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Applying Ecological Knowledge to Landuse Decisions

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Making ecological knowledge relevant for land-use decision makers.

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In the past 50 years, land use knowledge, ecosystem science, ecosystem services, and technology have had a central role in securing global food security, by increasing productivity at a faster pace than population growth. This apparent success has not resulted in poverty reduction for all land users and has not necessarily led to good land management. A large number of environmental processes with negative effects have modified ecosystems under inappropriate land management. Not only must this damage be repaired, but further damaging processes need to be avoided. This poses an immense challenge to all stakeholders and societies.

Ecological functions and services will have to sustain the world population. Food security and demand for wood products for growing populations will remain a challenge in the next few decades, especially under climatic and environmental global change. So too will the task of transmitting ecological and management knowledge to land-users and governments with very different financial resources. Ecosystem functions and services will be important in the adaptation to climate change, regulating water resources and controlling erosion, preserving landscapes, conserving ecotones and providing habitat for wildlife (Cruz et al., chapter 18, this volume). Governments are responding to public pressure to preserve ecological biodiversity (e.g. UN convention on biodiversity) and set aside more native ecosystems, forests and grasslands for controlled access and use, and develop new scenarios whereby land users will attempt to preserve ecosystem services important for human wellbeing in the longer term (Daily 1997).

To cope with the demands of these changes, scientists at all levels face challenges in communicating results to policy makers, other stakeholders and the public at large. Science and policy-making are not linear processes that question, analyze, and propose solutions: they are both complex non-linear iterative processes that deal with multiple, interlinked, and changing questions. Closer cooperation between scientists and decision-makers is desirable but difficult to achieve. Despite the difficulties in this process, it is essential that scientists embrace the challenge, change, and improve their interaction and communication with decision makers. Scientists must continue to increase knowledge but should also make their knowledge available and relevant to decision makers. Land use decisions will continue to be made by others - however scientific understanding of ecological processes and their changes in a global environment is so important to future land sustainability that it must be communicated clearly and early in order to be understood and taken into account by decision makers.

The wide variety of land-use change situations studied by Collaborative Research Networks (CRN) and related projects provides a unique opportunity to reflect on the effective communication of ecological knowledge to land-use decision makers. Building on the CRN experience, this chapter describes how a working dialogue can be developed with land-use decision makers from farmers to governments - and in very different social, economic and ecological contexts.

Ecological knowledge for land use decision making

Natural resource management has been largely based on traditional ecological knowledge and knowledge conveyed through agricultural extension services. Ecological knowledge is one of the many components of land-use decision making, together with economic, social and political considerations. Scientists play a key role in generating this knowledge and making it available, directly or indirectly to decision makers.

Scientific knowledge building and the subsequent development of user-applications occur within a system involving many actors including scientists, professionals, IT specialists, librarians, communicators and the end-users of scientific knowledge and its applications. Ecological knowledge, like other types of scientific knowledge, grows through the addition of new information to a general knowledge pool. Growth of scientific knowledge depends largely on the accumulation and organization of information produced by experimental or descriptive research and monitoring activities. Surveys may compile traditional forms of knowledge into information systems for information handling, forecasting or modelling. Scientific progress is highly dependant on open access to existing knowledge by scientists who contribute to this body of knowledge. Scientists are knowledgeable and familiar with searching for and working with information, and can play a central role in information flows out of the pool of ecological knowledge into land use decision making.

Involving specialist intermediaries in communicating ecological knowledge

Direct dialogue between scientists and decision makers accelerates the adjustment of land-use, especially when rapidly changing environmental (e.g., climatic) or socio-economic conditions require a rapid response. However, intermediaries are often needed to make scientific knowledge legitimate to a target audience, and feeding information to them may be the most appropriate way scientists can contribute to the dissemination of ecological knowledge. Agricultural extension specialists are a well-known example of specialized intermediates that translate scientific knowledge into relevant, credible and legitimate information that will more effectively reach the target audience (Cash et al. 2003). For the same reasons, other intermediaries such as NGOs and key community members should also be involved in the communication process.

Communication using indicators

Holling (1998) identified “two cultures in ecology”. He compared an “analytic approach” that develops its activity by expanding the existing knowledge base through experiments, with an “integrative approach” where progress is achieved through the integration of existing knowledge, from different disciplines. The integration of knowledge in programs such as the Millennium Ecosystem Assessment has been very successful in addressing a broad range of issues using scenarios, modelling and a key indicators.

Politicians and land users alike prefer to use relevant indicators of ecological conditions that are easy to use and highly descriptive. For instance, meteorological services issue daily public reports on UV radiation strength on a scale of 1 to 10. These are easy to understand and have been widely adopted by the public at large. Erosion indices have been used successfully for landscapes management. Land health and stability can be assessed through long term monitoring of ecosystem properties using indicators. Long term monitoring can answer questions related to ecological stability. For instance, Long Term Ecological Research (LTER) Projects , although costly, reach out to the broader scientific community, natural resource managers, policymakers, and the general public by providing decision support, information, recommendations and the knowledge and capability to address complex environmental challenges. However, it is essential that LTER projects develop useful indicators.

Indicators allow an expanding set of sentinel observations to be drawn into policy-making. As new knowledge becomes available or the focus of decision-making shifts, underpinning data flows can be augmented or replaced. Indicators can be descriptive, relate to performance, efficiency, policy-effectiveness or overall welfare, but in the context of sustainability it is their integration across different policy arenas that are most critical. These sophisticated combinations of data in the form of assessments of current and future outcomes enable specific patterns arising from different policy interactions to be differentiated. Without the use of indicator based assessments, the size of the data and information flows becomes overwhelming (Hák et al. 2007).

Enlarging the circle of peers

Within the scientific community, research results are routinely evaluated through a peer-review process. Research articles are reviewed by two or three experts in the field before becoming part of the body of approved scientific literature. However, the stakes have changed as environmental issues from local to global scales are now relevant to an increasing number and variety of stakeholders. Complex issues such as global environmental change face considerable uncertainty as well as high social relevance (or stakes) (Figure 2.1). In order to contribute to decision-making on these issues, ecological knowledge must therefore be validated by a larger circle of peers.

To become relevant, ecological knowledge must be communicated and discussed within broad circles of stakeholders, under the light of their own perceptions and experience (Figure 2.1). Through this process, stakeholders get involved in qualifying ecological knowledge for informed decision making (Funtowicz and Ravetz, 1993). By involving them, stakeholders can decide how to incorporate ecological knowledge in their decision process.

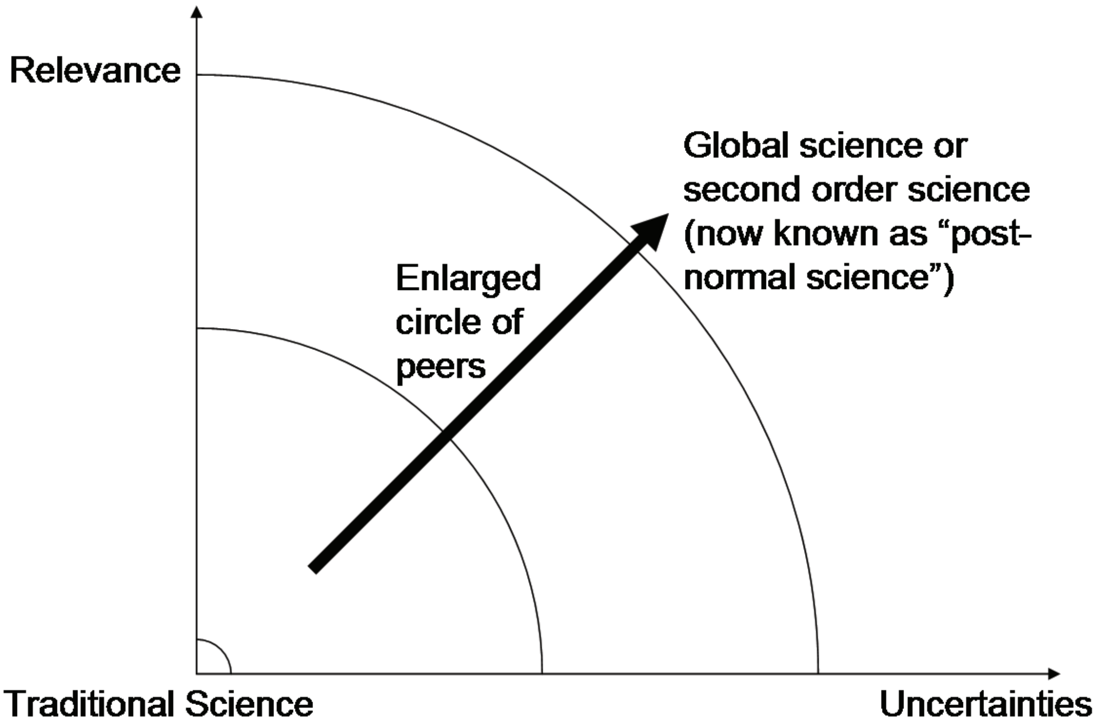

Figure 2.1: Effective scientific communication means enlarging the circle of peers involved in the research (Adapted from Funtowicz and Ravetz, 1993)

Making ecological knowledge relevant requires an understanding of the decision making process (Checkland & Holwell, 1998; Lynam & Stafford-Smith, 2003). Science must feed decision making systems with high quality information that is designed to inform non-specialists rapidly and effectively. This requires developing an explicit model of the decision making process itself, which can only be achieved through a multidisciplinary approach to land-use change (Tourrand et al., chapter 12 and Ojima et al. chapter 3, both this volume) and a dialogue between scientists and decision makers.

Communicating ecological knowledge through dialogue

Research projects are commonly designed within academic institutions, with no input from wider society or land-use decision makers. This might be called supply-driven research (scientist supply research questions and results – see Figure 2.2). Knowledge generated by this approach is often not directly or immediately relevant for the targeted audience, although it feeds the broader pool of scientific knowledge. Consequently, research results from these projects are often irrelevant to decision making.

Alternatively, some research projects involve stakeholders in the project design (also see: appendix 2.1). A research question that was formulated on the basis of stakeholder understanding of the issues at hand is more likely to generate results that can be easily communicated back, using the same understanding. This can be called demand-driven research (Figure 2.2). However, such projects often bring little new information and ignore research avenues with high potential immediate impacts.

Engaging research scientists and decision makers in a dialogue

Research projects that wish to make ecological knowledge both relevant and available to land-use decision makers need to strike a balance between supply-driven new issues and knowledge, and demand-driven relevancy to stakeholder concerns. This requires engaging in a continuous dialogue that will progressively generate new research questions and enrich decision-makers understanding of the ecological processes considered.

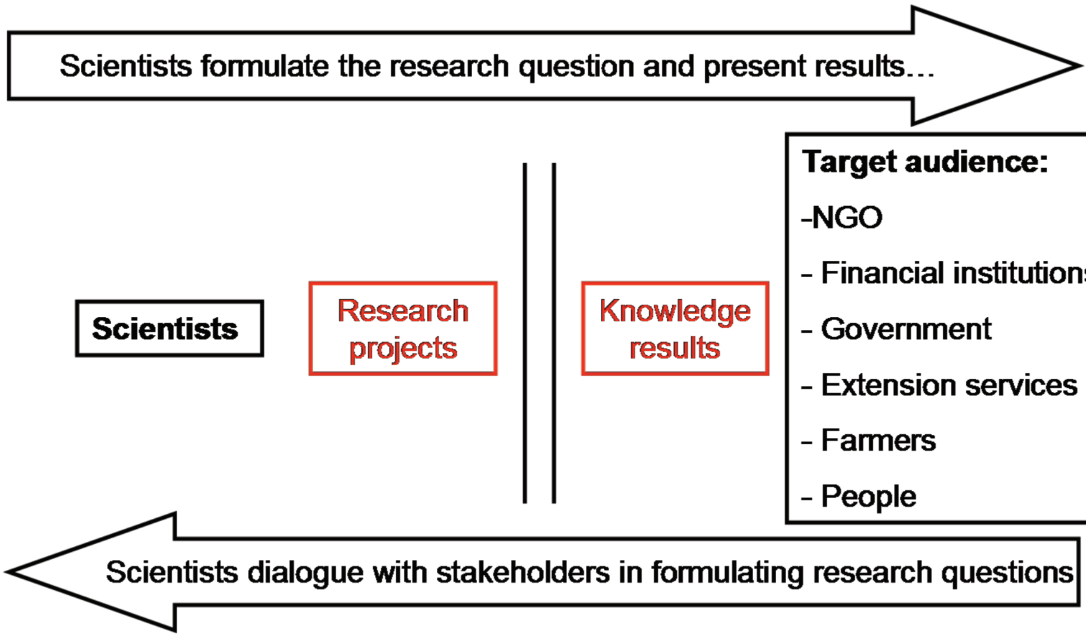

Figure 2.2: Two extremes in research project design. The upper arrow represents supply-driven research and the lower arrow, demand-driven research

Many CRNs and related projects presented in this volume and elsewhere (Tiessen et al. 2007) have engaged in such a dialogue, either in the formulation of their research questions, or during their implementation. For example, in the "Agroecosystem functioning and management in semi-arid Northeastern Brazil" project (Salcedo and Menezes, chapter 10, this volume), scientists based their insertion into the local social networks on a local NGO: Assessoria e Serviços a Projetos em Agricultura Alternativa (ASPTA) that had been involved for many years in rural development issues in the area. ASPTA was already trusted by local farmers, which made its involvement in the formulation of relevant research topics possible. ASPTA and farmers expected the CRN project to answer management questions that required the design of a rigorous scientific experiment.

Using scientific tools for communication

Cash et al. (2003) proposed methodologies and tools for linking science and decision making by facilitating collective action in a common forum. Among these approaches and methodologies, multi-agent systems (MAS) are especially suited to simulate the interactions of society with its environment at different geographical, spatial and social scales.

The CRN project described in Tourrand et al. (chapter 12, this volume) has developed MAS models to understand land-use dynamics in Amazonia. MAS are able to model many entities interacting among themselves and with an external environment. They are an alternative to classical equilibrium models in situations where emergent properties have to be explored, where system components are very heterogeneous (e.g., coupled ecological and social systems), or where spatial-explicitness is essential. Such models can be coupled with easy-to-grasp diagrams to support stakeholder debates, thus promoting collective action (as suggested by the Soft System Methodology – Checkland, 1999). Diagrams themselves are an important and effective tool for scientific communication (Larkin and Simon, 1987). They can be used to organize knowledge, support dialogue and help construct a common understanding of the issues at hand (Lambin and Geist, 2006; Le Page and Bommel, 2006). More generally, scientific tools and models can help effective communication if they are constructed using participatory methodologies, involving stakeholders and decision makers.

Formal participatory methodologies

Stakeholder participation is increasingly considered critical for both the effectiveness of research projects and the usefulness of their findings and policy implications. It can be defined as a process through which stakeholders influence and - in some cases - share control over the research initiatives that might affect them. Participation can take different forms, ranging from information sharing and various consultation methods, to mechanisms for collaboration and empowerment that give stakeholders more influence and control. Participating stakeholders can develop a sense of ownership of and responsibility for the research initiative and take part in deciding what issues might be important and relevant in any research project. Stakeholders can be individuals, groups or institutions such as local governments, directly affected land user groups (e.g., water consortium), indirectly affected groups (e.g., consumer organizations), NGOs dealing with land-use and environmental problems, civil society and private sector organizations.

Different methodologies, strategies and techniques have been tried to identify local stakeholders and promote their participation during field research projects. Each participatory approach is considered suitable for a specific type of situation, in relation to the types of contributions it aims to generate. Some of the earliest approaches are: Participatory Rural Appraisal (PRA, see Chambers, 1994a, 1994b); Participatory Action Research (PAR, see Fals Borda, 1998, and Rahman, 1993), Rapid Appraisal of Agricultural Knowledge Systems (RAAKS, see Engel, 1995); Participatory Technology Development (PTD, see Jiggins and de Zeeuw, 1992; and Farmer Participatory Research (FPR, see Okali et al, 1994). A detailed review of the different participatory approaches is outside the scope of this chapter but the corresponding literature can be found in appendix 2.2.

In spite of important differences between the various methodologies used to involve stakeholders, they all have in common that the research itself and the involvement of stakeholders are integrated as parts of one unique process. Since the late nineties, new approaches have been developed and documented. These include the Actor Oriented Approach (AOA, see Long, 2001) and the Sustainable Livelihood Approach (SLA, see Moser, 1998, Scoones, 1998, and Bebbington, 2004). In Castellanos et al. and Coutinho et al. (respectively, chapters 5 and 8, this volume) the conceptual bases of these approaches are described in case studies illustrating how stakeholders can be involved and how the land use decision process can be understood using the conceptual ecosystem services framework.

Making ecological knowledge relevant, credible and legitimate

Funtowicz and Ravetz (1990; 1993) discussed how science can influence political decisions. More recently, Cash et al. (2003) have reviewed how scientific activities can be linked with decision making and action. In doing so, they have again identified some necessary attributes of scientific knowledge to have effective impact: Ecological knowledge must be salient, credible and legitimate.

The general conclusions of Funtowicz and Ravetz (1990, 1993) and Cash et al. (2003) can also be applied to on-farm decision making. Scientific knowledge can be effectively communicated during its development and through packaging into tools such as modelling, scenario-based simulations, data banks, computerized decision making tools and maps. The nature and packaging of scientific knowledge are important in order for research results to be usable by decision makers.

Relevant ecological knowledge

As demonstrated in chapters 3 and 4 (this volume) as well as Finegan et al. (chapter 13, this volume), people are dependent on a suite of ecosystem services provided by land under various degrees of management. Demonstrating the link between ecosystem services and key underlying ecosystem functions or processes is a useful way to make knowledge relevant to land-use decision making. This approach has been successfully used by the Millennium Ecosystem Assessment.

Many CRNs have also used the ecosystem service concept to convey the importance of their research findings, thereby making them relevant to concerned land-use decision makers. The "Land use and cover in riparian areas of the Andean Amazon: Consequences for people and ecosystems" project (McClain et al., chapter 11, this volume) examined the hydrological processes that affect the maintenance of soil fertility that rural communities themselves recognize as essential ecosystem services.

Making knowledge credible

Scientists must be rigorous and knowledgeable to be considered as a credible source of knowledge. However, their credibility is not only based on their quality as scientists, but also depends on the quality of the dialogue between them and stakeholders. Credible scientists are open minded individuals developing a relationship based on mutual respect and trust with decision makers. Understanding the land-use decision making process is essential for this. Building trust requires time, an initial investment that serves to build long-lasting credibility. Of course, as in scientific collaboration, delivering promised outcomes to stakeholders is essential to building and maintaining trust. This also allows timely feed-back for keeping research projects on track. Decision makers are well-able to take ecological uncertainties into account and these must be made transparent to decision makers. In case of failure, the sharing of responsibilities in taking into account uncertainties will better preserve the trust between scientists and decision makers.
The reputation of institutions also influences the credibility of their scientists. Policy makers will engage in a dialogue with scientists from reputable institutions. The reputation of a researcher's institution is much less important for land-use decision makers such as farmers, for who the importance of direct personal interactions dominate.

Legitimacy of ecological knowledge

The involvement of institutions in land-use issues (i.e. within national governmental spheres) raises the question of their legitimacy, and with that the legitimacy of the knowledge it generates. Scientists should be careful when engaging with stakeholders and land-use decision makers: crossing the fine line between engagement and advocacy, when not explicit, can result in a loss of legitimacy. Engagement however, remains essential for ecological knowledge to become legitimate, as well as relevant and credible to land use decision makers.

Conclusions

Although ecosystem scientists have already made important and substantial progress in understanding the interactions of global change and land use, it is obvious that this progress is not going to be enough in the immediate future. Ecosystem scientists have learned to adopt a team approach and break down some of the discipline barriers within ecological science. Teams (earth, atmosphere, water and related scientists) are working together to understand the major ecosystems of the world (e.g. Amazon and Parana river basins) and they have made significant progress. But understanding the system is only the first step towards sustainability and, in isolation, it does not immediately produce land use options that can be implemented. Unless these scientists produce relevant, credible and legitimate information for decision makers influencing land use in a given region, they risk being sidelined to academic and research institutions and made irrelevant to land-use decision making. This would be extremely unfortunate as these are the people with valuable knowledge of the ecosystem and their expertise should be available to decision makers. Earth system science has to develop the skills and connection with the social sciences and with non-scientists like policy and media specialists.

Funding agencies and institutions have been slow to evaluate and fund research projects that propose to bring science and policy teams together. Those that do so have major obstacles to overcome. IAI is one such institution that has understood the importance of this approach and through its CRN projects is funding and attempting to learn how to accomplish this goal. This chapter draws on the experience of those currently working on these problems and provides some recommendations that should help bridge the gap. However, this interaction between scientists and decision makers is still in its infancy and it would be prudent to reassess progress at regular intervals.

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Appendix 2.1: Key questions for a starting research projects

Our analysis of the CRN experience in communicating ecological knowledge to land-use decision makers has given us the opportunity to list a set of key questions that project leaders should contemplate when designing a research project.

- Identify the target audiences

1. Who are the decision makers that might be interested in the project findings and its research question?
2. Will land-use decision-makers be include in the research proposal or research plan?
3. Who is going to lose or gain from the information the project will generate?

- Make scientific information available

4. How will you communicate results to the target audiences?
5. How could you translate the main hypotheses into key statements?

- Identify relevant information

6. Will you involve target audiences from the on-set of the project?
7. If so, will you do so informally or do you plan to use a formal methodology?
8. How will you evaluate if project findings addressed the concerns of the different audiences and impacted their decision making process?

- Make results credible

9. What level of abstraction and synthesis of results will you use in communicating results to each one of the audiences?
10. How do you plan to include an evaluation of certainty/uncertainty in the presentation of results?

- Making conclusions and recommendations legitimate

11. Do you plan to engage research results in the decision making process in spite of their uncertainty?
12. Do you plan to transform your engagement into advocacy?

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