystems are affecting people in terms of their supplies of food and water, living conditions, and physical and mental health, as well as threatening many of the others species that we feel responsibility for. There has been gradual recognition that these declines are being encouraged by a lack of understanding, at all levels of decision making, of the benefits and value of well functioning ecosystems. This lack of recognition is coupled with the fact that most of the services from ecosystems do not pass through markets and, as a result, don't automatically get valued economically.

Putting all this together, it is clear that we need to rethink some of the world's land-use practices. For this to happen, we need language and concepts that don't require a science or economics degree, and which allow all members of society to participate in working out the outcomes they want from their relationships with nature. The general public are often overlooked as the biggest group of consumers and voters whose opinions and attitudes influence the value placed on the environment in decision making. Yet, to date, there have been few cases where they have been engaged in discussions about the value of ecosystems, this is because it has usually been carried out in technical, jargon-rich language and concepts. All of society needs to be involved in asking when and how it might benefit society to change land-uses that currently deliver benefits like food, housing, manufactured goods, and economic wealth to people. And if changes are to be made, we need to have a fair way to share both the costs and benefits of the changes.

The concept of ecosystem services has been seen as one way to address these issues. The concept of service is familiar to all people. Scientists and economists have worked with communities to break free of the jargon usually associated with valuation and ecosystem science, and to simplify the huge complexity of ecosystems into around 15 major services that most people can understand and appreciate without specialist knowledge (see Figure 1).

"If current trends continue, humanity will dramatically alter or destroy virtually all of the Earth's natural ecosystems within a few decades."

This provides a basis for describing the consequences of ecosystem change in terms that mean something to all consumers and voters. It asks who benefits from these services and how costs and benefits can be fairly shared, and provides a basis for developing incentives, including new markets, to encourage investment in natural resource management that has greater overall benefit for communities and society generally.

What are ECOSYSTEM SERVICES?

Figure 1: One categorisation of ecosystem services from Gretchen Daily at Stanford University

Production of goods
Food: Terrestrial animal and plant products, forage, seafood, spice
Pharmaceuticals: Medicines, precursors to synthetic drugs
Durable materials: Natural fibre, timber
Energy: Biomass fuels, low-sediment water for hydropower
Industrial products: Waxes, oils, fragrances, dyes, latex, rubber, precursors to many synthetic products
Genetic resources: The basis for the production of other goods

Regeneration processes
Cycling and filtration processes: Detoxification and decomposition of wastes, renewal of soil fertility, purification of air and water
Translocation processes: Dispersal of seeds necessary for revegetation, pollination of crops and native vegetation

Stabilising processes
Coastal and river channel stability, compensation and substitution of one species for another when environments vary, control of the majority of potential pest species, moderation of weather extremes (such as temperature and wind), partial stabilisation of climate, regulation of the hydrological cycle (mitigation of floods, droughts, salinity)

Life-fulfilling functions
Aesthetic beauty, cultural, intellectual, and spiritual inspiration, existence value, scientific discovery, serenity

Preservation of options
Maintenance of ecological components and systems needed for the future, supply of goods and services awaiting discovery

Putting it into practice

It all sounds good in theory, but putting it into practice is another thing. Four big challenges that we are facing in Australia at present are:

- Finding ways to describe and communicate the concept of ecosystem services that are truly understandable to a wide range of people with different backgrounds, attitudes and values.
- Finding meaningful ways to measure the value of ecosystem services.
- Bringing science to bear so that we can explore and predict impacts of human activities on ecosystem services and identify opportunities for better relationships with nature.
- Devising better regulations, incentives and markets to encourage wise use of ecosystem services.

These challenges are being addressed by a number of studies around Australia that are cooperating under the banner of the Ecosystem Services Project. The Australian initiative also has strong links with initiatives in the USA, Sweden, New Zealand and South Africa. Many of the insights discussed in the following sections come from lessons learned from the Australian studies.

Developing the concept of ecosystem services

To develop the concept of ecosystem services so it is useful to community-based decision makers, the Ecosystem Services Group within CSIRO initiated a partnership with stakeholders in the Goulburn Broken Catchment in Victoria. Together, we have discussed the concept and its application to this catchment. With input from stakeholders and technical experts, we carried out an inventory of ecosystem services in the catchment, identifying which ones are important for which land uses, and which ones are some critical point that requires further investigation with greater scientific rigour. This inventory developed a diagrammatic explanation of ecosystem services (see following page).

It was important that the community developed their own list of ecosystem services, and this differed slightly from lists developed in other studies such as the one cited above. This is an important element of the interaction between scientists and community, in that the concept has to be relevant to the people receiving the services, rather than to the scientists with the theory.

Participants in this initiative include

Centre for Agricultural and Regional Economics Inc., Cotton CRC, CSIRO, Department of Land and Water Conservation (NSW), Emu Creek Catchment Association (Qld), Gwydir Valley Irrigators (NSW), Land and Water Australia, The Myer Foundation, Natural Resources and Environment (Vic), Onkaparinga Catchment Board (SA), Department of Natural Resources and Mining (Qld), National Parks and Wildlife Service (Qld), Rainforest CRC, The Goulburn Broken Catchment Management Authority (VIC), University of New England (NSW), University of Southern Queensland.

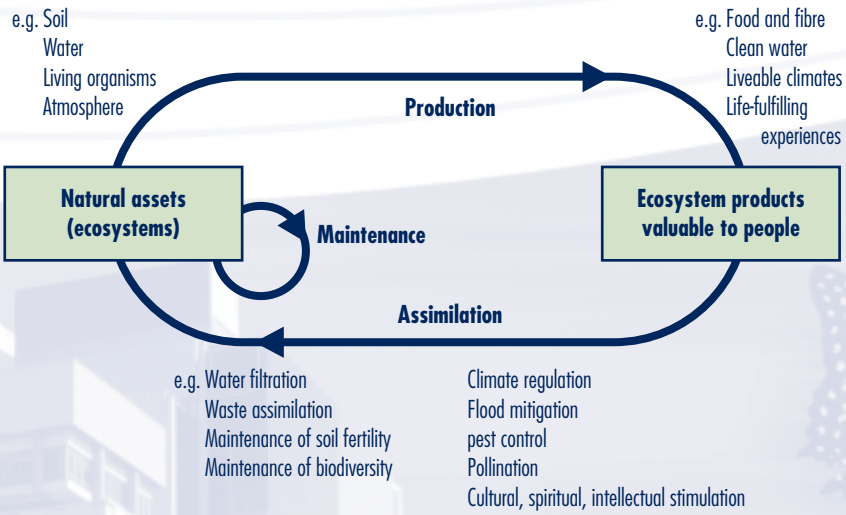

***Figure 2**: Scientists and community representatives worked together to develop this scheme to explain ecosystem services. The services emerge from transformations of natural assets into products (production services), or transformation of end products of production back into natural assets (assimilation services) or internal transformations that maintain natural assets (maintenance services).*

A full report on the inventory can be obtained by ordering or downloading from our web site (www.ecosystemservicesproject.org). There is an article on the Goulburn Broken work on page 34 of It's a Wrap.

The issue of value

In 1998, a group of ecologists and economists from around the world published a provocative article in the scientific journal Nature that estimated the value of the world's ecosystems at $33 trillion, or nearly twice the world's Gross National Product. Their central message was that the world undervalues its ecosystems and that replacing them would costs a lot more than all the money that is available. The article caused a furore. Some commentators questioned the methods used. Others questioned whether such an exercise was morally justifiable. Others suggested that the real value of the world's ecosystems is beyond measurement (because we cannot live without them) and that the authors had merely underestimated infinity.

This example illustrates some of the complexity and disagreement that has emerged as people recognise that Ecosystem Services are important to humans and try to measure that importance in economic terms. The issues that are currently being debated around the world include:

- What the word 'value' really means.
- How to measure the economic value of goods and services that do not pass through markets.
- Whether it is possible or even desirable to measure everything in economic terms.
- The need to recognise the true costs of replacing ecosystem services with technological alternatives *before* making the replacement.
- The fact that value depends on situations and people's knowledge and attitudes.

Economics text books devote whole chapters to defining and measuring economic value. At the simplest level, the value of anything is determined by people's needs, desires and attitudes. Economic value is measured in relation to what people are willing to pay to receive a good or service that they already have, or what they will accept as compensation for losing a good or service that they already have. The most straightforward way to measure willingness to pay is in markets, but many things that are valuable don't pass through markets. Many ecosystem services fall into this category. We don't, for example, buy and sell the air that we breathe. However, many ecosystem services have some connection to markets and this is how economists can estimate the economic value of those services. Water rights are bought and sold, which gives one estimate of people's willingness to pay. People pay to travel to natural places and will pay entrance fees. This gives an estimate of people's willingness to pay for access to ecosystems that provide cultural, spiritual and intellectual fulfilment. Properties with views of water or forests fetch higher prices than properties without views — the difference is an estimate of willingness to pay for the view.

Another way to estimate what people are willing to pay for ecosystem services, is to ask them either directly or through questionnaires designed to reveal their preferences. For example, if asked to choose between two scenarios that differ in terms of jobs and endangered species protected, you will in theory reveal your willingness to pay for the species by how willing you are to trade off jobs against them. This is an important distinction because the price of many ecosystem services might be very small under circumstances where they are abundant, but this does not mean their value to humans is also very low.

Two issues complicate the estimation of the value of ecosystem services. One is that what people are willing to pay is determined by their need and desires and their attitudes, all of which are influenced by the legal, economic and social systems they live in and by their level of understanding about what benefits they get from the environment. The second complicating issue is that price with value often get confused. Price is what people pay in markets and is set at a level that will attract an acceptable number of buyers. Value to society is the difference between price and what consumers overall would have been prepared to pay (this is called consumer surplus). To measure value in this way for ecosystem services is very difficult, because we need information on what people would be willing to pay as the service gets rarer, and such information usually is not available. For ecosystem services that are essential for life, you can imagine people's willingness to pay would rise rapidly as the service became rare, leading to very high values. Thus, diamonds fetch a higher price than water, because of their immediate rarity, but water has a greater value to society.

The most talked about way to estimate the value of ecosystem services is to ask what it would cost to replace them. The most celebrated example of replacement costs is the case of New York City. This city was faced with a water quality problem and compared the cost of building a new water filtration facility, with the cost of repairing and protecting the natural areas in the mountains where the water came from so that the water would be adequately filtered by ecosystem services. The cost was $8–10 billion for the facility versus less than $2 million for the catchment repair. In Canberra, it costs 10 times as much to filter water from a mostly cleared catchment than from another catchment that retains more forests. Melbourne already benefits from having protected its catchment forests many years ago. Sydney is currently considering the benefits of better management of native vegetation in its catchments. Adelaide struggles with water quality due to the impacts of land clearance in the Murray Darling Basin.

These are but of few of the many examples emerging from a focus on the importance and value of ecosystem services. Insights like those discussed above cannot be captured readily in a single number, even one as large as $33 trillion. Value needs to be considered in the context of challenges and decisions that people face now and in the future.

Bringing science to bear

It has been said that studies attempting to value the environment in the past have had limited success due to difficulties in producing convincing estimates of the value of non-market goods and services. In addition, the ecological data has not been good enough to answer the questions posed by economists and decision-makers. Various attempts have been made to develop mathematical models of ecosystem function but these have had limited use because there simply is not enough knowledge to allow us to model whole ecosystems with precision and reliability, and building models to answer any

Providing an Ecosystem Service — Pollinators

Firstly, much of our food comes from crops that require pollination by insects, birds or other animals. These pollinators are declining world wide due to loss of habitat and over use of pesticides. Honey bees have taken their place in many areas. It was once unthinkable that a farmer would pay anything for pollination services, as they just happened. Now farmers in many parts of the world pay large prices to purchase the services of bee-keepers to pollinate their crops. This illustrates how an ecosystem services can take on value because circumstances change. But what would society be prepared to pay to keep pollinators if honey bees were wiped out and numbers of other pollinators fell to the point that crops failed, garden plants were no longer able to reproduce and the forests and grasslands that provide recreation for people and homes for wild species were seriously affected? This is a question we may well have to face in parts of the world very soon as honey bees are being attacked by diseases and rates of pollination of native vegetation is declining substantially.

ECOSYSTEM SERVICES PROJECT

THE ECOSYSTEM SERVICES PROJECT IS A PARTNERSHIP BETWEEN THE FOLLOWING ORGANISATIONS:

THE MYER FOUNDATION
The Sidney Myer Centenary Celebration 1899–1999

75 years of Australian Science CSIRO

Land & Water AUSTRALIA research · development · innovation

The University of New England AUSTRALIA

Cotton CRC

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

Rainforest CRC

RIRDC
RURAL INDUSTRIES RESEARCH AND DEVELOPMENT CORPORATION

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and all questions never works. Another reason why ecological-economic studies have failed in the past is that they have not involved the key decision-makers in the process of the studies, and, as a result have often answered different questions to the ones being asked by those who are faced with making the decisions.

The approach being developed and tested in The Ecosystem Services Project builds on lessons learned by past studies, and on the wisdom of advisors around Australia and elsewhere in the world. It involves stakeholders at community, region, state and national levels in the design and carrying out of the studies. The first stage involving these stakeholders focuses on clarifying the concept of ecosystem services and developing an inventory of what services exist in the study area. Those services that are critical for further study are then identified. This is the start towards bringing science to bear effectively. The next stage is identification of future options, or scenarios, for the study area and the decisions and questions that need to be addressed. This then makes it very clear what scientific analysis is needed and makes the job of modelling easier and more achievable. We can use models to *explore* what *might* happen, and to identify where critical knowledge gaps exist and where investment in research would likely pay off. It is important that the scientific analyses are done with consideration of the economic and social systems that the ecosystems interact with. Examples of how scenarios can be developed and scientific models applied to these are given in other articles in this edition of *RipRap*.

Devising better regulations, incentives and markets to encourage wise use of ecosystem services

The concept of ecosystem services sets us up for considering fair ways to share costs and benefits of environmental management and provides a basis for establishing markets in ecosystem services. The idea of establishing markets is to get investment by those who benefit from ecosystem services in their protection. The market for carbon credits, for example, is based on the ecosystem services that plants provide in regulating the concentration of carbon dioxide in the atmosphere. As concentrations of carbon dioxide rise, more heat is trapped in the atmosphere and climate changes. If we accept that the ecosystem service of regulation of carbon dioxide is "owned" by all people, and that stability of climate is a right for society, then industries that add carbon to the atmosphere should be required to take steps to limit the impacts of their emissions. Creating the rules that allow these industries to offset their emissions by planting trees benefits them, as this is cheaper than technological alternatives, and benefits society as a whole. A similar argument has been made for establishing markets for water quality, salinity control, maintaining soil health, and biodiversity.

There are a few critical requirements for markets to establish and maintain a good mix of ecosystem services. We must be able to measure increases or declines in ecosystem services to be able to establish the return on investment. We must be able to develop rules to establish limits below which society does not want ecosystem services to fall. Because price paid in markets is intimately related to rarity, prices will rise as ecosystem services approach these limits and fall as they improve above them. The

biggest challenge is to establish institutions that encourage investment in "bundles" of ecosystem services rather than individual ones. Approaches to resolving these issues are discussed elsewhere in the edition of *RipRap*.

Putting it all together — ecosystem services analysis

The alliance of groups making up the Ecosystem Services Project have discussed a framework for bringing together all of the issues discussed in this article. This framework includes stakeholder partnerships, inventory, scenario development, ecological, social, and economic analyses, and attempts to provide the information needed to develop markets for ecosystem services (Figure 3). The framework is being tested to one degree or another in eight case studies around Australia (Figure 4), but most comprehensively in the Goulburn Broken Catchment in Victoria.

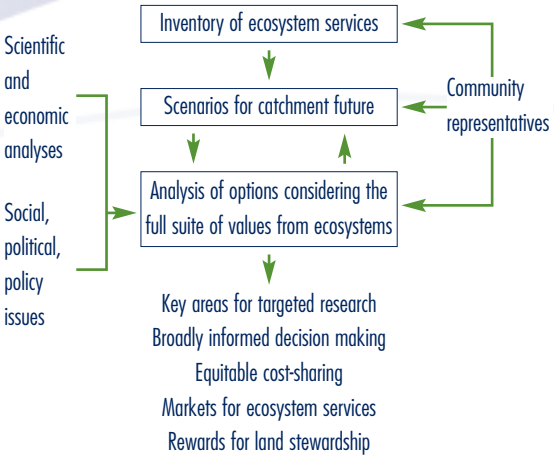


***Figure 3**: Framework for ecosystem services analysis*

***Figure 4**: Location of studies cooperating in the Ecosystem Services Project*

NEW Publication

Guidelines for Protecting Australian Rivers

Recognising the need to improve the protection and management of Australian waterways and floodplains, the National Rivers Consortium commissioned the Queensland Environmental Protection Agency and Montgomery Watson Harza to develop a set of *Guidelines for Protecting Australian Rivers*. Principal investigators for the project were Mr John Bennett, Mr Norrie Sanders, Mr Dane Moulton, Dr Ngaire Phillips, Dr George Lukacs, Associate Professor Keith Walker and Ms Fiona Redfern.

The Guidelines were designed to be applicable to all Australian rivers, in all conditions (from degraded through natural), and are intended for use by governments, developers/consultants and the community. They have been designed to provide:

- a conceptual framework overarching four separate guidelines for assessing ecological value, ecological sustainability, planning for river protection, and evaluating development proposals.
- a systematic approach to conservation management of Australian waterways.
- government agencies and proponents with tools and techniques for identifying and assessing the ecological and physical sustainability of water resource developments.
- proponents with greater planning certainty about the capacity of land and water systems to sustain development.
- a basis for data collection and research to inform decisions about development and management.

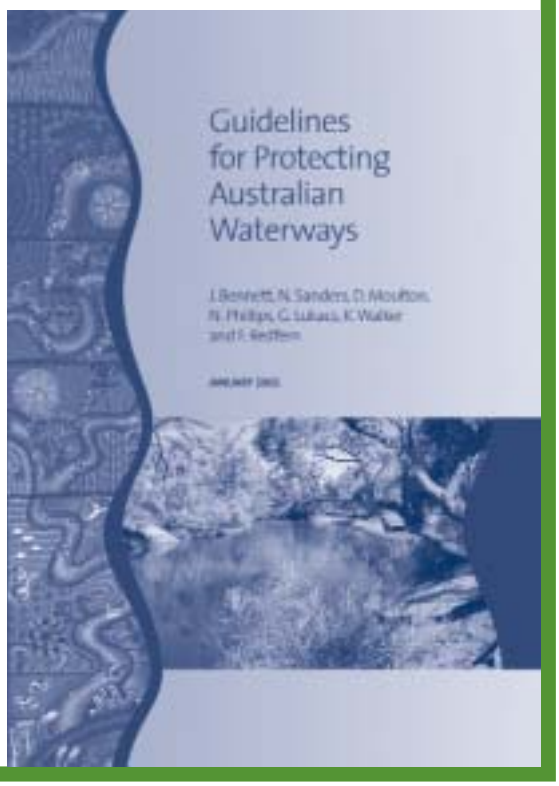
Copies of the Guidelines are available through

Canprint Communications on 02 6295 4444 or

Freecall 1800 776 616

and on our website at

rivers.gov.au



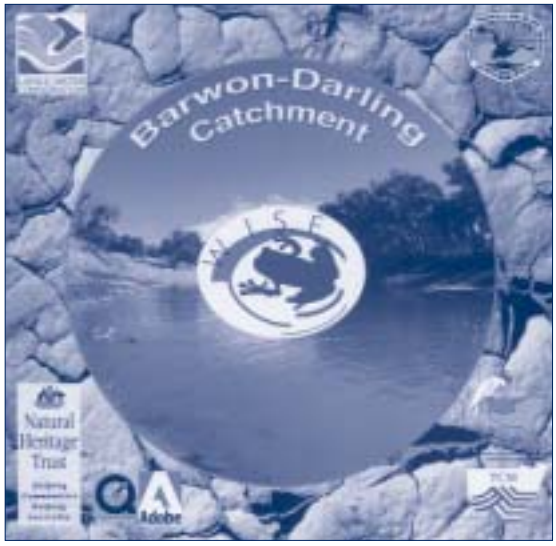
A WISE CD with a flood of information!!

Dr Richard Kingsford, along with his team at New South Wales National Parks and Wildlife, have produced an innovative software package for managing information on water for an entire catchment — WISE (Water Information System for the Environment). WISE is a catalogue of everything published on water in a catchment — this means that the catchment's wetlands, estuaries, rivers and creeks are covered, as well as information being provided about the catchment itself.

WISE does two essential things. It links publications to a particular location so that people can find out what is known about a wetland, creek, river or catchment in that area. It also 'captures' all of the information in a publication. Users can select a river or wetland and produce a list of all publicly available material that has information about that wetland. The software covers issues ranging from water quality and quantity, flora and fauna, through to the cultural values of rivers. Users can also choose one of these areas of interest and get specific information about that topic in relation to a particular wetland or river.

Community groups have welcomed the project as it provides a useful way of breaking down the barriers to scientific communication. Various community groups in the catchments were involved in developing each database through workshops, interviews and contributions of photos, videos and other material. Much of the information in the 'front-end' of the CD, for example, the catchment picture, animation and photographs has been produced through direct input from people saying how they wanted the material presented so that it was meaningful to them and their community.

The multimedia part of WISE allows people to 'see' the catchment. In the Macquarie-Bogan database you can go on a canoe trip down the catchment through animation and 'visit' various parts of the river. The Barwon-Darling CD contains a hydrology



animation of the sources of the water in the river. WISE also has more than 100 photographs of the catchment along with oral histories, video clips and other sound files. A catchment map allows you to see which towns and rivers make up the catchment and get some basic information for each.

The whole emphasis of the project has been to raise public awareness about issues of river management and ensure that communities, government and individuals are more informed about the management of our water. This database will provide these groups with the most up-to-date information for better and more informed decision making. Most importantly we now have a highly successful project where the resources and methodology can be applied to any catchment in the country.

The CD-ROMs are currently being used in schools and have considerably more potential for use at all levels of education. A project is now underway to put WISE on the Internet. CD-ROMs are available for the Macquarie-Bogan, Barwon-Darling, Namoi and Hacking River catchments. Databases for the Paroo, Warrego, Gwydir and Lower Darling will be available in 2002 and for the Illawarra, Castlereagh and Cooper in 2003.

The CDs can be ordered by accessing the National Parks and Wildlife Service website on

www.npws.nsw.gov.au

ECOSYSTEM SERVICES provided by healthy waterways

By Gary Jones

In recent years, the terms 'waterway or river health' and 'water quality' have almost become synonymous. The terms have been used in an increasingly broad way to cover many of the beneficial environmental and aesthetic 'values', 'attributes' or 'qualities' of water. These values or attributes may be chemical in nature, for example, we have traditionally thought that good water quality meant an absence of artificial chemicals and pollutants, and a 'natural' (typically low) level of chemicals and compounds found in nature (e.g. nutrients such as phosphate, nitrate, ammonia, trace metals, etc.). This chemical definition still applies, but there are other important attributes to water quality. For example, good water quality can be taken to describe a healthy water body with a near-natural balance of fish, invertebrates, plants and algae, with the appropriate in-stream, riparian and flood plain habitats for these organisms to live in.

A modern description of good water quality is also invariably linked to the purpose for which the water is used, or the societal and aesthetic values that we attach to it. For example, good quality water used for irrigation might imply low salt content and low contaminant levels; water for environmental (river health) protection may need to have low levels of nutrients and a temperature suitable for the survival of native fish; and, water for human consumption may need low turbidity and very low levels of water-borne pathogens. What these examples show is that there is no single definition of 'good' water quality, rather, it depends on the purpose the water is being used for, or more generally, our expectations of what benefits it should provide to us and the environment. These societal expectations may change from one river catchment to another, moving from upstream to downstream along a river system, or even in the same reach of a river or in one lake, depending on the interests and expectations of the local community. This multi-faceted view of river health and water quality underpins the National Water Quality Management Strategy and associated National Water Quality Guidelines.

So what condition of a waterway can be described as 'healthy', indeed, what exactly do we mean by a waterway? The term waterway is best used in a very broad sense to refer to any part of the landscape where water flows over or under the land, or pools on it to form a lake or wetland. A waterway can be permanent or temporary, freshwater, brackish, or estuarine. A healthy waterway is one that has: a balanced population of aquatic biota — fish, aquatic mammals, insects, plankton, bacteria and plants; natural

A waterway in the Goulburn Broken Catchment, Victoria

ECOSYSTEM SERVICES provided by healthy waterways

levels of sediment, nutrients and trace metals; an absence or only very low levels of human generated pollutants; good habitat condition; and, a hydrological regime that has not been sufficiently changed by human activity to have a detrimental effect on the aquatic biota.

Why are healthy waterways important?

Healthy waterways with good water quality have multiple benefits for Australian industry and the broad community. The ecosystem services provided by healthy waterways can be described under the following headings:

Agriculture

The transport of water from upper catchments to irrigated cropping and live stock production enterprises downstream, and its temporary storage, is a major ecosystem service provided by rivers, lakes and wetlands. Without these natural waterways, artificial canals and pipelines must be built to transfer water from one point on the landscape to another. However, the use of rivers as artificial conduits comes with an environmental cost. To improve the engineering efficiency of rainfall runoff capture and storage by waterways, thousands of dams and weirs have been built on waterways throughout Australia. Downstream flow patterns are often dramatically altered in many rivers and can have dire consequences for in-stream biota. Whilst these engineering changes are of great benefit to the agricultural and urban industry, and their communities, they present a threat to other ecosystem services provided by waterways.

Drinking water

As well as transporting and storing water for potable use, natural, healthy waterways provide an important service in improving the quality of drinking water. In turn, this reduces the cost of treating the water prior to human consumption. For example, human bacterial and protozoan pathogens (natural and human) from catchments may be removed during their passage downstream in rivers, or can be consumed by natural predators that live in water. Natural organic matter found in catchment rainfall run-off is also degraded and metabolised by river biota. This is an important function, or service, provided by waterways — natural organics, when chlorinated in drinking water treatment plants, produce carcinogenic by-products. The lower the levels of organic matter in raw water, the better the quality of the subsequent treated drinking water.

Recreation fishing and aquaculture

Fishing is Australia's most popular past time, and it forms the basis of an industry worth tens of millions of dollars annually to the Australian economy. Healthy waterways support populations of native fish species that are highly sought after by anglers in different parts of the country, for example, Murray Cod, Golden Perch, Australian Bass and Barramundi. Supporting sustainable stocks of native, and sometimes introduced species (e.g. brown trout), is a highly desirable service provided by Australian waterways.

Aquaculture is a rapidly growing industry in Australia and throughout the world, with many high value fish, crustaceans and shellfish being amenable to high turnover production by aquaculture enterprises. Healthy waterways provide the brood stock and genetic diversity of animals required to support a robust aquaculture industry. They also usually transport and provide the water required by the industry to sustain production in arid regions where such high level production would otherwise be impossible.

Other recreational uses and aesthetics

The use of waterways for recreation and for tourism is another important service. These activities include swimming, water skiing, canoeing, sailing, power boating, and house boating. The general aesthetic value of a healthy waterway, its floodplain and riparian trees, shady water holes, and great expanses of open water, touch the Australian psyche and form a central place in the lives of most Australians, especially those in inland Australia.

Opportunities and actions

There are many remedial and rehabilitation actions that can be used to restore Australia's waterways to a point that approaches what they once were. Clearly, some of our rivers will never be pristine again, as we cannot totally turn back the clock on two centuries of European development and degradation. The challenge is to make our agricultural and urban industries and

Top: *Murray Cod*
Middle: *Macquarie Perch*
Below: *Barramundi*

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ECOSYSTEM SERVICES provided by healthy waterways

developments ecologically sustainable. In the case of healthy waterways, this means the provision of environmental flow allocations and regimes for rivers, the provision of fish passages in dams and weirs, the revegetation and conservation of catchment, riparian and floodplain lands, the reuse and/or improved treatment of domestic and industrial wastes, and a smarter and more environmentally sensitive use of agricultural chemicals.

The opportunities to do these things are now upon us. Major national policy agreements such as the Council of Australian Government's (COAG) water reform policy, the National Heritage Trust, and the recent Prime Minister's Action Plan on Salinity and Water Quality, provide both the political will and financial backing to commence or continue the process of improved environmental management. At the local and regional level, collaborative community catchment management committees, and action groups such as Landcare and Waterwatch, have important roles to play in managing our waterways and catchment lands.

Under the COAG water reforms, all states are now implementing strategic planning and action programs to provide environmental flow allocations and regimes for rivers. The National Water Quality Guidelines have very recently been revised and updated to provide a robust and scientifically sound basis for protecting water quality. Finally, the concept of environmental stewardship of our land and water resources is beginning to be developed and this holds out a great opportunity for all members of the community to take a long-term view of waterway and water quality protection.

Where to from here?

There are knowledge gaps that need to be filled, but new knowledge is only a part of the solution. Having the political will and social empowerment to undertake the changes in land and water management that are required is a big part of what we now need to do to improve the health of waterways. We also need to value the Ecosystem Services being provided by healthy waterways so that we can manage our rivers more wisely to ensure we will still have benefit from these services in the future.

ENVIRONMENTAL ECOSYSTEM SERVICES —

One example

Water filtration

When sediment moves with water through the landscape there are many opportunities for this sediment to be captured and returned to the soil surface to become soil again. Examples of such filtering are buffer strips, grass swales, farm dams, floodplains and wetlands. The performance of such filters is wide ranging. For example, in one study near-natural riparian zones have been reported to trap greater than ninety per cent of incoming sediment.

The reality of most Australian rural landscapes is that they will continue to generate sediment through soil erosion by a variety of processes. The constraints of enterprises and the enormity of the task of revegetation ensure that we will have sediment moving in our landscapes at above-natural rates for many decades to come. Filtering is an efficient way of diminishing the downstream impacts of soil erosion within the above constraints. Filters normally occupy a relatively small area of land and, because of this, may be more acceptable to land-owners as a tool in managing sediment run-off.

Filtering of water as a service is strongly coupled to the erosion of sediment. A key step in planning the restoration of filters is to identify major sediment sources and place filters in their pathway. There is also a strong link to the ecological function of wetlands and riparian zones. It is now widely recognised that these areas have several functions in ecosystems.

As this example has shown, the ecosystem services provided by the riparian zone in filtering sediment and assisting in the control of erosion are significant. When combined with other ecosystem services such as provision of wildlife habitat, acting as a windbreak for crops, providing shelter for stock etc. we can see that filtering is just one of the many multiple benefits that can be gained through sound riparian management.

For further information

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Another example

Pollination

One of the key services provided to the fruit and vegetable and farming industries is the service of pollination. Pollination is the process of moving pollen from male flower parts to female plant parts. The pollen fertilises an egg cell in the flower, which then becomes a seed. Seeds are borne in fruits, so fruit formation also depends on pollination. For some plants, like grasses and cereal crops, the movement of pollen by wind is sufficient to pollinate flowers. For other plants, pollination can happen automatically with the male flower parts contacting female parts of the same flower. However, the majority of plants need animals to visit their flowers to help move pollen, and so produce seeds. Birds, bats, and even small possums can pollinate some flowers, but the most important pollinators are insects, with the most significant being bees. Australia has a rich fauna of native bees, but the most common bee is the introduced European honeybee. This species is managed commercially by beekeepers, and there are also abundant wild European honeybee populations in the region.

Pollination as an ecosystem service is integral to both the ecological and economic health of Australia's catchments. The existing service and the ability to provide this free service in the future, is increasingly under threat on a variety of fronts including over-reliance on a single bee species, pesticide use and lack of remnant vegetation.

Economically speaking, pollination is a significant contributor to the gross regional product of our catchments. Work undertaken in the Goulburn Broken Catchment has shown that pollination is vital for a number of important crop species. There is also a substantial contribution through the pollination of nitrogen fixing legumes such as clovers and lucerne, which improve soil and fodder quality, thus maintaining healthier livestock with less fertiliser input to pastures. Lucerne, a pollination-dependent species brought into the catchment as seed, is also important as a deep-rooted species that lowers the water table, helping to reduce salinity. Finally, there are the values associated with sustained regeneration in native vegetation.

For further information

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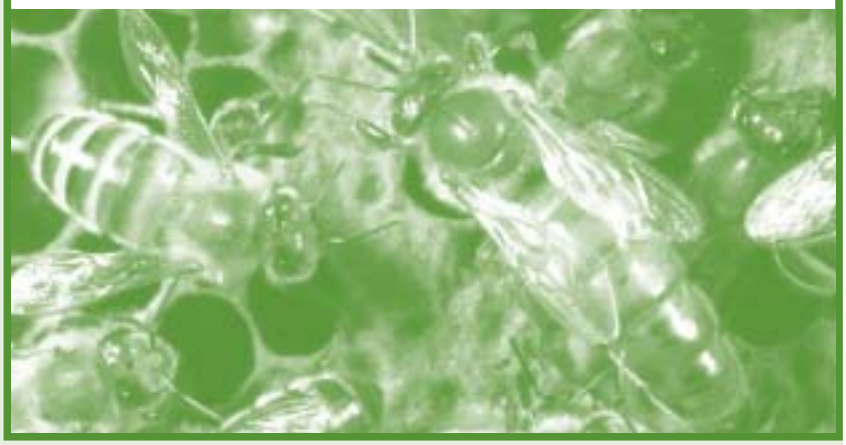


The River Styles® short course

FIRST CIRCULAR

Kirstie Fryirs and Gary Brierley,
Department of Physical Geography, Macquarie University

Email: gbrierli@laurel.ocs.mq.edu.au
kfryirs@laurel.ocs.mq.edu.au

Macquarie Research Ltd

The River Styles®, framework provides a catchment-framed geomorphic summary of river character and behaviour, condition and recovery potential. The explanatory and predictive bases of this procedure provide a rigorous physical basis for river management decision making.

Duration:	5 days, 9 am – 5 pm, Monday–Friday
Date:	29 April – 3 May 2002
Presented by:	Assoc. Prof. Gary Brierley, Ms Kirstie Fryirs
Venue:	Goulburn, NSW
Indicative cost:	$1200–1500 (to be confirmed in early 2002). A minimum of 16 people is required for the course to run.

Price includes:
- tuition
- course booklets
- site visits and bus hire
- field costs and materials
- venue
- morning/afternoon tea

Price excludes:
- Travel to and from Goulburn
- Accommodation in Goulburn
- Main meals

Application information for the River Styles® Short Course will be circulated in early 2002. Further information on the River Styles® framework, can be obtained from Kirstie Fryirs. A short email noting your expression of interest can be forwarded to kfryirs@els.mq.edu.au

Valuation of Ecosystem Services — the contribution of economics

By Nick Abel and
J. Marty Anderies

Some people reject the need to estimate the economic value of ecosystems or the services they provide, arguing that because they are infinitely valuable, economic estimates have no meaning. In one sense this is correct, because without the resources and the life support and waste absorption services which ecosystems provide, humans could not exist. However, humans readily modify ecosystems and, in doing so, affect the flows of ecosystem services, increasing some and reducing others. Humans make choices about the benefits and costs of using ecosystem services — they make economic choices. The discipline of economics can help make these choices more efficient (more benefit per unit of cost), and more equitable now and across generations.

How do people value goods and services?

Many people equate the value of a good or service to its market price. Mainstream (neo-classical) economists are uncomfortable with this because price is a reflection of current demand and supply, not value. The value of a good or service is what people would be prepared to sacrifice in order to obtain it, and price does not measure this. A person dying of thirst would exchange a nugget of gold for some water, yet because water is abundant and gold scarce, one is very cheap and the other is expensive. Mainstream economists, therefore, measure consumers' values in terms of their willingness to pay for goods and services ('consumers' surplus' in Figure 1). For the same reason, they measure the value of producing a good or service in terms of willingness to produce ('producers' surplus' in Figure 1). The value to society of a good or service is the sum of consumers' and producers' surpluses.

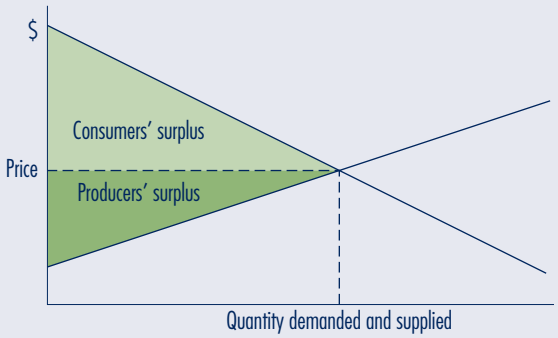


***Figure 1**: Price is not value*

In practice, however, economists are often obliged to relax this rigorous approach to valuation, and instead estimate 'value' in terms: of cost savings (e.g. using native vegetation instead of technology to filter water); opportunity cost (what people are willing to forego in order to secure a good or service — e.g. switching from wheat production to agro-forestry in order to prevent the rise of groundwater); or costs of repairing a damaged facility.

Although the mainstream economic approach influences decisions by governments that affect the distribution of benefits and costs in society, it is not an accurate reflection of social values. This is because what mainstream economics labels 'willingness to pay' is also a measure of ability to pay, which is a consequence of the distribution of wealth and power in society. The mainstream approach will, therefore, reinforce pre-existing patterns of wealth and power, and in Australia will tend to reinforce urban values over rural ones, and industry over conservation. It will also reinforce the structure of an economy that is using ecosystem services in unsustainable ways. Future generations have no ability to pay or protect their interests — which may include the continuing supply of ecosystem services — this means that they rely on the ethics of current generations, which are severely tested when times are hard or opportunities large and tempting.

The mainstream economic approach also influences decisions by governments that affect ecosystems (e.g. water allocations for irrigation; discharges of pollutants; clearing of native vegetation), and the ability of those ecosystems to continue to provide services. Since property rights over most ecosystem services are not clearly defined, they are not bought and sold, so they appear not to have an economic value. One consequence of this apparent lack of value is that ecosystem services are used inefficiently — for example they may be over-used to the detriment of future supply (e.g. over-allocation of water). In particular, producers tend to pass the costs of production (e.g. salinisation) onto resources that are 'owned' by society.

The ecosystem services concept — completing the circle

These deficiencies in the lay-person's and in the mainstream economist's valuations of goods and services have been recognised and addressed mainly through laws, regulations, taxes and techniques such as environmental impact analysis. These approaches have been concerned with the consequences of production for ecosystems, including their un-marketed goods and services (e.g. native species, beautiful landscapes — known as 'intrinsic values'). The ecosystem services concept is different in that it is concerned not only with these impacts, but also with the contribution of ecosystem services to production (see Figure 2). Production values range from wheat, to the 'production' of beauty in a landscape.

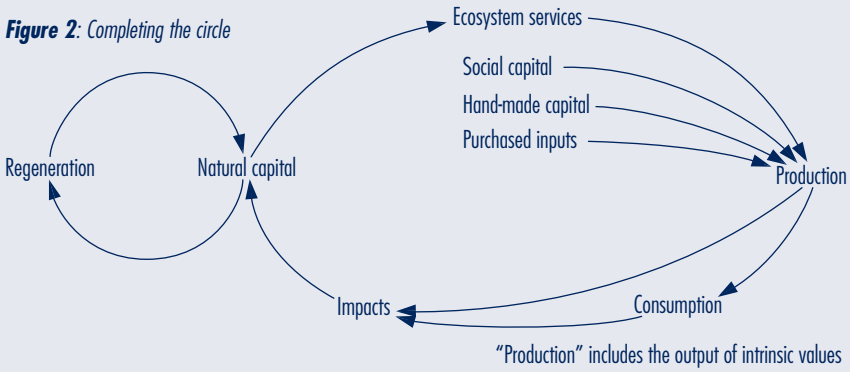
In Figure 2, ecosystem services are supplied by 'natural capital' (ecosystems). They are combined with purchased inputs in production processes using human-made capital (e.g. machinery) guided by social capital (e.g. knowledge). Production processes and consumption both impact upon natural capital. Its ecosystems may be able to sustain these impacts because of their powers of regeneration, or they may decline. Given these relationships, the roles of the economist in ecosystem services research are to:

1. estimate the value of natural capital in terms of the flows of ecosystem services to production;
2. analyse the efficiency with which ecosystem services are combined with industrial inputs in the production process;
3. estimate the economic costs of the impact of production and consumption on ecosystem services over time;
4. examine the distribution of benefits and costs among different stakeholders; and across generations;
5. propose changes in institutions (policies and laws) and markets that would lead towards equitable and efficient use of ecosystem services.

Economic methods

As was discussed previously, economic value is determined by the shapes of supply and demand curves (see Figure 1), which depend on social and environmental context. This means that a change in technology (stone tools to iron ones) can turn a valuable resource into a valueless one and *vice versa*. We are currently using scenarios to provide these contexts for our research in the Goulburn Broken Catchment. Our scenarios include floodplain rehabilitation, land use intensification, re-vegetation of a sub-catchment, intensification of agriculture, and tourism. Within each scenario, alternative land use patterns will be evaluated for their effects on 1–4 (refer to left of page).

***Figure 2**: Completing the circle*

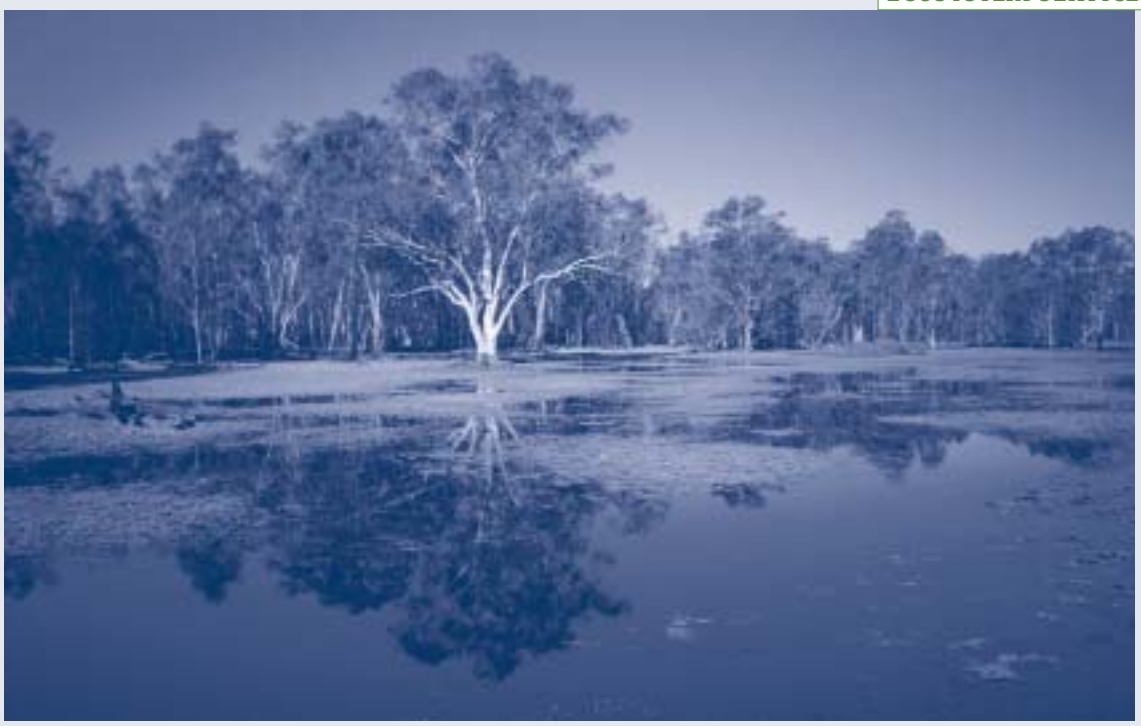


Using scenarios

In the floodplain scenario, attaching costs and prices to a dynamic simulation model enables us to estimate the economic values of ecosystem services in relation to water quality and quantity, carbon storage and animal production.

We will examine how moving levees to allow the re-establishment of wetlands will affect evaporation and transpiration, hence the yield of water. It will also affect the quality of water through reduced bed and bank scouring, and increased filtering and deposition. The value to producers of a marginal change in the supply of water of a given quantity and quality will be estimated from changes in the value of irrigated production (producers' surplus based on current market prices).

The recovery of wetlands will represent an increase in intrinsic values that we can estimate by extrapolation from other work, such as the Barmah Forest study (Stone 1992). We can also explore the implications for the regional economy of increases in tourism using input-output analysis. On the costs side, however, is that the spread of wetlands is likely to increase the incidence of Murray Valley encephalitis (Boardman et al. 2001).



This project will place a value on the ecosystem services provided on a floodplain like the one pictured.

The relationships between water quality and quantity, the frequency and extent of algal blooms, and the effects of those blooms on water quality will also be explored. Interactions between livestock production and water quality are in the model. These include: the effects of livestock upon the regeneration of vegetation and its filtering capacity; bank erosion and turbidity; and defaecation and stream nutrient loads. These effects appear as costs in the negative impacts of water quality on agricultural production. In addition, the value to producers of marginal changes in the area and type of land grazed is also being estimated. Livestock products are valued at market prices, and producers' surplus estimated from marginal cost curves. The effects of changing market prices are also being investigated.

Developing new markets

Other areas that we will be investigating include the development of proposals for changing institutions and markets that would lead towards equitable and efficient use of ecosystem services. Recent experience with markets for irrigation water, and emerging understanding of the potential for marketing carbon sequestration services, has encouraged researchers in this project, and elsewhere, to investigate markets for ecosystem services, including the conservation of biodiversity. This work is at an early stage.

Institutional analysis

Institutional change can be an effective way of changing the structure of an economy and realising values that are currently suppressed by the distribution of property rights. We have developed a simple model to study how the relationship between communities, larger scale institutions, and the resource base affects the ability of the community to self organise and address simple commons dilemmas. Through the model analysis we attempt to illustrate i) the importance of the relative time scales upon which the natural system and community action operates, ii) that if the community acts in isolation, whether it successfully avoids degrading the resource base depends on the initial conditions (i.e. the community governance solution to the commons dilemma is not robust), and iii) how changing the rules by which the community operates and including interactions with institutions at a larger scale can remove this dependence on initial conditions and enhance the robustness of community governance.

Further reading

Stone, A., 1992, Contingent valuation of the Barmah Wetlands, Victoria, in M. Lockwood and T. DeLacy (eds). Valuing Natural Areas: Applications and Problems of the Contingent Valuation Method. Proceedings and Related Papers from a Workshop, 29–30 June, Charles Sturt University, Albury.

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For further information

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Farms for THE FUTURE

Farms of tomorrow could produce and trade new environmental commodities — such as carbon, biodiversity and salinity credits — in addition to more conventional crops and livestock.

By Carl Binning

It sounds too good to be true: a farm that makes a profit by improving the environment. Yet, this is exactly what scientists now envisage. The idea is to create new business opportunities for farmers while producing cleaner air, reducing salinity, and increasing biodiversity. But will this work — and how?

Examining markets for ecosystem services addresses a number of challenges in attaining this vision for the future of Australian farming. Can we invest in our farmlands so that they not only produce wheat and sheep, but also new commodities like clean water and greater biodiversity. How do we value and market these unconventional commodities and the ecosystem services that generate them? By what mechanisms can governments, businesses and individuals invest in environmental improvement?

Researchers working in this area are now suggesting that we will soon be defining a range of ecosystem services and products that can be bought and sold through a new currency, most likely a system of tradable 'credits' for carbon, water quality, salinity and biodiversity. We are already seeing trade in carbon credits as a counter to global warming. A system is being envisaged (see Figure 1) whereby ecosystem services, environmental commodities and markets relate to each other.

A key outcome of the project will be the establishment of an accounting system that allows on-ground measurement or calculation of contributions at a farm or catchment scale. For example, if a farmer shifts towards agroforestry, which may help to lower the water table, how do we measure this contribution against salinity targets that have been set for the entire catchment? And what is its monetary worth?

We will also test different ways of encouraging non-government investment in ecosystem services. This will help governments to target environmental projects that will secure this investment. Engaging these private-sector investors will require the establishment of effective investment pathways linking regions, governments and investors.

The project will also identify and pursue various opportunistic and entrepreneurial strategies. Lifestyle farming in the Goulburn Broken Catchment, Victoria, and the sale of bush blocks in south-west Western Australia to Perth buyers are two possibilities. These opportunities involve the harnessing of existing market forces to redesign Australian landscapes, whereas the marketing of ecosystems services amounts to a fundamentally new approach to farming.

For further information

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For further information about markets for ecosystem services, please refer to the report *Making Farm Forestry Pay — Markets for Ecosystem Services* available from the RIRDC web site at www.rirdc.gov.au

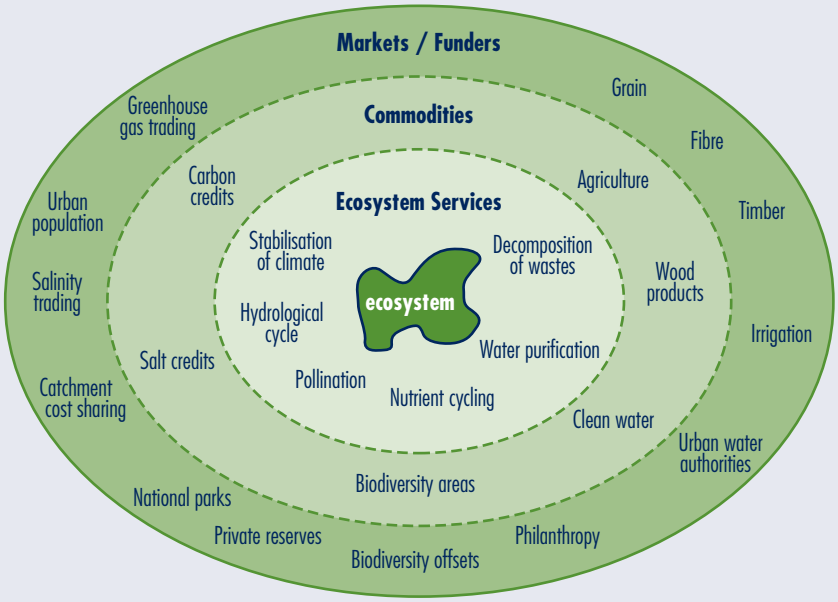

***Figure 1**: A functional ecosystem is at the heart of the system as it provides ecosystem services like water purification that, in turn, produce commodities, in this case clean water, that can be bought and sold or traded as a credit.*

Modelling the benefits gained by enhancing ecosystem services

By Art Langston and Jenny Langridge

Understanding the benefits that can be gained by enhancing ecosystem services in a catchment is an important pre-cursor of valuing those benefits. In the past, research has been performed that investigates the function of plants and animals in regulating their own communities. Typically, such research focuses on individual species and relationships at single scales. In contrast, getting a handle on ecosystem services requires an integration of knowledge of all species and ecological relationships across a range of scales. Clearly such an objective quickly becomes intractable. The solution the Ecosystem Services Project has applied to this problem is to use workshops as a tool to identify key questions about the functioning of ecosystems and, thus, the key components of the catchment that need to be studied.

This process naturally leads to a compartmentalisation of the catchment and selection of appropriate scales at which to model or analyse the ecological processes that support ecosystem services. For the Goulburn Broken region, this resulted in our choice to model individual components of the catchment in order to provide information on the questions that are specific to different scales, as well as feed information into and analyse ecosystem services at the catchment scale. Three scales of modelling and analysis are described in this article: enterprise (irrigated dairy); landscape (floodplain vegetation); and catchment (in stream water quality).

The resource management questions that are being asked at each scale are listed in Table 1. These should not be considered a comprehensive account of the analysis that is required to fully understand ecosystem services across the Goulburn Broken. Rather, we have selected these examples to highlight the different approaches that can be taken to modelling ecosystem services and the types of questions that can be answered by each approach. Each of these models are in varying stages of development. We have finished development of the enterprise model, are in the process of refining and calibrating the landscape model and are in the conceptual design phase of implementing the catchment scale model.

Table 1: Scales of ecological analysis in the Goulburn Broken Catchment and the associated economic and resource management issues

Scale of analysis	Economic and resource management issues
Enterprise	Costs of replacement of ecosystem services with technological alternatives; and control of nutrient export into the stream system.
Landscape	Costs of replacement of ecosystem services with technological alternatives; enhancement of habitat for native biota; filtration of in stream nutrients and sediments; and potential for carbon storage.
Catchment	How and when should catchment managers intervene in land-use and ecological processes to enhance catchment scale ecosystem services whilst minimising the financial and social costs.

Enterprise scale: biophysical processes supporting irrigated dairy production

Workshops have been held in the Goulburn Broken to develop a conceptual model based on the dairy industry. This model has been developed with strong stakeholder input and the simulation model that was subsequently developed was particularly applicable to an irrigated dairy pasture system consisting of annual and perennial grasses.

Some simple economics were calculated in the model based on income from milk production, and these and the value (not $) of other goods and services were compared for various management scenarios. Preliminary results suggest that an increased use of trees for shade and of water re-use systems would increase milk production by recycling nutrients and decrease off-farm impacts, with less nitrogen and phosphorous leaving as runoff. In addition, biodiversity benefits might provide income if a biodiversity market develops in the future. Further development of the model would focus on including more ecosystem services, for example: natural pest control on grazing land on dairy farms; regulation of water tables to buffer against salinity; and waste assimilation and maintenance of soil fertility by soil organisms.

Landscape scale: effects of changing land use and flooding regimes on floodplain vegetation

To address problems of flood damage to levee banks, and changes in the channel and bank environment of the lower Goulburn River, the Goulburn Broken Catchment Management Authority (GBCMA) has proposed to re-establish the northern floodplain of the river. This involves constructing new bunds to the north and developing a leveed floodway of approximately 13 700 hectares. There is a need to further explore the implications of different approaches to the valuation of ecosystem services as input into a process of more detailed design of the proposed floodplain rehabilitation scheme.

Landscape scale (continued)

A conceptual model of all key ecosystems services in the floodplain and the biophysical processes that contribute to them has been developed. Services considered include: meat, wool, and milk production; provision of shade and shelter; habitat regeneration; carbon sequestration; pest control; erosion control; water filtration (maintenance of water quality); provision of aesthetic values; river flow regulation; recreation; maintenance of biodiversity.

The model is being developed with a focus on the three major scenarios recommended by stakeholders: (1) a baseline reflecting the current levee system and land management; (2) the floodplain rehabilitation scheme as proposed but with minimal livestock grazing, and; (3) the floodplain rehabilitation scheme as proposed and with maximum livestock grazing. There is also a strong focus on the role of vegetation in filtration of sediment, erosion control, carbon sequestration, and river flow regulation.

The model that has been developed is dynamic, partially spatial and driven by flood (and other) events. It uses analysis of output from more specific and complex models (e.g. hydrological models and livestock production models). A key part of the model development has been to represent a range of biodiversity measures currently used for operational assessments of biodiversity value (e.g. the Biodiversity Benefits Index used by Victorian Department of Natural Resources and Environment). This allows model results to be mapped against the operational biodiversity indices.

Moving from the enterprise ➜ landscape ➜ catchment scale. Aerial picture Goulburn Broken Catchment, Victoria.

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Catchment scale: how ecosystem services flow between land uses

The enterprise and landscape models described previously are designed to address issues and questions specific to the geography and land use of that component of the catchment. However, there is a need for an integrating model that addresses whole of catchment issues. To this end, a catchment scale model is being developed which has three purposes:

1. to explore the implications of land-use change on ecosystem services that link the major biophysical zones of the catchment;
2. to provide coarse information about changes in productivity and viability of land uses over time, either under the influence of changes in ecosystem services or any instruments that might be implemented to manage those services; and,
3. to enable exploration of the trade-off between ecosystem services and potential technological substitutes.

The catchment is being considered as four geographic and land-use catchment components: mountains dominated by forestry and tourism enterprises; foothills dominated by grazing and increasingly recreational farming; plains dominated by grazing and dryland cropping; and the irrigation area dominated by irrigated dairy and horticulture.

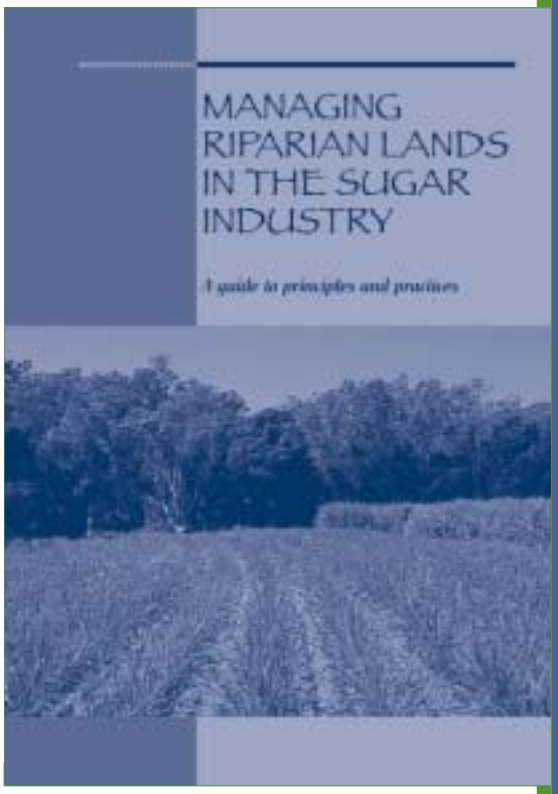
Associated with each catchment component we are producing analyses of the biophysical influences on ecosystem services. The dairy enterprise and floodplain models provide input to the catchment scale model concerning the irrigated and plains parts of the catchment. Models for the plains area also are being developed in conjunction with the CSIRO Heartlands Project, which is addressing issues of multiple objective landscape design. The movement of water within the soil and associated movement of salt is a major issue within this component.

By taking this approach within each component of the catchment, a full accounting of the biophysical processes that underpin ecosystems services that are relevant to the land uses of that component is achieved.

NEW Publication

Managing Riparian Lands in the Sugar Industry (LOVETT AND PRICE)

The Sugar Research & Development Corporation and Land & Water Australia have co-funded the development of a guideline for the sugar industry that focuses specifically on riparian management on cane farms. Key industry, research and government departments involved in the sugar industry have been involved, as well as an important group of cane growers who worked with the research team to define the issues to be covered and ensured that the guideline met their industry's needs. The guideline is intended for use by extension officers and those working with cane growers to develop more sustainable management practices on-farm.



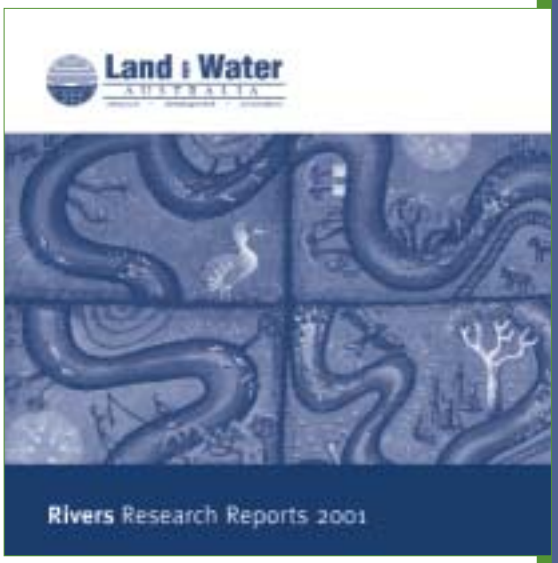
The guideline is freely available from
CANEGROWERS Tel: 07 3864 6444,
Sugar R&D Corporation Tel: 07 3210 0495 and
Land & Water Australia through Canprint Communications
on 02 6295 4444 or Freecall 1800 776 616

It will also be on the Sugar R&D Corporation's website in the next few months. **www.srdc.gov.au**

NEW CD

Rivers Research Reports CD-ROM

This easy-to-use CD-ROM contains 20 of the most popular publications from the Riparian Lands Program and the National Rivers Consortium. It features the Rehabilitation Manual and Riparian Land Management Technical Guidelines, RipRap and six Research Reports, all with easy navigation through the contents pages. The CD-ROM is a compact way to store your reports and it allows you to explore electronically or download your favourite sections to print.



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Incorporating PEOPLE'S VIEWS into the valuation of ecosystem services

By Wendy Proctor

How can we inform people about the benefits of maintaining healthy ecosystems? What factors should be taken into account in valuing ecosystems? This article tells of one possible method to incorporate the public's views into the valuation of ecosystem services. This method draws on the advantages of two public participation decision-making techniques: 'Multi-criteria Decision Analysis' and the 'Citizens' Jury'. The combined technique determines values or priorities for ecosystem services through a deliberative and structured process.

Participation and structure

One method of incorporating public (in particular stakeholder) participation into the decision-making process of natural resource management is the Citizens' Jury. The Citizens' Jury is based on a model that is used in the criminal justice system in many countries. The typical jury ranges from 10 to around 20 participants. The jury can be selected either randomly or through a stratified random sample. The jury is given a specific charge, which is well worded, clear and direct. Ideally the process uses a facilitator, with the jury given sufficient time to deliberate, ask questions and call 'witnesses' (experts in the area of concern). The final outcome is usually a consensus position reached by the jury.

Multi-criteria Decision Analysis (MCA) is a means of simplifying complex decision-making tasks which may involve many stakeholders, a diversity of possible outcomes and many, and sometimes intangible, criteria by which to assess the outcomes. In many public decision problems, such as those involved with environmental policy, the objectives of the decision may conflict and the criteria used to assess the effectiveness of different options may vary widely in importance. MCA is an effective technique in which to identify trade-offs in the decision-making process with the ultimate goal of achieving compromise. It is also an important means by which structure and transparency can be imposed upon the decision-making process.

Combining both approaches — deliberative multi-criteria evaluation

MCA has the great advantage of being able to provide a framework or approach to complex decision-making problems that allows the problem to be broken down into workable units and be structured to enable the complexities of the problem to be unravelled. However, with multiple decision-makers, MCA does not provide adequate guidelines on how to analyse or aggregate multiple preferences. Citizens' Juries, on the other hand, do allow for an effective approach of interaction between multiple decision-makers and for conducting an iterative process, chiefly through the deliberative aspects of the jury approach. In general, however, Citizens' Juries have not addressed the problem of structuring the decision-making task.

A logical progression to overcome the problems and to enhance the advantages of both methods is to combine the two approaches. This new form of participative decision-making combines the facilitation and deliberation qualities of the Citizens Jury process with the analytical and integrating qualities of the Multi-criteria Analysis technique. A series of steps are followed when using this combined approach.

1. Choosing the jury

Jurors can be selected based on a demographic overview of the population that will be affected by the decision. This overview can include such factors as gender, age, place of residence, ranking of the environment in relation to other social issues, occupation, income, income source and level of education. The choice of jurors can be made using a stratified random sample of this relevant population.

2. Choosing the scenarios and the objectives

Although the objectives and scenarios should be chosen by the jury, input from other sources, such as expert advice, can occur. The objective

It is important to include people's views when considering ecosystem services. Photo: Mallee Catchment Management Authority

can be as broad as necessary, but in the case of multiple decision-makers, overall agreement should be reached. An example of scenarios for a land use decision problem could be a business as usual or current scenario, a scenario that reflects land management that has an environmental conservation bias and a scenario that reflects land management with a bias towards pursuing economic and social goals (e.g. maximised incomes or employment etc.). The overall objective of this example could be to maximise the quality of life of all the inhabitants of the affected region.

3. Selecting the criteria

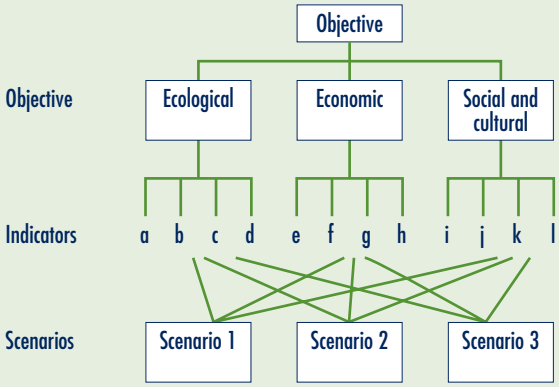
The jury is given the task of selecting the criteria. The criteria are designed to compare and assess each of the scenarios and therefore must relate to the overall objective of the decision-making task. The lowest level of the criteria structure are those which are measurable (quantitatively or qualitatively) and are known as indicators.

The decision problem can be schematically described by building a 'decision hierarchy'. Figure 1 provides an example of a decision hierarchy for a hypothetical land use problem involving three possible scenarios. The highest level of the hierarchy is the overall objective of the decision problem. A number of criteria can then be identified as being important for each scenario to meet the overall objective. These criteria can be grouped into Ecological (including those related to ecosystem services), Economic, and Social and Cultural. Each group of criteria will be associated with a list of indicators that are used to measure how well the criteria are being met by the identified scenarios.

4. Weighting the criteria

In Multi-criteria Analyses, the preferences and values of the decision-maker are accounted for by the weighting or scoring placed on each of the criteria. The weights may be qualitatively expressed, quantitatively expressed or a mixture of both. The weightings make explicit those areas that may ultimately require possible trade-off solutions and, as a result, provide a greater focus for a complex decision problem. The Citizens' Jury process could be used to great advantage in determining the weights of the criteria.

***Figure 1**: A decision hierarchy*



5. Evaluation of the scenarios

The scenarios are assessed in two stages: first, by how important each of the criteria are to the stakeholders (the preference weights) and second, by how well each scenario performs in terms of each of the criteria of assessment (the scenario impacts). The second stage is displayed by means of an Impact Matrix (Table 1). The overall ranking of the scenarios is determined by a simple mathematical operation involving the preference weights and the scenario impacts. It is essential to carry out a sensitivity analysis using different values of the most crucial and contentious criteria and impacts with further iterations of the process carried out if necessary.

Conclusions

This article has described a method of incorporating public views into the process of valuing ecosystem services through investigation of a number of different resource use scenarios for a region. It has shown that one technique, Multi-criteria Decision Analysis can be combined with another, the Citizens' Jury, to enhance the advantages of both and overcome some of their disadvantages when they are used in isolation.

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Table 1: Example of an Impact Matrix for the land use decision problem

Criteria	Possible indicators	Impacts		
		Scenario 1	Scenario 2	Scenario 3
Ecosystem services criteria				
Pollination	Pollination sensitivity to landuse (index[1])	4	7	2
Life fulfilment	Impact of landscape change on landuse (index[2])	++	+	+++
Climate regulation	Capacity to adapt to climate change – Level of carbon sequestration (index[2])	++	+++	+
Pest control	Estimated plague pest species (no.)	10	3	5
Genetic resources (ecosystem, species and genetic diversity)	Habitat hectares score (index[3])	23	14	10
Shade and shelter	Area of suitable species (ha)	45	25	30
Water health	Quality of runoff from sites (index[2])	+++	+++	+
Soil health	Area of salinised land (ha)	10	5	15
Economic criteria				
Economic benefits and costs	Costs of managing sites, revegetation, capital works ($)	345 000	230 000	560 000
Social and cultural criteria				
Aesthetic values	Average land prices ($/ha)	5 000	10 000	12 000
Cultural value	Qualitative index2	+++	+	+

Index 1 *On a scale of 1 to 10 with 1 being nil sensitivity and 10 being maximum sensitivity*
Index 2 *+ = low, ++ = med, +++ = high*
Index 3 *On a scale of 1 to 100 with 1 being the lowest level and 100 being the maximum level*

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How to reveal our NATURAL ASSETS — communicating ecosystem services

By Rachel Parry and Steve Cork

Ecosystem services, as has been defined in other articles within this edition, are the functioning of natural ecosystems that provide "services" that are essential for human health and survival. Examples of the kinds of services we receive from nature include water filtration, regulation of atmospheric composition, maintenance of soil fertility, pollination, pest control, and cultural, spiritual and intellectual stimulation.

Despite receiving these benefits, the ecosystems that deliver them are in decline. In Australia, we need look no further than the growing salinity problems, water quality issues, continuing tree clearing and meeting greenhouse gas emission targets. Putting all this together, it is clear that we need to rethink our land-use practices.

The concept of ecosystem services has been seen as one way to address these issues. Instead of asking what do we have to give up in order to have a healthy environment, we ask the question what do we have to gain by maintaining ecosystem function? This includes asking who benefits from the delivery of ecosystem services? How can costs and benefits be fairly shared? How do we develop incentives, including new markets, to encourage investment in natural resource management that has greater overall benefit for communities and society generally?

So what does communication have to do with ecosystem services?

Ecosystem services are unabashedly anthropocentric (focused on humans). The concept of receiving a service is familiar to all people. We receive services everyday — be it from a barber, baker or block of bushland. However, we also need to recognise that most people don't realise they are receiving services from the environment because they are not always in a tangible format, such as a haircut or a loaf of bread. At the same time we need to think about these issues in a way that most people can understand and appreciate without specialist knowledge. For this to happen we need language and concepts that don't require a science or economics degree to understand, and that allow all members of society to engage in dialogue about the outcomes they want from their relationships with nature.

So, the question becomes, *how do we engage, in a meaningful way, with communities around Australia to re-examine our relationship with the environment?*

The Ecosystem Services Project

The Ecosystem Services Project is an Australia wide initiative that is examining the services people obtain from the natural environment, the value of these services economically and socially, and the opportunities that can arise from considering these services more fully in land management policies and decisions.

The Ecosystem Services Project is asking such questions as:

- Who benefits from these services?
- What are current land management practices doing to these services?
- What will happen to these services under future land-use scenarios?
- How far can land use intensification proceed before environmental thresholds are crossed and systems start to collapse?

We recognise that answering these questions requires true partnerships among a range of institutions, agencies and individuals.

Without repeating the detail of The Ecosystem Services Project (see Theme article), it was identified early on that communication would have to be an integral part of the project. To this end, the inclusion of project partners and stakeholders in the communication process began with a strong emphasis on developing relationships.

A communication strategy was developed in the Autumn of 2000 which has focused on

So, the question becomes, how do we engage, in a meaningful way, with communities around Australia to re-examine our relationship with the environment?

four key areas of communication; strategic communication, information management, stakeholder relations, and internal communication. Each of these is outlined below.

Strategic communication

Developing both a national communication strategy, along with regional strategies is the primary focus within this communication 'category'. Within both the national and regional strategies there is an identification of the communication objectives, desired communication outcomes, target audiences, key messages, a detailed work plan and evaluation processes.

These plans, developed in close consultation with project stakeholders, guide the communication processes within the Project. At this stage, the primary audiences for the Ecosystem Services Project are government and policy decision makers, local catchment authorities, landholders and the general public.

Information management

The key element of the information management portion of communication activities has been to develop branding for the project. The branding is comprised of a number of elements; the logo, photo montage, colour scheme, 'describer words' and the way in which we interact with our clients, partners and stakeholders.

Our focus is on *people*, the social, economic and ecological *environments* that they live in, the *values* that they derive from their ecological environments (many of which are unrecognised by most people), and the *opportunities* that arise from those environments and values (which also are largely unrecognised).

After much discussion and input from our clients and stakeholders, the Ecosystem Services logo was decided upon. The typographical treatment of the logo conveys the words of the project while the fluid lines above the words are purposely vague, but convey elements of fluidity, landscape, topography etc. The use of a new logo rather than one or a few of the existing logos was to reinforce the fact that this initiative is a true partnership and to avoid the perception of dominance by any one partner. Project partners are acknowledged in any written or oral information and is intended to convey a "whole is greater than the sum of the parts" approach, and that the project's strength lies in its collaborative nature.

Other key elements within information management has been an update to the web page

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(www.ecosystemservicesproject.org), media liaison, fact sheets, a launch event, published reports, numerous public presentations, journal articles etc.

Stakeholder relations

As has always been the philosophy in the Ecosystem Services Project, a great deal of emphasis has been placed on participatory and interactive relations with our stakeholders. Communication is intertwined with research and uses a process of reflection and action together with the community of interest. Local perspectives form the basis for action, and this includes working with communities, education and outreach. To this end, engaging with the community via workshops, presentations and meetings has facilitated the process of ensuring that stakeholder input and opinion continues to be a key driver in the project.

The face-to-face nature of the work that has been undertaken in the project is both time and resource intensive. However, we have felt this to be an integral part of the overall success of the project. To date, over 100 national and international presentations, workshops and seminars have been given about the project and the nature of ecosystem services. This has resulted in a continuous flood of requests for further information and involvement both in Australia and overseas.

Internal communication

With the growing number of areas around Australia that are interested and engaged in undertaking ecosystem service oriented work, there remains much work to be done in ensuring that the lines of communication are open in an effort to facilitate the exchange of ideas and methodologies. In March 2001, there was a workshop in Atherton for representatives of all case study areas. This two-day workshop was designed to identify areas of potential collaboration and to exchange ideas on methodologies. It was also agreed that such a meeting should be held every year. The next meeting, early this year, will include representatives of a much wider number of projects dealing with ecosystem services around Australia. In this way, the lessons we are learning can be shared widely.

Conclusions

The communication and marketing of the project has been pivotal in the first couple of years of the project's development. To have communication embedded so strongly in a scientific project is unique and serves two primary purposes — firstly, to engage with communities and decision makers about a new way to envisage our relationship with our environment, and secondly, to identify new areas of research that need to be undertaken in the area of ecosystem services.

Is it working?

The Ecosystem Services Project originally envisaged working with two communities in Australia, with a growth target of four. Currently, there are eight different regions undertaking ecosystem services research, with other independent studies and work also being undertaken. It would seem likely then, that ecosystem services is a concept and an approach to natural resource management that is resonating at both a community and decision maker/policy level.

ECOSYSTEM SERVICES PROJECT

www.ecosystemservicesproject.org

ECOSYSTEM SERVICES PROJECT

THE ECOSYSTEM SERVICES PROJECT IS A PARTNERSHIP BETWEEN THE FOLLOWING ORGANISATIONS:

THE MYER FOUNDATION
The Sidney Myer Centenary Celebration 1899–1999

75 years of Australian Science CSIRO

Land & Water AUSTRALIA research · development · innovation

The University of New England AUSTRALIA

Cotton CRC

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

Rainforest CRC

RIRDC
RURAL INDUSTRIES RESEARCH AND DEVELOPMENT CORPORATION

New RELEASE

Australian *Streamflow*

Australian *Streamflow* is a CD-ROM based tool that allows the impact of Australia's variable climate on rivers and streamflow to be analysed and forecast for a particular location across the country.

"If you are a professional river manager, storage manager or irrigator, now is the time to get serious about incorporating climatic variability into your water use planning. *Streamflow* has been designed specifically for your use and can be run on a personal computer." says Barry White, program coordinator for Land & Water Australia's, Climate Variability in Agriculture Program.

Streamflow is a plug-in enhancement to *Australian Rainman*, which uses rainfall information from 3900 long-term rainfall stations to help people working in Australia's highly variable climate make better management decisions on the impact of climate on water availability.

Why you should be using *Rainman* with *Streamflow*

If you are in the business of managing water then you should be using *Streamflow*. Taking account of climate variability in water resource planning and management will become more routine as our understanding from tools such as *Streamflow* and *Australian Rainman* become widely accepted.

Streamflow has been designed to give irrigators, storage managers, water agency managers, river management agencies, researchers and farmers the power to:

- Examine historical records of streamflow at over 400 locations across Australia, with site information for each gauging station, the catchment and the water agency providing the data. Some streamflow stations also have long-term data provided from computer models of rainfall-runoff relationships.
- Analyse monthly streamflow for Australian rivers and daily streamflow for some rivers.
- Forecast seasonal streamflow for any length of season up to one year ahead based on the Southern Oscillation Index and the Indian Ocean Sea Surface Temperatures.
- Maximise water-use efficiency, improve reliability of supply, achieve higher agricultural production at a cheaper unit cost and reduce risk in decision making.
- Improve drought management, with historical information on exceptionally dry periods and wet periods readily available.
- Determine the area of cropping and the likely level of watering achievable.
- Support catchment management decisions such as the best time to do riparian revegetation and erosion control.
- Determine the chances of high and low environmental flows occurring.
- Manage river regulation for flooding and dependable water supplies.
- Optimise pumping times for off-river storage.
- Calculate how many days you can harvest water from a river and how much water you can harvest.
- Provide advance warning of water storage problems and determine volumes of water available for diversion by licensed pumping.
- Update and import new data from water management agencies or other sources.
- Statistically compare the probabilities of seasonal outcomes to see whether the changes are significant or just due to chance.

Further information

Streamflow requires prior installation of Australian Rainman Version 3.3. The cost of Rainman including GST is $104.50 (Standard) or $440 (Professional). Streamflow costs $104.50. Both can be ordered by telephone and credit card from Karen Taylor, telephone 07 4688 1348. For technical information, contact Nick Clarkson, tel 07 4688 1248, fax 07 4688 1477, email Nick.Clarkson@dpi.qld.gov.au

New South Wales

By Keith Uebel

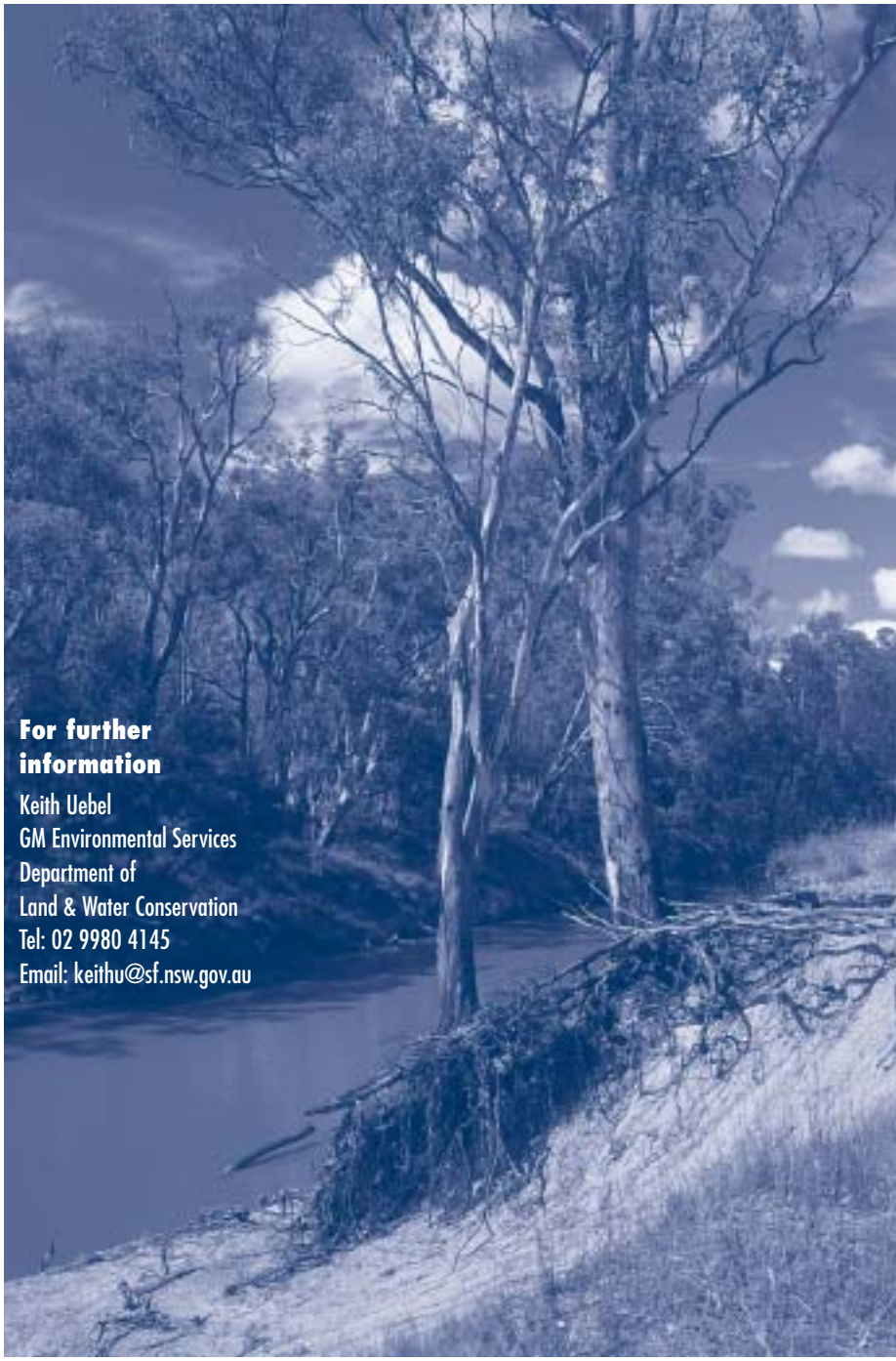
Environmental services scheme for rural areas

In a move to provide greater recognition for the environmental benefits produced on farms, the NSW Government is seeking landholders to take part in the development of an Environmental Services Scheme. Staff from the Department of Land and Water Conservation, State Forests and NSW Agriculture will work with 20 landholders, or landholder groups, to identify and implement land use changes focusing on salinity control, remediation of acid sulphate soils, carbon sequestration and biodiversity enhancement.

Activities such as changing pasture and grazing management, planting new forests, managing regeneration of native vegetation, replanting riverbank vegetation, or re-establishing wetlands, all have the potential to generate environmental services, and will be integrated with regular on-farm production activities during the project.

Practical issues like the costs associated with including such environmental services within rural production, how to define and create ownership of the services produced, and the type of financial, contractual and incentive arrangements necessary will all be examined. Participants will represent a range of locations, enterprise types, and environmental and production benefits, with the land use changes funded through $2 million from the *NSW Salinity Strategy*.

Those landholders involved will have the opportunity to enhance the sustainability of their property, improve their catchment and help explore ways of achieving a new approach to natural resource management. The information gained will help to expand the scheme to other areas and, eventually, to develop markets through which a range of environmental services can be traded. Landholders interested in the scheme can call 1800 353 104 for an information package. Expressions of interest will be called early in 2002.



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New South Wales

Dirt, dollars and decline — key results from Gwydir forum

By Nick Reid, Letitia Silberbauer, David Thompson, Ian Oliver, Brian Wilson

The Gwydir Region in northern NSW is located west of the Great Dividing Range. The 26 550 km^2 catchment is nested within the Murray Darling Basin with a total population of 80 000. The major centres in the region are Moree, Warialda, Bingara, Uralla and Guyra. The physical geography of the catchment is divided into three distinct biological and economic zones — tablelands, slopes and plains.

This catchment is the focus of the Gwydir Ecosystem Services Project (GESP), a collaborative effort between the University of New England, The Centre for Agricultural and Regional Economics (CARE), DLWC's centre for Natural Resources, the Cotton Cooperative Research Centre and CSIRO Sustainable Ecosystems. The focus of the GESP is to:

- undertake an inventory of ecosystem services in the Gwydir Catchment;
- study the impact, vulnerability and manageability of ecosystem services in relation to each land use;
- assess the ecological, economic and social impact of changes in delivery to ecosystem services;
- develop a framework and tools to assess ecosystem services; and
- raise awareness and understanding of ecosystem services.

In order to ensure that the outcomes and processes of the project are customer focused, the GESP team has developed an iterative and participatory process with members of the Gwydir community. An expert reference panel has been convened which serves as a scientific 'sounding board'. Similarly, in order to ensure the information going into, and coming out of the project is relevant to the ultimate end users — the catchment community — a community consultation process has been established.

A range of representatives from the Gwydir Catchment community participated in a two-day workshop in June 2001. The maintenance of soil health, the decline of ecosystem services and where to spend taxpayer dollars on research were focal points of discussion. A key point of understanding to emerge from the workshop, was that ecosystem services can be found operating everywhere — from parks to pastures to paddocks. Almost 50 participants went through a process of ranking ecosystem services in relation to their importance in sustaining a range of land uses. Maintenance of soil health was consistently ranked the highest, with maintenance and regeneration of habitat, maintenance of healthy waterways, life fulfilment and maintenance of river flows and groundwater levels also ranked highly.

Participants were then asked about the vulnerability of the highly ranked ecosystem services. The array of threats, combined with the technological and economic feasibility of managing these threats, led stakeholders to conclude that the most important ecosystem services in the Gwydir Catchment are highly vulnerable. The workshop participants also highlighted the social barriers to managing threats to ecosystem services, including lack of awareness, willingness, motivation and incentives for resource users to change their management practices. When asked to spend a $100 of taxpayer money to investigate ecosystem services, soil health and habitat attracted the most funding. However, not just 'science' attracted the dollars. Social research on ways to mitigate declining quality life in rural areas was a target for money as well.

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A key point of understanding to emerge from the workshop, was that ecosystem services can be found operating everywhere – from parks to pastures to paddocks.

Services and Dis-services of rainforest insects to crops in north Queensland

The aesthetic appeal and resulting tourism benefits, are some very obvious advantages of the rainforests of Far North Queensland. Rainforests also deliver many other services to humans such as regulating water flow, storing carbon, supplying new pharmaceutical chemicals, housing insects which contribute to pollination, and acting as refuges for fauna. Forests can also have negative impacts, or deliver 'dis-services' to humans, for example, insect pests. Some insect species that originate in the Australian rainforest, or use the rainforest for a part of their life cycle, cause economically important damage to nearby crops.

CSIRO Entomology is undertaking a study to examine the role of insects — both in terms of the advantages and disadvantages they provide to north Queensland crops. The economic significance of the services and dis-services provided to agriculture by rainforest insects will be examined by looking at pollination, herbivory and biological control of pest arthropods by insects in production systems adjacent to the rainforest. Specifically the project aims to:

- predict the proportion of pollination in a range of agricultural systems that is provided by insects reliant on rainforest;
- quantify the level of herbivory and subsequent production losses caused by various rainforest insects in a number of important agricultural crops adjacent to rainforest;
- determine the source and abundance of potential natural enemies (parasitic and predatory insects) of major pest arthropods of a number of important agricultural crops; and,
- estimate the economic value of pollination, crop damage by pests and biological control of pests as services/dis-services provided by rainforest insects so that these relationships and values can be incorporated into economic models.

This assessment will incorporate published information, consultation with other researchers and growers, and field surveys of pollinators, pests and control insects in a wide range of crops. The research will allow the contributions of rainforest insects to be better incorporated into decision-making on natural resource use. CSIRO is working with land managers that receive faunal services from rainforest, for example, growers and grower organisations, Department of Primary Industry and Landcare groups, as well as with The Wet Tropics Management Authority and Department of Environment and Heritage that provide faunal services.

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Sugar cane farm with adjacent rainforest, North Queensland.

Australian Capital Territory

By Alistar Gringbergs

Recognising the value of ecosystem services — launch of urban wetland in O'Connor

On Saturday the 8th of December the Sullivans Creek Catchment Group (SCCG) opened the O'Connor Demonstration Wetland. Around 150 local residents, representatives from community groups, ACT Government departments, members of the ACT Legislative Assembly and the housing construction industry were welcomed to the wetland site by a member of the community on behalf of the Ngunnawal traditional owners.

The SCCG formed out of concern for the long-term health of Sullivans Creek and its catchment, and has worked closely with the catchment community to identify the values people place on their environment, and the issues of concern they had about their local area. These issues included poor water quality, a lack of habitat for aquatic plants and animals, and the low visual quality of the creek corridor.

Concrete channels associated with traditional urban stormwater management allow few recreational activities, and contribute to under utilisation of the urban open space required to accommodate flood ways. The O'Connor Wetland project is designed to help address some of these issues by providing a range of ecosystem services, for example, improving water quality, providing habitat for birds, fish, amphibians, reptiles and macro-invertebrates and increasing the recreational and visual amenity of the area.

The SCCG was able to win the support of Canberra Investment Corporation, CIC Pendon and Community Housing Canberra who were responsible for the adjacent City Edge housing development. The SCCG's corporate partners not only recognised the value of supporting the wetland project but also brought valuable building, engineering and construction management skills to the project. This was backed up with a financial contribution of $165 000 toward the project. Other sources of funding included the ACT Government and the Commonwealth Governments — Natural Heritage Trust.

The opening of the wetland came at the end of six weeks of hard work by SCCG members and community volunteers who spent their weekends helping to plant over 54 000 wetland plants, grasses, sedges, shrubs and trees. The wetland brings together community aspirations for an improved urban environment and there are plans for similar wetlands throughout the Sullivans Creek Catchment.

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Some facts about the Sullivans Creek Catchment

- Sullivans Creek is the second largest tributary flowing into Lake Burley Griffin which is a major recreational and visual feature for Canberra.
- Sullivans Creek is the most densely populated and developed sub-catchment in the ACT, and is the most degraded and polluted creek in the ACT.
- Lake Burley Griffin is located on the Molonglo River, a major tributary of the Murrumbidgee River, which is a major tributary to the River Murray.
- Canberra is located high upstream in the Murrumbidgee Catchment — which is a unique situation in Australia. For all the other major catchments in Australia urban areas are located at their base downstream. The Murrumbidgee Catchment is one of Australia's most productive catchments that the ACT pollutes due to the size of its urban footprint and its location upstream.
- Canberra is the largest city in the Murray-Darling Basin, making Sullivans Creek a significant down stream polluter for Australia's largest catchment.

A decision support system for the Onkaparinga Catchment

Once a catchment group has created an inventory of ecosystem services, they will need to make decisions about how those services are managed. This is likely to involve taxing questions about how much of each ecosystem service is supplied. For example, should the area of farmland be decreased to allow rehabilitation of terrestrial habitats? Should the development of high-value horticultural crops be encouraged to increase a region's economic welfare?

These sorts of questions will present catchment decision-makers with complex trade-offs. In making their decisions, catchment managers can be faced with huge amounts of data, but a paucity of policy relevant information. They also face competing priorities held by diverse community groups, tight budgetary constraints and considerable uncertainty. Further, many catchment boards are newly formed and are still building institutional experience in managing people, organisations and nature.

The Policy and Economic Research Unit (PERU) of CSIRO Land and Water is working with the Onkaparinga Catchment Board to resolve some of the difficulties. Under this research partnership, a project is commencing that will develop a prototype catchment decision support system (DSS). The DSS will allow 'what-if' scenario type modelling of catchment policies. It will inform decision-makers by identifying trade-offs between competing objectives. As the DSS reaches maturity it will help planners draft the next catchment plan, due for release in 2005.

The Onkaparinga Catchment, located just south of Adelaide, provides an excellent setting for the development and testing of decision support systems designed to facilitate the management of ecosystem services. With a population of 174 000, the Onkaparinga Catchment comprises a mixture of urban, agricultural and conservation land uses. The major industries include viticulture, other forms of intensive agriculture, manufacturing, services and tourism. Some of the issues facing natural resource managers include the allocation of surface and ground water, water quality (nutrient loads and salinisation), habitat loss, invasion of weeds and unemployment (up to 16% in the upper catchment). The landscape also has extremely high aesthetic and recreational values.

The first task was to meet with managers of the Onkaparinga Catchment to ask *What exactly did they need a DSS for?* This was achieved through a half-day workshop that sought to:

~ Identify a set of indicators that could be used evaluate alternative policy options for the catchment.
~ Identify a set of physical on-ground changes that could occur in the catchment either through planned interventions by the Board or as a result of unplanned biophysical, institutional or economic forces.
~ Identify a set of policy options open to the board to attain desired landscape changes.

With this information, the project team will construct a DSS that brings to life spatial and non-spatial databases available for the Onkaparinga Catchment. The DSS is likely to contain 'off the shelf' models that explain relationships between land use changes, nutrient runoff, farm profitability, revegetation (especially in riparian zones), farm dams and environmental flows. As these processes are modified the DSS will report on a set of environmental, social and economic indicators deemed to be important to the Catchment Board.

Whilst the exact look and feel of the DSS interface is not yet known, it is likely to present policy questions to decision makers using a multiple criteria analysis (MCA) framework. The MCA technique facilitates the exploration of alternative policy options, in the light of a set of multiple, and often conflicting, objectives. The Onkaparinga Catchment model will present decision-makers with an MCA model that allows interactive specification of criteria weights and how they influence the relative rankings of policy options.

In the first instance, a prototype DSS will be constructed for the Onkaparinga Catchment. It is hoped this will be refined as improved data and models become available. The philosophy behind constructing the Onkaparinga DSS is to develop a tool that genuinely meets the needs of decision-makers. This means making assumptions and exploring new areas of science involving integration between social, economic and biophysical disciplines. It also means stepping outside the realm of the tried and tested.

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Or in other words,
it's better to provide an approximate answer to the right question than an accurate answer to the wrong question.

By Steven Cork and David Shelton

An inventory of ecosystem services in the Goulburn Broken Catchment

The Goulburn Broken Catchment has become the site for the first, and so far, most substantial case study under the National Ecosystem Services Study. The framework described earlier in this edition of *RipRap* (see page 9) is being applied in the Goulburn Broken, with the first phase of this project the development of an 'Inventory of Ecosystem Services'.

Development and trial of methods for inventory of ecosystem services

Developing an Inventory of Ecosystem Services is difficult, as there have been relatively few comparable assessments of ecosystem services at a catchment, or similar geographic scale anywhere in the world to use as models. The objectives of the inventory phase of The Ecosystem Services Project were to:

- describe the full range of goods (products) produced from the environment in the study area;
- identify the dependence of these products on ecosystem services; and,
- identify the ecosystem services of highest priority for further study and management.

There are substantial limitations on the information available to address these objectives. The study team worked with local stakeholders to assemble a comprehensive list of those products/goods from ecosystems that people value, in economic or other terms. These products/goods included tangible, marketable commodities such as beef, wool and wheat, as well as less tangible, marketable products like recreational opportunities, aesthetic beauty, sites of cultural importance and intellectual or spiritual stimulation. A range of different people were involved in workshops to derive these lists with scientists, economists, representatives from industries, agencies and the general community all taking part. The products/goods listed through this process were aggregated into groups on the basis of the industry and land-use expected to have similar impacts and management pressures.

The second part of the process involved people working out what ecological processes were important in producing the products/goods identified. These were then aggregated into higher-level services such as those shown in Table 1. Once the products/goods were identified, and the role of ecosystem services in their development considered, the services were ranked by local stakeholders and scientific experts. This process was complex as the ecosystem services

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Catchment facts

Location of the Goulburn Broken Catchment in Victoria

Often referred to as the "food bowl" of Australia, the Goulburn Broken Catchment is located in Northern Victoria, Australia. The Catchment is diverse in terms of landuse, consisting of an irrigated region in the north (270 655 hectares in size) primarily made up of horticulture (fruit) and irrigated dairy pasture; a central dryland grazing and cropping region (1 397 130 hectares in size); and, a southern high country area valued for its timber, tourism and recreational uses (690 603 hectares in size). Approximately two-thirds of the catchment has been cleared for agriculture with 190 000 people calling the Catchment home, of which 17 000 are employed in agriculture and associated industries.

The population of the Catchment is predicted to grow to approximately 210 000 by 2021 (an annual rate of 0.6%). The Shepparton Irrigation Region contains 63% of the population of the Catchment, but significant population growth is predicted for the southern shires close to the Hume Highway. These areas are within two hours drive of Melbourne, which is leading to increased interest in the land for rural lifestyle living, cheaper housing and new industries. This is leading to land values in the area increasing, making it less cost effective to purchase land for traditional agricultural enterprises. Some of the increased land value is attributable to retained native vegetation, a value that has not been recognised in the past.

Table 1
Ecosystem services (rows) judged to be of high importance to various land uses (columns) in the Goulburn Broken Catchment

Services	Land uses											
	Dairying, on farm	Fruit and grapes	Vegetables	Grazing	Crops	Intensive animals	Forestry	Food processing	Housing	Water production	Recreation	Areas of cultural/ future options
Pollination		■										
Life fulfilment	■			■					■			■
Regulation of climate	■	■				■		■				
Pest control		■	■	■	■							
Provision of genetic resources				■								
Maintenance of habitat		■	■	■			■		■		■	■
Provision of shade and shelter	■	■		■	■				■			
Maintenance of soil health	■	■	■	■	■							
Maintenance of healthy waterways	■	■		■			■	■		■	■	
Water filtration and erosion control			■	■	■					■		
Regulation of rivers and groundwater	■	■			■					■	■	
Waste absorption and breakdown	■	■	■	■	■	■		■	■	■	■	

were often interconnected. Three assessment criteria were used to assess relative importance:

~ *Overall importance/impact* — the overall importance of the service was considered in terms of the importance of the products to the catchment (Gross Value of Production), the perceived importance of the ecosystem service to the products, and the impact of the land-use/industry on the ecosystem service's capacity to maintain natural assets.

~ *Importance at the margin* — the impact of a small change in a service on the production of, or the maintenance of natural assets.

~ *Manageability* — the capacity to manage the land-use/industry to ensure the ongoing delivery of the service.

A ranking of low, medium and high, was used for each ecosystem service. For the highly ranked services, drivers of decline in service delivery were identified along with the observed impact and a set of possible ameliorative actions.

Key findings of Goulburn Broken case study

Application of the inventory process described above to the Goulburn Broken Catchment revealed that all ecosystem services were of high importance (usually implying that further decline in the service would have a significant impact on production) for at least one major land-use or industry (Table 1).

Further consideration of the ecological and management drivers of this situation revealed nine key issues that the Ecosystem Services Project will be investigating further:

~ integration, evaluation and management of the multiple benefits provided by the inter-actions between ecosystem services;

~ the trend towards intensified landuse in some areas, particularly for irrigated agriculture, and the need to carefully manage offsite impacts;

~ change in land ownership, particularly in areas close to Melbourne which are being purchased by wealthy "lifestyle" farmers.

continued over

This could provide a significant opportunity to improve environmental outcomes;

~ quantification of the multiple benefits of revegetation to further improve cost-sharing arrangements;

~ the need for catchment planning to take explicit account of the life-fulfilling values of nature, including indigenous culture, and the intrinsic values of biodiversity, and landscape amenity;

~ management of soil (acidification, sodicity, soil carbon, breakdown of structure) and evaluating the services provided by soil biodiversity;

~ accounting and planning for the dependence of non-agricultural land and water values (tourism, recreation) on the catchment's resources;

~ engaging in more work on water management with a focus on salinity, environmental flows, nutrient management and the potential conflicts with non-agricultural requirements; and

~ working out how to adaptively manage for emerging and longer-term issues such as climate change, shade and shelter, waste management, pest control and pollination.

Conclusion

The ecosystem services analysis framework is the first step in an analysis of ecosystem services, and is essential for identifying and prioritising the relative importance of the services and goods produced by ecosystems. The next step in the process uses scenario analysis to look at the highly ranked issues and services in more detail. Under future scenarios, the changes in delivery of the "highly ranked" ecosystem services will be assessed using both economic and other indicators of value. We have been very fortunate to be able to work in partnership with the people of the Goulburn Broken Catchment, whose knowledge of their ecosystems, their impacts on those ecosystems and the social and economic constraints within which ecological decisions can be made is exceptional.

Ecosystem services research in New Zealand

My interest in the Ecosystem Services concept was first awakened in 1997 when a fellow scientist and I wrote a report for the New Zealand Ministry for the Environment on the 'Value of New Zealand's Biodiversity'. The report concluded that each year in New Zealand, land and freshwater ecosystems contribute services to economic production and consumption to the tune of $44 billion (NZ: 1994), with the value of the marine ecosystem services being almost certainly higher, but difficult to estimate reliably. At that time I was working on a mathematical methodology for an ecological approach to calculating values for natural assets and the ecosystem services they provide.

It was a complete revelation for me to realise that every year the ecosystems in our country provided services of such a high market value, yet were not included in our system of national accounts. I began to think of the implications and consequences of losing or damaging our natural asset base, and realised we were facing some enormous ecological and environmental problems. At first I struggled with the idea of treating natural assets as commodities, but at the time it was the only way we could see of making the biodiversity contribution to economic activity more visible to the public and to policy makers.

Following a recent visit with CSIRO Sustainable Ecosystems, I have started work with fellow scientists in Landcare Research to develop plans for an ecosystem services research project in the Motueka River Catchment at the top of the South Island of New Zealand. This research site is currently the focus of a multi-disciplinary, integrated catchment management (ICM) project that began in 2000 with primary funding from the New Zealand Foundation for Science, Research & Technology. The Motueka-ICM project has strong stakeholder support and, although relatively new, is already engaged in innovative and creative scientific research focused on the effects of land use on freshwater and coastal ecosystems. A major portion of the program is focused on how scientific knowledge is (or isn't) used by different stakeholder groups (including native Maori tribes), in decisions about managing water resources.

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An important learning is recognising and accounting for the fact that each of us have different reasons why natural assets are important to us, and these include a diverse assortment of cultural, spiritual, economic, medical and scientific values. It is difficult to capture all these concerns in a purely market-based valuation exercise. An excellent feature of this research is that it provides an opportunity for everyone to express their concerns and values in a process designed to discover what is important to us as a community.

Ecosystem services research in New Zealand is more than just an academic exercise. The New Zealand Resource Management Act (1991) provides legal guidance for avoiding, remedying and mitigating against development activities that impact on the "life-supporting capacity of ecosystems". Earlier town and country planning in New Zealand came under the jurisdiction of the Town and Country Planning Act (1947) and attempted to strike a balance between the conservation ethic and development values. As of 1991, all proposed development in New Zealand must be shown to be in harmony with the sustainability ethic embodied in the aims and purposes of the 1991 Resource Management Act, which includes consideration of the needs of future generations.

Furthermore, markets for ecosystem services have the potential to provide a strong incentive for the "on-ground" outcomes that the New Zealand Government is looking for in implementing its new Biodiversity Strategy. The idea of using markets for ecosystem services as an incentive to sustain biodiversity on private lands was cited in a recent report (Weaving Resilience into Our Lands: future roles for native plants on private lands) by the Parliamentary Commissioner for the Environment. Much work will need to be done before we see operational markets for ecosystem services. In the meantime, the collaborative research links between the CSIRO Ecosystem Services group in Canberra and Landcare Research in New Zealand has made a good start.

"... all proposed development in New Zealand must be shown to be in harmony with the sustainability ethic..."

Behind me is the central north Island plateau. The snow-capped mountain you can see on the horizon is Mount Tarawera. Between me and the mountain lies farmlands, rivers, remnant forests … when it comes to symbolising ecosystem services, this view does it for me. Anthony Cole.

Conservation farming and ecosystem services research in South Africa

Numerous ecological parallels can be drawn between South Africa and Australia. It is, therefore, not too surprising that many of the conservation and productivity challenges facing rural areas in these two countries are very similar. The removal and extinction of indigenous plants and animals is not only a conservation problem, there is also growing evidence that native species contribute to sustainable agriculture. This is of particular importance in a country such as South Africa where farmland occupies more than 80% of the land area. The National Botanical Institute in South Africa is currently heading a study titled, 'The Conservation Farming Project'. This is a three-year project funded by the Global Environmental Facility of the World Bank, looking into the importance of conservation in agricultural landscapes.

This project has four study sites which have been located in areas rich in biodiversity. These areas are; the Bokkeveld Plateau near Nieuwoudtville (Northern Cape), the Nama Karoo near Beaufort West (Western Cape), Valley Bushveld near Kirkwood (Eastern Cape), and the Southern Drakensberg grassland near Underberg (KwaZulu-Natal).

The Conservation Farming Project will compare approaches taken by individual farmers in these four areas, assessing those which benefit conservation, and whether conservation friendly approaches to farming are economically beneficial compared with more traditional farming approaches. The factors that influence farmers decisions about landuse practices and their adoption of alternatives, are also being investigated. A project team comprised of natural scientists, social scientists and economists has been assembled. Detailed biodiversity assessments of plant and insect species are being carried out at all of the sites. Bird and small mammal studies are taking place at selected sites. Carbon sequestration, as well as the above and below ground biomass is being assessed at all four study sites.

In addition to these components, ecosystem services are being investigated. Ecosystem services are defined here as the direct benefits farmers derive from ecosystem goods and processes. The study of ecosystem services has not taken place in South Africa before. Previously, the focus has been on placing monetary values on ecosystem goods, for example, what is the value of an individual elephant. Due to the very broad nature of the research focus of ecosystem services, this component of the Conservation Farming Project is focused on only two of the four study sites, those in the arid western half of South Africa, the *Nieuwoudtville* and *Beaufort West* sites.

Nieuwoudtville

The *Nieuwoudtville* site is at 700 metres above sea level, receiving 350 millimetres of rainfall per annum. Wheat production and sheep farming are the dominant agricultural activities. Ecosystem service research here is focused on determining what benefits farmers derive from the remaining natural vegetation in this fragmented landscape.

Beaufort West

The *Beaufort West* site is dominated by sheep farming in a rangeland system receiving less than 300 millimetres of rainfall per annum. Here we are comparing ecosystem services under two very different grazing regimes, assessing how they may differ with different management practices.

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For more information and project updates please visit our web site: **www.nbi.ac.za**

The scale of the Conservation Farming Project is at the individual farm scale. A bottom up approach to the ecosystem service study is being used, where farm level benefits and services as well as disservices are being explored. Identifying and developing the ecosystem service research focus was achieved through discussions with farmers on a one-to-one basis, as well as within a group workshop context. As a result, the study is focused by the farmer's perceptions.

Three main research directions developed to date are: vegetation as a resource to the farmer; effects of disrupted ecological processes or food webs; role of landscape structure in farming.

~ In understanding vegetation as a resource to the farmer, a number of experiments have been set up. These look at: productivity on different farms in a mixture of vegetation types; a species level study of growth and flowering patterns; a palatability assessment of different species in different vegetation types; a structural assessment linked to temperature studies; and, which plant species are responsible for degrading the quality of wool.

~ The effects of disrupted ecological processes are being explored in a single study that is looking at the impact of predators on sheep farming. The natural diet variety and abundance available to predators will be compared to stock losses on individual farms. The variability and number of faunal species, which comprise the natural diet of these predators, is dependent on the structure and availability of natural habitat. Different vegetation structure and fragment areas will be examined in relation to stock losses.

~ The role of landscape structure is being explored in studies looking at the utilisation of the landscape by sheep, both daily and seasonally. The importance of landscape heterogeneity to the farmer will be determined.

We are currently about halfway through our study and aim to have concrete results by June 2002.

GAB FEST 2002

A resource under pressure Toowoomba, 11–13 March 2002

GAB FEST 2002 — A resource under pressure (11–13 March) is the Great Artesian Basin (GAB) Consultative Council's inaugural symposium. This symposium will cover key areas of groundwater resource management in Australia including infrastructure renewal, water reform, advancements in technology, changing attitudes and improvement of environmental, cultural heritage and socio-economic values. A post conference tour (13–15 March) will highlight groundwater issues in the Roma and St George regions.

The 5th GAB Spring Researchers Forum (10 March) will also be held in conjunction with *GAB FEST 2002*, and is hosted by Environment Australia. The Forum will explore spring issues from across the Basin, drawing on an extensive panel of experts to present and discuss new research and management. The Forum will include consideration of the 4 April 2001 listing of communities dependant upon flows of GAB springs under the Federal *Environmental Protection and Biodiversity Conservation Act (1999).*

Further information on the symposium, post conference tour, Spring Researchers Forum and registration can be found at www.gab.org.au or by contacting the GABCC on 07 3236 4272

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