# Monitoring and adaptive management: resolving social and organisational issues to improve information sharing in natural resource management

Will Allen [1a] , Ockie Bosch [2] , Margaret Kilvington [2] & Ian Brown [4] , and Don Harley [3]

[1] Landcare Research, PO Box 282, Alexandra, New Zealand [1a] Corresponding author; email: Email [2] Landcare Research, PO Box 69, Lincoln, New Zealand [3] Cambrian, RD, Omakau, New Zealand [4] Otago Regional Council, PB , Dunedin New Zealand

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**Abstract:** Adaptive, or 'learning by doing', approaches are often advocated as a means of providing increased understanding within natural resource management. However, a number of organisational and social issues need to be resolved if these approaches are to be used successfully. A case study in the South Island high country of New Zealand is used to review what is needed to support an ongoing community-based monitoring and adaptive management programme. First, the case study is described, paying attention to the social context of the resource management problem. The results of a workshop which explored this problem are then outlined, along with a proposed information flow suggested by participants. Requirements for future steps to resolve these problems (such as information protocols and a multi-stakeholder information system) are discussed. Finally, some broad lessons are drawn from this exercise that could help others developing similar approaches.

*Key words:* Natural resource management, collaborative learning, information management, social and organisational requirements.

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## Introduction

Issues of natural resource management emerging in the last 20 years are highly complex, and the task of assimilating and managing the information needed to promote best management practices (BMPs) has become increasingly difficult. The changing nature of resource management adds a further complexity. Solutions need to be monitored closely during implementation to confirm their effectiveness, and to help refine future actions. In addition, as economic, technical and social systems continue to evolve and affect management decisions, they will also contribute to changing the definition of what is best management practice. Accordingly, successful

resource management must be based on the linked processes of monitoring and adaptive management, or 'learning by doing'.

Similar learning-based approaches are well established within the field of organisational and agricultural management. Within business, the linked processes of monitoring and adaptive management are accepted as an integral component of decision making, and represent a conscious attempt on the part of organisations and agricultural enterprises to improve productivity, effectiveness, and innovativeness in uncertain economic and technological market conditions (Senge *et al.* 1994). However, learning-based approaches are not yet widely used to support the longer-term decision making needed for the management of natural resources. In particular resource management monitoring, while commonly undertaken, is rarely linked with subsequent management decision making. One of the more common reasons for monitoring is to meet a regulatory requirement, for example, environmental agencies may be required to comply with State of the Environment reporting, or an individual land manager may have lease requirements. Another is to obtain data as a protection against action by a regulatory agency or other interest groups.

More recently the importance of using monitoring to learn how land-use practices affect natural resource trends has also been recognised. Increasingly the emphasis is on helping land managers to gain understanding to manage the land for which they have a primary responsibility. It is, after all, the decisions they take today that will heavily influence the future state of the lands that they manage. This recognition is leading to the development of more collaborative -- often referred to as community-based or participatory -- approaches towards monitoring and management (e.g. Burnside and Chamala 1994, Bosch *et al.* 1996b, Allen 1997, Abbott and Guijt 1998). These approaches recognise that science alone cannot provide all the answers, and must be combined with a structured process of local participation that emphasises shared learning and locally-relevant indicators and methods. The challenge is to bring local and scientific knowledge systems together to provide both land managers and scientists with more opportunities to inform and stimulate each other (Bosch *et al.* 1996a) Any framework to achieve these must be capable of:

- integrating existing local and scientific knowledge into guidelines for best management practice;
- incorporating tools with which land managers can monitor and interpret the outcomes of management actions;
- continually capturing new information gained through research (scientists), and the adaptive management and monitoring process (land managers);
- transforming this new data and information into useful knowledge to expand our understanding of best practice.

Although adaptive management approaches have been advocated for environmental management situations for around 20 years (Holling 1978, Walters and Hilborn 1978), their success in practice has been rather less than spectacular (McLain and Lee 1996, Dovers and Mobbs 1997). There is also a growing appreciation that, given the multi-stakeholder nature of most environmental situations, the more immediate barriers to overcome are organisational and social, rather than technical. These barriers include a tendency to discount non-scientific forms of knowledge, institutional cultures within research and policy making that work against genuinely

participatory approaches, and a failure to provide appropriate processes to promote the development of shared understandings among diverse stakeholders (e.g. Campbell 1995, McLain and Lee 1996, Pretty 1998).

We use a case study in the South Island high country of New Zealand to review what is needed to support an ongoing collaborative monitoring and adaptive management programme. First, the case study is described, paying attention to the social context of the resource management problem. The results from workshops which were held to explore the establishment of an adaptive management approach are outlined, along with a proposed information flow suggested by participants. The requirements for future steps to resolve these problems (such as information protocols and a multi-stakeholder information system) are discussed. Finally, some broad lessons are drawn to help others developing similar approaches.

## Case study context: the South Island high country of New Zealand

It is particularly appropriate to use an agricultural example to highlight issues in natural resource management, because as Dahlberg (1979) points out, agriculture represents the basic interface between people and their environment. From this perspective, the grasslands of the South Island high country present a number of advantages for those concerned with the improvement (or evaluation) of research and development (R&D) programmes. The high country comprises a microcosm of the major resource management issues surrounding extensively grazed ecosystems worldwide (Allen 1997). Today, there is a worldwide trend towards a holistic, multi-use, multi-value view of such extensively grazed grasslands. Grazing has increasingly become a variable component or even been abandoned in some areas, a change that highlights the diverse values that these grasslands are now expected to serve. In New Zealand these encompass national aspirations concerning issues such as indigenous Maori land rights, preservation of biodiversity and natural landscapes, sustainable management, tourism, and recreation, as well as traditional pastoral considerations.

The South Island high country not only encompasses a wide range of contrasting situations, but is also characterised by conflicts over resource use between different interest groups. However, as recently as a decade ago, those working in the New Zealand high country were at least confident in the knowledge that they were dealing with what everyone knew was a largely extensive pastoral system. Today, whether the high country should be regarded as an agricultural, tourism, or conservation system, or some combination of all these, is a matter of contention.

Public interest groups are no longer content to evaluate rural systems such as the high country merely in terms of economics and production, but are looking towards measures of ecological health, environmental ethics, and equity. A range of public pressure groups increasingly voice their concerns about issues such as the effect that agricultural practices are having on the environment, or conflicting land uses. We also have farmers who publicly question whether they are farming 'sustainably' .... and challenge science to define the land management practices that need to be implemented to be 'sustainable' (Allen and Bosch 1996). However, although science is continuously adding to our knowledge, the complexity and diversity within the South Island tussock grasslands makes it impossible for scientists alone to interpret and develop the required comprehensive knowledge base (Bosch *et al.* 1996b).

Local land managers and resource management agency staff recognize that land-user-based monitoring is needed as part of an adaptive management approach if we are to manage our natural resources successfully. For example, in 1994 the High Country Committee of Federated Farmers put together a farmer resource kit with details on various monitoring methods that individual farming families can use on their properties. A report by the Parliamentary Commissioner for the Environment (1995) stated that ongoing monitoring by land managers is essential to increase the understanding of issues affecting tussock grasslands. The same report also stressed that decision makers and land managers need to promote and adopt management approaches that are based on both research and monitoring.

In response to these calls an ongoing community-based research programme to encourage adaptive management as an approach to improving understanding of the tussock grasslands in the high country was initiated. The Integrated Systems for Knowledge Management (ISKM) (Bosch *et al.* 1995, 1996a; Allen et al. 1995, Allen & Bosch 1996) was used as the framework for this research programme. The ISKM framework focusses on strengthening participation and self-help in natural resource management projects. As such, it is not a new project type or innovative development concept, but rather a specific approach that emphasises a number of key steps applicable to developing the knowledge and action needed to change problem situations constructively.

The ISKM framework (Figure 1) consists of familiar processes used in other fields of cooperation, and was designed around basic management actions. The first three of these involve: establishing a climate for change with the different parties involved and setting goals and objectives, searching for information, and developing a shared understanding and action plans to address the issue. These action plans also need to be supported by appropriate monitoring tools and processes that can help managers check that they are working, and to guide their responses if changes are needed. The fourth step in ISKM involves the development of a management information system which captures decision making information for the benefit of the wider community of stakeholders. This can be as simple as meeting minutes, but given the complexity of many natural resource issues computer technology will become increasingly relevant. Finally, ISKM stresses the need to develop feedback loops to maximise the benefits from monitoring and evaluation and develop a collaborative-learning/self-improving environment.


**Figure 1** ISKM -- a participatory research framework to facilitate the identification and introduction of more sustainable resource management practices. The two phases interact to create an effective learning environment.

Over the past six years the activities outlined in the first four steps in the ISKM framework can be seen to have been undertaken in respect to the South Island tussock grasslands, albeit with funding obtained through a range of projects. The implementation of these activities have often been managed by different groups, and involved farmers, conservation managers, policy makers in local and national government, and researchers from a number of different institutions.

One of the key activities undertaken during this time is the development of a Tussock Grasslands Management Information System (MIS) to provide background ecological knowledge and best practice guidelines for different vegetation states. This information system draws on both farmer, conservation manager and science knowledge which has been discussed at forums with representatives of these different groups. The resulting MIS (http://www.tussocks.net.nz) is Internet-based, and has been designed as an open-ended system that can be continually updated as new information becomes available through research and monitoring (Bosch *et al.* 1999).

In addition, support for ongoing farmer-based monitoring has been provided through a concurrent research project involving scientists and farmers in the development of Condition Assessment Models for measuring (monitoring) and interpreting vegetation change in the different ecological areas within the tussock grasslands. These models describe the major vegetation changes that could occur in a particular area under different management practices and climatic conditions (Gibson and Bosch 1996). This information is contained in a user-friendly computer tool (REDIS) that enables land managers to interpret the results of monitoring by indicating where a particular site is situated along a condition gradient (Gibson and Bosch 1999).

These models were subsequently made available to individual land managers through landcare groups in the high country. Training was provided to help land managers

identify key indicator plant species and to use the software package. However, while the models were relatively well received by land managers, there is no certainty that their use will ensure the ongoing feedback and sharing of information (step five of ISKM) that is required if we are to successfully answer questions about ecological sustainability in the high country.

## Key issues around information management

To deal with this substantial gap in the information system required for monitoring and adaptive management, a number of workshops have been held over the past two years with representatives of major stakeholder groups (farmers, local government, and researchers). These workshops were developed as formative participatory evaluation exercises, to determine future programme direction. This feedback provides an important component of ongoing resource management approaches where proposals for action are necessarily reshaped as experience is gained and as more of the stakeholders become concerned about a particular issue, cost, or benefit (Allen 1997). Each workshop began with a semi-structured discussion session in which participants were: i) encouraged to talk about the general issues, concerns and opportunities that sharing information/community-based monitoring raises for them; and ii) to build on these points and develop an appropriate framework.

### Information flows and concerns

Participants acknowledged that an adaptive approach to management and sharing of the information gained through this was crucial to an improved understanding of tussock grasslands dynamics. The motivating factors of pride in land management and a concept of stewardship were acknowledged as a major incentive to become involved. However, the risks to individual land managers over possible misuse of data and information were also seen as a potential barrier.

Being proactive in proving sustainability is another factor which could encourage community-based monitoring and adaptive management. Community responsibility was cited as a reason for becoming involved by some farmers, although an unwillingness to learn that there might be a problem clearly puts some others off. Many of the external (i.e. off-farm) social pressures and influences cited by participants are driven by the recent international public interest towards sustainability. International markets increasingly requiring proof of sustainability are also a motivating factor, although the effect of low commodity prices (reducing farm income) can work against this.

Who benefits and who therefore should contribute to the cost of such a collaborative exercise is a major issue. The concept of a more collaborative learning-based approach to the management of the high country has emerged mainly from sustainability, rather than production issues. The downstream benefits of improved management understanding through public knowledge jointly developed by land managers, in addition to government-funded scientists, provide an argument for the wider community shouldering more responsibility for monitoring costs. This, in turn, points to the importance of institutional support for collaborative learning-based approaches to natural resource management.

## A framework for information flows

Workshop participants developed an outline of the information flows that would enable an adaptive management approach to provide increased understanding and knowledge for the different groups involved (Figure 2). This is similar to ISKM, and in itself provides a validation of the research steps set out at the beginning of the programme. However, it goes further and indicates the activities that remain to be done in this particular social setting for the process to become ongoing and self-improving.

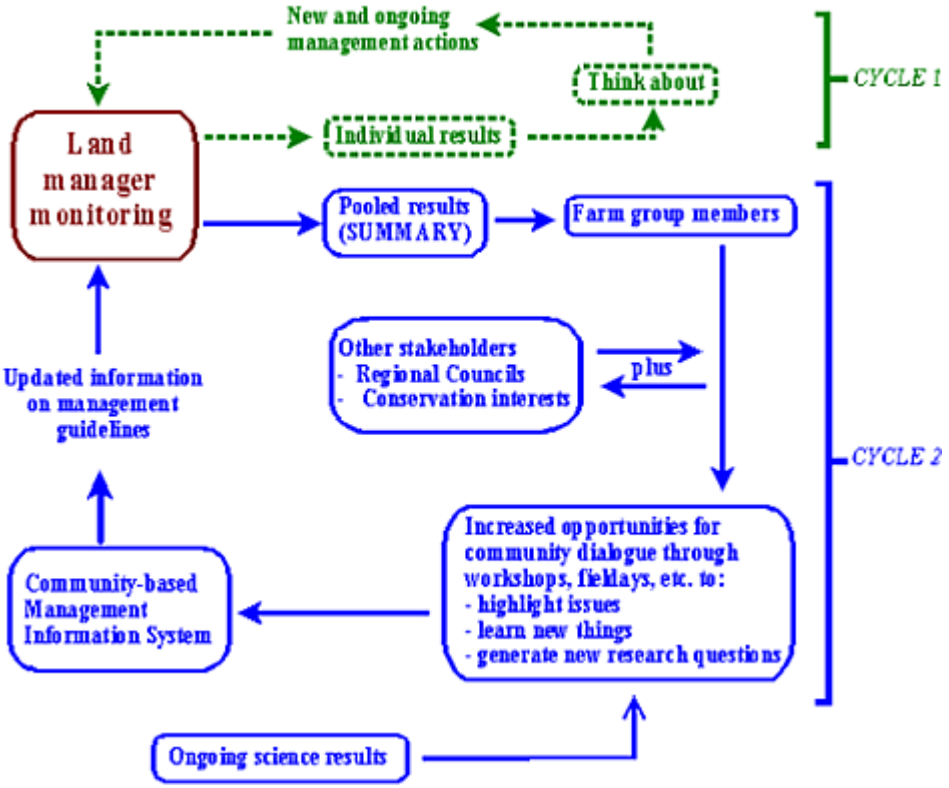


**Figure 2** A conceptual model of information flows within a community-based monitoring programme (Cycles 1 and 2 - see text).

This discussion began by revisiting the goals of this community-based monitoring programme in the South Island high country. Clearly, farmers will always use monitoring results from their own properties as a basis for considering future management options (Cycle 1). However, the question that emerged through this discussion was whether or not individual use of the Condition Assessment Models in this way would provide enough benefits to encourage the use of the monitoring tool independently of a more collaborative approach to information sharing. It is significant that land managers made no mention of shorter-term financial gains as an incentive during either workshop. This is due largely to the nature of the condition assessment model, which measures species change rather than available forage, which is the measure required for feed budgeting within a farm planning cycle of up to a year. It was also pointed out that the first question an individual will have when he/she looks at their own farm results is whether or not the trend indicated is similar to the results appearing on neighbours' properties, to ascertain the influence of climatic effects.

This discussion led to the development of Cycle 2, which was concerned with sharing the results among different stakeholders, and hence adopting a more multi-stakeholder approach. It was noted that as this requires farmers to become involved in monitoring as part of a wider learning exercise, rather than to provide results that would directly feed into day-to-day management planning, it would only appeal to some farmers. A useful first step in this regard was seen as pooling the results from the farmers that were involved locally within a farming (e.g. landcare) group. It was felt that this could easily be done by whoever is managing the data, and such pooling would help differentiate between trends that were due to climatic effects and those that were due to management.

Farmers felt they would gain more by involving others (such as local government policy makers) as partners in such a learning exercise, rather than treating them as adversaries. This was represented by a complementary step. An external audit for such farmer-based monitoring programmes was also seen as important to develop accountability, and build trust in the results by other stakeholders. The use of such monitoring systems could also form the basis for a future quality assurance accreditation scheme, to improve market access.

The provision of community forums for information sharing was seen as another necessary step through which different stakeholders could more effectively share, and understand, this information. In this way the system would provide a pathway for scientists to help analyse information from on-farm monitoring and offer more insight on the lessons that can be learnt. These forums were also seen as providing an opportunity for scientists to share the results of their own research with the wider community, and to work more directly with land managers to identify new research priorities. Moreover, by providing an environment for a number of groups to collaboratively learn about the tussock grasslands, it seemed possible to share costs and bring in skills that might otherwise lie outside the means of any individual farming group.

Participants saw that it was important to disseminate the lessons further. Accordingly, another useful step is to capture and make readily available the new knowledge gained through the whole process, thereby adding to the community's existing public knowledge base. The problem that was left unresolved at these workshops was who should maintain and facilitate this resource, given its joint development and wide base of information providers and users. Finally, as the workshop discussions confirmed, one of the major challenges to developing an effective multi-stakeholder information network is supporting the active participation of stakeholders, and resolving the social and organisational issues associated with collaboration.

## Issues with sharing information: the next steps

The issues that this evaluation raised over sharing and managing information are those which appear to have prevented the successful implementation of other international examples of regional or catchment-based adaptive management initiatives. While this remains an ongoing process, some initial thoughts on what these social and organisational challenges mean for the programme, and possible ways to resolve them are outlined below.

**Protocols for sharing information**

Although the information system described in this paper is designed to build trust and confidence between information providers and users, in the shorter term strong emotions associated with information often create a barrier to its availability (Allen and Kilvington 1999). Among science researchers much personal self-worth and commercial worth is linked to the information generated. Fear over misrepresentation affects the willingness of researchers to offer their information for use in systems over which they have no future control. Many other stakeholders may have similar fears, with some justification, that their information might be used incorrectly, or against them, if released.

In the tussock grasslands of the South Island high country, only a decade ago, the research emphasis was directed towards improving the efficiency of an extensive pastoral system. Indeed, there are few references in the agricultural research and development literature internationally to participatory approaches other than those that comment on farmers and scientists dealing with agricultural management issues (Allen 1997). However, today, given increasing public interest in the high country, research is increasingly directed towards issues of sustainability, and hence meeting the needs of a range of stakeholder groups concerned about the impact of natural resource management practices. In many cases, such stakeholders have for some time considered themselves in opposition to one another.

Land managers are aware that some groups may seek to use farm-based monitoring data against them, rather than as part of a collaborative learning exercise. One way forward is to develop information protocols that safeguard such use (see Box 1).

**Box 1: Draft Protocol for monitoring information sharing** *(Provided by Don Harley, Hawkdun Land Management Group)*

**To specify data ownership:**

Information stored on central database is the property of the group and individual owner, and to be controlled by the land management group or its agent.

**To protect individual privacy:**

The site data and property identification are to be coded to retain anonymity and are not to be divulged to third parties without the property owner's consent.

**To enable the benefits of sharing data within the group:**

However, unless otherwise specified by the individual, pooled results can be released in summary form.

**To provide for working in with other parties (e.g. local government):**

Where joint/collaborative arrangements with third parties exist, then third

parties share ownership and access to the results for the sole purpose of that specified in the arrangement.

Similar concerns have been raised regarding access by scientists to private research sites to look at soil and vegetation trends. In one recent case access was denied, largely because farmers were unsure about what use would be made of the subsequent research findings. However, because the project process was prepared to openly address this conflict, and bring in the appropriate skills, the situation was able to be resolved. The subsequent conflict management exercise resulted in the establishment of information management protocols, which enabled the research to proceed. These protocols protected the rights of landowners to be advised of research results prior to their being released to third parties, and provided for discussions of the implications of research results by the different stakeholders involved before publication (Allen and Kilvington 1999).

Such protocols could also include transaction costs (the flow of data is encouraged when these are low), permitted/excluded uses, and disclaimers (in the event of incorrect data and to avoid liability). However, protocols are only a starting point to building goodwill, trust, and fairness in sharing information.

## Managing multi-stakeholder information systems

A first version of a Tussock Grasslands Management Information System is currently being developed with the support of a range of different user groups. This will enable structured information to be captured and made available to those unable to directly participate (Bosch *et al.* 1999). While the notion of a centrally-based information system seems an ideal way of resolving the tensions over disparate information sources, such a system will often be unsustainable in multi-stakeholder situations such as this where, quite understandably, stakeholders expect to retain full control over their own data and information. An alternative is to promote a network concept which conveys the reality that the information system is a collection of participating stakeholders rather than a particular information project or item of technology (Figure 3).

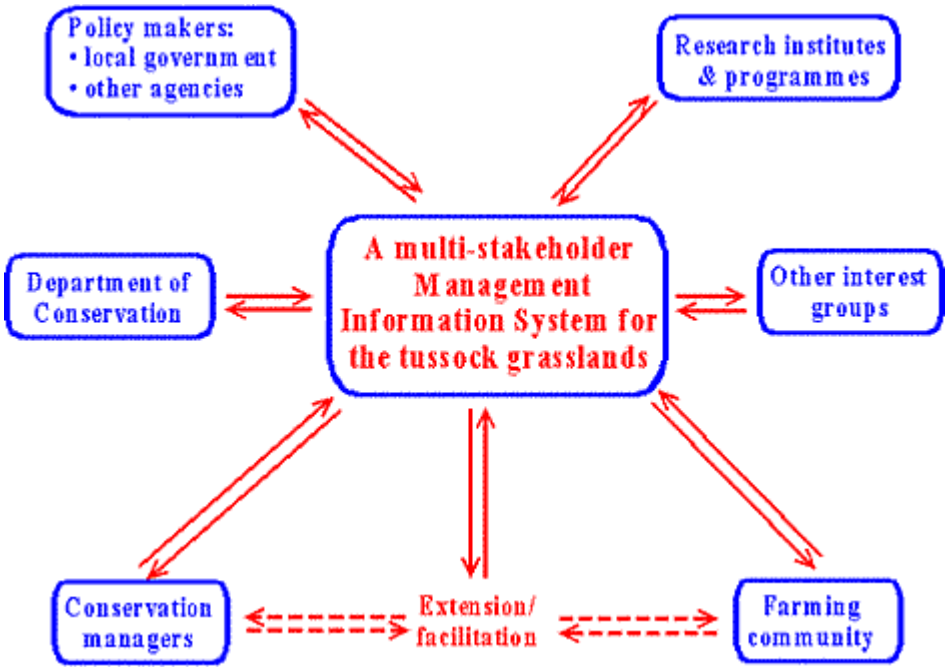


**Figure 3** A network of information providers and users in the high country

Given the decentralised grouping of agencies, land managers, and other individuals within the natural resource management arena, the Internet is emerging as a valuable tool in information management. It allows different groups or organisations to maintain control over their own information, while sharing a common 'gateway' with a number of complementary systems. Internet technology will inevitably play a role in future information systems, not least because it offers a unifying platform on which the collection of information for both internal and external use can be provided. The potential of the Internet to promote collaborative learning and problem solving has been pointed out by a number of researchers (e.g. Carrascal *et al.* 1995, Allen *et al.* 2000).

However, while a start has been made and information is currently being shared among farmers and researchers from a number of different institutions, developing a shared system in this way is raising new issues. Fears of misrepresentation, misinterpretation, and misuse of data and information that has been provided for collective use must be allayed. This involves constant negotiation with researchers, policy makers and local landowners. Questions of security of information, how to credit information, and how to release and circulate draft information, all have to be worked through with all the contributing stakeholders.

This approach also provides new challenges for extension. Not all farmers, community members or conservation managers are going to be directly involved in such a collaborative research approach to high country management, nor should we regard all those who become directly involved in such participatory processes as direct users of such a multi-stakeholder information system. There are also a number of individuals who do not have, or necessarily want, access to computing and Internet facilities. Increasingly, however, people do belong to a range of groups (e.g. landcare, NGOs). These groups are serviced by facilitators and group leaders, and act to develop an effective cooperative environment for information exchange and learning.

In this way there is potential for such facilitators and group leaders to be seen as the interface between the Internet-based information system and individuals. In itself, the Internet has the potential to form a powerful and immediate link between group facilitators, group leaders, researchers, and other relevant agency staff. Strengthening this link will contribute towards more effective sharing of information among the diverse range of groups involved in natural resource management.

A major consideration is how to institutionalise the process so it continues beyond the life of the research programme. The difficulty centres around who has the mandate to provide ongoing support for such a system, and whether it should be undertaken by one or multiple groups. In turn, these questions are related to how different groups regard the goal of such an information system -- is it just to benefit land managers, or is it a public good?

## Concluding comments

Clearly the multi-stakeholder perspective taken within this South Island high country initiative challenges the common perception of what a 'programme' is. It recognises that each group of participants (scientists, funders, land managers, policy makers, etc.) has its own viewpoint, and its own reasons for becoming involved. As Schwedersky and Karkoschka (1994) point out, it is traditional to observe programmes within an operational cycle, from planning via implementation through to evaluation. However, to take into account the various perspectives and interests of the participants, we must look beyond this cycle. Inevitably, 'the programme' can be regarded as a number of sub-projects, each of which is 'steered' by a different group of participants according to their values and aspirations. In the real world, 'cooperation' is a far more realistic goal than 'consensus'. It is unlikely that groups with different interests, objectives, and values will work as members of a single 'community' team. But with the help of appropriate participatory and systems-based processes it may be possible to help meet the different needs of those involved and develop 'win-win' strategies.

As Allen and Kilvington (1999) highlight, the key to implementing such systems is to develop a clear understanding among all the different participants about the goals and objectives. One of the main points that has come out of this evaluation is that a monitoring system such as that described here is primarily designed to facilitate a collaborative approach to improving our understanding of what is happening in rangeland ecosystems. As such it is more likely to interest a small number of farmers from all over the high country who wish to more closely link their management results with the more formal scientific research process. In this sense, these farmers cannot just be seen as system users, rather they become 'co-researchers' in developing public good knowledge, and consideration needs to be given to how their input can be best supported.

In the broadest sense, such open-ended information systems as described here are intended to improve efforts to share information by building trust and confidence between information providers and users. Such systems can empower a wide range of individuals, groups, and organisations to work together and support decision-making change within a framework of collective information production. The guidelines and strategies developed by the stakeholders will draw on a larger base of information than is available to any one of the parties acting alone. They are thus likely to result in

more effective outcomes. The probability of commitment to, and adoption of, changed practices is also likely to be higher because stakeholders have had a hand in designing them. However, in seeking to develop an information system that is truly part of the broader social system by which information is translated into knowledge and action, we need to pay attention to social and organisational as well as technical issues. As Allen and Kilvington (1999) point out, future multi-disciplinary approaches need to include personnel with complementary skills in the management of participation and conflict, and the integration of biophysical and social aspects of problem solving.

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