Cooperative Research Centre for
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Resilience Management

A Guide for Irrigated Regions, Communities and Enterprises

John Wolfenden, Michael Evans, David Essaw, Fiona Johnson,
Andrew Sanderson, Glen Starkey and Bill Wilkinson

January 2007

BETTER IRRIGATION BETTER ENVIRONMENT BETTER FUTURE

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A Resilient Irrigation Community will be Better Equipped to….

Succeed in irrigation enterprises;

Take better care of the environment;

Develop smart solutions to complex problems;

Survive in a rapidly changing world;

Diversify and innovate in crops and technologies;

Inspire communities and enterprises to grow.

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How to get the most out of this report

This report is intended for practical use by irrigation community leaders as a set of plain-English “how-to” guidelines for strategic planning towards a sustainable industry.

You may already have a strategic plan in place for your irrigation business, or even for a whole regional irrigation industry. However, the role of communities in developing stronger and more resilient industries with a smaller environmental impact and greater social cohesion is now beginning to be recognised.

This report provides a framework of tools for strategic planning which include and support the social processes of community, leading to more robust strategic plans that address social and environmental conditions as well as the needs of industry.

The aim of strategic planning in developing more resilient irrigation communities is three-fold:

- Establishing *learning communities* through group-forming and knowledge-sharing processes;
- Creating a *vision* for sustainable industry based on best practice and available opportunities;
- Developing *resilience management* practices that create the potential to respond adaptively to unforeseen change.

A first step to getting the most out of this framework is to recognise that resilience management cannot be done in isolation or by any small select team. It necessarily involves many other people, who must be identified, brought together, and inspired to work together in a long-term way.

The identification of a community, and the purposeful development of their skills in shared learning and communication, is not an easy task. It will require strong but flexible leadership, varying amounts of compromise and reconciliation, and most importantly, time. Communities may resist change even where there is a clear need and a strategic vision for it. People may grieve or suffer other psychological stresses as a result of change and its pressures. These reactions need to be dealt with sensitively, through open discussion and planning that responds to people’s emotional needs. This is not simply an exercise in engineering design and strategic planning – the human dimension is of paramount importance.

The formation of a learning community can, however, *begin* with just one person. That individual will need to develop a team of people who can support the process in practical ways: finding venues, chairing and facilitating meetings, collating and considering public submissions, locating and managing data, developing and demonstrating plans, and implementing and monitoring projects and on-ground works.

The team will find that parts of this framework are of use to different people at different times. Techniques for creating a shared vision, or for collaborating on a project plan, or for assisting the wider community to put it into practice, can be applicable over a time-frame of years. You will need to have a long-term picture of where you are going, and you will need to come back to the framework as well as many other sources of information again and again.

This framework will give you a good idea of the type of community learning processes you can realistically aim for, as well as a range of general tools and techniques for achieving good results. It provides a broad approach to resilience management that is necessarily open-ended on the detail, as each community is different and faces different sustainability challenges.

Most importantly, the framework is not the only resource you will need for guidance in resilience management. It is however a comprehensive overview of the “sustainability landscape” that you will need to travel, and suggests where else you need to look for information. We wish you the best of luck on your journey!

Section 1: Introduction and Concepts

Irrigation farmers, suppliers and their communities face a continuously changing world. Of course, change is with us in all aspects of our lives – hence the old saying "The only thing that doesn't change, is change itself".

Here we are interested in those changes directly affecting the irrigation industry such as:

- Climate change which will most likely lead to increased evaporation and reduced rainfall in many places;
- An increasing priority being given to water for the environment, resulting in less water being made available for extractive industries such as irrigation; and
- Institutional reforms leading to increased water trading and in many cases the increasing need for individual irrigators to directly manage their risk of reliability of supply.

The above changes are such that there is little or nothing individuals or their immediate communities can do to affect them. We recognise that some policy changes such as increased water for the environment and institutional reforms can not be influenced at a local level. This report is focused on actions that can manage the *impacts* of changing policy or external environment, and that can be implemented at a local or regional scale.

The more things change, the more they remain... insane.
Michael Fry and T. Lewis.

Change is the constant, the signal for rebirth, the egg of the phoenix.

Christina Baldwin.

Change is often threatening, and can cause increasing stress and feelings of inability to cope. There can be a sense that all is madness. But change also offers opportunity. Our hope is that this report will provide some ways of thinking about change to help reduce its complexity, and some tools to help exploit the opportunities.

Introduction

Why this framework?

Researchers from the Cooperative Research Centre for Irrigation Futures (CRCIF) have undertaken a number of projects under the general heading “Change at a Range of Scales”. These projects have sought to detail various drivers of change, and perhaps more importantly, detail some practical steps that irrigation communities can and/or are doing as a positive response.

As is the case with most research projects, each has generated a report written in a rigorous technical manner that is appropriate for such reports. This framework has been written to bring the key findings from those projects, and together with some additional information on adaptive management and strategic planning, provide a more accessible reference for those who are interested in pursuing these ideas and concepts.

The research project reports are available through the CRCIF website (www.irrigationfutures.org.au). Citations details for the reports are provided in the reference section of this guide.

Who might use it?

Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has. **Margaret Mead.**

The authors have been involved in projects in rural communities in many parts of Australia. In many of these places we find groups of local people who have organised themselves in order to plan for a more sustainable future for their community. These groups can take many forms – they might be formalised through bodies such as Catchment Management organisations or Regional Bodies, or established in other ways such as best-practice grower groups.

Whether people have organised as per the examples above, or in many other ways, it is most likely that what has effectively been formed is a Community of Practice.

The concept of a Community of Practice (often abbreviated as CoP, or CP) refers to the process of social learning that occurs when people who have a common interest in some subject or problem collaborate over an extended period to share ideas, find solutions, and build innovations.

We have targeted this framework at existing or potential Communities of Practice for Sustainable Irrigation. Actual membership of such CoPs is up to the members themselves to determine. Anyone with an interest in irrigation could create one – it could have local or national (even international) scope, and could include irrigators, local Council representatives, members of water management and regulatory agencies, environmentalists and so on.

So, who might use this framework? Anyone with an interest in being part of finding more sustainable ways of doing irrigation such that irrigation businesses, their connected communities and their natural resources become more resilient.

Concepts

Strategic Planning

Strategic planning is often made out to be more complex that it really is. In essence, strategic planning asks and attempts to answer some basic questions:

- *Where are we now?* This involves undertaking an analysis of the present situation and stakeholders, plus the relevant history. It may also include using tools such as SWOT analysis to provoke discussion of strengths, weaknesses, opportunities and threats;
- *Where do we want to be?* This involves: developing a vision of a preferred future; identifying the purpose of various initiatives; agreeing on core principles; developing goals (desired end-results or eventual impact of action) and objectives (the specific shorter-term results necessary to achieve goals);
- *How do we get there?* Developing action plans that articulate what needs to be done, by whom, by when, and with what resources;
- *How do we know what has been achieved?* Agreeing on suitable performance indicators — ways of measuring and evaluating the extent to which objectives have been achieved. Also, agreeing on a monitoring system to support evaluation and management;
- *What have we learned?* How can we build on the strengths of what we have achieved, and how can we do these things even better in the future?
- *How do we adapt?* Critically examining how strategies are driven by social and cultural forces, and understanding how these forces may need to be redirected for sustainable changes to occur. A consideration of the psychological impacts of change should at least partly inform this adaptive thinking.

The great difficulty of strategic planning is in deciding on the best course of action, out of the many competing objectives that the community may have for its limited resources.

The solution will usually involve dialogue between individuals and groups in the community. People need the opportunity to put their views forward and become involved in strategic planning in constructive and practical ways.

A useful framework to guide strategic thinking and discussion is shown in Figure 1.

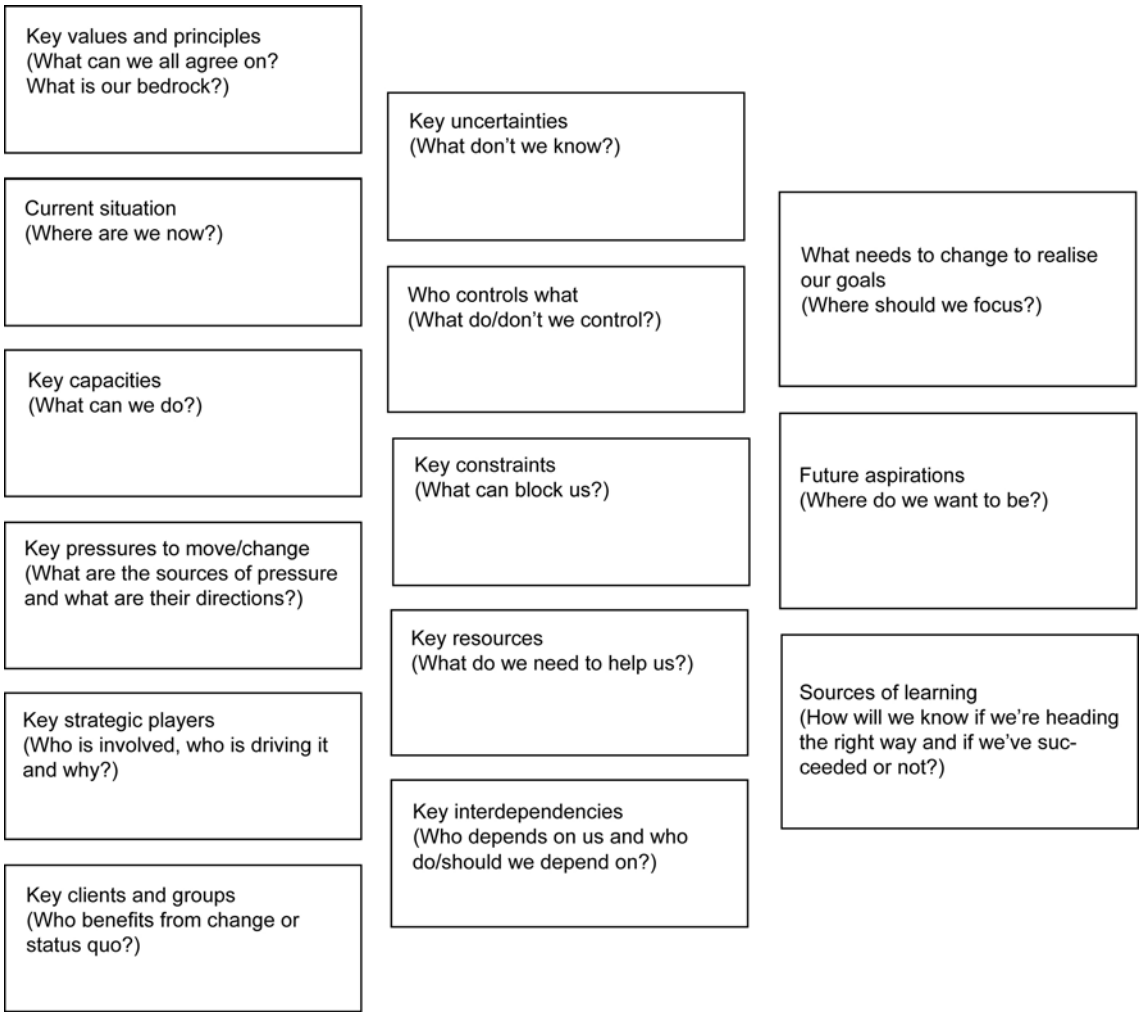


Figure 1: Guidelines for strategic thinking and discussion – working from left to right, evaluate the current situation and develop a range of alternative futures. (Source: New England Business School, UNE)

Adaptive Management

Strategic planning needs to be an ongoing process, particularly when change is rapid and open-ended as seems to be the case in many agricultural systems today. Strategic plans are usually updated on a five-year cycle at least.

One of the most effective methods for this type of cyclic planning is known as *Adaptive Management* (Figure 2). Adaptive management is cyclical and involves a number of stages, briefly summarised as:

Stage 1: Assess the current states and trends of the system using available data and local knowledge;

Stage 2: Design management strategies based on scenarios of possible future states after proposed interventions in the system;

Stage 3: Implement strategies by putting in place initiatives that are expected to drive change in a desired direction;

Stage 4: Monitor key indicators that are expected to most clearly show the effects of strategic initiatives. These should include indicators of environmental and social health as well as productivity;

Stage 5: Evaluate the monitoring data for trends showing improvement or decline in key indicators;

Stage 6: Review how effectively the strategic initiatives have worked to improve key indicators and resolve problems, and to what extent they have led to unexpected new problems;

And again…Repeat the cycle by reassessing states and trends, including the new data and new ideas generated upon reflection.

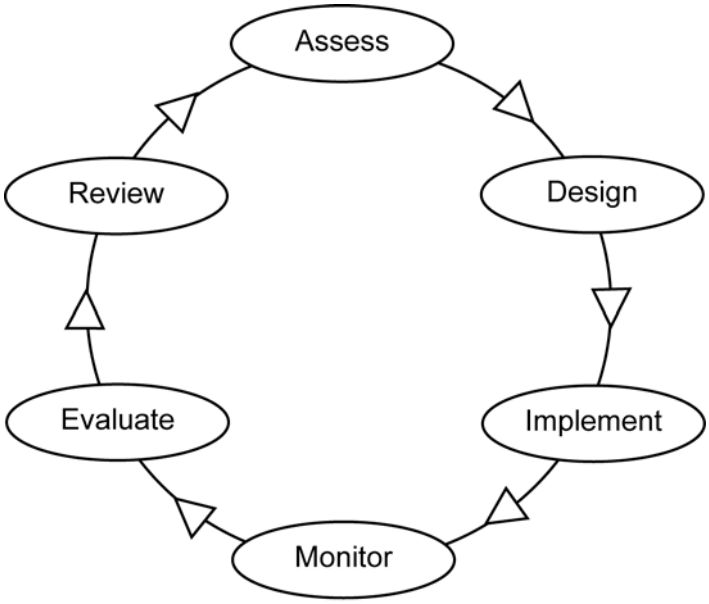


Figure 2: Adaptive management cycle consisting of six stages.

This cycle is sometimes referred to as a *learning* cycle, in the sense that evaluation and review lead to new ideas on how best to manage the system. The learning process may lead to profound changes in how the system is understood, managed and structured. The opportunity to "learn by doing" as part of this cycle can greatly reduce resistance to change and the stresses that come about through a perceived loss of control.

Resilience

In common use, ***resilience*** usually means either:

- The ability to recover quickly from illness, change, or misfortune; buoyancy; or
- The property of a material that enables it to resume its original shape or position after being bent, stretched, or compressed; elasticity.

The scientific literature on social-ecological systems defines resilience somewhat differently as:

- The capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity, and feedback mechanisms.

The ideas of stable structure and function can be imagined as a system that can return to an original size/shape and an original place in relation to other systems that may depend on it. Both these ideas are included in the technical meaning of the word resilience.

Example: an irrigation system would be resilient if after reductions in water allocations and availability, it was still producing basically the same crops and supporting the same community.

Related concepts

We have chosen to use the social-ecological systems theories because they make explicit that *people are an integral part* of the sustainable management challenge. These theories provide a way of understanding how people and natural systems interact, and a basis for developing plans to achieve improved outcomes including improved profitability, social capacity and environment.

Social-ecological systems are dynamic – that is, they *change* through time. The theories therefore also provide insights into how to manage change.

Along with *resilience*, the social-ecological systems literature also refers to *adaptability* and *transformability.*

Adaptability – the capacity of participants in the system to influence resilience.

Example: adoption of improved irrigation technology for improved water-use efficiency. This would enhance the overall resilience of the irrigation system in the face of reduced water availability.

Transformability – the capacity to create a fundamentally new system when ecological, economic or social structures make the existing system untenable.

Example: increasing salt levels in the water and soil in an irrigated area might require the change to more salt-tolerant crops, thus altering the overall function of the system.

Finally, we can think about resilience at a range of ***scales*** – because of cross-scale interactions, the resilience of a system at a particular focal scale will depend on the influences from scales above and below.

Example: the resilience of a given irrigation community will be influenced from above (i.e. bigger scale) by factors such as climate change and government policy, and from below (i.e. smaller scale) by factors such as soil fertility and farm debt levels.

The Resilience Concept Package

When thinking about resilience, we therefore need to consider the whole resilience package, not just the immediate notion of resilience itself.

The Resilience Concept Package	
Resilience	The capacity to bounce back after disturbance
Adaptability	What we can do in advance to help things return more or less to 'normal' after some disturbance
Transformability	The ability to create an essentially new system when circumstances demand this
Scale	It is important to consider influences from both above and below the system of interest

Resilience Management

Adaptive management and the resilience concept both emerged from the work of the noted systems ecologist C.S. Holling and his colleagues at the University of British Columbia and the International Institute of Applied Systems Analysis.

Resilience Management is an approach to strategic planning and adaptive management that seeks to maintain or improve the resilience of social-ecological systems. The objective of adaptive resilience management is to improve our ability to adapt to changing circumstances, sometimes through transformation of the wider social-ecological systems in which we live.

Note: Increased resilience isn't necessarily always a desired outcome. For example, weed systems can be quite resilient, and it's their resilience that makes them a nuisance! In this instance, management would be about seeking to *reduce* resilience of the weed system so that the weed can be controlled or eradicated.

Resilience management involves identifying resilience indicators as part of the strategic planning process, and implementing adaptive management systems designed to improve the conditions that drive those indicators. Many of the types of social-ecological indicators that are applicable to resilience management are suggested in this framework, however there will also be many indicators that are specific to a particular area.

Understanding which indicators to monitor, and how to integrate them into an area-wide resilience landscape, will require the work of a Community of Practice with considerable local knowledge as well as some technical support. Much of the work involves learning, and applying learning in practice. Resilience management provides no methods for “measuring resilience” as a number. It is best approached qualitatively, through dialogue. Strategy development can include scenario analysis, however the emphasis should remain on dialogue.

Some overall strategic approaches suitable for resilience management are presented in this framework, however once again it is expected that considerable local knowledge will be required to develop strategies that are relevant to a given area.

More information on the theory behind Resilience Management can be found in Appendix A.

Section 2: Learning to Manage Better

Community of Practice

We have written this framework assuming that it would best be used by a 'Community of Practice' (CoP) formed to pursue increased resilience for its community. Actually, the CoP label itself doesn't matter that much – many areas already have informal networks of people acting as though they are a CoP but not calling themselves that.

The CoP label is useful when it makes it easier to locate information about others who are doing similar things. Following is some information obtained from an internet search on the 'community of practice' term.

What is it?

Communities of practice are small groups of people who have worked together over a period of time and through extensive communication have developed a common sense of purpose and a desire to share work-related knowledge and experience (Sharp 1997).

The sort of CoP that might be formed to manage resilience would probably have the following features:

- It would have a strong emphasis on learning about the local system, and on taking action to improve the resilience of that system.
- It would not be defined by an organisational chart, but rather by the ways that people actually work together.
- People would have many different roles and knowledge.
- Membership would generally be open to those who wanted to be involved and to contribute.
- Through time, members would develop shared understanding about their local irrigation system and community, along with a strong 'action focus' to work within that system.

Establishment

It may be that you are already part of an appropriate group which is already, or could take on the role of working towards improved resilience for your local irrigation community.

If not, then really all you need to do in the first instance is to gather together a group of people who would like to get involved in this. If possible, you should include people who are already part of strong social, professional and/or political networks so that they can help your newly formed 'Community of Practice' to get established and to become recognised.

As one of the early actions with the group, we strongly recommend that you undertake a visioning exercise. When employed as a tool to help a group find and pursue a common purpose, the development of a shared vision can be an extremely powerful mechanism.

In his book *The Fifth Discipline: The Art & Practice of the Learning Organization*, Peter Senge gives the following thoughts about shared vision.

> A shared vision is not an idea. It is not even an important idea such as freedom. It is, rather, a force in people's hearts, a force of impressive power. It may be inspired by an idea, but once it goes further – if it is compelling enough to acquire the support of more than one person – then it is no longer an abstraction. It is palpable. People begin to see it as if it exists. Few, if any, forces in human affairs are as powerful as shared vision. (Senge 1990, p. 206).

Building shared vision

The authors have observed, participated in and facilitated a number of visioning exercises over the years. We have seen many of these not achieve much more than a few sentences on a page that no-one is particularly inspired by, let alone approaching the sort of dynamic power described by Peter Senge.

Recognising the potential motivating power of shared vision, we have continued to read and experiment as we search for a straight-forward approach that will work well for a Community of Practice group. We have identified the *appreciative inquiry* approach as one that will meet this need.

Appreciative Inquiry

Appreciative Inquiry is based on the principle that positive questions lead to positive change. Positive questions bring out the best in people, inspire positive action, and create possibilities for a positive future. It can be argued that reality is a human construction; we are free to choose which part of the story to inquire about. Questions of hope, joy and enthusiasm bring stories, images and experiences of joy and hope. Conversely, questions about problems and stress lead to stories, images, and experiences of problems and stress. This hold true because human beings want to turn toward positive images that give them energy and nourish happiness (Watkins and Mohr 2001; Whitney and Trosten-Bloom 2003).

This can actually be put to practical use quite simply, as is demonstrated in this recent example undertaken with the North Burdekin Water Board in Queensland.

As part of working with them to explore how Triple Bottom Line Reporting might be useful in their organisation (see *Section 3 Monitoring*, below), a meeting of the Board was convened and among other things a visioning exercise was conducted (see Shepheard, Wolfenden and Attard 2006).

The participants were invited to consider the following questions in order:

1. What does the organisation do well now?
2. What would you like the organisation to do more of?
3. What other things might the organisation aspire to do better or differently in the future?

This exercise was facilitated and the various responses to the questions recorded on a large whiteboard as a record of the 'group think' that ensued. Using these questions meant that we did not have to labour the idea of coming up with a vision. Rather, it is a natural and relatively easy outcome of working through the questions.

This approach produces positive discussion focussing on the opportunities (not threats) and strengths (not weaknesses). Once the positive frame of thinking is in place, and

people are reasonably comfortable with the emergent vision, it is then time to ask the fourth question in the series:

4. What plans need to be made now, and what actions should be taken now and into the immediate future, in order to move towards that vision?

This last question provides the opportunity to consider some of the barriers and problem issues – the *threats* and *weaknesses* referred to above. Note though that through using the appreciative inquiry approach, a *positive frame of reference* is first established to help deal with the negativity that consideration of problems often generates. This is a powerful technique which helps people in harnessing their creativity rather than feeling burdened by all the problems.

The appreciative inquiry approach can also be explored through the Four-D Model shown in Figure 3.

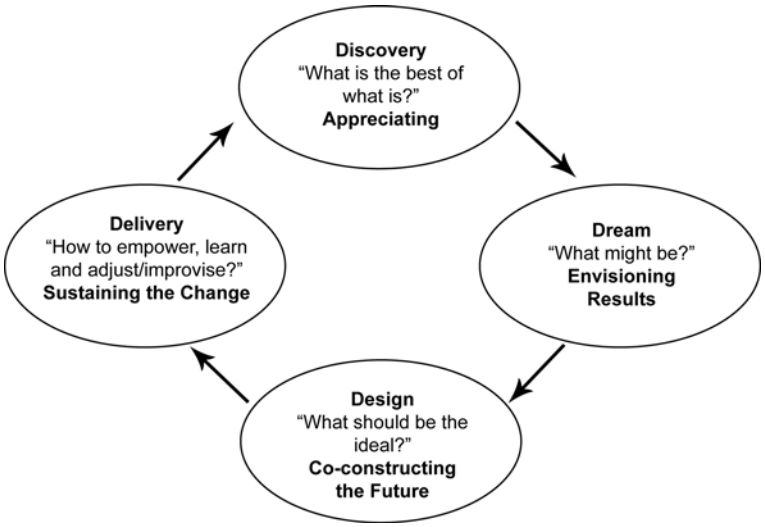


Figure 3: The Four-D Model of Appreciative Inquiry (Adapted from Watkins and Mohr 2001)

Water and irrigation management is a complex process involving many stakeholders, with different knowledge and at different levels. The success of management initiatives in such a context depends on the capability to facilitate cooperation between stakeholders and integration between different sources of knowledge.

An approach where stakeholders listen to each other and participate in the development of shared insights, has the potential to reshape the practice of sustainable water resource management (Meppem and Gill 1998).

Be purposeful about learning

Learning in a Community of Practice should be purposeful. It should not be something that is just left to chance, or something hoped for. Adoption of the adaptive management cycle as a foundation for managing towards improved resilience, will serve to explicitly embed learning as part of ongoing activities (see Figure 2 and adjacent text).

Some things to watch for

Some of the benefits of the learning community approach include (Zerba, 2006):

- It empowers communities to understand and solve resource management problems at a local scale.
- It offers the community a sense of ownership of their local water resources, which may result in an increased likelihood of the management arrangements succeeding.
- Landholders are more likely to cooperate with a community-based management regime than a government regime
- May reduce the need for compliance actions from the government.

These benefits also tend to reduce the psychological stresses of change and create opportunities for individuals and communities to discover a new sense of control despite imposed and planned or unplanned changes.

However, there are also a number of concerns that have been highlighted in relation to the implementation of co-management arrangements, namely (Zerba, 2006):

- They rely on the local group being able to function effectively. Some local groups can suffer from issues like dominant members overpowering other members, vested interests and a lack of trust and respect within the group. Such issues can lead to the breakdown of the group structure.
- Devolving power to local groups may result in some stakeholder groups not being adequately represented.
- They can give rise to issues associated with power, conflict and accountability.

From the above, a number of risks for community-based management groups can be seen. These risks stem from the dynamics of small groups:

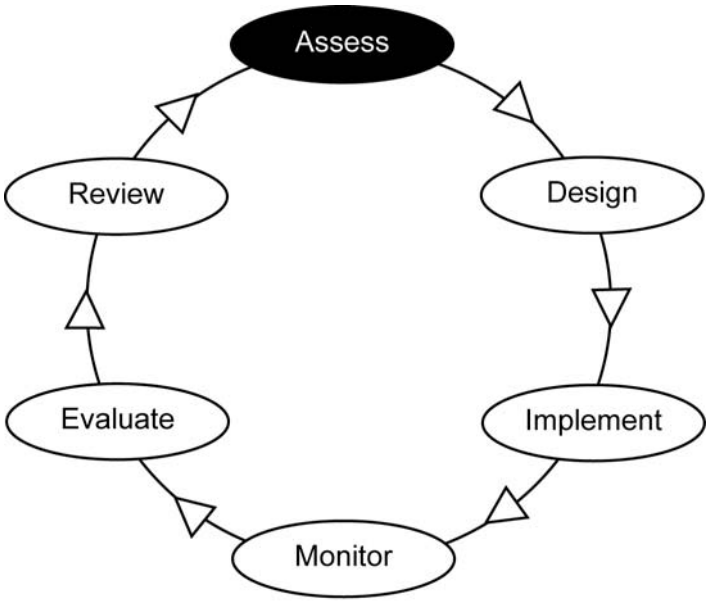
> Project success often depends upon small group decision-making, which is in turn influenced by the communication and interpersonal skills of group members. Research … demonstrates a clear correlation between positive group dynamics and team productivity. Knowing how to draw together a team and how to provide them with the skills and tools necessary for teamwork may be among the most crucial roles of the project manager. (NASA 2006).

Healthy group dynamics will be a crucial consideration if a Community of Practice is to be effective. We recommend that your group pay particular attention to this, and perhaps in the initial stages engage the services of a good facilitator to help get things underway. Alternatively (or as well), you might like to do a web search with the key words “small group dynamics” – there is a wealth of information that could be of assistance to help with this.

Section 3: Tools and Processes for Resilience Management

How to Approach the Adaptive Management Cycle through Appreciative Inquiry

Adaptive Management Stage 1: Assess



Assess the current states and trends of the system using available data and local knowledge

The main objective of assessment is to define the scope of the problem – basically the gap between where you are now and where you want to be at some future time – and in the process explore the potential outcomes of alternative actions.

Appreciative inquiry is an ideal framework for assessment, since it leads to a positive re-framing of problems into opportunities. A typical approach would be to ask positive, or appreciative, questions such as “What are we doing well now?” and “What can we do better in the future?”

Appreciative inquiry is a natural framework for visioning, or the *systematic* and *constructive* creation of positive views of the future. The final step of the assessment process is the construction of a vision based on appreciative inquiry into issues relevant to the future.

The assessment stage will usually involve some fairly advanced learning about the system and how it works. As a result, assessment will often involve the entire Community of Practice in talking, thinking and reading more widely about issues. Some specific approaches to assessment and guidelines for discussion are suggested in the following sections.

Assessment Step One: Draw a Map of the Issues and Institutional Arrangements

One of the main difficulties of assessment is finding a framework that triggers thinking, jogs memories and provides some certainty that the assessment has covered all the relevant issues.

One way of doing this that ties in closely with stakeholders' local knowledge is to sketch a map of the area under consideration and then plot all of the issues (not necessarily to scale) in their geographical context. This method is easy for stakeholders to relate to and creates a framework for very detailed thinking about how the system fits together.

Issues maps can become very large, depending on the number and complexity of issues that need to be considered. Conventional whiteboards are generally not large enough for this kind of work. Commercially available large-format white plastic cling-film sheets, suitable for attaching to clear wall space, are ideal (see Figure 4).

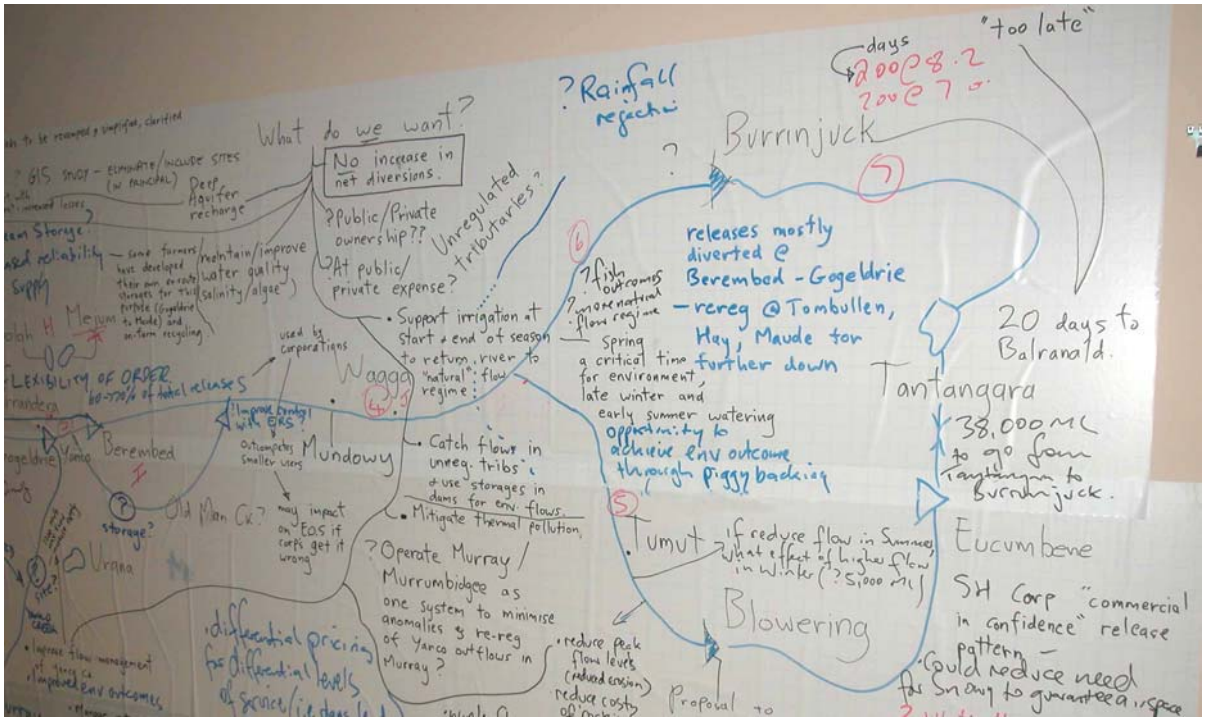


Figure 4: Part of an issues map sketched during an assessment workshop.

> "Folio Contact Flipchart Cling Film" is available from Just Boards in Queensland (1800 654 917), or Elizabeth Richards (www.elizabethrichards.com.au). A similar product "Avery Write On – Cling Sheets" is available from OfficeMax (www.officemax.com.au). Other suppliers may also stock similar products.

The workshop which created the issues map in Figure 4 began with a large cling-film whiteboard showing a schematic map of the study area, with key water storages, rivers and towns. During the workshop stakeholders were able to produce from memory and available documents a very comprehensive description of the issues. The resulting

issues map was over five metres long – only part of the diagram relating to the upper catchment is shown here.

Strongly associated with the various issues, are the *institutional arrangements* which affect how things happen. Institutions can take many forms which include:

- Organisations (e.g. a bank, a public company, or a government department),
- Government statutes (e.g. acts, regulations, by-laws),
- Rules of behaviour or play (e.g. football rules, industry code of conduct), and
- Unwritten rules (e.g. 'don't annoy the General Manager until she's had her morning cup of coffee').

As part of understanding the basic settings within which learning and change will occur, it is important to ensure that you have a good working understanding of the various relevant institutions and how they interact. There is a relatively simple way of doing this very similar to the issues mapping described above.

The first thing to do is to draw a sketch map of the area of interest. In many cases this will be part or all of a river catchment. The following example is drawn from a CRCIF research project that was undertaken in the Lower Burdekin catchment of Northern Queensland. Key geographical features should be drawn. In this case (Figure 5) the key features are the Burdekin Falls Dam (B.F. Dam), Burdekin River, Bowen-Broken catchment, Haughton River, groundwater systems, the delta feature at the river mouth with the associated wetlands, and the towns of Ayr and Home Hill. It is important to keep this initial diagram fairly sparse, with just enough information to stimulate thinking about the specific institutions which apply in various parts of the system.

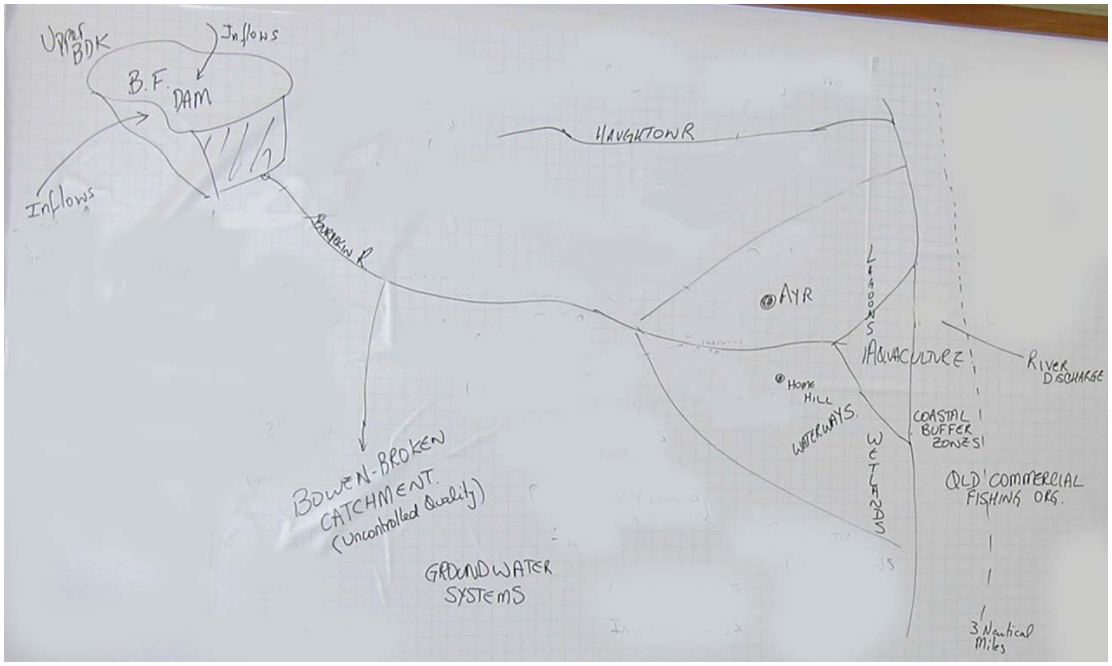


Figure 5 Sketch map of the Lower Burdekin catchment in Northern Queensland.

Once the system is sketched, participants are invited to work down (or up) the catchment, identifying the various organisations and/or rules which influence various activities and behaviours. The result of this exercise for the Burdekin example is given in Figure 6.

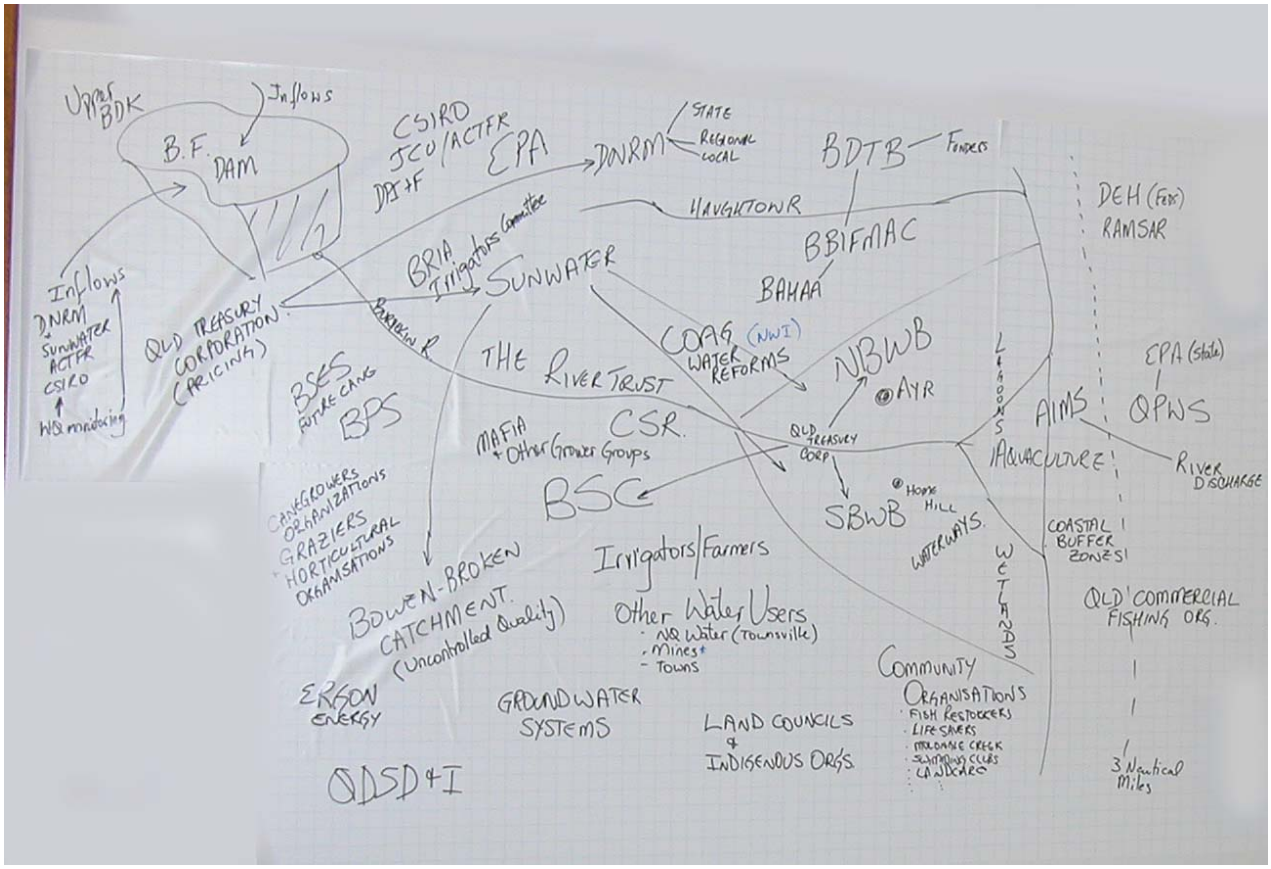


Figure 6 Various institutions identified for the Lower Burdekin system.

Note the various abbreviations and acronyms that are used – this is all meaningful to the people involved in the actual exercise and provides a quick summary of the discussion as it proceeds. If needed, a formal report can be prepared which expands all the abbreviations and provides more detail about each institution. (See Wolfenden and Attard 2006 for how this was done for this example.)

This particular approach tends to emphasise organisations with a direct impact or involvement in the area of interest. It is also important to consider any non-local organisations which may have an indirect influence. These can simply be listed as they are identified.

Also note that most institutions identified are actually *organisations*. Participants should also consider what rules, either written or unwritten, might apply. A range of these were identified in the Burdekin example (Figure 7) – of course you would generate something quite different when undertaking this for your area.

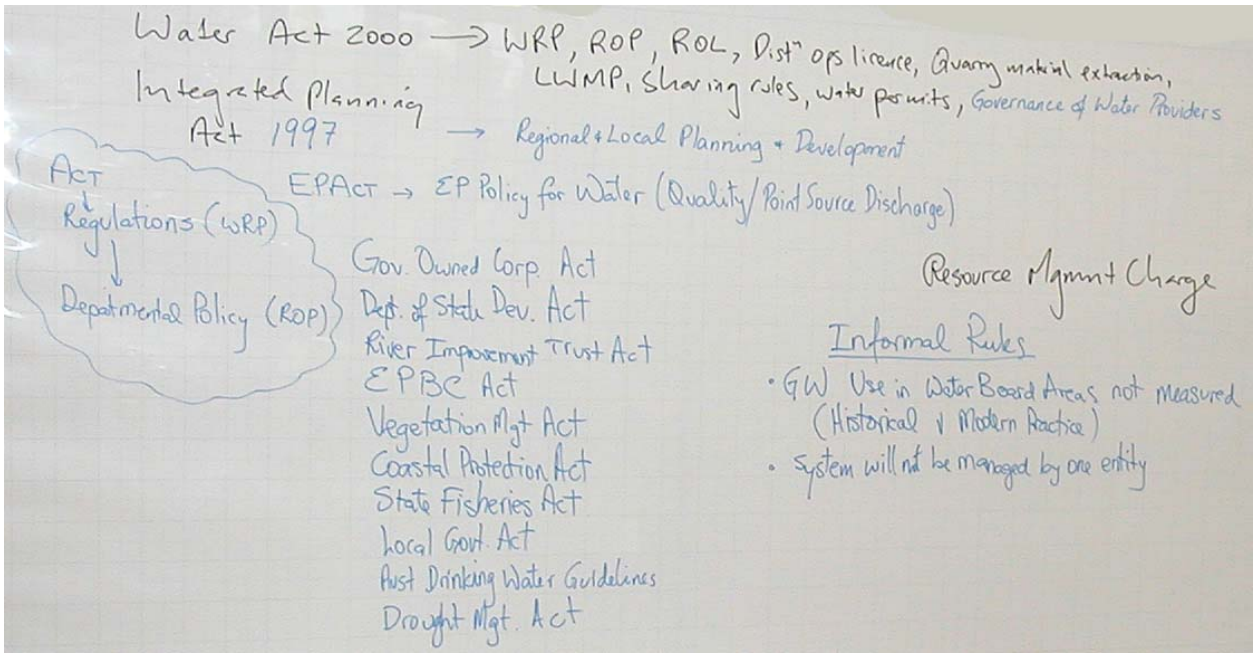


Figure 7 Written and unwritten rules

Assessment Step Two: Do a 'Resilience Stocktake'

A resilience stocktake is an assessment of indicators revealing as much as possible about the resilience, adaptability and transformability of the system in question. These should include indicators of economic, social and environmental health, some of which are suggested in Table 1:

Table 1: Some Possible Indicators for a Resilience Stocktake

Indicators		
Resilience	**Adaptability**	**Transformability**
• Soil health • Water supply reliability • Other biophysical indicators • Diverse community networks • Diverse economic base • Low relative debt levels • People entering/leaving the community • Industry/government partnerships	• Capacity building • Knowledge sharing • Co-investment in R&D • Value-adding approach to conflict resolution • Integrated approaches and collective solutions • Mechanisms for incorporating learning into planning	• Innovation • Adoption • Diversification • Adaptive institutions • Local empowerment to change

The stocktake should consider not only the current state of these indicators, but also how they are changing, in other words what the *trends indicate*. Indicators that are improving, deteriorating or staying approximately the same, may indicate very different courses of action.

Resilience/Adaptability/Transformability Indicators: Some Rules of Thumb

It may not be immediately clear how the indicators in Table 1 fit into the categories of Resilience, Adaptability and Transformability. For instance, how are the very different indicators "soil health", "water supply reliability" and "diverse community networks" all indicators of resilience?

Adaptability and transformability indicators are relatively straightforward. To keep the ideas simple, these single-sentence definitions will suffice:

> **Adaptability Indicators**: Reflect a community's capacity to learn and share ideas.
>
> **Transformability Indicators:** Reflect a community's capacity to create new opportunities and reorganise itself.

Resilience indicators are a little harder to define. As a general rule, resilience indicators come in two types:

> **Type 1 Resilience Indicators: Inputs**

Prosperity depends on a steady supply of inputs such as natural resources, people and invested capital. Prosperity can appear to increase even as the sources of inputs are declining – we can "mine" the system – but this will ultimately lead to a downturn when these stocks are depleted.

Sustainable supplies of inputs such as soil nutrients and water are essential to future prosperity. Minimising "negative outputs" such as debt servicing or people leaving the area is another, reversed way of looking at inputs. A range of such indicators will apply both to economic systems and to natural ecosystems that depend on resource inputs.

An advantage of monitoring inputs is that they tend to give advance warning of future downturns. Note in Figure 8 that the "Inputs" curve begins to decline some time, possibly decades, before economic output begins to decline. By monitoring these inputs we can be alert to the warning signs and make better plans. Note the resemblance of the two curves in Figure 8 to the idealised adaptive cycle in Figure 15.

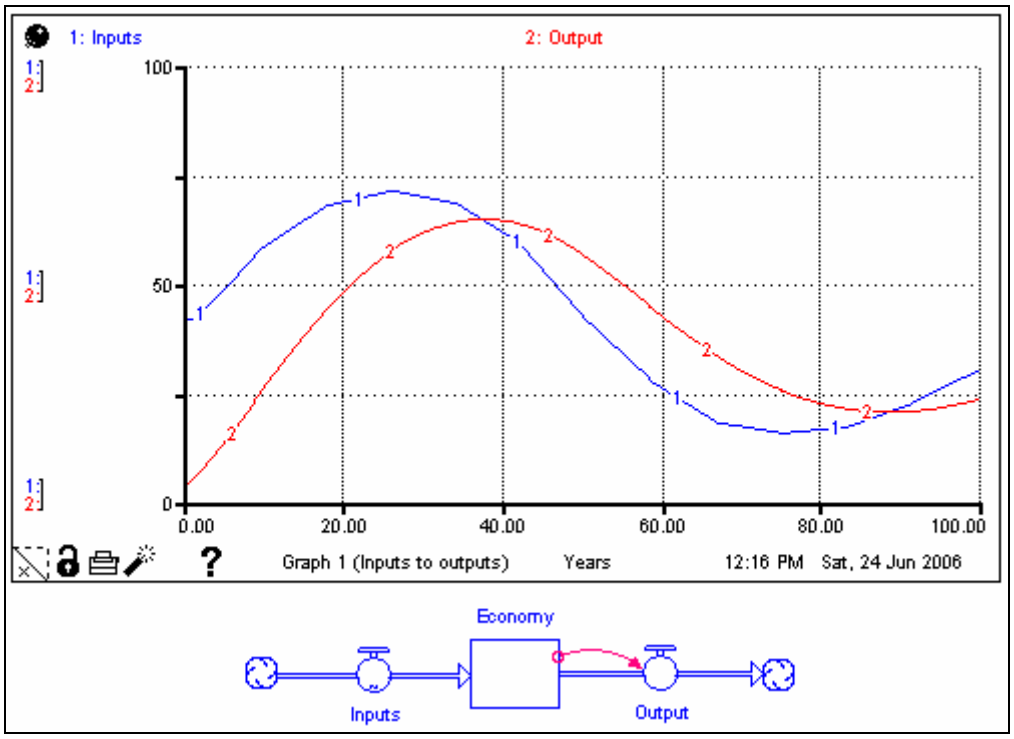


Figure 8: An adaptive cycle is approximated by a simple input-output curve. The "stock-flow" diagram shows inputs and outputs as variable flows into and out of the economy.

Type 2 Resilience Indicators: Social Capital

Social capital refers to the developed social infrastructure of public and private associations, and also *partnerships* between associations.

Example: the existence of a Community of Practice drawn from a diversity of groups in the community reflects a high level of social capital.

The number of connections in a system tends to increase its resilience, since stress is shared among a larger number of components and hence is more effectively absorbed.

Diverse community networks and industry/government partnerships tend to create greater opportunities for people to develop and prosper, as well as a greater ability to share new ideas and adopt new practices. Social capital, as such, also adds to the adaptability and transformability of the social-ecological system.

Example: a complicated local economy with multiple industries and partnerships (Figure 9) is more adaptable than a simple economy with few industries, because of the wider range of opportunities.

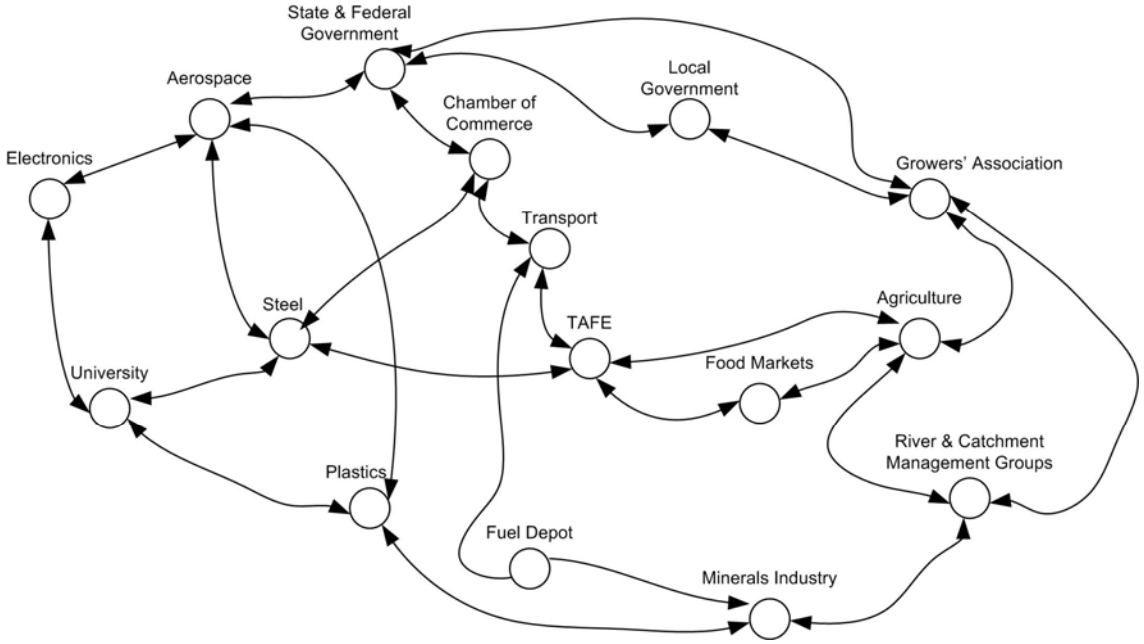


Figure 9: Social capital through economic and institutional diversity. A resilient system?

Stakeholders exist not as isolated individuals or business entities but as members of a community. The resilience of the community impacts on each stakeholder's business. Regardless of which part of the industry you are in, your future business success is linked to your community's resilience and its capacity to adapt and transform.

Assessment Step Three: Visioning

Visioning is a process of collectively agreeing on the strategic targets and defining the gap between those targets and the current situation. Visioning is guided by the previous steps of mapping, and stocktaking, but is a less formal process that requires open-minded thinking on desirable alternative futures, which in practice requires a separate workshop or session. Appreciative inquiry, or the asking of positive and aspirational questions about the system, is an ideal framework for this step.

> The visioning described here might already have been undertaken as part of forming the Community of Practice. Alternatively, the CoP visioning might have elicited general aspirational goals for the CoP, whereas the Assessment Visioning suggested here might deal with more specific ideas.

Visioning discussions should range broadly over the desirable features of healthy social, economic and environmental systems, and how far the current system is from having those features. All of the information drawn together in the previous steps can be reconsidered. Participants can be encouraged to look at the information from an idealistic and creative perspective – to 'dare to dream'. This can be done without specific reference to "appreciative inquiry" as such, but should be framed as positive, constructive attempts to tell the future as "a story we would like to hear".

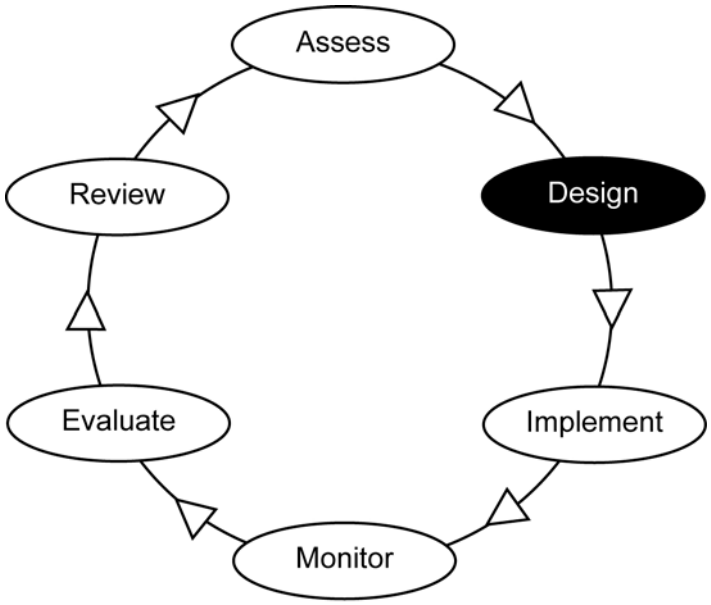
No specific details on how the gap will be closed are required to successfully complete a visioning exercise. Some participants will feel that the exercise is pointless without the detail. Facilitators can remind participants of the risk that visioning will become

'bogged down' in detail, and invite people who identify strongly with the detail to participate further in the following design stage.

Visioning is often described in terms of a journey: Where we are now, where we want to be, and how far is it? This does not necessarily say how we will get there, in fact the route may be unknown and only discoverable in practice through trial and error.

The Visioning step should at least arrive at the original objective of Assessment, which is to define the gap between where we are and where we want to be. It is not necessary to also arrive at a clear plan on how to get there; this is covered in greater detail in the Design stage.

Adaptive Management Stage 2: Design



Design management strategies based on scenarios of possible future states after system intervention

The design phase is a major challenge that in most cases will require technical support drawn from outside of the Community of Practice. The main challenge is to develop a working model of the social-ecological system that allows participants to test alternative scenarios and decide on an appropriate course of action.

While the Assessment stage generally involves the whole Community of Practice in discussion and thinking, the Design stage usually comes down to a smaller number of key representatives who *self-select*, or volunteer and commit time to attend design workshops. These representatives do not require specialist design skills, but should be informed of the potential complexity and uncertainty of the design process so that self-selection is properly thought through.

If possible, the working group needs to attempt to forecast the outcomes of specific actions, to assess which actions are most likely to meet strategic objectives. These forecasts are unlikely to be exactly realised, nevertheless scenario development is an important part of the learning process.

The following sections outline the steps of a communicative design process that supports stakeholder decision-making through the use of technical modelling tools.

Design Step One: System Definition, or What do we need to know?

This step overlaps to some extent with the Assessment stage described above, but begins to add some logical structure to the large amount of information that can be produced during the assessment stage. Design Step One contains three basic actions: Filtering, Sorting and Knowledge Gap Analysis.

Filtering (or Critical Assessment): Information obtained during the assessment stage will vary in relevance and quality. It is important to reach agreement on which information can be used, which needs further work and which can be discarded. To do this, the working group can classify information according to the action settings suggested in Figure 10. For categories of Low and High Relevance and Quality of available data, the working group may decide to a) Carry out further research to improve data quality, b) keep data information for high value use in modelling, c) discard information as of no further use and d) reconsider how the information may be used, or discarded.

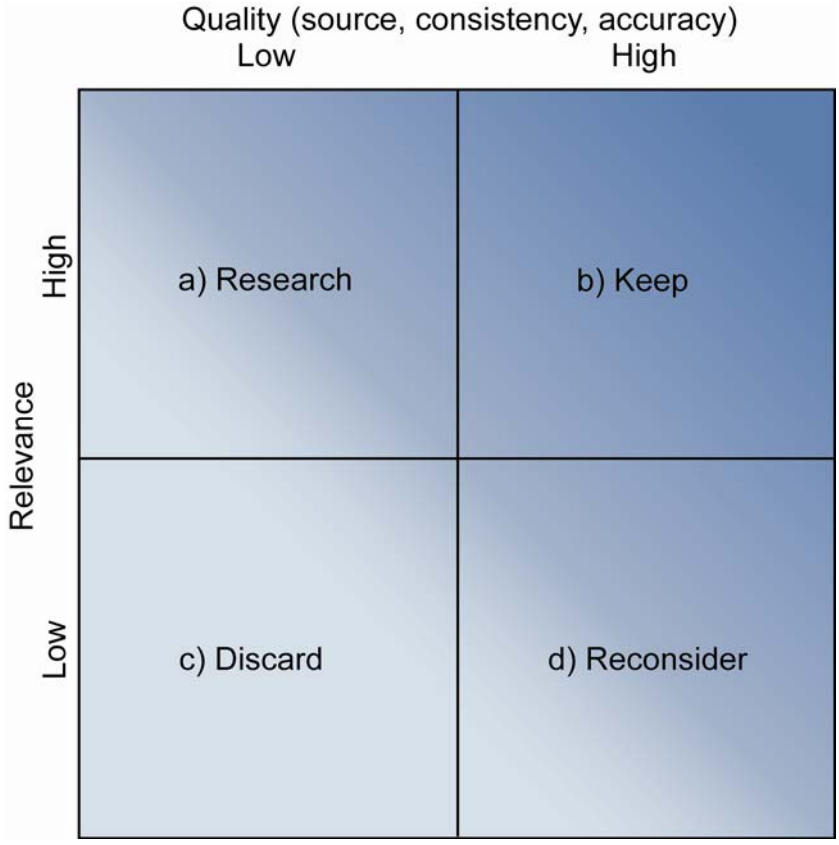


Figure 10: Information filtering tool.

Sorting (or Sector Mapping): Information obtained during the assessment stage will relate to a number of different "sectors" of the system – particularly the economic, ecological and social sectors. This information needs to be sorted into appropriate sectors connected by the relationships between system components.

An ideal way of doing this is by developing a "sector map" as per Figure 11. In this diagram, the circles and arrows represent information that cause other information to trend in certain ways. As a system diagram, this example is incomplete: it needs to include information for other relevant issues identified in the assessment.

Information gathered in the issues mapping step of the Assessment stage can be transferred to the sectoral map for an additional perspective on those issues. Again, a large-format cling-film whiteboard is useful for this kind of work.

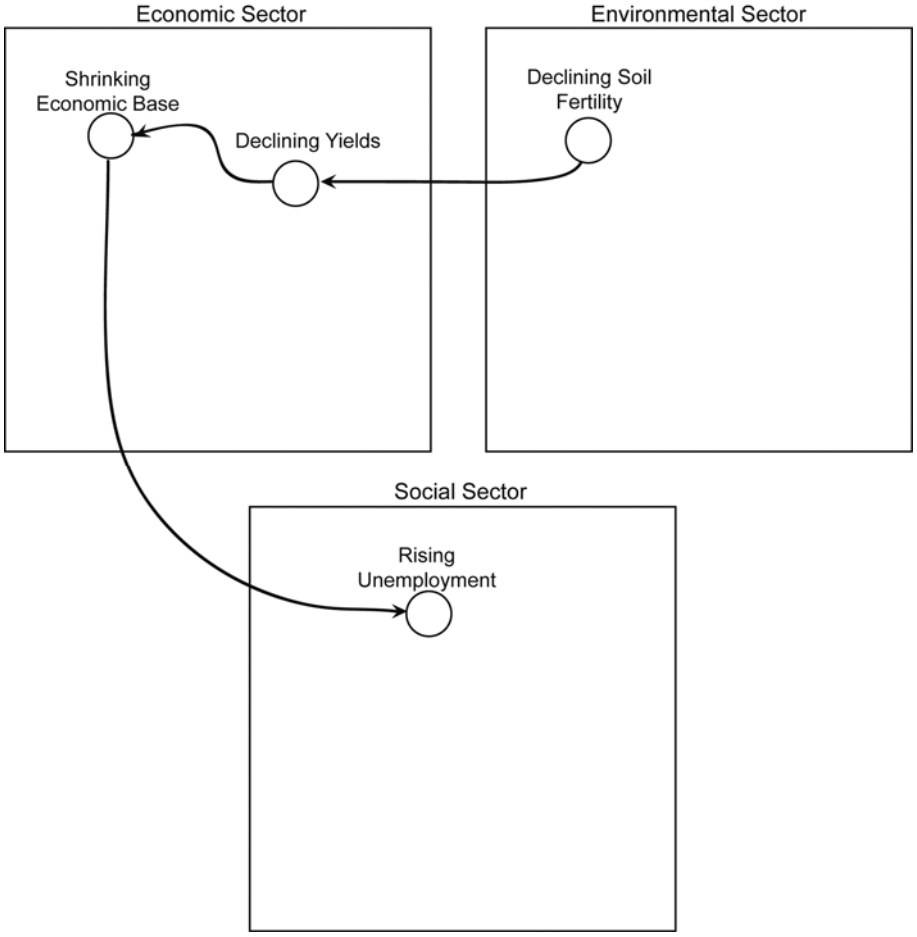


Figure 11: Elementary sector diagram for the basic problem of declining soil fertility and its impact on economic and social sectors.

Knowledge Gap Analysis: The filtering and sorting actions described above are designed to highlight knowns and unknowns in the available information. The "Research" and "Reconsider" categories of Figure 10 highlight areas where the available information could be improved. Furthermore the effort of thinking through a sectoral diagram will highlight where the relationships between various pieces of information are not well understood or need further definition.

A gap analysis should identify areas where further work or research is required, as for example in Table 2. This provides an opportunity to specify or re-specify the information that is required to understand the system and make reasonable forecasts on how it may behave in the future.

Table 2: Example knowledge gap analysis based on filtering and sorting data.

Information item	Work required
Soil fertility decline and land use.	Soil fertility data is sketchy across the catchment. Studies need to include soil use history to enable correlation of land use with rates of decline. (Critical assessment identified data of low quality and high relevance)
Socio-economic tools to improve soil fertility	The relationship between socio-economic forces and soil decline needs to be reassessed to find acceptable ways of arresting the decline (Sector mapping identified a gap between the Social and Environmental sectors)

Design Step Two: System Mapping, or How does the system work?

The understanding of how a social-ecological system "works" is built by describing how the different components of the system influence each other to cause change.

Example: "increasing soil fertility increases crop yields" is a descriptive statement about the relationship between soil fertility and crop yields as previously sketched in the sector map. Many such relationships can be summarised as a system map.

A system map also defines the relationships between managed conditions and resilience indicators identified in the assessment. It then becomes possible to identify which parts of the system can be managed to improve the indicators. It should also be possible to assess how the same management strategies may drive other parts of the system in undesirable directions.

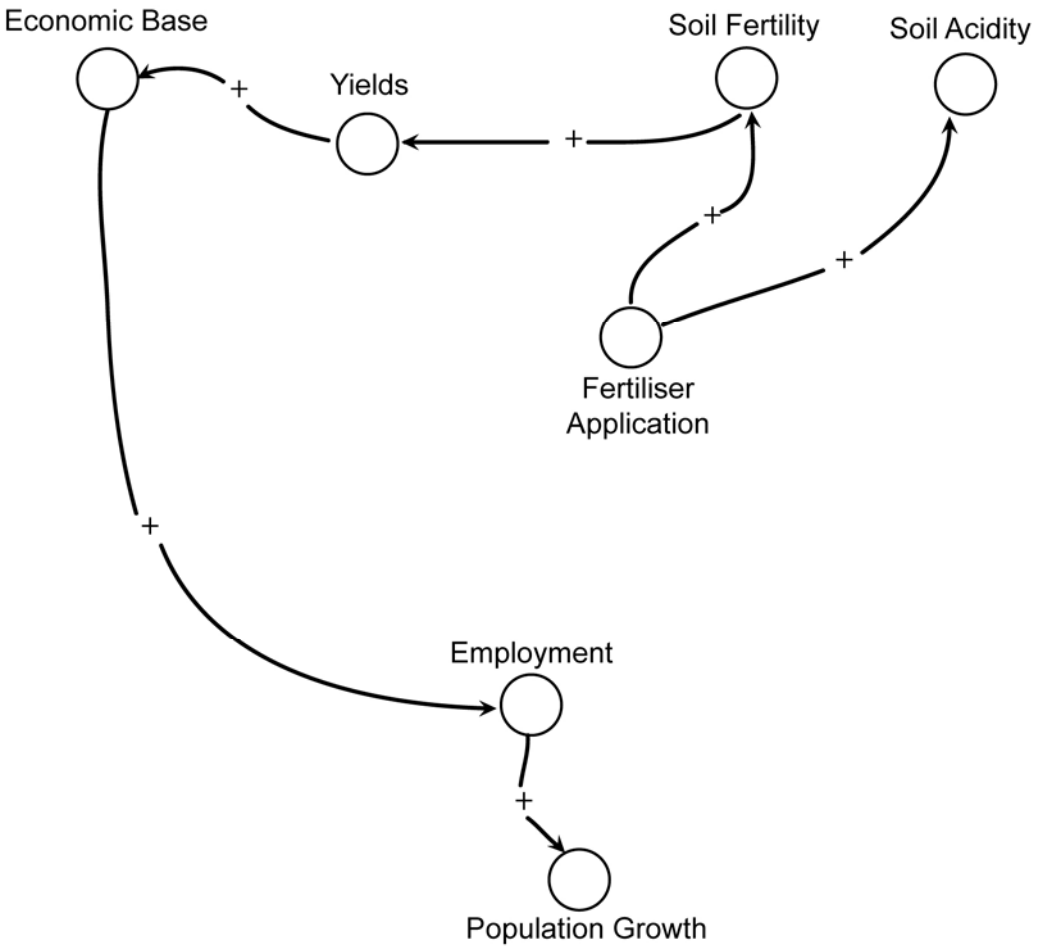


Figure 12: System map partly developed from the Sector Diagram in Figure 11.

In the above diagram, + signs indicate positive influences between components of the system, for instance as employment increases so population growth is expected to increase.

Mapping these relationships enables the complexity of a social-ecological system to be appreciated and management strategies designed to maximise positive outcomes while minimising unintended side-effects.

System maps can be developed into quantitative system models that define the numerical relationships between system components (See Appendix B), however this should only be done if there is a high degree of uncertainty about relationships that could trigger unexpected consequences. Quantitative models define system relationships more precisely, but require a much higher level of technical input.

Design Step Three: System Management, or What can we do?

Having defined how resilience indicators and other parts of the system influence each other, it becomes possible to say what can be done to manage the whole system more effectively. There are two *strategic design* objectives here:

1. Define management strategies that will cause resilience indicators to trend in desired directions; and
2. Anticipate flow-on effects and refine management strategies to minimise undesirable outcomes.

Example: having linked “Declining Soil Fertility” with “Declining Yields” in Figure 11, the working group may move to reject broadacre fertiliser applications because of impacts on soil acidity. The overall strategy of “improve soil fertility” must be refined so as not to degrade soil condition in other ways.

Social-ecological systems tend to have multiple cross-relationships of this kind that can only be managed by careful consideration of all the possible flow-on effects.

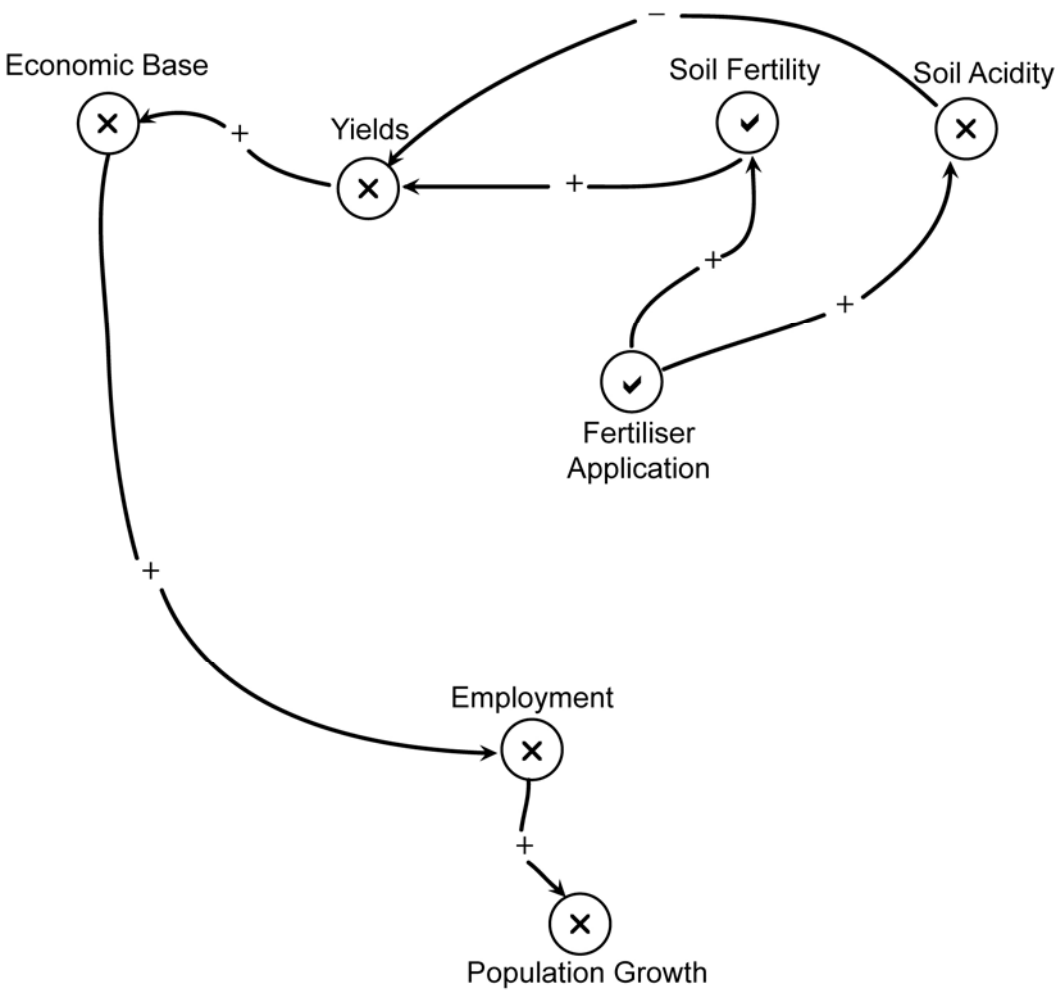


Figure 13: System management diagram

In this example, the proposal to apply fertiliser to improve soil fertility (✔) was identified as potentially increasing soil acidity (**x**). This negative effect has been tracked through the system and conservatively assessed as having a net negative effect on crop yields and hence on the economic and social systems. (Note this is just an example and should not be read to imply that this would actually occur in any particular situation).

This part of the design process tends to alternate between creative generation and destructive testing of ideas: Management strategies are suggested, sketched on the system map and tested by tracking their effect through all the dependent relationships. Strategies that create positive trends in key indicators with no or minimal negative consequences can then be put forward for more detailed consideration.

Design Step Four: What have we learned?

Each of the design steps described so far provide opportunities for learning about the system and how it can be managed to achieve specific objectives:

Step 1: Learning about:

- Quality and relevance of available information;
- Systemic relationships between different types of information;
- Requirements for better information and/or understanding of systemic relationships.

Step 2: Learning about:

- Details of relationships between different types of information;
- Details of the social-ecological system as a network of relationships.

Step 3: Learning about:

- Complex interactions between different parts of the system;
- The level of decision-making that this complexity requires;

The process also provides a framework for communicating existing knowledge, so that even when knowledge is not "new", it certainly becomes more accessible. Participants can learn from each other.

It is essential that these learning outcomes are recorded as the project progresses, and documented for future reference. This documentation would serve to highlight management strategies that were found to be effective, and the types of information that these strategies require. These strategies can then be communicated back to the Community of Practice for selection of a preferred alternative.

Design Step Five: Community-based Selection of Alternatives

With the modelling stage completed and learning outcomes clearly identified it is essential to bring the design alternatives back to the Community of Practice for further discussion and selection of a preferred management strategy. Depending on the level of potential public impact it may be necessary to communicate and consult with wider communities of interest, through public meetings, calls for submissions or other quasi-political mechanisms.

The selection of a preferred alternative may be complicated by competing interests in the community. Discussion may at times appear to return to the level of debate seen in the assessment stage, reflecting unresolved uncertainties and complexities mingled with the political process.

Managing this dialogue will require a commitment to open and transparent public decision-making, balanced with a good understanding of the additional knowledge developed through the design process. Effective communication strategies must be developed to ensure that the wider community shares in the learning outcomes and can engage in informed decision-making. Psychological stresses arising from change can be anticipated, identified and managed more effectively if communication is managed to a high standard.

The most effective communication strategies explain concepts through the use of illustrations and graphs, preferably focussing on concrete "real world" concepts rather than abstract theoretical ideas. Graphic animations in particular are very useful tools for explaining what needs to be done, and how things may change.

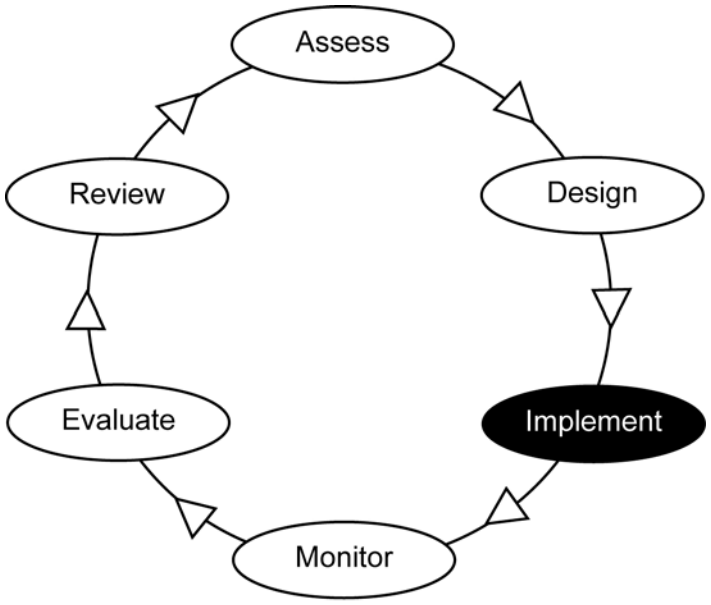
Preliminary design and feasibility studies as components of the communication strategy

Reaching consensus on an agreed management strategy will require consideration of feasibility, based on preliminary designs and costings. As a general rule, communication strategies need to be based on alternative action plans that are consistent with the available and potential resources.

A realistic assessment of the available financial, human and political or partnering resources must be conducted. This may be revisited later in the planning stage, as well-developed plans often attract additional resources. Commitments of financial and in-kind assistance from the Community of Practice and its partners can be expanded as plans develop.

What can be achieved with the available resources should be explored in the form of preliminary feasibility studies covering the range of alternatives. This in general will require specialist support in estimating the costs of engineering and other works, logistics, information management and other items for each alternative. The expertise traditionally associated with 'design' can at this point make a rich contribution to community-based selection of alternatives.

Adaptive Management Stage 3: Implement



Implement strategies by putting in place initiatives to drive change in a desired direction

Putting the plan into operation will require the development of monitoring networks and procedures, as well as infrastructure and/or operating rules to put the selected management strategy in place. Mobilising an optimum level of community support and resourcing often requires extensive communication, planning and partnerships between stakeholders, peak industry groups and government agencies.

It is difficult to generalise the implementation process to any degree, however a few general points about planning for implementation can be highlighted.

Implementation Planning: a Project Plan *and* a Communication Plan

Implementation, by definition, is a short- to medium-term *project* that establishes management procedures and infrastructure within a Community of Practice, which then becomes responsible for maintaining and using those procedures and infrastructure in the medium- to long-term.

Implementation requires planning on two levels:

1. Standard project planning of tasks and resources – who does what and when for successful completion of the project?
2. Communication planning – who needs to know what, and who needs additional support, for successful transition to the new management strategy?

Standard project planning is relatively straightforward, so long as the preliminary design and resourcing plans are feasible. Project planning can be delegated to the technical and policy detail levels, provided that the project plan and communication plan are coordinated and resourced appropriately.

A communication plan is an important component of change management – the actions taken to ensure that all stakeholders are informed and in reasonable agreement with the proposed changes. The communication plan identifies who needs to be informed both of tasks within the implementation project and of procedures that will be changed under the new management strategy.

A communication plan should allow time for further discussion of issues, as stakeholders may only speak up when it comes to the “crunch” of changes that will effect them. This time allowance may need to be a significant fraction of the implementation timetable if such late feedback is to be genuinely included in design modifications. Most importantly, a communication plan is an important aspect of helping to minimise the psychological stresses of change.

Implementation Partnerships: Co-ordinating Top-down and Bottom-up Action

Partnerships between stakeholders, peak industry groups and governments may be essential for strategies implemented at the landscape level. Plans are likely to cross boundaries and impact on stakeholders at multiple levels. The best way to deal with this is to anticipate it and plan for partnerships that link these different levels together.

Government partnerships in particular are essential to support community-based action. While all of the planning activities described above can be carried out by community groups, putting plans into practice will invoke the regulatory role of Local and State Governments. Sustainability planning that anticipates government involvement at a partnership level is more likely to succeed than planning that encounters the Government on an ad-hoc basis or as a regulator only.

Industry partnerships are also valuable for managing commercial relationships that may be effected by new management strategies. Data sharing agreements in particular may be essential for area-wide evaluation of locally recorded data (Wolfenden and Evans 2007). These agreements can be anticipated and formalised as partnerships with a minimum of legal complexity.

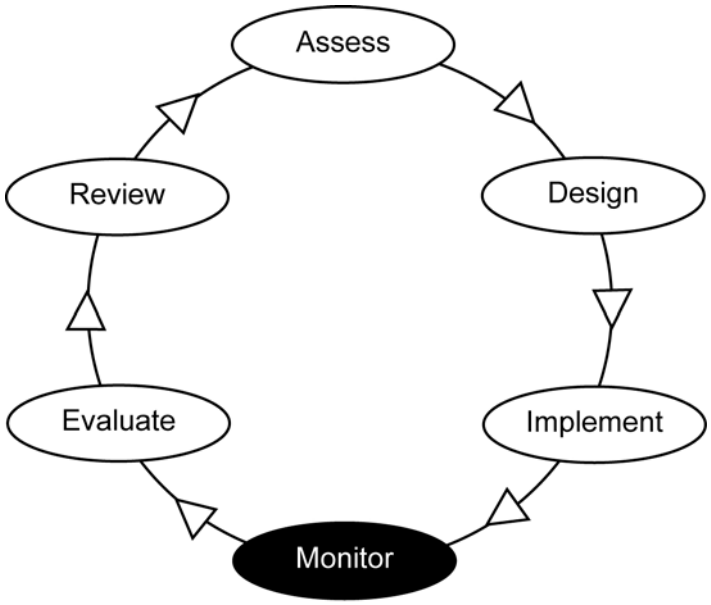
Implementation at the Grass Roots: Well-informed Communities in Action

In-kind contributions of effort and co-ordination of effort are a valuable resource that communities of practice are uniquely able to provide, particularly once a critical mass of support for a project is achieved. Planning for the involvement of a Community of Practice in implementation will reduce costs and increase uptake and adoption of the selected management strategy. Grass-roots participation also provides a means for communities to find new forms of control and thus alleviate some of the psychological impacts of externally imposed change.

A first essential for this type of grass-roots participation is an effective communication process. When people are informed and their contributions of knowledge are treated as valid, participation in projects with clear community benefit can be quite high. The alternative of a poorly communicated implementation plan is likely to result in resistance to implementation and low levels of adoption, with little or no in-kind support. This can happen even when a plan appears to receive reasonable levels of support during the selection of alternatives.

Coordination of in-kind contributions from different groups within the community is also essential, not only to ensure co-ordinated outcomes but also to ensure that no inequalities in costs and benefits begin to emerge. Resentment between different factions at the community level can lead to disruption of the implementation project and reduced levels of adoption.

Adaptive Management Stage 4: Monitor



Monitor key indicators that are expected to most clearly show the effects of strategic initiatives.

The CRC Irrigation Futures has undertaken the Sustainability Challenge project, which among other things investigated monitoring to support triple bottom line reporting (Christen *et al* 2006, Shepheard, Wolfenden and Attard 2006). The Sustainability Challenge project has developed an Irrigation Sustainability Assessment Framework (ISAF) that is in many ways analogous to the Adaptive Resilience Management processes described in this framework. We commend this work to the interested reader – it has the potential to usefully complement the ideas in this framework.

The Sustainability Challenge reports include some useful comments on monitoring which are directly relevant to the present discussion.

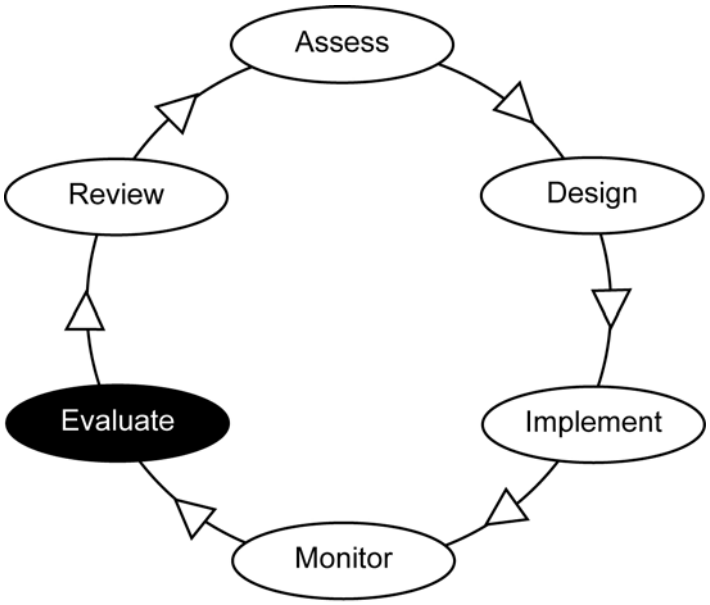
> The … approach is objective driven – we believe it is imperative to identify what the issues are and set objectives for the organisation to work towards **before** discussing what indicators will be used to monitor performance. (Christen *et al* p.14.)
>
> A sustainability indicator helps us to understand where we are in terms of sustainability, which way we are going and how far we are from where we want to be in the future. Indicators may be used to monitor the current condition of natural resources, trends in the condition, and, where appropriate, the social and economic aspects related to the productivity of natural resources. A good sustainability indicator can alert managers to a problem before it becomes unmanageable, and help to develop strategies to improve the situation. (Christen *et al* p.25.)
>
> The whole point in having objectives (setting targets) and then developing indicators to monitor performance (progress towards targets) is to constantly re-evaluate your organisation's actions to enhance sustainability. (Christen *et al* p.29.)

The above points suggest a need to carefully plan, in the design stage, the specific system behaviours that you wish to monitor. Monitoring systems and surveys should be designed with the evaluation stage in mind as an end product. The types of questions that designers need to ask, to ensure that the monitoring network provides relevant information for the evaluation, will include:

- What do we need to know about the whole landscape and its management?
- What types of data can we monitor locally to provide that knowledge? and
- What analysis is needed to convert (evaluate) local data to meaningful information at the landscape scale?

Also note that in many instances, there may be a lack of actual data and/or measuring equipment for the indicators you need to monitor. In exploring the concept of Triple Bottom Line reporting in the Lower Burdekin Catchment of Queensland, it was found that "There is a general lack of monitoring of key environmental indicator variables that could be used within the reporting structure" (Shepheard, Wolfenden and Attard 2006 p.15). Monitoring to an appropriate level may in fact require investment in measuring and data capturing technologies, and you will need to incorporate the need for such investment in your planning.

Adaptive Management Stage 5: Evaluate



Evaluate the monitoring data for trends showing improvement or decline in key indicators

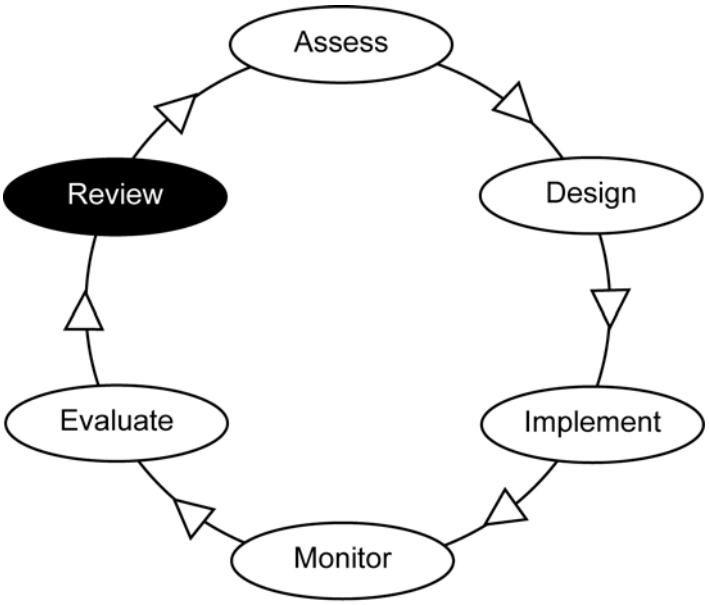
The evaluation stage is intended to comprehensively bring together information, not only from the monitoring network but from stakeholder surveys and wider indicators of community satisfaction (or otherwise), with the current management strategy. The emphasis of evaluation is on collation, organisation and analysis of that information at a technical level.

The Evaluation stage is distinct from the subsequent Review stage in that the evaluation must be impartial and objective, while the review has relative freedom to interpret results according to wider social and political considerations. To prevent these considerations unduly influencing the analysis, it is important that data be collated and analysed with only minimal input from the review team.

As noted in the previous section, monitoring systems and surveys should be designed with the evaluation stage in mind as an end product. The evaluation process is thus specified as an element of design, and should need little further input from the review team. Exceptions may arise where there have been major changes in knowledge requirements, possibly as a result of incidents during implementation or operation of the new management strategy.

While evaluation will focus on the key indicators, it may be that some unexpected outcomes of the management strategy have occurred which are not covered by the indicators. Part of evaluation should be to identify and document any such surprise outcomes, for subsequent appraisal through the review and reassessment stages.

Adaptive Management Stage 6: Review



Review how effectively the strategic initiatives have worked to improve key indicators

The Review stage, while covering much the same information as the subsequent (re)assessment phase, is highlighted as a distinct stage for two reasons:

1. Review is a fundamentally backward-looking process: what did we do, and how well did it work? In contrast assessment is forward-looking: what needs to be done now/next?
2. Review should be carried out by the same working group responsible for design and implementation, to allow for critical *reflection* on the details of why things did and did not work. In contrast, assessment is a wider public process, as discussed above.

Review involves consideration of information and analysis provided by the evaluation stage, however it may also include wider considerations that add to the interpretation of information. The review should not move too far from the consideration and interpretation of past events – planning for future management strategies for example should be excluded – for the simple reason that future-oriented thinking rests with the whole Community of Practice during the subsequent (re)assessment stage.

Reflection and *learning* are essential parts of any review process. The review team must support and encourage each other to honestly and openly discuss successes and failures. The emphasis should be on reviewing the capacity of the strategy to accomplish its objectives. Where failures occurred, systemic weaknesses should be considered first, rather than automatically placing “blame” on individuals or events.

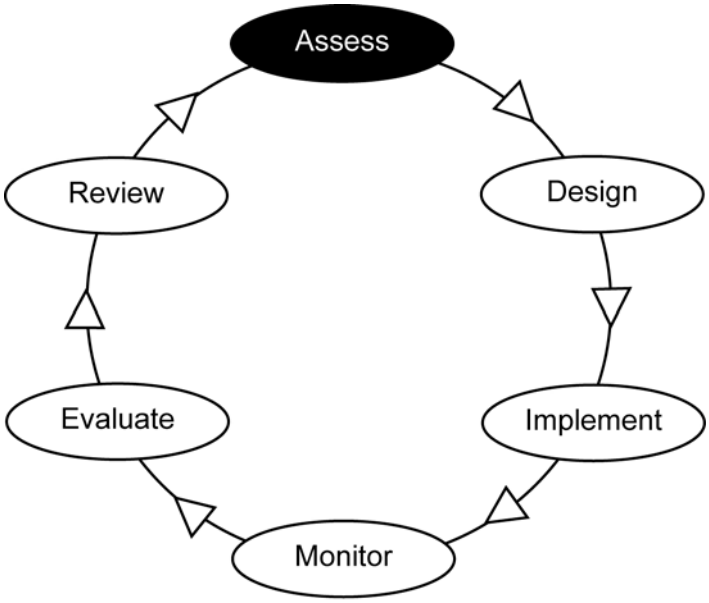
Participants should also explicitly consider what has been learned. This is more than just what worked and what did not work, but includes the questioning of whether it was even sensible to be undertaking the various strategies in the first place. It is important to avoid ‘target fixation’ – yes we met the targets, or no we didn’t. There is a need to also question whether, in hindsight, that target was even sensible or useful.

A failure in original target selection also provides a learning opportunity. It invites the question “How could we have done this differently last time?”, and more importantly, “How might we improve on this next time?”.

The outcomes of review need to be reported in a form that is suitable for the next stage of adaptive management, the assessment stage. The current state and trends of the social-ecological system, a review of how specific strategies have produced specific outcomes, and changes since the last assessment stage, among other locally-specific topics, should all be covered in an accessible public report.

Note on interpretation: Social-ecological systems are complex, and may behave unpredictably. Often it will be found that an indicator that was expected to increase under the new strategy has actually decreased, indicating that there are important feedbacks or delays in the system. Strategic design methods that take these feedbacks into account are more complex, but create a more robust adaptive management process. See Appendix B for a brief discussion of these more advanced design methods.

Adaptive Management Stage 7: Re-Assess



Adaptive management is a continuous cycle. Revisit the assessment stage, modify your plans and actions as necessary and continue around the loop.

It might also be appropriate to revisit your various visioning steps. Do the visions articulated previously still serve as a unifying theme for people? If not, perhaps these need adjusting. If the vision changes, then goals and objectives might also be affected and so forth.

Integrated Area Wide Management – bottom-up self-empowerment

Integrated Area Wide Management (IAWM) is the name given to an initiative being undertaken in various places in Australia. Wolfenden and Evans (2007) have documented the case-study of Emerald in Queensland. The following text is provided from that report. We highlight IAWM here as a practical example of how many aspects of resilience can be actively enhanced through on-ground activity by landholders in partnership with industry bodies, government and others.

The intent of IAWM has been to establish practical on-ground solutions to build landholder and local service provider capacity to become adept at managing both property and landscape scales in a manner that will make a difference. The model has a business focus that involves building an independent objective support system that connects growers, existing private and government service providers and land managers at a local level. It provides practical condition and trend monitoring tools and methodologies, and integrates whole systems information, both existing and new, in a way that encourages land managers to use the information. Most importantly, it builds local skills and capacity for assessing and monitoring both production and environmental condition and trend. The result is that land managers feel more in control and a true 'learning environment' is established that encourages change where appropriate.

Key features of IAWM include:

1. Focusing on how knowledge is managed and exchanged
2. Participation of landowners in data collection, interpretation and review
3. A safe learning environment is essential for data sharing partnerships to emerge.
4. Shared data is used to build area-wide data sets that are validated on ground at the farm level.
5. Area-wide data sets are in turn used to inform management decisions at the farm level.
6. Irrigators need access to government natural resource and water quality data, and can contribute their own data in partnership.
7. Private sector consultants are also involved in building data sets and as such require separate partnering arrangements.
8. IAWM is a practical, cost-effective means to monitor impact of land management on land and water.

It is noted that IAWM is *necessarily* "bottom-up" (implemented and owned at the farm level) rather than "top-down" (government or industry level). The need for this grass-roots ownership is founded in extensive on-farm monitoring networks and the need for a safe learning environment that balances confidentiality with an effective means of peer-to-peer feedback on shared resource management issues.

The *mission* of IAWM is described as: *To develop excellent local community capacity to participate in biophysical monitoring and landscape management*…to be accomplished by engaging and skilling landholders and their service providers, and working collaboratively with scientists to implement practical yet rigorous monitoring programs.

The articulated *vision* of IAWM has a number of components including:

- To provide a safe learning and information exchange environment that allows growers and industries to pursue a continuous improvement learning cycle.
- To build capacity and a process of involvement within the reform agenda.
- To support rural industry groups to undertake some level of landscape information management within an agreed framework.
- To provide an integrated data resource centre (e.g. data sets, knowledge, in-kind support, funding).
- To integrate production and landscape issues and support better decision making.
- To build partnerships that enable relevant change to occur more efficiently.
- To develop more cost effective biophysical monitoring systems.
- To implement better NRM outcomes based on looking at things at both the farm and landscape levels in an integrated manner.
- To gain due recognition of industry Farm Management Systems, so that growers need not complete more than one planning process.

IAWM has many dimensions, and as such is difficult to represent in few words. This makes it difficult to communicate to others who might otherwise be interested in exploring it further. We propose that it might thus be useful to construe IAWM as one or more of the following:

- A model for sustainable collaborative data-sharing partnerships.
- A process-based model for capacity building in information supply and management.
- A participative action-learning model.
- A framework that encourages rural groups to participate in formal knowledge and information management.

IAWM can be seen to transform the learning cycle under which innovation and adoption lead to business practice improvements, from a government-driven model to a more responsive stakeholder-driven model. Rather than circumventing government policy, IAWM creates new opportunities for partnership with government such that policy is informed by adaptive on-ground action.

IAWM can not be construed as a 'shrink-wrapped product' that can be neatly packaged up for others to use, and a process-based approach to implementing IAWM is favoured. Such an approach might be promulgated as a facilitation kit targeted at peak industry groups and agencies, setting out the stages of an IAWM implementation, including the identification of local issues, assessment of the local suitability of IAWM, templates for data sharing partnerships, and general timetables for key milestones.

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Appendix A: Some Resilience Theory

Change Happens in Cycles

It is important to consider how the resilience of social-ecological systems may change over time. Such systems tend to develop and decline in cycles at a range of time scales, two of which are of particular interest:

Business Cycles (Figure 14): medium-term "boom and bust" economic cycles that create changing opportunities for a given set of industries or crop products over years or decades.

Example: Agricultural and related industries that survive in more or less the same form despite economic booms and downturns. Similar cycles occur in ecological systems, for example dieback and regeneration in remnant vegetation.

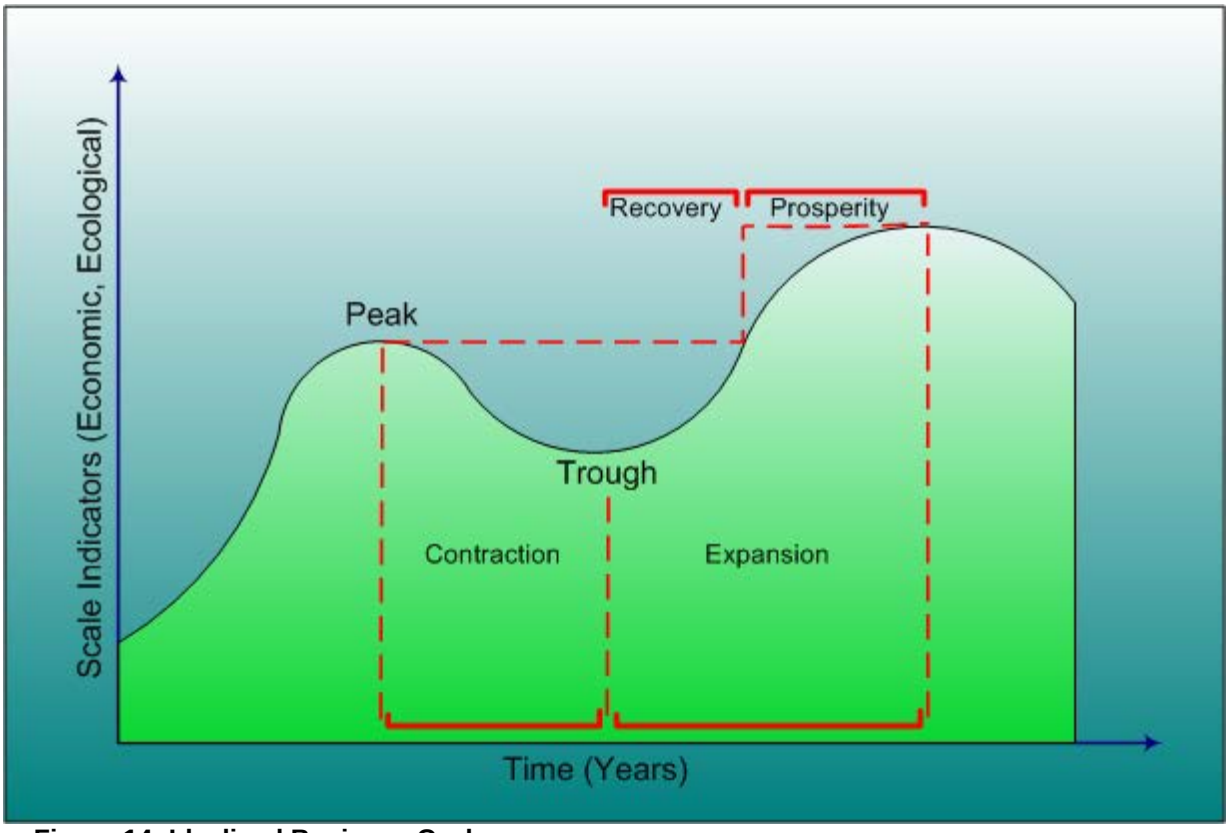

Figure 14: Idealised Business Cycle.

The business cycle involves shifts over time between periods of relatively rapid growth of output (recovery and prosperity), alternating with periods of relative stagnation or decline (contraction or recession). The "scale indicators" on the vertical axis might include economic or ecosystem production rates, to name the most obvious (if not the most easily measured) indicators. Since no two cycles are alike in their details, some economists dispute the existence of cycles and use the word "fluctuations" (or similar) instead.

Adaptive Cycles (Figure 15): long-term cycles that drive the evolution or historical development of a system over decades or longer.

Example: as farming technologies develop, the economics of different crop mixes will be permanently altered, leading to a decline in the old ways and rise of the new. Similar long-term and irreversible changes can be seen in ecological systems.

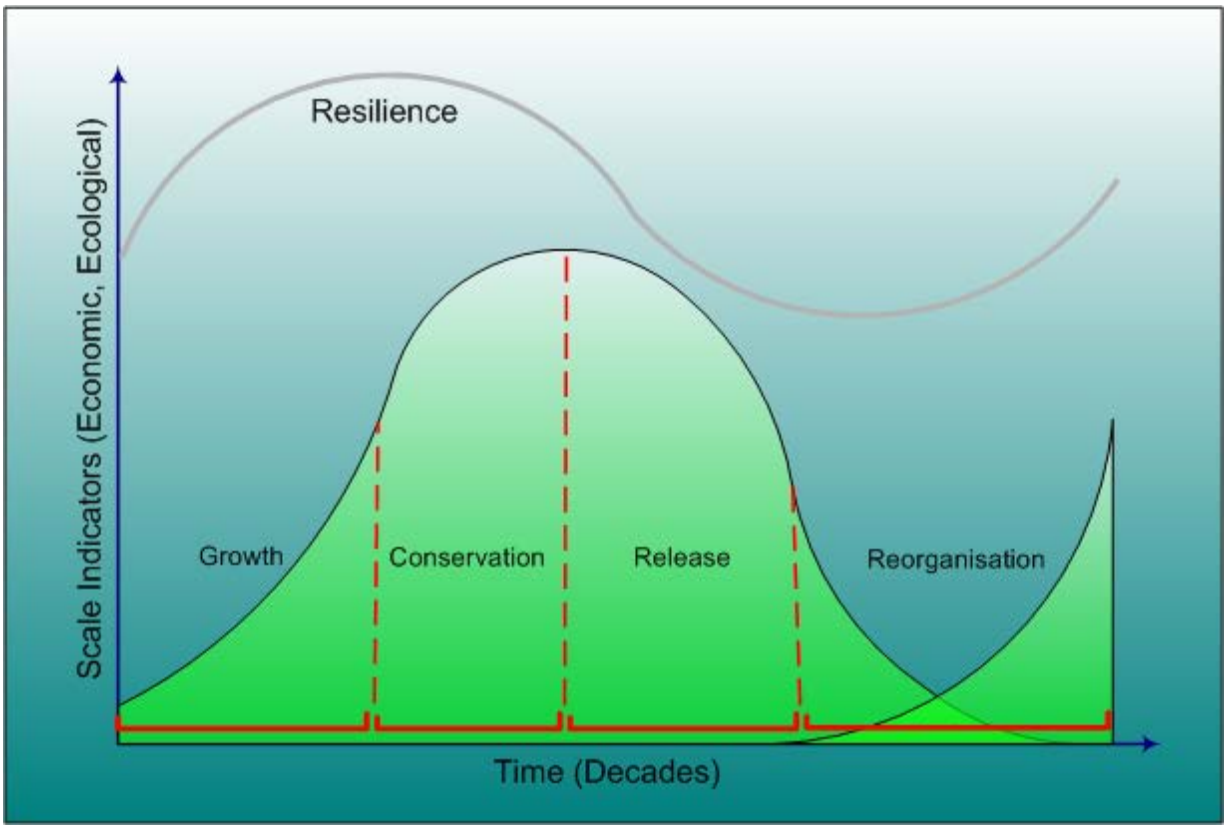

Figure 15: Idealised Adaptive Cycle.

The Resilience of the system rises and falls as resources accumulate (Growth) and become locked into the system (Conservation). The increasingly brittle system may begin to fail, leading to a Release of resources which can then begin to re-accumulate in other system structures (Reorganisation).

Business cycles and adaptive cycles differ in the degree of change that occurs: the technologies and institutions of an economy remain relatively constant throughout a business cycle, but new systems emerge, decline, and disappear or are replaced through an adaptive cycle.

The business cycle and adaptive cycle concepts are useful guides to discussion on broad strategic approaches (Figure 16): only small structural changes may be needed in the case of business cycle downturns or the growth phase of an adaptive cycle, but major innovations may be required where resilience is falling as this implies much more significant degrees of transforming change.

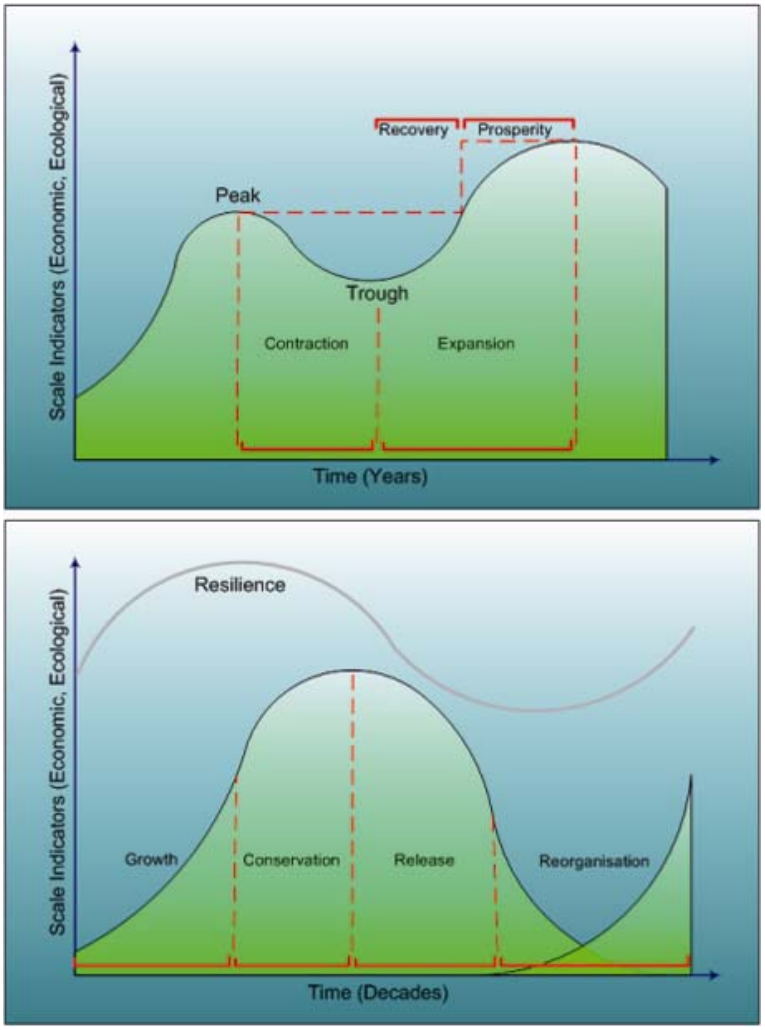

Figure 16: Comparison of change on the range of scales from business cycles (left) to adaptive cycles (right)

This represents a significant shift in thinking about how to manage agricultural systems. Folke *et al.* (2002) describe this shift as from "command and control" management strategies (which assume complete knowledge of systems), to an acceptance of uncertainty and the resulting need for both caution and creativity in our thinking and planning:

> 'Paradoxically, management that uses rigid control mechanisms to seek stability can erode resilience and enhance breakdown of socio-ecological systems…The scale of these breakdowns increases with increasing technological capacity. In contrast to an efficiency-driven, command-and-control approach, management that accepts uncertainty and seeks to build resilience can sustain social-ecological systems, especially during periods of transformation following disturbance.' Folke *et al.* 2002:2

There may be no pre-existing solutions for these strategic types of problems. This framework is not meant to replace original thought and solutions for your area.

Appendix B: Quantitative System Modelling

The process of system mapping described in the design stage of adaptive management can be developed into quantitative system models that define the numerical relationships between system components, however this should only be done if there is a high degree of uncertainty about relationships that could trigger unexpected consequences. Quantitative models define system relationships more precisely, but require a much higher level of technical input.

Quantitative system modelling begins with the same information as in design steps one and two, but adds numerical values to the description of relationships. For example, a better description of soil fertility and yield would include measurements or estimates of *how much* yield we can expect for a given level of soil fertility (Figure 17). The data in Figure 17 suggest that there is a threshold below which fertility starts to decline. The unbroken line is a simple "model" of that behaviour, that could be included in a computer model of the system to estimate how yields will follow changes in fertility.

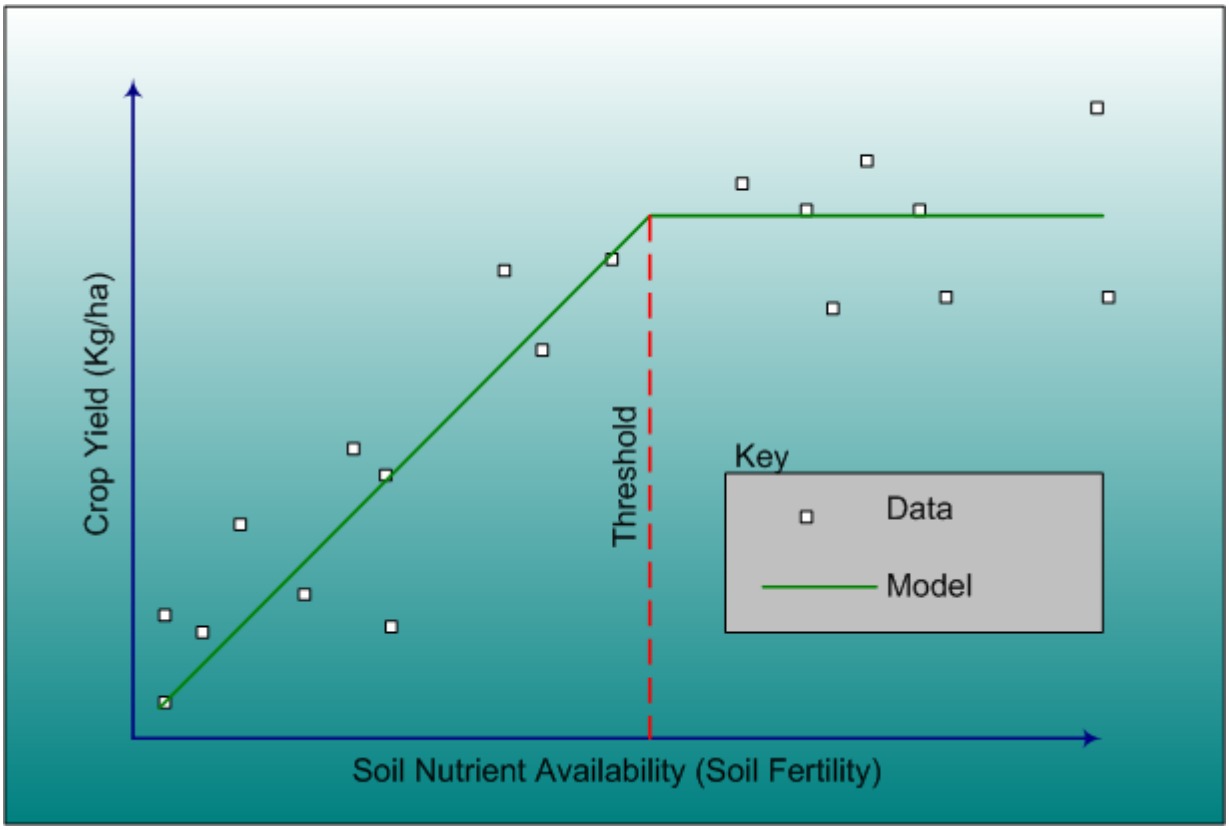

Figure 17: Idealised model of soil fertility and yield for a specific crop and nutrient.

These kinds of numerical relationships need to be measured or estimated for all the key relationships of a system map. System relationships can be both complex and uncertain, so the work of quantifying the system can be technically very demanding. Relationships tend to cross the boundaries between different areas of scientific and technical knowledge, so the ability to combine them into a set of inter-related descriptions may require the coordination of inputs from a number of highly skilled people (Figure 18).

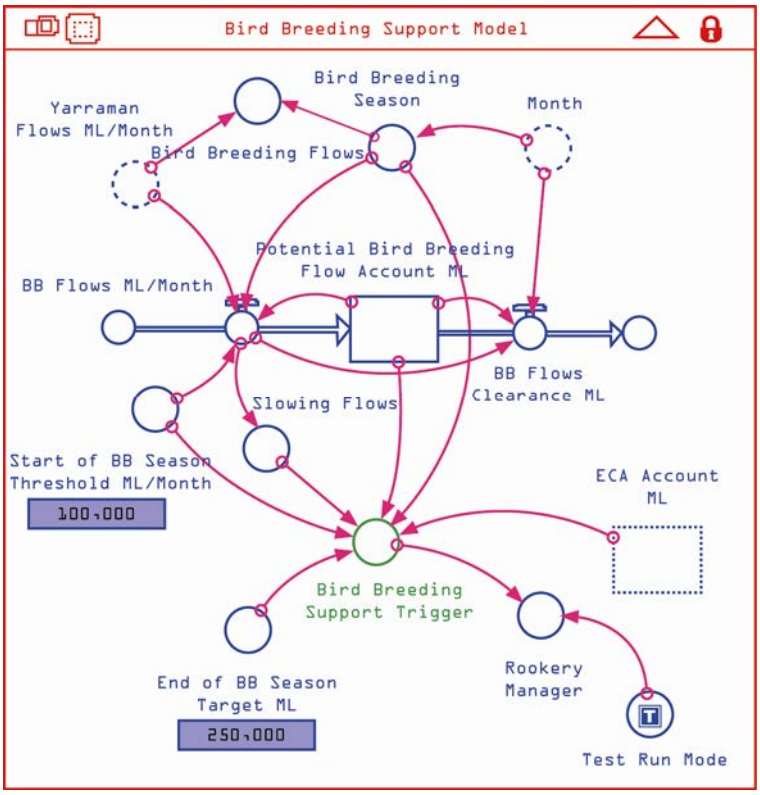

Figure 18: Bird Breeding "Sector" of an environmental water management model.

The bird breeding model in Figure 18 sets out the relationship between environmental conditions and the likely success of bird breeding events. In constructing this sector model, conditions triggering different types of events were discussed and agreed on by a committee of resident wildlife managers and stakeholders. The resulting information classes and relationships were modelled by specialist consultants. Inputs from outside the sector are shown as dashed circles.

This process is known as *group model building* (Vennix 1996, 1999) or occasionally as *mediated modelling* (Van den Belt, 2004). The most common outcome is a computer program of some sort, however other outcomes such as board games and learning activities have also proved popular.

If the aim is to develop a computer program, it is unlikely that actual computer modelling will be carried out during workshops. Nevertheless many of the relationships can be built and refined in workshops, making use of stakeholder local knowledge as well as technical expertise.

There are many different methods for this type of model design and construction, however it is essential that it is done in a way that can be understood by all participants. Specialists need to use plain language and simple diagrams such as flowcharts and timelines to represent complex relationships. This restriction should be built into any tendering process for technical support. It is *always* possible to explain concepts in simple terms, however complex the theory.

Participants' perceptions of the analysis, such as its acceptability, understandability and relevance, are also important. Stakeholders need to be able to accept the model as a reasonably accurate description of the system, given the uncertainties and complexities of the data and their relationships. Generally speaking, specialists and non-specialists will need to learn from each other in order to develop a model that all can accept. This learning process will require support and opportunities for reflection.

In adaptive management, a model must be designed in such a way that stakeholders can *use it to practice the decision-making process*. This requirement sets important limits on the type of model that can be built and how it can be applied (see the box on Analytical Modelling, below).

One way of "practicing the decision-making process" is to work through a model interactively. The program (or game facilitator, or whichever) pauses at decision-critical points, displays information about the situation at that point, and offers participants the choice of alternative actions. Stakeholders can then discuss the situation as a group and make decisions based on their best collective understanding. The decision is input back into the model and the consequences of the decision can then be observed as the model continues.

This type of interactive or *adaptive* modelling is similar to the adaptive management process, in that different decisions may be made at different times due to learning about the consequences of previous decisions. This experience provides participants with the opportunity to practice adaptive management as a realistic role-play of the real-world decision-making process (see Figure 19).

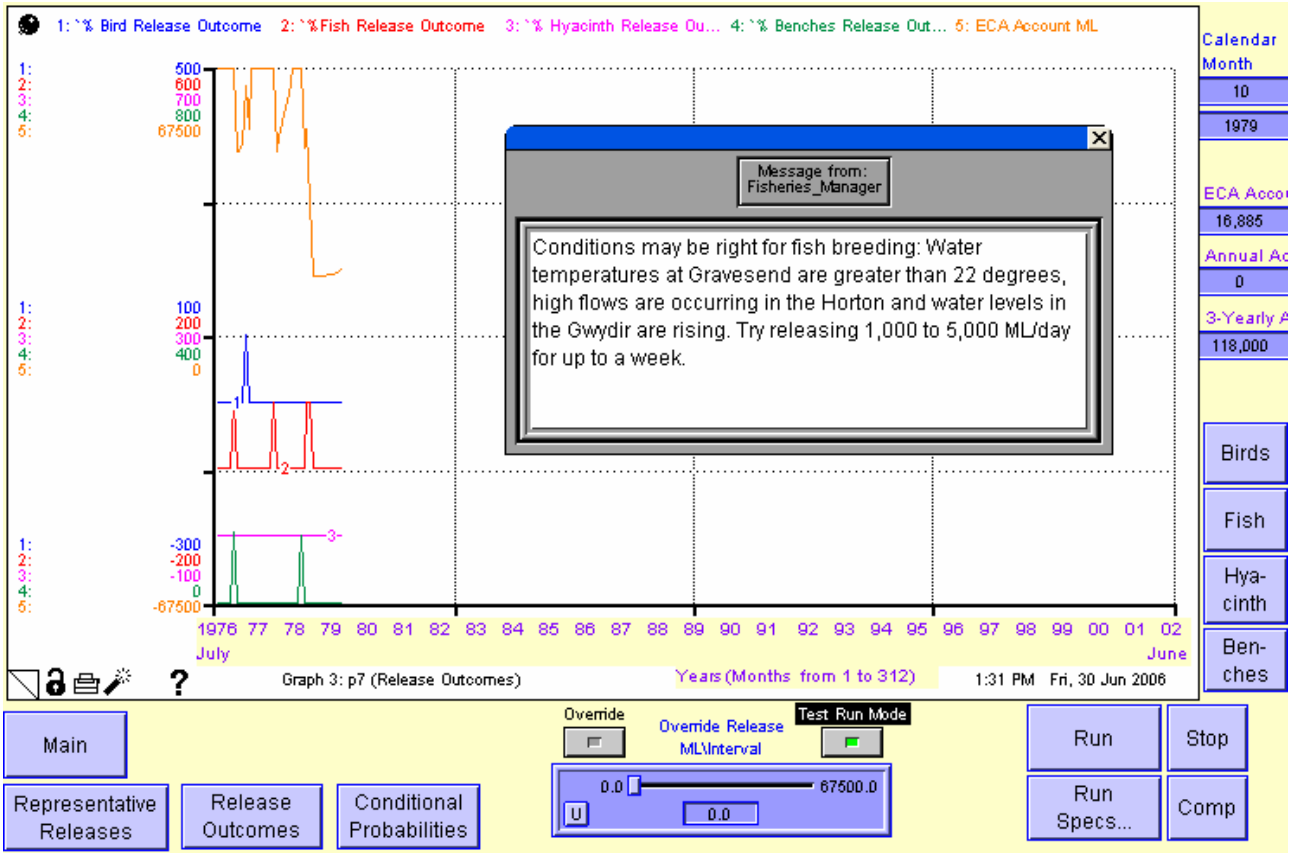

Figure 19: Adaptive modelling of environmental water management in the Gwydir River.

The above model is designed to examine water resources data and identify points in time when streamflow conditions favour the release of environmental water. Participants examine the situation based on the available data and collectively decide how much water to release. The message shown here is based on ideal conditions estimated by fisheries managers in the catchment.

Participants in this type of exercise should be reminded that a model is only an approximate description of the real world. However, by practicing adaptive responses

to a model, participants can develop expertise in dealing with the more complex reality. Most importantly, adaptive modelling does not *control* decision-making by computing the "answers" as inflexible analytic outputs, but *supports* decision-making by providing participants with enough information to form their own conclusions.

An alternative approach is to run a computer model in "analytic" mode, i.e. the model runs from start to finish, calculates the outcomes of input decision criteria and displays the output at the end of the run. This method is common in many types of technical analysis, such as engineering and economics, however it is *not recommended* in resilience management, for the following reasons:

- Analytic models do not allow participants to engage with the details of *why* certain things happen in the model, but simply present all the results at the end. It is seldom feasible to work through all the output to see why certain things happened, so generally the results can only be either accepted or rejected. This limits the opportunity to learn about the system and can result in preconceived ideas or political positions effecting the decision.

- Analytic models do not allow for alternative responses to given situations, and as such provide no opportunity to practice adaptive decision-making.

Both these criticisms relate to the ability of a model to support learning by participants. Adaptive models have been referred to as *Learning Support Systems*, as opposed to *Decision Support Systems* which are typically designed and constructed as analytic models (Evans and Wolfenden 2005). Further information on the development and use of such Learning Support Systems can be obtained from either Dr Michael Evans or Dr John Wolfenden at the University of New England.

Partner Organisations

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Land & Water Australia

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SunWater

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UNE
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