2 Reading between the Lines: Knowledge for Natural Resource Management

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Abstract: There are a number of spatial models available to support natural resource management decision making, however which one is best suited to answering the question at hand? Specific tools and approaches have various data, information and knowledge requirements. In this chapter the concept of the knowledge hierarchy (Ackoff 1989) is used to explain the dimensions of modelling and planning. This hierarchy is important as it provides a sound theoretical basis from which scientists and modellers can better relate to the planners and policy makers. To facilitate a better relationship between science and decision making, Steinitz's (1960) landscape decision framework provides a basis for linking six levels of questions and models. In conclusion, natural resource managers and planners need to better utilise spatial models to simplify and better understand complex phenomena, and utilise communication tools such as landscape visualisation to improve discipline integration. There is an urgent need to bring together expertise in the fields of natural resource management so that scenarios for change can be explored and critical decisions concerning our natural resources can be made based on collective wisdom.

2.1 Introduction

In May 2007 the Victorian Department of Primary Industries hosted the 'Place and Purpose' conference. This event was a significant showcase for, and forum to debate, the latest tools, directions and research questions on the theme 'Spatial Models for Natural Resource Management and Planning'. The contributions in this book were developed as a consequence of the Place and Purpose conference (DPI 2007). The accounts of models and their visual outputs that are reported in this volume are a credit to the collective efforts of modellers to make their (modelled) advices and options more accessible to the next user or decision maker. However, there are assumptions underlying these endeavours and they are embedded in our tools and approaches to decision making. I offer this short dissertation on the topic of knowledge for natural resource management (NRM) to provide a perspective on this area. I want to take a step away from any particular applications, consider some general theory, provide some lessons from a science fiction allegory, and to advocate for simplicity out of complexity.

2.2 Knowledge Hierarchy

Ackoff (1989) proposed a knowledge hierarchy relating data, information, knowledge and wisdom to an increasing degree of connectedness and understanding. I have added the dimensions of modelling and planning to Ackoff's system to illustrate how these components of knowledge supply the modelling and planning needs of NRM in a general way (Fig. 2.1).

Modelling requires knowledge, that is, understanding of a system's pattern of relationships. A model may be conceptual, qualitative or numeric. Modelling in landscape analysis typically uses real data, their relationships and process behaviour in systems. Modelling may be used to generate a better representation of landscape, such as, using digital elevation data and airborne geophysics to model and delineate land units. Modelling is also used to explore scenarios by altering model inputs or environmental variables, for example, a change in land use and its resulting hydrological impact. Planning requires decisions. Planning puts things in order for the future. Successful planning depends on foresight and wisdom. Proficient planning may use the results of models but decisions may not be dictated by the results of models, in fact the models used in planning may simply be conceptual. In Fig. 2.1 it is therefore suggested that modelling and planning do not directly overlap. This is a good illustration of the different domains occupied by scientist or modeller, and by those concerned with policy and planning decisions. This is not meant to imply that modellers are without wisdom, nor that planners necessarily exercise it!

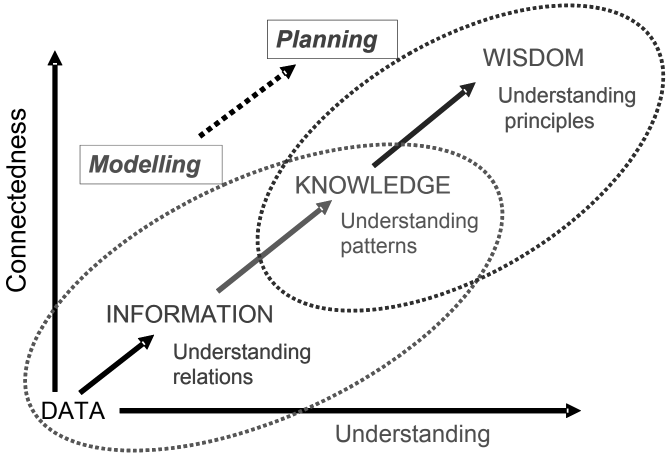

Fig. 2.1. From data to wisdom and modelling to planning; their relation to degree of connectedness and understanding

Decisions need to be made — where to do this or that, how much of this land to use, which ecological remnants to preserve, how much water to allocate to different uses. These decisions are in the domain of NRM and planning. They are both private and public decisions as they affect economic success as well as community wellbeing. Such decisions have wide reaching and lasting impact, many of them will take us, and the resources we use, down a one-way street or a road from which there will be no turning back. They are ephemeral decisions with terminal effects — we cannot readily reclaim agricultural productivity from bitumen and concrete, and we cannot effectively reconstruct lost ecosystems. The lines we draw on maps through natural systems can have irreversible consequences (Fig. 2.2). Some degree of reading between the lines is required to ensure harmonious interaction or sustained protection of use across artificial boundaries. McHarg, in his seminal work *Design with Nature* (McHarg 1969), pioneered the way and set the foundation principles now commonly applied in GIS and spatial models. Meine (1997) in his essay 'Inherit the grid' draws attention to the issues raised by disjunction between a north–south grid and the earth's curvature and the ecological disruption generated by land tenure.

Sound decisions require reliable methods to present and evaluate options; those who make the final decisions need effective means to engage others in the decision-making process. In the last two decades the decision processes for management of natural resources in Australia have become increasingly complex. Different levels and divisions of government, non government organisations serving the interests of primary industries or conservation, and individuals with a stake in the land are involved in seemingly endless iterative planning cycles. Strategies, action plans and consultative processes with open and transparent logics are all mandated for any aspect of government funded NRM investment.

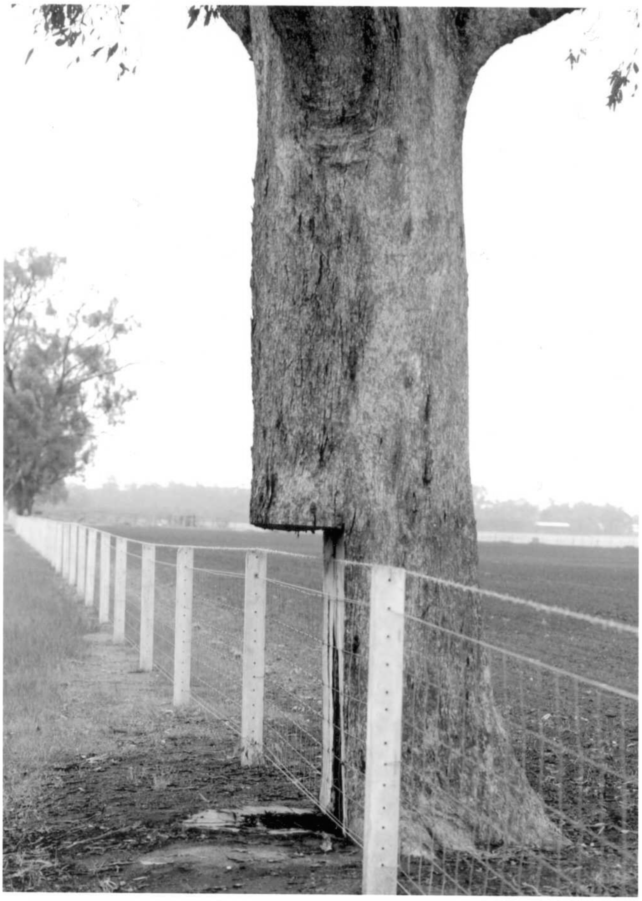

Fig. 2.2. Lines that define land use artificially divide the natural world (Photograph: Peter Hyett, *The Bendigo Advertiser*, June 2003)

This, on one hand, is very positive as it is easy to become involved in providing specialist advice into these planning activities. In fact, as specialists, we are frequently asked to comment on strategies, provide scoping studies, model processes in the landscape, and propose research that can assist with answering NRM questions. On the other hand, it is difficult, or often feels difficult, to provide the quality of advice that is truly useful to decision makers. We need to find ways to close this gap and to improve communication and understanding from both sides. There is a general need to improve the timeliness and the quality of support for NRM. There are many issues that arise in consideration of improvement. From the research side, requirements for better data, increased understanding of processes and ability to validate model outputs are all seen as essential. From the decision maker's side, requirements are for simple indicators of NRM performance and clear options for moving forward.

2.3 Timelag between Question and Answer

Campbell (2006) espouses the need for a well-designed NRM knowledge system to focus on the interfaces between scientists and decision makers. He acknowledges that scientists are often frustrated that policy is often poorly informed by the best science, whilst policy makers are frustrated by the lack of timeliness in scientists' answers which usually carry requests for more research funding. Results of research are consequently delivered long after the political imperative has defined the question.

This issue of timelag between question and answer is wonderfully parodied in the *Hitchhiker's Guide to the Galaxy* (Adams 1979). Inhabitants of the planet Magrathea had become so frustrated by constant philosophical bickering that they built a super computer, 'Deep Thought', to provide the answer to the ultimate question concerning 'life, the universe and everything'. After 7.5 million years Deep Thought gave an annoyingly simple answer: 'forty-two'. This seemed incomprehensible and irrelevant because the ultimate question (terms of reference for the consultancy?) had been insufficiently defined. A more powerful computer (the Earth) was then designed by Deep Thought to run a ten million-year program to follow up the initial research and actually define the ultimate question. In Adams' fictional universe the follow-up research was unfortunately not completed as, five minutes before the ten million-year program was completed, the Earth was demolished by Vogons to make way for a hyperspatial express route. The demolition notice had been posted somewhat inaccessibly to Earth in Alpha Centauri and the planning approval signed by the galactic president, Zaphod Beeblebrox, 'with love', because he thought someone was asking for his autograph. There is a quaint bureaucratic allegory here too which could be elaborated, but which, at the very least, illustrates major failures in communication.

2.4 Organising the Questions

Adams' story provides an amusing allegory for many principles that govern our own work:

- research takes time
- there is always a lag between question and answer
- the answer needs to satisfy the question
- research should be driven by clear questions
- the answer needs to be simple, but not too simple
- usually the answer generates a new question
- answering the next question is usually more costly than the first
- general trend in science understanding and in models is towards greater complexity
- completion of research can depend on external factors that have nothing to do with the research itself.

The issues and processes are complex. The challenge, particularly for decision making, is to make these issues and complexes simple, or, perhaps more correctly, the challenge is to make them appear simple. Perhaps we need the equivalent of Douglas Adams' Babel Fish which is a (fictional) kind of universal knowledge broker and translator?

There are many approaches that can assist in engagement and closing the gap between scientists modelling processes, planners making decisions and the communities affected by the decisions. Visualisation methods and their associated models described in other chapters in this volume are all important examples of how this can be done in different or specific circumstances. However, to return to the mission stated in the opening paragraph, to step away from particular instances and consider some general overarching theory, it is worth considering an approach by Steinitz (1990). Simple principles are often the best, they can be returned to time and again and applied to different situations.

Carl Steinitz, an educator and Geographical Information Systems (GIS) specialist, sought an integrative approach to examine: the questions we ask, what we know about what we do, and what we teach. He was convinced that, despite individual differences and some collective professional differences in emphasis, there is an overwhelming and necessary structural similarity among the *questions* asked by, and of, landscape architects and other environmental design professionals. This led him to the development of an overarching framework for organising the questions associated with altering the landscape. This framework can be used: to organise applicable knowledge or models directed towards landscape change, to identify areas where contributions of theory are needed, and to assist in the decision-making process.

The landscape decision framework proposed by Steinitz (1990) links six levels of questions and models that are deemed essential to landscape design and landscape planning and is illustrated in Fig. 2.3. The framework is simple to explain and its logic is rapidly grasped.

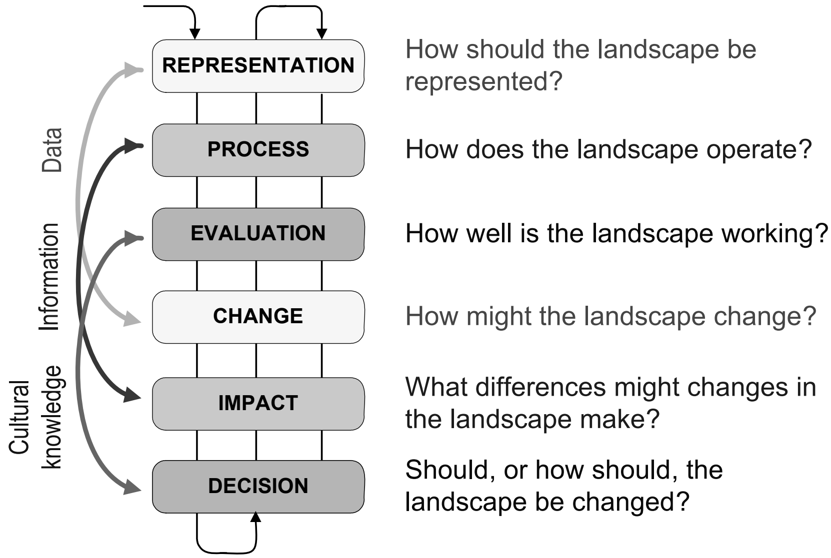

Fig. 2.3. Landscape decision framework (after Steinitz 1990)

This framework complements Ackoff's framework (Ackoff 1989) that is represented in Fig. 2.1. The requirements for data, information or knowledge can be related to each question. Representation of landscapes, present or future, simply require data, in this case these are attributes of land at a spatial scale sufficient to the question. Questions concerning processes in the landscape and potential impacts of change have information requirements, such as, relationships between land attributes and activities in the landscape. Evaluations concerning landscape (e.g. indicators of economic, social or environmental health) and preferred options for landscape change or preservation of the status quo sit firmly in the realm of (cultural) knowledge.

The questions are to a large degree interdependent but all should be driven by the decision question. The scope of the decision determines the spatial scale for landscape representation and the attributes that need to be included. It will also dictate the processes that need to be understood or modelled — hydrological, social, economic, climate, for example. In turn, process models have certain requirements for input data parameters and scale, and so on. As well as providing structure for a decision-making process, the framework thus provides a means of auditing the adequacy of data, information and knowledge required to make a sound decision. As a test of the simplicity and overarching applicability of this framework it is worth the reader's time, when reading the other contributions in this volume, to envisage how each of the areas of work presented are accommodated by, and contribute to, the schema presented in Fig. 2.3.

2.5 Integrating Disciplines

No single person in the NRM business can possibly have full command of each of these necessary building blocks for decision making. Multi-disciplinary projects are therefore common in NRM. As the complexities of issues become recognised these projects also tend to be large. There is an underlying, sometimes explicit, assumption that these large integrated projects are the best way to reach the solution. Is this true, what can be learned from past efforts? What are the requirements for a successful large integrated multi-disciplinary NRM project?

Tress et al. (2007) investigated the issues surrounding these types of project. They used an online survey but also contacted some organisations and groups directly. Participants in the study represented thirty countries. Responses were in agreement about a number of fundamental issues. High on the list was the need for an *integration* plan that would define how the different disciplines would actually contribute to a single solution. There was also universal recognition that extra time was needed to enable communication between disciplines and to overcome the language and conceptual differences of the participating specialists. They emphasised the need to have regular meetings and events to develop a common language and to gain familiarity, trust and common understandings in the team. Contrary to popular practice they also concluded that it was better to plan smaller rather than larger projects. They also highlighted problems which can exist in any project but which become amplified in the larger projects. Their advice to plan realistic outputs that can be delivered on time, and to avoid setting expectations too high in order to please funding agencies and stakeholders should ring true for all of us.

2.6 Conclusion

So, we acknowledge that the job is not easy, would seem to need more time, certainly needs more clarity, but also needs to be done faster and smarter. A framework such as that of Steinitz can at least simplify project planning by partitioning the expertise and designing a process for effective communication between each of the six questions.

Returning to Adams' allegory, the super computer, Earth, was destroyed, but Slartibartfast and a team of terra-forming engineers were able to build 'Earth mark two' based on Deep Thought's original blueprint. We do not have that option — there is no backup for the system that we are trying to manage. It is therefore of the utmost importance that NRM is served by the best that can be provided in terms of decision support in the ascendancy from data to wisdom. Major challenges are to make what is complex, simple, and to provide expedient advice regarding scenarios for change. These challenges are in urgent need of our service.

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References

Ackoff RL (1989) From data to wisdom. Journal of Applied Systems Analysis 16:3–9

Adams DN (1979) The hitchhikers guide to the galaxy. Pan MacMillan, London

Campbell A (2006) The Australian natural resource management knowledge system. Land and Water Australia. Canberra, ACT

DPI (2007) Place and purpose – spatial models for natural resource management and planning'. Department of Primary Industries conference, 30–31 May 2007, Bendigo. Available at http://www.dpi.vic.gov.au/placeandpurpose

McHarg IL (1969). Design with nature. Natural History Press. New York

Meine C (1997). Inherit the grid. In: Nassauer JI (ed) Placing nature: culture and landscape ecology. Island Press, Washington, DC, pp 45–62

Steinitz C (1990) A framework for the theory applicable to the education of landscape architects. Landscape Journal 9:136–143

Tress G, Tress B, Fry G (2007) Analysis of barriers to integration in landscape research projects. Land Use Policy 24:374–385

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