IS KNOWLEDGE MANAGEMENT THE ANSWER FOR ICM?

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Abstract

This paper shares our experiences in dealing with community and governance-level stakeholders and relates examples that support our thesis: that without a common level of understanding of the issues and the information (or lack of it) related to those issues, integrated catchment management will struggle to occur.

Introduction

The foundation for the Motueka River ICM research program was created through extensive consultation with end-users and stakeholders and input from two internationally-recognised experts. The seeds were sown during a workshop attended by a wide array of stakeholders who identified that holistic and sustainable management of land, river, and coastal resources - a "ridge tops to the sea" perspective - was a top priority. The program's goal is to improve the management of land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting land uses. This ambitious goal is being accomplished through an innovative combination of historical research, biophysical experimentation, simulation modelling, and social learning. This combined approach has been designed specifically to improve interactions between science providers and community stakeholders and to maximise the uptake and use of new knowledge and tools developed from scientific research.

The program is now entering its 3rd year. One of the key outputs to date has been the production of an integrated knowledge base comprising a web site, a searchable reference library, and a technical report that summarised available knowledge and documented research issues. Communities of interest have many myths, perceptions and anecdotes concerning the nature of resource management issues. These are a rich resource but need to be considered against information that has been critically reviewed and evaluated to provide a common knowledge base so that all parties can move forward.

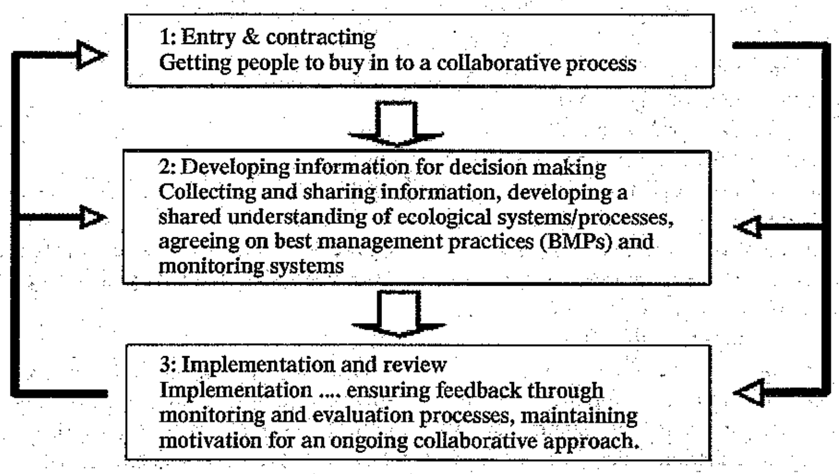

Figure 1. Steps in a collaborative process (from Allen & Kilvington 1999).

Integrated Catchment Management

Over the past two decades, the challenges facing landowners, resource managers and scientists have multiplied. Where once our rural environments were viewed as single-sector-oriented productive landscapes, they now face demands by new players - such as those voicing their views on issues such as landscape, recreation, conservation and tourism. This is particularly true for Integrated Catchment Management (ICM) initiatives where there are many players involved and many perspectives for resource management. Science and other information is subject to diverse and contested interpretations. To work in these areas ICM practitioners are seeking collaborative approaches that accommodate multiple perspectives and utilise multiple sources of information. Collaborative approaches, such as ICM, can be viewed as a three-phase social process of:

(i) entry and contracting - recognition by those affected that there is a problem that needs solving;

(ii) developing knowledge for decision making - a common, shared understanding of the knowledge that is relevant to the problem; and

(iii) implementation (taking action) and review (Fig.1).

This paper aims to share some of our experiences in dealing with stakeholders in step two of this process. In particular, recent thinking about the management of knowledge provides insights into the process outlined in Fig. 1.

Our principal thesis is that without a common level of understanding of the issues, information (or lack of it), and knowledge related to those issues, real integrated catchment management will struggle to occur. We note that the second stage, which we argue is critical to the success of ICM, is often not performed well. In many cases information is assembled but the degree to which that information and subsequent knowledge is shared or understood is often left wanting. For ICM to be successful we believe the old paradigm of knowledge is power needs to be discarded in favour of a new paradigm that knowledge is empowering, in which the power to act comes from the sharing of knowledge *and* the creation of new knowledge driven from informed, and motivated stakeholders.

Knowledge and knowledge management

Where does knowledge management (KM) fit into ICM? The KM movement -

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a phenomenon that is increasingly becoming a part of many organisations and businesses today - has, we believe, application to ICM. Many of the KM fundamentals can readily be adapted to ICM-type problems. *"Knowledge is information that changes something or somebody - either by becoming grounds for actions, or by making an individual (or an institution) capable of different or more effective action."* (Drucker, P. 1989: The new realities. Harper & Row, New York) The terms "information" and "knowledge" are often used as though they are interchangeable, when in practice their management requires very different processes. Knowledge management, in an ICM context, focuses on the processes and people involved in creating, sharing and leveraging knowledge among science providers, communities, resource managers and policy makers. Information management, in contrast, is more concerned with establishing processes and systems to gather, organise, summarise and package information - including its timely delivery to the right decision makers for the situation involved. Early users of KM based much of their practice on the assumption that valuable knowledge exists out there, and all we need to do is capture it, codify, and share it. This view of KM is often associated with phrases such as:

- getting the right information to the right people at the right time,
- if we only knew what we know now, and
- we need to capture and codify our tacit and explicit knowledge before it walks out the door.

In this view the practice of KM begins after knowledge is produced and its purpose is to enhance the deployment of knowledge into practice. This is first-generation KM where the emphasis is not on knowledge production but on knowledge integration. However, a new view has emerged in recent years - second-generation KM (McElroy 2002). Its practitioners don't assume that valuable knowledge already exists but take the view that knowledge is something that is produced in human social systems through individual or shared processes that have regularity to them. This 'knowledge life cycle' (McElroy 2002) emphasises both knowledge production and integration (Fig. 2). Some of the claims embodied in this view include:

- People engage in learning as a result of experiencing gaps in their understanding about an emerging problem, which involves a lack of knowledge of what actions to take in order to achieve the desired outcomes.

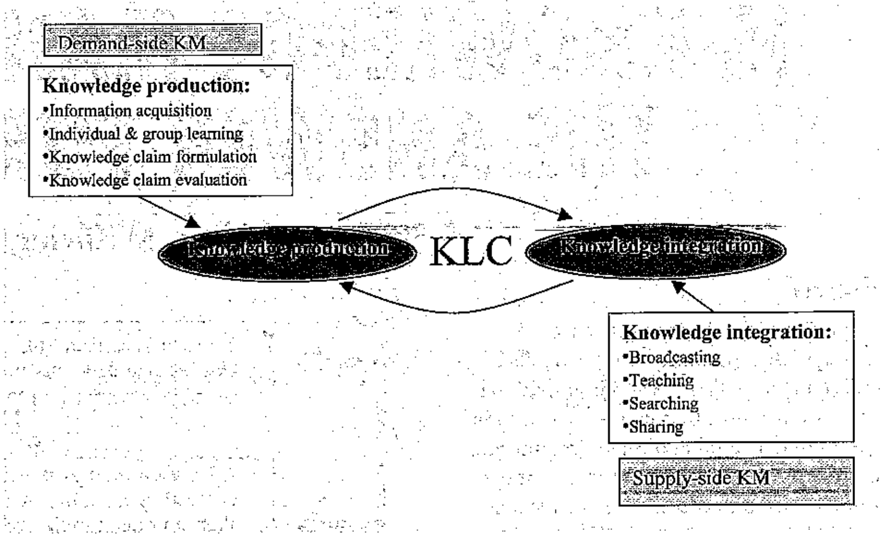

Figure 2. Elements of the Knowledge Life Cycle (KLC) (modified from Fig 3.7, McElroy 2002) Knowledge Management in the ICM Motueka research program.

- Detection of problems by individuals triggers learning activity that eventually leads to the formulation of ideas, theories, and assertions about which potential actions might lead to the desired outcomes.
- As they engage in learning and development of new knowledge, individuals may attract others and form groups, share ideas, peer review ideas - knowledge production.
- Not all knowledge claims (statements, theories, hypothesis, etc.) formulated by individuals and groups succeed. Those that do may then start to be integrated into a wider population of people - knowledge integration.

Practitioners of second-generation KM believe that people tend to self-organise around the production, diffusion, and use of knowledge. Managing knowledge thus is far more than building computer-based repositories of facts and figures - rather knowledge is the product of natural knowledge processing behaviours (innovation) found in all living systems. Create the condition in which innovation thrives and the evolution of knowledge will naturally follow. However, given the diverse set of decision environments inherent in the resource management arena, such a system will, to some extent, use information technology for part of its function.

Second-generation KM thinking begins with the assumption that knowledge is something we produce and that innovation is a social process not an administrative one. Understanding how knowledge is created, how it is shared and diffused throughout an organisation, group or community and not just how to codify it in artificial form, lies at the very heart of second-generation KM thinking. Second-generation theory acknowledges the existence of knowledge processes and knowledge life cycles in human social systems. Thus its practitioners have come to recognise the concept of organisational learning and the collectively held knowledge it produces (McElroy 1999; Allen *et al.* 2001).

In our introduction, we posited that successful ICM requires three key elements (Fig. 1). Often these elements form a cycle with feedback loops and refinement along the away. We believe the collaborative approach outlined in Fig. 1 is analogous to the move in knowledge management circles from first-generation or "supply-side KM" (McElroy 1999) - practices designed to enhance the supply of existing knowledge to those who need/use it, to second-generation KM, which introduces "demand-side KM" which instead of focusing on the supply of existing knowledge seeks to enhance the capacity of the users to produce it (McElroy 2002) (Fig. 2). The mission of demand-side KM is to enhance the capacity to satisfy demand for new knowledge. However, second-generation KM is really about both of these - knowledge sharing and knowledge making set within a cyclical or holistic framework - referred to as the Knowledge Life Cycle (McElroy 2002) (Fig. 2).

The Motueka ICM research program is a collaborative, holistic approach to large-scale, regional environmental issues. The Motueka River ICM research program was founded through extensive consultation with end-users and stakeholders and input from two internationally recognised experts. The seeds were sown during a workshop attended by a wide array of stakeholders who identified that holistic and sustainable management of land, river, and coastal resources - a "ridge tops to the sea" perspective - was a top priority. The program's goal is to undertake research to help improve the management of land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting land and water uses.

This ambitious goal is being accomplished through an innovative combination of historical research, biophysical experimentation, simulation modelling, and social learning. This addition of social learning to the research mix has been designed specifically to improve interactions between science providers and community stakeholders, and so to maximise the uptake and use of new knowledge and tools developed from scientific research. The program takes a partnership approach that aims to help policy- and decision-makers, resident stakeholders, and researchers achieve the environmental outcomes they seek for the issues they have raised. Some of those key resource management issues are:

- Water demand and water management
- Sediment impacts including gravel extraction on aquatic habitat
- Water quality, particularly impacts of pathogens and nutrients on fresh and coastal waters
- Riparian management
- Aquatic ecology - trout and native fish response to land and water uses
- Catchment - Tasman Bay interactions with a rapidly expanding mussel farming, scallop harvesting and aquaculture industry.

In the first three years of our research, we have focused largely on first-generation KM practices, i.e. "build it and they will come" philosophies in relation to information and knowledge. There has been a focus on the production of an integrated knowledge base comprising a website (http://icm.landcareresearch.co.nz), searchable reference library, and a technical report documenting available written and some tacit knowledge and summarising the research issues (Basher 2003). This "push" approach has recently started to give way to a number of "pulls" from stakeholders who, either in response to increasing exposure to information and knowledge, or because they have started to self-organise into groups, are keen to learn more about the nature of the problems they are facing and are demanding and seeking the production of new knowledge. Thus, we are starting to see the emergence of second-generation KM practices in our stakeholder communities.

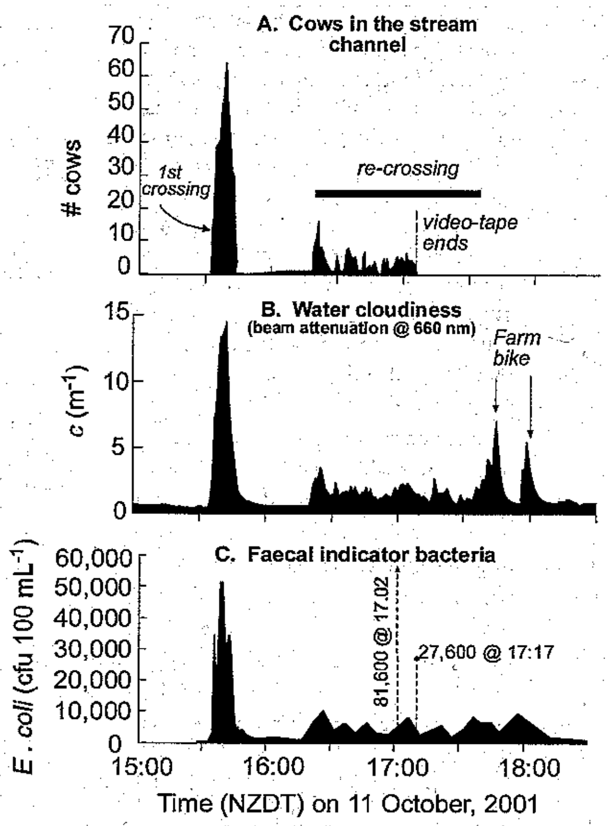

Figure 3. Relationship of water quality to number of cows in the stream channel. A. Count of cows on the ford taken from the videotape. B. Water cloudiness measured as light beam attenuation, c(660). C. Concentration of the faecal indicator bacterium, *E. coli* (two high values, possibly due to aggregates of faecal matter, are treated as outliers). Flow time was 2.2 minutes from the ford to the monitoring site 60 m downstream. (Reproduced from Nagels *et al* 2003).

Case study: Knowledge management pull

Pastoral agriculture has been implicated as the single largest cause of water pollution in New Zealand. Characteristic concentrations of the favoured faecal indicator organism *(Escherichia coli)* in agricultural streams are typically around 20 times higher than in forested catchments, and frequently exceed guidelines for contact recreation. Direct access of livestock to stream channels is thought to be a major cause of diffuse faecal pollution (Ministry of Agriculture and Fisheries 1993). A catchment monitoring program initiated in October 2000 highlighted that one Motueka catchment, the Sherry River, had a potential problem with bacterial contamination (both faecal coliforms and campylobacter). This information was presented to the research program's touchstone stakeholder group (Community Reference Group). Results indicated that the river was unsafe for swimming in its lower reaches. This new knowledge flowed back into the relevant community and was further presented to a meeting of the eight major landowners in the catchment in July 2001. The farmers expressed concern at the high bacteria results, especially as they and their families enjoy swimming in the river. Stream crossings by dairy herds were suspected as the major culprit. An ad hoc Landcare group was formed to research the problem, what might be causing it, and how to deal with it.

A multi-disciplinary ICM research team conducted an experiment in October 2001 (Davies-Colley *et al.* in press; Nagels *et al.* 2003) in which a cow crossing was recorded by two video cameras, and water quality effects documented by continuous monitoring of turbidity and beam transmittance, and by close-interval sampling for analysis of faecal indicator bacteria and other variables. The crossing of the whole herd (246 cows) as a bunch on the way to the afternoon milking produced a major "spike" of turbidity, with visual clarity dropping temporarily from 2 m to as low as 100 mm. Very high faecal bacterial concentrations were measured in the turbid plume (exceeding 50 000 cfu/100 mL of *E. coli*) - compared with a contact recreation guideline (median) of 126 cfu/100 mL. After milking, the cows crossed back over the river as individuals or small groups, and turbidity and *E. coli* were variable and much less elevated, albeit for a longer period of time. Total mobilisation of both light-attenuation and faecal bacteria was similar on both crossings. Comparison of cow voiding "events" in the 17-m-wide stream with fresh cow pats counted along the raceway suggests that the cows were more than 50 times as likely to void in the stream than in equivalent distances elsewhere on their path to and from the milking shed. This work thus directly documented appreciable water pollution associated with cattle access to streams.

Our finding that the faecal bacterial level from this source quadrupled background (diffuse) pollution from pasture under relatively low flow conditions in the Sherry River implied that a major improvement in water quality could be derived from bridging streams intersected by farm raceways. The net result of the experiment was that local farmers began to think seriously about bridging their crossings and getting the cows out of the river. The first bridge, a new $50,000 farm bridge, marked the start of a surge of action, which at November 2003 had three of the four river crossings bridged and extensive riparian plantings occurring adjacent to the fourth.

A by-product has been the formation of the community or Landcare group. The farmers are now monitoring the health of the river themselves to detect what changes occur after their actions. Already they gain benefits from using the bridges as far as saving time and stress in getting cows to and from milking, and being able to get cows across the river when in flood. Although motivated by a desire to look after the river, the farmers can also see the benefits that the bridges provide to their business. In KM terms, the landowners have self-organised into a group, are learning both as individuals and as a group, and are beginning to demand and produce new knowledge to meet a range of new challenges faced. Through producing and using new knowledge they are in a position to take the actions needed to achieve their desired outcome - reduced pathogens, or a river safe to swim in, and an improved public perception of dairy farming in the environment.

Summary - Where To From Here?

In knowledge management terms, the relationship between our research program and its stakeholders is moving from one with an initial focus on first-generation information push approaches to second-generation approaches where stakeholder groups are becoming organised, are seeking to learn more, and want to be a part of the process of creating new knowledge. This shift in attitude on the part of several groups has not yet been mirrored by all stakeholders in the catchment or by all researchers in the program. Some groups still are not engaged in active dialogue, choose to ignore either the information or knowledge that is "pushed" at them, or do not consider that a problem exists that warrants their attention now. This raises questions for the internal learning progress of the program and how these groups and individuals can be engaged in future dialogues. This is part of the social and institutional learning research that is currently under way in the research program (http://icm.landcareresearch.co.nz/science_themes/humandimensions/people_social.htm).

In summary, our traditional approaches in ICM research of working with communities and stakeholders in various forms of multi-stakeholder participatory processes to identify needs or issues together with a "push" of information and integration of knowledge is beginning to lead us, researchers and end-users alike, into knowledge production via individual and group learning to meet new problems as they arise.

Recognition of the role that KM plays in innovative businesses has, we believe, important implications and parallels to ICM efforts and provides a transferable blueprint for successful ICM. In terms of the research program, we will continue to expand the physical knowledge base and the network of individuals and groups with whom we interact. We will endeavour to facilitate access to information and knowledge that is produced by the program and its stakeholders. We see that an increasing effort to facilitate and engage groups will be pivotal to the creation of new knowledge and the resolution of many of the problems facing stakeholders of the Motueka catchment.

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References

Website http://icm.landcareresearch.co.nz/Default.htm

Allen, W., Bosch, O., Kilvington, M., Oliver, J. & Gilbert, M. (2001). Benefits of collaborative learning for environmental management: Applying the Integrated Systems for Knowledge Management approach to support animal pest control. *Environmental Management* 27:2 pp. 215-223

Allen, W. J.; Kilvington, M. J. 1999: Why involving people is important: The forgotten part of environmental information system management. MODSS '99 Brisbane, Australia, 1-6 August 1999 (Available at: http://www.landcareresearch.co.nz/research/social/envinfsys.asp)

Basher, L. R. (Compiler) 2003: The Motueka and Riwaka Catchments. A technical report summarising the present state of knowledge of the catchments, management issues and research needs for integrated catchment management. Landcare Research, Lincoln, NZ.

Davies-Colley, R.; Nagels, J.; Smith, R.; Young, R.; Phillips, C. Water quality impact of cows crossing an agricultural stream, the Sherry River, New Zealand. *New Zealand Journal of Marine & Freshwater Research.* In press.

Ministry of Agriculture and Fisheries 1993: Towards Sustainable Agriculture: Freshwater Quality in New Zealand and the Influence of Agriculture. Technical Paper 93/10.

McElroy, M. W. 1999: The second generation of knowledge management. *Knowledge Management* (October): 86-88.

McElroy, M. W. 2002: The new knowledge management. Complexity, learning, and sustainable innovation. Butterworth Heinemann 246 p.

Nagels, J. W.; Davies-Colley, R. J.; Donnison, A. M.; Muirhead, R. W. 2003: Faecal contamination over flood events in a pastoral agricultural stream in New Zealand. *Water Science and Technology* (in press).