

Chapter 8

Local knowledge and its implications for ICM

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Abstract

This paper discusses local understanding about catchment processes and its potential contribution to the progress of Integrated Catchment Management (ICM) and reports on some trial exercises undertaken in the Herbert River Catchment. The paper contrasts two approaches to local understanding: 'technical knowledge' and 'landscape literacy'. This is followed by a discussion of what would be involved in development of a method for identifying and evaluating differences in local knowledge and the role of these differences in an ICM context. The first section of the paper considers some of the conceptual prerequisites to how local knowledge can be incorporated into ICM. The final section considers some of the pragmatic issues which were encountered in some trials conducted in association with this paper.

Introduction

The origins of this paper stem from an evaluation process of a research program on Integrated Catchment Management (ICM) in the Herbert Catchment of north Queensland. Throughout the evaluation process, interviews and workshops with farmer groups demonstrated that farmers and researchers have significantly different understandings of the landscape they interact with. Whilst researchers were comfortable with the notion of a catchment and the processes which occur within it, the evaluation demonstrated that the concept was not natural for farmers, who were focussed at a farm scale. This raised the issue of considering the role of different approaches to knowledge, and their relevance to ICM. To investigate these issues, a series of interviews and workshops were designed with farmers and resource professionals on the subjects such as sediment entering the water ways and land clearing for cane farm expansion.

This discussion paper considers the outcomes of these interviews and workshops, and the reasons for incorporating local knowledge into ICM generally. It considers two main approaches to investigating local knowledge. The first of these is consideration of Indigenous Technical Knowledge – which has involved the study of specific knowledge that local peoples have developed about the resources they use. This knowledge is based on intimate interaction with a resource on a small scale. Unlike science, the knowledge does not necessarily attempt to explain broad phenomena with common principles. The individual ways that farmers and other resource users have interacted with the natural world can offer insights that the broad application of scientific principles and experiments may overlook. The second approach to local understanding discussed in this paper considers the ability of land users to read the health and status of the environment they interact with. This approach has been termed 'landscape literacy' or 'land literacy'. Given its broad approach and consideration of the cultural and historical factors shaping the way humans interact with the environment, it has much potential in the evaluation of ICM.

Conceptualising local understanding

The nature of local knowledge

Local knowledge has been viewed and defined in a number of contrasting and, perhaps for different purposes, equally valid ways. Local agroecological knowledge is often a contemporary and dynamic explanation of how the world works with potentially universal application. It can be primarily derived from observation and experimentation by farmers, or it can be a system of unique and idiosyncratic elements of traditional knowledge that are culturally bound, predominantly heuristic and passed on through generations.

Indigenous knowledge and scientific knowledge.

For the purposes of better understanding indigenous knowledge, a useful comparison can be made with scientific knowledge. Whereas scientific knowledge aims to discover universally applicable phenomena such as gravity and temperature, the scale and focus of indigenous knowledge local. It is concerned with explaining local circumstances, and as such indigenous

knowledge has only limited experimentation. By contrast, scientific knowledge relies on almost infinite replication through experiments to prove the universal consistency of phenomena. Unlike the formal modes of distributing scientific knowledge -journals, seminars and scholastic instruction, indigenous knowledge is distributed through informal mechanisms such as the knowledge a parent passes to a child. There is no significant difference in terms of accessing scientific and indigenous knowledge. Both tend to be reasonably open unless providing access to the knowledge is going to disadvantage those who hold it. A final difference is that supernatural explanations may be present in indigenous knowledge, whereas they are absent in scientific knowledge.

Knowledge as Understanding that can be Articulated

This approach requires some important definitions. Data are a recorded set of observations (which may be quantitative or qualitative). Knowledge is the outcome, independently of the interpreter, of the interpretation of data. Understanding is the outcome, specific to the interpreter, of the interpretation of data or knowledge: the comprehension that the interpreter achieves. So, the interpretation of observation may advance an individual's understanding. Some part of this advance can be articulated and communicated as knowledge. The distinction between what can and cannot be articulated is of importance in taking a practical view of local knowledge and its contribution to R&E. Furthermore, it is compatible with the knowledge engineering paradigm that underpins many powerful theoretical, methodological and implementational advances in cognitive science and artificial intelligence.

Knowledge is thus seen as a central aspect of culture, derived from education and experience, that may be used, in conjunction with consideration of a value system and competing priorities and possibilities, to make decisions and, therefore, lead to actions (such as farming practice). Actions may also be intuitive, short circuiting the consideration of knowledge in their genesis. What is perceived about the natural world, however, is influenced by what can be observed, and, the way in which perceptions are transformed into knowledge is influenced by the mode of learning, which may differ from one society to another. It is clear then, that the way in which knowledge is acquired and transformed into decisions, depends on the cultural context but knowledge is distinguishable from other aspects of a person's, or a community's, culture. This definition of knowledge as being something that can be separated from the person who knows it, essentially a position that conforms to a Popperian philosophy of science (Popper, 1972), is quite different to the more widespread sociological definition used within the recent farming systems literature which views the two as inseparable. So, for example, Scoones and Thompson (1994) challenge 'the assumption of a positivist view of investigation that sees knowledge as a tangible stock or store to be tapped' and see 'the process of knowing' as 'engaged, value-bonded and context determined' they argue that the 'human mind is not simply a mirror that accurately reflects a reality' but that 'interpretation, translation and representation are social acts that cannot be assumed to be neutral and objective'. Taking this perspective further, Röling (1996) states that "Reality is not assumed to exist independently of the human observer or to project itself on the mind through the senses...". Blaike et al.(1997) put these theoretical considerations into context by stating "These processes [of advancing ideas], and hence knowledge, are inextricably linked to the social, environmental and institutional contexts within which they are found. For example, a partly deforested hillside in the tropics may be viewed very differently by a local subsistence farmer ..., a cattle rancher, and an NR scientist...". In addressing perceptions of landscape, Colquhoun (1997) takes the view that knowledge includes "intangible deep feeling of what meets us in a landscape". These definitions make local knowledge essentially indistinguishable from local people conflating knowledge, values, perceptions and even emotions.

Local Knowledge, Indigenous Knowledge and Technical Knowledge

The terms 'local knowledge' and 'indigenous knowledge' have often been used interchangeably. However, here local knowledge denotes locally derived understanding which is based more on

experience and real world observation than indigenous knowledge, which may reflect cultural beliefs and values to a greater extent. This distinction has important practical implications. So, investigation of indigenous knowledge (principally the realm of anthropological and ethnographic research, which are particularly concerned with mapping and explaining cultural differences), has tended to focus on knowledge that is idiosyncratic and culturally bound, often being traditional and handed down orally. Such investigation has practical as well as academic application – of 242 published papers retrieved from a search of CAB Abstracts for 1996/7, 85 are concerned with medicinal aspects of rare ethno-botanical knowledge or the ethics associated with the search for such knowledge. Some indigenous knowledge, and hence research into it, has profound implications for resource management and development. Historically, for example, it has been suggested that the cultural beliefs held by Mayan Indians that people were literally made of maize (thus making it a sacred plant) precluded commercial exploitation of this crop by indigenous people, whereas Hispanic settlers were not so restricted (Asturias, 1949). Such cultural beliefs can be pervasive, the sacred nature of maize in the previous example was bound up with notions of soil fertility and its decline through continuous cropping. Sallas (1994), working today in the Peruvian Andes, reports similar culturally derived constraints to the adoption of modern potato varieties, that although higher yielding than local varieties, are less resistant to some pests and diseases and require inputs of chemicals for yields to be achieved. The modern potato varieties and the chemicals applied to them are considered by older people in the community to 'bring more diseases' and to be 'poisonous' both to 'mother earth' and to the people who eat the potatoes.

Indigenous Technical Knowledge (ITK)

Sinclair and Walker (1999) contend that many management actions undertaken by farmers have an explanatory basis, although such explanations may differ from a scientific rationale and may require careful interaction with farmers to elicit. Unfortunately, farmers' explanations for agroecological phenomena, have not received adequate attention, and in the present enthusiasm for moving from considering what people do, as in studies of ITK - or farmer's performance, to the cultural context in which knowledge is generated - or the process of knowledge generation and development (Scoones and Thompson, 1994), there is a risk that the gains from explicit representation of farmer's explanatory understanding will continue to be overlooked. The key issue here, once again, boils down to whether it is valid to abstract farmers' knowledge about ecology from the broader set of considerations that govern agricultural practice and whether this can be done without overly distorting it. A major confusion has arisen here between the limitations of using external scientific ('etic') explanations of local practice and seeking the farmer's own ('emic') explanation. So, for example, Richards (1989) in an influential article, explains how complex intercropping layouts in a field, that scientists may interpret as a carefully planned arrangement based on consideration of inter-specific competition and weed and pest control may, in fact, represent a set of contingent responses by the farmer to various events throughout the season so that what is observed at the end of the season is the result of a completed performance (influenced by a range of unfolding ecological and socio-economic factors), rather than the result of a specific plan in the mind of the farmer at the beginning of the season. However, while it is clear in this case that the farmer may not have planned the design from the outset, and that what transpired over the season and why can only be interpreted by considering the sequence of events that actually occurred in time (which may be impractical if the dialogue begins at the end of the season), knowledge of plant ecology on the part of the farmer is not precluded, it has not, in fact, been adequately sought.

Sinclair and Walker (1999) argue that a major justification for abstracting farmers' ecological knowledge from other social and cultural aspects determining agricultural practice, is that it can be postulated that core knowledge about natural processes is likely to have some applicability across contexts, rather than being entirely unique to the situation and society in which it was derived. This is a somewhat contentious view that flies in the face of postmodernist approaches to anthropology Tyler (1987). There is, however, some compelling evidence to support this

likelihood. Firstly, Berlin's seminal work on ethnobiological classification (Berlin 1992) reveals widespread regularity in the way in which people classify and name plants and animals in quite different non-literate societies. Thus, he asserts that when people function as ethnobiologists they 'discern' rather than 'construct' order from their observation of a biological reality, in which groups of plants and animals appear as a series of discontinuities, whose structure and content are seen by all human beings in essentially the same way. He contrasts this with other areas of human experience which are culturally constructed and to which anthropologists have devoted much study, such as social organisation, ritual, religious beliefs and notions of beauty, for which no such universal regularity may be expected.

An ability to read the landscape

The body of theory on indigenous knowledge tends to concern information about some means of achieving an objective. However, the use of this 'technical knowledge' as a basis for evaluating understanding is fraught with difficulty. Technical knowledge may be purely empirical or based on some explanatory or mechanistic understanding. This is significant because the origins of technical knowledge may dictate the extent to which it can be extrapolated to providing solutions to different but related problems. Empirical technical knowledge may be brittle while that derived from some sounder model of system functioning may be more robust. This means that while investigation of the current state of technical knowledge may provide a basis for planning R,D&E priorities, it does not provide a very effective means of monitoring change in local understanding. Even characterising the current state of technical knowledge for research planning purposes is problematic. For example, when is technical knowledge inadequate? When resource managers can not solve a problem? What about instances where they can not see a problem? Furthermore, taking a problem-oriented perspective makes it difficult to distinguish the biophysical, social, institutional, legislative influences on and components of solutions.

An integrated approach : 'landscape literacy'

In recognition of the constraints associated with a problem-oriented perspective, some researchers working in the field of local knowledge have instead focused on, for example, the indigenous ecological knowledge that appears to underlie management practice and technical knowledge. The term that we use here to describe this hypothesised deeper, mechanistic understanding is 'landscape literacy'. This approach refers to the ability to 'read' the health and status of individual's surrounding environment (Campbell 1996).

Landscape literacy, sometimes termed 'land literacy', has been investigated in Australia in association with the National Landcare Program (NLP). The NLP has triggered a series of 'watch' and 'care' type programs which have been popular with state and federal resource management agencies and resource users alike (Campbell 1996). Examples of these include 'Saltwatch', 'Rivercare' and 'Coastcare' and they involve community monitoring of biophysical phenomena. The 'land literacy' approach has included some original approaches, such as farm fly overs to observe land management issues from the air Campbell (1996).

This involved taking farmers for a flight over their farms to demonstrate visually the position of the land in the context of a catchment. This enabled farmers to see catchment scale biophysical phenomenon such as erosion unfolding through their farms. It also enabled farmers to better see how run-off can be an issue at a farm level. Whilst such initiatives can illustrate the difference between the scale at which the farmer is familiar and that at which biophysical processes operate, it doesn't represent a 'meeting of minds' as such, because the onus is on the farmer alone to change his or her thinking.

According to Campbell (1996) the most significant aspect of the 'land literacy' approach is the speed and effectiveness with which they transmit local environmental knowledge and share techniques to encourage people to 'read' the health of their landscape. Yet the programs he describes have had difficulty proving themselves significant data gathering through rigorous

processes. Yet even if the technical credentials of land literacy programs are confirmed, there remain further problems with this approach. For example, whilst community based monitoring 'watch' and 'care' programs foster an increased understanding of biophysical processes amongst the rural community, they only represent a 'meeting of minds' if resource users share their version of catchment processes. Structured ways of incorporating their knowledge therefore need to go beyond the level of recording biophysical data into a centralised database.

A further problem with landscape literacy is that it is more a concept than a measurable attribute. Direct measurement of the current state of landscape literacy is probably therefore exceedingly difficult. However, detection of significant changes in landscape literacy through a structured program is achievable and likely to be more relevant. One such measure could be the assessment of changes in the quality of 'problem formulation' by the community or groups within the community in response to natural resource management challenges. Given that the assessment of integrated approaches such as ICM is more concerned with detecting broad changes in thinking and behaviour, landscape literacy provides a powerful means of evaluating ICM. The study of landscape literacy is also more relevant to the analysis of broad orientations to landscape and the delineation of different groups within a catchment based upon their perceptions of their surrounds. Moreover, it provides a useful framework for considering the differences in perception between resource researchers and resource users.

Why might the assessment of local understanding be relevant to an ICM strategy?

We argue that there are three broad categories of reasons for considering assessment of local knowledge as a contribution to the ICM process.

1. ICM promotes a holistic or systems perspective on resource management issues. This must include consideration of the differing perceptions and understanding of resource management issues across different stakeholder groups.
2. Investigation of local knowledge provides a means of targeting and evaluating implementational, research and extension priorities. This can be achieved by helping to identify constraints on action (understanding, processes, institutional structures...), by helping to educate the resource management professionals involved in the ICM process on issues from the local perspective and helping to identify key gaps in understanding as identified locally.
3. Evaluating the impact of an ICM process. Given that ICM is a participatory process that places considerable emphasis on capacity building, an ability to characterise changes in local knowledge provides a powerful tool in the assessment of the impact of an ICM initiative.

Systems thinking and participation

One of the fundamental goals of Integrated Catchment Management (ICM) is to address problems experienced by resource users in an holistic manner. However, this is complicated by the fact that diverse members of a management regime –such as a catchment- do not view and understand their world in exactly the same way. Furthermore, it would be a mistake to assume that stakeholders and resource users conceive or understand the catchment in the same way as resource professionals and researchers. This is simply because different people develop their knowledge of a resource or environment in their own individual way, and this is shaped by cultural and historical processes. Unless this is acknowledged and accommodated, integrated approaches to resource management such as ICM may be constrained by misunderstanding. It follows, therefore, that, systems approaches may seem as foreign to resource users as conventional research and development strategies. This is because systems approaches, like reductionist science, are an abstraction applied to simplify reality sufficiently to improve understanding. To achieve this, they are based on assumptions and objectives - different assumptions and objectives allowing different understandings. The research question for this paper concerns where a given management approach -in this case a systems understanding of a catchment- is inconsistent with how the human agents within the system (eg. farmers, resource users) conceptualise it. Where a model of system function which is based entirely on an external

perspective (whether integrated or not) is used to underpin research development and extension programs, the relevance of this research (and hence support for it) may be compromised.

Local knowledge as a means of targeting and evaluating research and extension

Assessment of local understanding in relation to catchment management could contribute to an ICM programme by providing a basis for targeting research and extension activities and providing a basis for evaluating the impact of an ICM process.

Targeting research and extension activities.

One of the essential questions facing research, development and extension providers intending to facilitate participatory initiatives such as Integrated Catchment Management is the extent to which natural resource management at a catchment scale is constrained by an inadequate technical understanding of bio-physical processes (ie. a problem that can be tackled through analytical research) and the extent to which it is constrained by inadequate process. If bio-physical understanding is demonstrably inadequate then further bio-physical research is merited. If bio-physical understanding is adequate but process inhibits appropriate response to the implications of that knowledge, then biophysical research is of lower priority. If some mixture of ignorance and inadequate process applies, the implications for R,D&E are concomitantly more complex. The use of local knowledge has the potential to assist targeting research priorities by analysing local observations of biophysical phenomena. Furthermore, if external research staff consider these observations, then the research program may not only be better targeted, but more accepted by local communities.

Educating Professionals

In many circumstances research and extension staff have only a limited appreciation of local knowledge and, in some cases, of local practice. This clearly constrains their ability to understand the nature of the problems facing farmers, the constraints they are under and the opportunities for improvement. It also affects their ability to communicate with farmers, affecting both their ability to obtain information from farmers about their system during diagnosis and then their ability to disseminate information and other products of research to farmers in the extension phase. Farmers' knowledge may also be more developed in some aspects, particularly those that are locally important, than that of researchers and the scientific literature. There are some stark examples of where ignorance of farmer knowledge and practice has led to inappropriate research and extension efforts and how systematic documentation of such local knowledge has led to researchers changing their behaviour (Sinclair and Walker 1999).

Local Perception Of Inadequacy Of Knowledge

In certain circumstances farmers may be aware of aspects of their knowledge systems which are less well developed than they would like, which then constrains their ability to manage their farming practice. This represents articulation of research requirements by farmers (Sinclair and Walker 1999).

Evaluating the impact of an ICM process

One of the main objectives of ICM as a policy initiative is to foster an ability at a local level (including both the community and local state government representatives) to conceptualise and agree on natural resource management problems as and when they arrive and, thereby, agree on and implement solutions in an integrated and holistic manner. There are various ways in which changes to this capacity might be measured, including case study consideration of 'on the ground' activities. While important, this measures some synthesis of change in local understanding and motivation with institutional, financial and other circumstantial factors. Direct consideration of changes in local understanding of catchment issues and processes helps to deconvolve these factors and, therefore, provides one line of enquiry in evaluating improvement or otherwise in the capacity of the community within the catchment to achieve the sustainable and balanced use of natural resources. In summary, an increasing understanding

of the state of the environment and impacts on the environment can be an important indicator of the efficacy of the ICM process.

Approaches to investigating local knowledge

In the previous sections we have discussed the nature of local knowledge and explored the potential relevance of the investigation of local knowledge to ICM processes. Any practical application of approaches to investigating local knowledge in order to inform and evaluate program initiation would need to be based on some approach to knowledge elicitation and analysis. For example, assessment of the impact of an ICM process through consideration of impact on the 'landscape literacy' of resource users and managers in a catchment might document changes over time in the characterisation of the bio-physical aspects of a key set of natural resource management problems (both causes and consequences) and proposed solutions to these problems. Analysis might consider the extent to which consensus as to the nature of pertinent problems and potential solutions has evolved and evaluate the extent to which changes in perception are supported by data and, thereby, assess the contribution of ICM to any such changes. These objectives would need to be underpinned by a series of workshops and interviews with a range of different community groups within the catchment. In this section we explore some of the tasks that might be tackled and some approaches to those tasks.

Key research tasks

For defined groups within the catchment a study would need document the following on an annual basis.

1. Characterisation of each issue
For example,
How is the issue conceptualised / perceived (causes, implications etc.)?
How much consensus is there in characterisation of the problems?
Can differences be delineated into broad groups of approach?
2. Completeness of understanding for each issue
For example,
Has the perceived problem / issue been demonstrated to be a real problem / issue?
If not, why not?
In particular, what further information is required if the problem is to be adequately understood?
3. Availability of potential solutions for each issue
For example,
What are the perceived solutions to the problems?
What is the nature of the proposed solutions (including type eg. technical intervention, institutional change, fiscal change, economic change, social change..) ?
What consensus is there on potential solutions?
What further information is needed in order to further develop and evaluate potential solutions to a point where application is appropriate?
4. Analysis of change over time.
For example,
Are stakeholders becoming aware of differences in approach amongst other groups?
Are the differences in local understanding becoming more or less pronounced throughout the ICM process?

To investigate some of these issues, a series of trials were conducted with resource users and professionals in the Herbert River catchment. These trials were useful in revealing some of the pragmatic and operational issues involved in the elicitation of local knowledge. Two main

approaches were trialed: work with individuals and work with small groups. The trials involved a combination of structured interviews, semi-structured interviews and scenario based discussions. A summary of these trials is discussed below.

Trial 1: knowledge elicitation, representation and analysis: interviews with individuals

A trial of methods was designed to explore a range of approaches to eliciting technical knowledge relating to catchment management (with an initial focus on characterisation of the physical nature of issues / problems) in order to scope out some of the operational issues that would be involved in the design of a large scale research project. The trials contributed to a broader evaluation exercise for the ICM research program in the catchment. The overall evaluation exercise addressed issues such as water quality; water quantity (availability); drainage; flood protection; riparian zone management; habitat management and protection; soil erosion and sedimentation; and pest management, and the local knowledge trials reflected these broad categories. Given the 'integrated' nature of ICM individual issues were not treated in isolation. For the individual interviews, three techniques to knowledge elicitation, representation and analysis were investigated. Two farmers, two researchers and one drainage engineer were interviewed. Each completed all three parts of the trial in a single interview of between one and one and a half hours.

1. Questionnaire survey.

A number of statements of problems, causes and consequences within the catchment were derived from the overall ICM evaluation program. Informants were asked to react to these statements by using a 5 point scale. Analysis of responses to the questionnaire survey enabled some quantitative measure of consensus of understanding on the physical nature of issues in the catchment across and within groups concerned with catchment management. The questionnaire survey was well received by all informants and seemingly both straight forward and of interest to them. The results are presented in Appendix 1. These results are of interest but fail to capture much of the detailed understanding displayed by the different informants. The results of the questionnaire apparently identify a considerable diversity of views across informants without obvious patterns in terms of informant type. However, this masks an impressive convergence of opinion between informants that was clear during the interviews. Although significant effort was put into the structure and content of the questions, it is clear that at the very least much more sophisticated questions are required. However, on the basis of these trials it is unlikely that this type of questionnaire survey alone will adequately reveal the structure of perception.

2. Semi-structured discussion

This part of the interview focussed on soil erosion in the Herbert and what happens to soil from paddocks in both the upper and lower catchments once it is washed off the paddock and into the stream system.

The following were focussed on in particular:

- i) The factors that determine whether significant soil erosion will occur as a result of rainfall.
- ii) Factors determining how much sediment enters the river system
- iii) The fate eroded soil once it enters the stream system

The semi-structured interviews investigated the potential for explanatory knowledge to be used to help create a formalised knowledge base, with a view towards developing consensus models of the behaviour of the physical system. It was also considered a potential way to capture a range of inconsistent perceptions across the informants. By contrast with the questionnaire, most informants found the semi-structured interview seeking explanatory knowledge uncomfortable. Although this did produce some interesting results, notably in the different approaches to explanation taken by the different informants, it was not found to be a very successful means of eliciting knowledge. Although the semi-structured interviews were not very successful, the knowledge elicited, as well as much of the subsidiary information collected while completing the

questionnaire were highly amenable to representation within the formal grammar and knowledge base structure used.

The questions for the semi-structured interviews are reproduced as Appendix 2. An excerpt of these interviews is reproduced in Box 3.

Box 3

The following excerpt provides an example of local knowledge being used to explain the relationship between rain impact, ground cover and sediment flow: In this example, the informant can see some benefits from ground cover being used to reduce sediment entering the waterflow, however, he has difficulty seeing on-farm benefits from stream side vegetation:

INTERVIEWER : In terms of ground cover side of things, why does that minimise soil erosion?

INFORMANT: It minimises and might even reduce rain drop impact. It also slows down the speed at which the water flows over the land and therefore removes most of its erosive energy and also the energy that it has available to carry sediment as it moves.

INTERVIEWER : Those are the two main impacts?

INFORMANT: Yes I think so.

INTERVIEWER : And vegetation along the stream banks is important?

INFORMANT: Yes but all that does is to cause energy reduction at the top of the stream bank rather than over the whole paddock behind it and as I said before, in my opinion, having that sort of track is probably beneficial to the waterway but its not necessarily beneficial from the point of view of conserving the soil resource because you could envisage the situation where you allow the stuff to build up until you had a great big build up of sediment behind whatever track you had and what are you going to do with it then? You could dig it up with a spade and spread it back on the paddock but it would just get washed up again, so I tend to think the use of vetava [grass], whilst its not a bad idea, its bit of a band-aid measure. You're better of stopping the stuff from being removed from its point of generation to start from.

3. A scenario-based approach

This exercise was based on three fictitious plans for cane expansion in a fictitious catchment. Information was provided in the form of a map and three scenarios presented in relation to that map. Informants were asked which they would favour and, more importantly, their justifications for favouring that plan. The scenario-based exercise was recorded and the taped interaction was used to explore, for each informant, a representation of the argument and evidence that they used to present and justify their selection. Two means of doing this were explored : descriptive analysis and use of a formal grammar designed to capture the structure of an argument.

The scenario-based exercise proved more difficult for the informants than was expected.

However, it was extremely successful in that it captured a considerable amount of information about the interpretation and application of knowledge as well as the knowledge itself. Despite general consensus on physical issues of concern in cane expansion, each of the three scenarios (which have different potential environmental impacts and implications for productivity) was selected by at least one informant. This range of responses can be attributed to different values, different views of what the future holds and different interpretations of the implications of common understanding. These factors are obviously at the heart of ICM.

The text of the scenario exercise is reproduced as Appendix 3. An excerpt from the scenario based approach is represented in Box 4.

Box 4

Excerpt from scenario based approach to eliciting local knowledge.

INTERVIEWER : I want your ideas on how you go about considering which option would be most appropriate

INFORMANT: I feel that I wouldn't want to be draining this area here through that eastern block, I feel it needs something like that would have to be done

INTERVIEWER : Why would you not want to do this?

INFORMANT: I think it would be too much downstream effect not only on landholders but also on this whole wetland area

INTERVIEWER : What would that be?

INFORMANT: You going to be putting water from one catchment area into another catchment area which already is a huge catchment area to start with and your sending it the longest way to get to the coast.

INTERVIEWER : It would be an increase in water coming through that grazing land and into the wetland?

INFORMANT: That's right I would say that if a study was done into what the drainage capacity of this area would be, it wouldn't be able to handle that also, because you've got all these streams running into it also. The other thing is that you have a lot of problems with drainage schemes. I don't think enough consideration is taken into the fact that not only the water from the farms ends up in that drainage scheme but the land around it the surrounding country side tends to go into that area, we've seen this happen in the Herbert before where drainage schemes haven't been planned properly

Trial 2 : Making comparisons across groups: workshops with multiple participants

Following the first series of trials, the use of small groups was investigated as a means of eliciting local knowledge. It was decided that a number of different (but preferably related) scenario selection exercises would provide a useful trial, considering different management options in a fictitious catchment. Maps of the topography and hydrology of the hypothetical catchment, current land use and tenure, soils and land use suitability for sugar cane were prepared to support the exercise, and a scenario description was also prepared (see Appendix 4). Two groups of 8 farmers each were approached, each representing having different demographic characteristics and different levels of experience in sugar farming. The first consisted of farmers over 50 with more than 20 years cane farming experience. The second consisted of farmers under 40, all of whom were at least second generation cane farmers. All of the first group attended the workshop. Some members of the second group accepted the invitation but did not in the end attend.

Both workshops resulted in considerable and heated discussion, thereby providing a considerable insight into farmers' perceptions of catchment scale issues. While the scenario provided a useful point of departure and reference for this discussion, it proved hard to keep the discussion focussed on the scenario, such that it proved impossible to get a clear justification for the group for selection of a particular scenario. It is anticipated that altering the scenario rules and moving towards a scenario selection and vote at the end of this workshop would mitigate this problem. On the basis of the trial only, it was difficult to clearly delineate differences between groups of farmers. Nonetheless, some interesting insights from this introductory study are worth noting, an example of which is reproduced in Box 5.

Box 5

The group workshops indicated that there were different perspectives amongst farmers. However, based on the scale of the study it was difficult to delineate significant broad trends in perception. The same applied to the farmer's ability to 'read the landscape' or 'land literacy'. Some comments gave isolated examples reflecting farmer's land literacy. Though insufficient to draw significant conclusions on the basis of this land literacy, it revealed that it could be elicited reasonably well with minor changes to the workshop process.

As part of the group based workshops, farmers were asked about expansion into wetland's areas. For this group of farmers most agreed that wetlands were best left untouched because they thought that wetlands helped to absorb nutrient runoff from farms and provided wildlife habitat. These farmers tended to think beyond their own farm into the surrounding area (workshop comments in different font).

"Should there be expansion into the wetlands area?"

"Wetlands shouldn't be touched - not allowed to. "

"I don't believe they should be drained - they are important wildlife habitats and they help to preserve aquifers. "

Other farmers were more focussed on their own farm operations. If wetlands should be expanded into or not was a case of whether wetlands were suitable for cane growing:

"When a wetland is next to a creek it is impossible to keep it drained."

"Forget about trying to drain mangroves - no other land use is worthwhile."

"It depends on what you call a "wetland". If you conserve everything; you can't grow cane. On the other hand, you could knock it all over and have nothing but cane. Up till now the policy has largely been; knock it down and grow cane."

Other farmers looked at the question from a dual perspective:

Box 5 continued.

"Some of the wetlands should be kept but not all of it - some would be OK to develop."

This group of farmers were mostly agreed in their approach to clearing remaining patches of rainforest. The economic argument was the strongest:

"What about the remaining patches of rainforest - are they worth keeping?"

"Many of the trees in these areas are not original vegetation - in fact they are more recently grown - 80 years or less."

"There is pressure to clear for economic reasons. The government or the community needs to be prepared to buy back the land at the market value."

"The landowner will always go the way of economics."

"If the community wants to preserve the forest then it should be prepared to buy it. The farmer had to buy it first."

The discussion continued on the basis that clearing is acceptable and it shifted to consider how close clearing should get to streams.

Catchment Coordinator: "The Water Resources Act (1993) protects the top of the banks but the River Trust does have the power to enforce wider restrictions."

"The River Trust and the BSES need to accept responsibility to assess clearing to river banks in order to determine how much protection is required. This should be tied up with legislation."

"This would be hard to police."

"Could there not be registered easements between all properties which would be tied up by law."

Other Issues for Consideration

The workshops attempted to use hypothetical situations to trial elicitation of local knowledge. It became apparent that the use of hypothetical scenarios were problematic. What emerged was that farmers were much more confident with knowledge which applied specifically to their farm. This reveals something about the nature of local knowledge. An advantage is that it provides experience and perspectives that may be overlooked by scientific method, however applying outside of the farm requires ingenuity and initiative. An example of this issue is presented in Box 6.

Box 6

Identifying problems from first hand experience

It became evident that farmers were having difficulties making predictions about the hypothetical catchment because their understanding was so intrinsically tied to their own individual circumstances. Whilst asked to consider some potential scenarios, farmers spoke almost entirely of their first hand experience:

‘Around my house, floods have dropped sediment – as much as 4 inches.’

‘My local creek is now always dirty – never clear’

The workshop highlighted some important characteristics of local knowledge. Unlike scientific method, the predictive capacity of local knowledge is low. The advantage of local knowledge is that it can provide an impressive level of detail and insight by drawing on personal experiences, and inform an agenda for systematic research.

The validity of an investigation of local knowledge

The interviews and workshops with farmer groups in the Herbert Catchment described in the previous section were undertaken as methodological trials and were not intended to produce particular insight into local knowledge and ICM in the Herbert. Nevertheless, assessment of the material elicited illustrates that while farmers knew precisely what the word 'catchment' meant, they did not naturally view the landscape that they live and work in as being part of a catchment and, therefore, did not see the catchment as a natural unit of management. By contrast, for natural resource professionals who were the authors and champions of ICM, a model of the landscape as a set of catchments that provided natural units for rational management was both intuitive and powerful. The limitations of this simple but external model of the landscape makes the expected 'meeting of minds' between the two groups more demanding than would otherwise have been anticipated.

This simple example illustrates the basis for a view that while local knowledge is a critical component of initiatives such as ICM, this does not provide a justification for its explicit and professional investigation. As the pendulum swings away from an interventionist external paradigm for development to an increasingly participatory one, it is being argued that development professionals should leave the systems thinking to the target communities – if provided with the range of technological solutions available, local communities can undertake their own systems synthesis to generate solutions (Blaike et al., 1997). It would appear to follow from this that farmers do their own analyses, research and information exchange and there is no need for a systems perspective on the part of development professionals. It is increasingly fashionable to put this view forward in terms of contrasting hard and soft systems approaches (Scoones and Thompson, 1994) with the implication that since rural development is inherently a process played out by various people making decisions (referred to as actors), that only soft systems methods (Checkland and Scholes, 1990), that concentrate on the social organisation of knowledge (Engel, 1995) are appropriate. In this frame of analysis, attempting to obtain a systematic understanding of what local people know about the ecology of their environment and farming practices is criticised as being inherently extractive, because it is assumed that it must entail the imposition of an external rationality (Scoones and Thompson, 1994). This view questions the validity of systematic study of local knowledge by development professionals as a part of the development process but, notwithstanding its current popularity, unnecessarily polarises the debate on relevant methodology for working with rural people and their knowledge, and raises concerns, which on further examination, are invalid.

In reality, hard and soft systems methods are not mutually exclusive but, in fact, play different roles and are appropriate for different purposes and hence for application at different hierarchical levels. The 'hardness' of a system is determined by how well defined, stable and quantitative the system mechanism and purposes are. It is, therefore, useful to conceive of resource management activities as consisting of harder ecological systems at the organism, field, farm and catchment levels that are managed by people within household and other social

structures, thereby creating increasingly soft systems as more of the social structure is included. Farmers, therefore, albeit within a complex soft systems framework, are managing the ecology of their farming practices, which can be tractably understood, at least to some extent, using a blend of hard and soft systems methods. Thus, partial views of the relatively 'hard' ecology of a farming system are a useful and valid tool, providing their partial nature is fully understood, in as much as what farmers actually do in their farming practice is determined by other social and cultural factors, as well as their knowledge of agroecology. Indeed, a systematic appreciation of farmers ecological knowledge can sometimes help to distinguish the action of socio-economic determinants.

Although it is a danger that has often been apparent when researchers have analysed local knowledge, seeking to obtain a systematic view of local knowledge does not necessarily imply the imposition of an external rationality. It is possible to seek local explanations and to represent them. The western scientific tradition does not have an exclusive claim to systematic understanding of ecological processes and it would be patronising to posit that farmers do not have locally derived understanding that may be systematic. There is, in fact, increasing evidence from various agrarian societies, from studies using a variety of different methods, that farmers often possess a sophisticated, locally derived and general understanding of agroecology comparable with, although different from, scientific formulations (Berlin 1992; Fairhead and Leach 1994; Richards 1994; Thapa, Sinclair, and Walker 1995). It is important then not to confuse the development and use of formal methods with the imposition of a particular rationality. Quite different explanations for particular ecological phenomena or the efficacy of farming practices can be codified using formal notation. Indeed, dealing with local knowledge explicitly, may assist in revealing where external interpretation occurs, as well as common ground between different knowledge systems. The use of formal methods to represent local knowledge (a process of abstraction rather than extraction) can, therefore, be seen as according rural people's knowledge a status on a par with scientific knowledge rather than as an 'extractive' process that somehow diminishes or distorts it. However, empowerment of local people in a participatory development process does not necessarily preclude the need for strategic research and extension by development professionals. In fact, the existence of sophisticated ecological knowledge amongst farmers, based on their own observation and experimentation, improves the prospects for research to be done by supporting institutions that address fundamental questions that farmers have difficulty tackling because of resource constraints or limitations in their ability to make observations. While in many situations it is unlikely that professional researchers can improve on farmer's adaptive research, they may well be in a position to contribute by doing strategic research and extending information about ecological mechanisms that farmers find difficult to observe. To design such strategic research and extension activity on the basis of what farmers require and to be able to communicate effectively about agroecology, development professionals need to be aware of what farmers already know (Sinclair and Walker, 1999). It is for these reasons that a more suitable reaction to the failings of a systems approach based on external perspectives, is to seek an internal (local) construction of a model of the system that development professionals can access and use. Furthermore, this approach is both compatible with, and complementary to, participatory approaches to research and extension.

In summary, it is reasonable to propose that initiatives that are aimed at impacting on management (implying that people change their behaviour) are likely to be much more efficient where premised on the conception of the system used in management than on some external conception or none at all. This does not mean that the models of system functioning held by farmers are more correct than the models that might be generated by external professionals. However, the farmer's model of the system is an important consideration for ICM and a representation of a local community's view of the systems and practices under development will seriously enhance research, development and extension. The discussion of local knowledge presented in this paper provides some useful insights into the complex set of issues involved in eliciting, recording and analysing local understanding of

catchment processes. Conceptually, there are some clear advantages of incorporating local knowledge into ICM processes, notably in terms of targeting and evaluating research. A review of literature revealed that educating natural resource professionals about farmer knowledge and practice has the potential to change their perception of what is important, the terminology they use and the type of research they do. It may reveal important understandings of the catchment which scientific inquiry has overlooked.

Where attitudes and behaviour are unsustainable, it is important to understand why these attitudes and behaviours exist, and what sort of perception of the land they reflect. The literature review and the trials confirmed that local knowledge has the potential to play a significant role in addressing these issues. It can assist research and external managers to understand the ways catchment groups perceive their environment, and what the implications of these perspectives are. Local knowledge is also a key consideration for improving rates of adoption in research, development and extension programs. Through the analysis of local knowledge, ICM programs can be developed in such a way that public participation is meaningful to both researchers and resources users alike.

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Appendix 1 : questionnaire survey

Codes for informants in questionnaire results :

- 1 - Farmer
- 2 - Farmer
- 3 - Researcher
- 4 - Researcher
- 5 - Drainage engineer

Response codes:

- SA - strongly agree
- A - agree
- NS - not sure
- D - disagree
- SD - strongly disagree

Water quality (pollutants)

The problem

Water quality within the rivers, streams, estuaries and ground water in the Herbert is declining.

Nutrient loads within the rivers, streams, estuaries and ground water in the Herbert are unacceptably high.

Pesticide residues within the rivers, streams, estuaries and ground water in the Herbert are unacceptably high.

	SA	A	NS	D	SD
		3	4	125	
				123 45	
			34	125	

Causes

Urban areas are a significant source of pollutants in the Herbert catchment.

Agricultural production is a significant source of pollutants in the Herbert catchment

Mining is a significant source of pollutants in the Herbert catchment

Aquaculture is a significant source of pollutants in the Herbert catchment

	SA	A	NS	D	SD
		134	25		
		34		125	
		124 5		3	
			5	123 4	

Consequences

Pollutants in the streams, rivers and estuaries of the Herbert catchment are causing significant damage to freshwater and coastal ecosystems

Pollutants in the streams, rivers and estuaries of the Herbert catchment are causing algal blooms

	SA	A	NS	D	SD
			34	125	
				123 4	5

Ranking

Rank the following sources of pollutants in terms of importance at the mouth of the Herbert River (1=greatest, 4=least).

Urban sources

Agricultural production

Mining

Aquaculture

How confident are you about this ranking?

Water quality (sediments).

The problem

Soil erosion and sediment loads in the Herbert River are significantly higher than they would have been under natural conditions.

Soil erosion and sediment loads in the upper catchment are significantly higher than they would have been under natural conditions.

Soil erosion and sediment loads in the lower catchment are significantly higher than they would have been under natural conditions.

SA A NS D SD

	SA	A	NS	D	SD
		345		12	
		123 45			
		4		123 5	

Causes

Removal of native vegetation in the lower catchment is a primary cause of increased sediment load

Removal of native vegetation in the upper catchment is a primary cause of increased sediment load

River bank collapse due to inadequate riparian zones is a primary cause of increased sediment load

	SA	A	NS	D	SD
		245		13	
		123 45			
		145	3	2	

Erosion rates have not increased but more sediments are reaching the river system as a result of removal of substantial areas of riparian vegetation on tributaries of the Herbert river

Stock concentration along water courses in upper catchment is a primary cause of increased sediment load

Road construction and similar work is a primary cause of increased sediment load

Old mining areas are a primary source of increased sediment load

Impacts

Increased sediment loads are causing accelerated sedimentation / aggradation of the river system

Increased sediment loads are reducing the efficiency of natural and man-made drainage systems

Sedimentation of stream beds is causing an increased number of overbank flood events

The Hinchinbrook Channel and Missionary Bay are experiencing increases in sedimentation

	12	35	4	
	135	24		
4	135		2	
1	235	4		

	134 5		2	
	123 45			
	15	34	2	
4	135	2		

Ranking

Rank the following causes for increased sediment accession into the drainage system in terms of importance (1=greatest, 7=least).

- Inadequate vegetation cover (upper catchment)
- Inadequate vegetation cover (lower catchment)
- River bank collapse
- Stock concentration along water courses
- Removal of riparian zones as sediment traps
- Road construction
- Erosion from mining areas

How confident are you about this ranking?

Surface water quantity - wet season

The problem

The way in which water moves through the catchment has changed as a result of man's activities

Rainfall runoff from inland areas of the catchment is significantly faster than it would have been under natural conditions.

Coastal areas of the catchment are more often inundated with water and that water stays around for longer than it used to.

Causes

Clearing of native vegetation for conversion to pastures increases runoff rates

Clearing of native vegetation for cane production increases runoff rates

Clearing of native vegetation for forestry increases runoff rates

Converting pasture to cane land increases runoff rates

The introduction of levees and other control features and unintentional interventions (eg. raised banks for the railway) have significantly altered water flows

Drainage schemes in areas of expansion are having a serious impact down stream by increasing the rate of runoff

Laser levelling is having a serious impact down stream by increasing the rate of runoff

Increased flooding risks can primarily be attributed to siltation of the river beds.

Consequences

The design capacities of drainage schemes in the coastal areas of the catchment have been exceeded

	SA	A	NS	D	SD
234 5	1				
	123 45				
	123 5	4			

	123 45			
35	124			
	1	5	234	
	134 5		2	
235	4		1	
5	123 4			
	45	3	1	2
	235		14	

	123 5	4		
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Paddocks in the lower catchment are under water more often and for longer
 This leads to a decline in cane yield

Increased flooding is causing significant land degradation

Increased flooding is causing habitat destruction

	123 5	4		
	123 45			
		5	123 4	
	4		123 5	

Surface water quantity - dry season

The problem

Base flows in some areas in the river and stream systems are significantly reduced from their natural levels

Causes

Increased runoff rates during the wet season mean that less water is stored in the catchment through into the dry season

Extraction of water for irrigation from the river during the wet season means that less water is stored in the catchment through into the dry season

Consequences

Some wetland areas are becoming drier as a result of inadequate recharge during drier periods

Reduced base flows in the dry season are causing increased habitat destruction

Reduced base flows are having an ecological impact - for example on fish breeding

Changes in the timing of water flow may cause acid sulphate soil problems to occur in the Herbert

SA	A	NS	D	SD
	134	2	5	

	124		35	
	4		123 5	

	12	4	35	
	3	14	25	
	13	4	25	
	35	2	14	

Ground water

The problem

Ground water resources in some areas within the Herbert catchment are becoming depleted

Causes

Excessive pumping of ground water in some areas for irrigation is having an impact on ground water levels.

Alteration of drainage characteristics of catchment is leading to more runoff and less deep penetration to recharge ground water

Consequences

Reduction in ground water means that the baseflow in streams in the dry season has dropped

Reduction in ground water means that the baseflow in the main river in the dry season has dropped

SA	A	NS	D	SD
	3	4	125	

	34		125	
	234		15	

	234		15	
	34		125	

Appendix 2 : Semi structured interview questions

1. Presentation of the issue

I'd like to talk in more detail about one particular issue - soil erosion in the Herbert and what happens to soil from paddocks in both the upper and lower catchments once it is washed off the paddock and into the stream system.

There seems to be considerable disagreement about how widespread this type of erosion is in the catchment and what its consequences are.

In particular :

- i) What are the factors that determine whether significant soil erosion will occur as a result of rainfall? Why?
- ii) What factors determine how much sediment enters the river system? Why?
- iii) What happens to eroded soil once it enters the stream system?

Appendix 3 : Scenario selection by individuals

(supported by use of an A0 sized map showing a fictitious catchment in north Queensland in some detail)

Having looked at your opinions on the issues and the basis for some of these I'd like to briefly look at the implications they have for decision making.

I would like to present three plans for cane expansion in a fictitious catchment and ask you which you would favour and, more importantly, your justifications for favouring that plan.

Details

A mill (in the town) shown requires an increased throughput to remain economically viable.

Two areas for expansion have been identified - Eastern Block and Western Block.

Expansion has been agreed for one of the two sites - the question is which?

The Eastern Block would require drainage of the small wetland area.

The Western Block could be converted without drainage.

However, extensive drainage taking water from this area completely would increase land use suitability from 3 to 2 for most of the area.

Scenarios

Scenario 1 : Convert Eastern Block.

Scenario 2 : Convert Western Block without drainage scheme

Scenario 3 : Convert Western Block with a drainage scheme.

Appendix 4 : Group-based scenario discussion

Cane Expansion in the Milltown Catchment

The Milltown catchment is somewhere in north Queensland. Cane has been grown in the area for many years, however the management of the catchment's sugar mill (situated in Milltown) feels that it has to increase production in order to remain nationally and internationally competitive. Two areas have been identified as being suitable for expansion - The Common on the eastern side of the catchment, formerly Crown Reserve land but now under leasehold to Milltown Council, and The Station, part of a freehold grazing property on the western side of the catchment.

Conversion of The Common would require some drainage works. Conversion of The Station could be done without a drainage scheme. However, a major drainage scheme has been proposed which would increase the land use suitability for cane of most of The Station from 3 to 2. This would involve a major drain running up through the lowland rainforest area to the south of Milltown and then across the southern edge of the town to the sea.

The Milltown catchment is typical of many in north Queensland. Flooding and drainage, water supply for irrigation in the dry season, water quality, acid sulphate soils, soil erosion and the sedimentation of river systems are all actual or potential problems. Habitat management and protection are also significant issues with rapidly declining lowland rainforest and wetland areas. Two high-profile and endangered animal species are found in the catchment.

We would like you as a group to discuss the ways to try to meet the sugar mill's needs for increased through-put and the industry's desire to produce more cane in the Milltown Catchment. In making your recommendation (as a group) think as broadly as possible about options for the catchment. Whatever you recommend, we are particularly interested in the reasons for your recommendation and the issues that you feel needed to be considered in reaching your conclusion.