Challenges to science and society in the sustainable management and use of water: investigating the role of social learning

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1 Introduction

This first paper in the special issue examines how the SLIM project1 emerged as a major European research project investigating social learning for the integrated management and sustainable use of water at catchment scale. SLIM's original research questions and conceptual framing arose from particular experiences associated with the formulation

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Water catchments
Interactive social science
Praxis
Governance mechanisms

Abstract

Water catchments are characterised by connectedness, complexity, uncertainty, conflict, multiple stakeholders and thus, multiple perspectives. Catchments are thus unknowable in objective terms although this understanding does not currently form the dominant paradigm for environmental management and policy development. In situations of this type it is no longer possible to rely only on scientific knowledge for management and policy prescriptions. "Social learning", which is built on different paradigmatic and epistemological assumptions, offers managers and policy makers alternative and complementary possibilities. Social learning is central to non-coercion. It is gaining recognition as a potential governance or coordination mechanism in complex natural resource situations such as the fulfilment of the European Water Framework Directive, but its underlying assumptions and successful conduct need to be much better understood. SLIM (social learning for the integrated management and sustainable use of water at catchment scale), a European Union, Fifth Framework project assembled a multidisciplinary group of researchers to research social learning in catchments of different type, scale, and socio-economic situation. Social tools and methods were developed from this research which also employed a novel approach to project management. In this introductory paper the rationale for the project, the project design intentions and realisations, and the case for researching social learning in contexts such as water catchments are described. Some challenges presented by a social learning approach for science (as a form of practice) and society in the sustainable management and use of water are raised.

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1 SLIM is an acronym derived for the 'social learning for the integrated management and sustainable use of water at catchment scale' project, a multi-country research project funded by the European Commission, i.e. Directorate General Research, as part of the Fifth Framework Programme for research and technological development, 1998–2002; SLIM ran for 42 months from 2001 to 2004.
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of a new perspective on resource dilemmas. As such, the paper is a study of the history of ideas that constitute the initial starting conditions for SLIM and that seem important for contextualising the papers that contribute to this special issue.

We start by examining resource dilemmas as a special context brought about by humans having become a major force of nature and by the increasingly contested means of access to, and use of, common pool resources as typified in the hydrological cycle. We trace how water catchments are traditionally characterised and explore the implications of considering catchments as if they were socially constructed. We then analyse the suitability of the dominant governance or coordination mechanisms for resolving resource dilemmas, viz.: regulation, information transfer and market mechanisms, and establish a rationale for alternative, complementary mechanisms that seem more suitable for dealing with resource dilemmas. The alternative we propose and set out to study was social learning achieved through a particular set of ‘variables’ that shaped the SLIM research design as well as evolving and becoming more coherent through SLIM case study research. Social learning, if adopted as a complementary governance mechanism, has implications for research management and practice as well as posing some challenges to science and society. These implications are discussed.

2. The SLIM project starting conditions

SLIM was one of a series of European Union (EU)-funded investigations concerned with the socio-economic aspects of the sustainable use of water (see http://cordis.europa.eu/fp5/src/ec-en7.htm; http://www.harmonicoop.info/links.html). SLIM’s focus was on understanding the application of social learning as (i) a conceptual framework, (ii) an operational principle, (iii) a policy instrument, and (iv) a process of systemic change. By elucidating each of these we wished to provide evidence as to whether a new, complementary approach to water governance was desirable and feasible.

It was no coincidence that SLIM began at the same time as the passage of the Water Framework Directive (WFD) through the European Parliament (Kaika, 2003; EU, 2003). As with the other projects funded at the time, the EU, as research commissioner, sought insight into the ways the WFD could be implemented not only through ‘right laws’ and ‘right prices’, but also through communicative and participatory approaches (see Ollivier, 2004). SLIM was, however, not directly involved with the WFD, or its implementation per se—WFD implementation would only start in earnest in most of the SLIM countries towards the end of the research project. But we were conscious that the legislation would fundamentally change the historical basis of managing water in Europe (Kaika and Page, 2003). It also seemed appropriate, based on our experiences in developing country settings (e.g. Roling and Wagemakers, 1998), to assume that the shift within the WFD to managing water based on its ecological status would present challenges for catchment management that were new to most European policy makers and water managers. Said one Dutch water manager who had spent 15 years in development work in Bhutan, Zambia and Brazil whom SLIM interviewed in 2003: ‘When I took this job there was no-one who had any idea how to translate cubic meters of water into human behaviour’.

SLIM emerged in, and was implemented by, a group of researchers whose basic understanding of social change was influenced by work in agricultural research, rural development and extension education (Chambers and Jiggins, 1987a,b; Roling, 1988; Russell et al., 1989; Watson, 1992, 1996; Russell and Ison, 1993; Ison and Russell, 2000; Bawden, 1994; Roling, 1994; Roling and Wagemakers, 1998; Roling and Jiggins, 1998; Gibbon and Jakobsson, 1999; Roggero et al., 1996; Powell, 1996; Steyaert, 2002; Hubert, 2002; Leeuwis and Pyburn, 2002). A majority had collaborated around common concerns in the LEARNING caucus of the European meetings of the International Farming Systems Association (IFSA) (LEARN Group, 2000). As researchers we had become aware of, and begun to contribute to, an emerging third approach to extend and complement the main governance mechanisms of (i) hierarchy, comprising regulatory and information providing practices, including education and (ii) market (Powell, 1994). This third approach has emerged in recent years in response to the frequent failure of instrumental and strategic reasoning based on the prevailing technical rationality on which water policies and practices are mainly built (Barraque, 2003; Pahl-Wostl, 2007). This ‘social learning’ (SL) approach is based on the idea that sustainable and regenerated water catchments are the emergent property of social processes and not the technical property of an ecosystem (Morris et al., submitted; Steyaert and Jiggins, 2007). That is, desirable water catchment properties arise out of interaction (engaging in issue formulation and monitoring, negotiation, conflict resolution, learning, agreement, creating and maintaining public goods, concertation of action) among multiple, inter-dependent, stakeholders in the water catchment. We describe this overall set of interactions when it occurs in a complex natural resource arena as social learning.

Thus, if ecosystems are perceived as bounded by the conceptualisations and judgements of humans as agreements to what constitutes an improvement, it became important to know if social learning could be done purposefully and well. In the next paper Blackmore (2007) traces the theoretical roots of social learning and the particular conceptualisations adopted by SLIM—we do not engage with these here.

Our starting position was that where such an interactive approach applies, centralised and objectified policy does not become irrelevant but can be encompassed within a broader understanding of how knowledge, and thus issues, are constructed and employed in policy processes. A ‘social learning approach’, we argued, provides a context for a dynamic local decentralised process, and, in the case of large watersheds, for concerted parallel local processes. ‘Social learning’ also rests on a different set of epistemological assumptions—that knowing occurs with the act, the process, of constructing an issue and seeking improvements (Blackmore, 2007; Steyaert and Jiggins, 2007). In contrast, the traditional policy instruments are built on an epistemological foundation of fixed forms of knowledge (i.e. reified understandings of the nature of the ‘problem’) as depicted in Fig. 1. These two different foundations do not preclude their complementary use but such use requires awareness of the
Fig. 1 – Policy coordination mechanisms compared (i) within the current paradigm of environmental management comprising hierarchy and the market used to address pre-determined environmental problems based on a fixed form of knowledge and (ii) social learning for concerted action based on the process of knowing. N.B.: Further theoretical underpinnings of this figure are developed in Blackmore (2007).

differences and of the implications for practice, whether in policy development, research or water management.

At the time SLIM began there was growing interest in developing alternative approaches to water and catchment management. In North America Sabatier et al. (2005) describe how in the past 20 years ‘the traditional approach has come under increasing criticism [in part reflecting] the increasing complexity and conflict in water resource issues.’ (p. 3). They point out that historically ‘decision making has been quite technocratic, with public involvement usually relegated to public hearings and comment periods that fine-tune agency proposals. The scope of decision making has generally consisted of specific types of pollution sources or specific areas within a watershed (such as the coastal wetlands) rather than the watershed as a whole.’ Similar initiatives were occurring in a range of developing country settings (e.g. Carter, 2006; Poats, 2006; Chorlavi Group, 2006).

The water sector was characterised by Pahl-Wostl (2002) as ‘undergoing major processes of transformation at local, regional and global scales’ and, like many technological resource management regimes, as ‘inflexible and not built to adapt to changes in environmental, economic or social circumstances’ (p. 394). In institutional terms these particular historical features pose problems in an era of rapid change. Some argue that similar situations exist in research organisations; Syme (2005), reflecting on his own research organisation, points to the need for ‘a cultural change in engaging others, including the general community, in assisting it with designing and answering the “right” questions’. The history of the water sector, and research institutions, or more specifically social research praxis, were important contextual factors when SLIM commenced.

We elaborate on these starting conditions for SLIM because one of the outcomes of SLIM was to add ‘the history of the situation’ as a key SLIM variable (see below) in what was to become the SLIM framework, or heuristic (Steyaert and Jiggins, 2007). Russell and Ison (2000) explore how we are all limited by our own historicity in terms of the traditions of understanding out of which we think and act. Situations and indeed methods and techniques are also products of particular histories. Historical dependence and sensitivity to initial starting conditions are features of complexity. As outlined in Section 3, complexity is one of the key features of a resource dilemma; Law and Urry (2004, p. 400) also outline why complexity could be a new model for the social sciences.

For the purposes of this paper, and indeed the special issue, we emphasise that as our research ‘system’ (i.e. project) was non-deterministic, or non-linear, then its progress was sensitive to initial starting conditions and to the different traditions of understanding of those researchers who joined the project. For example, in order to drive the internal process of learning within the SLIM team, a mid-term review of country theory papers was organised and on two occasions process observers joined team workshops (see Steyaert and Jiggins, 2007). This helped the project to align its espoused theory with its theory in practice and hold team members accountable to processes of adaptive management through shared learning. In this process hard choices had to be made as to what recommendations to take on board (e.g. following the mid-term review we paid more attention to the dynamics of power in terms of social asymmetries), but were unable to meaningfully engage with gender as an issue despite its known significance. Ison et al. (2004) discuss the management of this process.

3. The resource dilemma as a new context

3.1. Entering the age of the environment

The SLIM proposal was motivated by Jane Lubchenco when, in her maiden speech as President of the American Society for the Advancement of Science, she claimed that ‘humans have become a major force of nature’ and backed this up with a long list of the ways in which humans were transforming the face of the earth (Lubchenco, 1998). As an active member of the Resilience Alliance that includes ecologists and ecological economists (e.g. Ostrom, 1992) her concern was to contribute to enhancing societies’ ability to retain their integrity in the face of shocks and surprises. The conceptual concerns of the Resilience Alliance, particularly ecological, economic, cultural and political principles of institutions for the environment (Hanna et al., 1996), influenced the design of the SLIM proposal.

The Resilience Alliance was a response to the widely shared realisation that the cyclical dynamics of ecosystems was incompatible with the linear growth pursued by economic policies, a fact that would invariably lead to weakened ecosystems and vulnerable societies, as Holling and his collaborators (Gunderson et al., 1995) phrased it. Holling’s lemniscates model of the cyclic nature of ecosystems, later applied to human organisations by Hurst (1995); see also Jiggins

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2 Later she acted as an important contributor to the Millennium Ecosystem Assessment (UN, 2006).
et al., 2007 and Toderi et al., 2007), was the basis for ‘adaptive management’, i.e. learning, experimentation and careful probing, as a realistic approach to capturing human opportunity. The Gunderson et al. (1995) issue explicitly mentions social learning, not in the Bandura (1977) sense of imitation, but in the sense of learning by a collective to engage in more appropriate concerted action (Parson and Clark, 1995).

Earlier, Funtowicz and Ravetz (1993), referring to Kuhn’s (1970) work on paradigm shifts in science, had spoken of the emergence of the need for a ‘post-normal science’ to deal with fundamental uncertainty with respect to highly salient issues for which puzzle solving science no longer provides satisfactory answers. This post-normal science would require ‘extended peers’ who included not only academic disciplinarians but also a wider public that had to live by the results, and ‘extended facts’, which included not just causes but also reasons. Given the basic uncertainties of the environmental crisis, answers would need to arise from widespread participation and democratisation of science.

In 1992, the translation appeared of the work of Beck (1986) on the risk society and the need for ‘reflexive modernisation’, i.e. a society capable of reflecting at multiple levels about its own circumstances. It is argued that a society, whose greatest risk is its own collective impact on the very thin troposphere on which all life depends (Flannery, 2005), needs to manage ‘second-order emergence’ (Gilbert and Troitzsch, 1999). The concept of second-order emergence, common in artificial life studies, and defined as an emergent behaviour that adds additional functionality in a system (Steels, 1990) can be distinguished from first-order emergence, defined as a property not explicitly programmed in. With second-order emergence the system can use its own emergent properties to create an upward spiral of continuing evolution and emergent behaviours, something that may be necessary to ensure that humans become capable of reflecting on their collective impact, particularly the implications of the unintended consequences that arise from neo-classical, or rationalist, economic theories-in-action. These inklings of a global society that takes the ecological imperative as its most serious predicament were later, hopefully only temporarily, drowned out by neo-conservatism, which has been actively engaged in thwarting climate change research (Pierce, 2006).

SLIM was thus conceived from the realisation that we had entered a new age of the environment and that ‘social science’ had a contribution to make, although not in its traditional form. This realisation that a new, interactive form of social science was required had grown out of deliberations of the LEARN Group (Hubert et al., 2000). It is a position advocated by Law and Urry (2004) when they claim that social science methods enact 19th century realities and that researchers doing social science now need to recognize that they create new realities. This position is more attuned to the recognition that human fate is no longer only a question of controlling nature, but especially also one of learning how to deal with ourselves. Within our milieu, this realisation was perhaps best formulated by Bawden and Packham (1993) of Hawkesbury College (now University of Western Sydney), with whom several prospective SLIM researchers actively collaborated at the time; they advanced the claim that sustainability is the emergent property of a soft system. In making this claim they drew on the work of Checkland (1981, 1999 and with Scholes, 1999), the ICI manager and chemical engineer who learned the hard way that human societies cannot be managed as ‘hard systems’ in which the goals can be assumed as given. Said Checkland: ‘It is the goals that are the bone of contention’. His theoretical work on soft systems and the development of soft systems methodology, that itself relied heavily on the work of Geoffrey Vickers (Checkland and Casar, 1986), has been influential in SLIM, not in the least because of the participation of members of the Open University’s Systems Department. The group of people who later came together in SLIM actively participated in the international debate. Examples are Röling and Jiggins (1998) on adaptive management, Woodhill and Röling (1998) on social learning, and Russell and Ison (1993) on contextualised science.

3.2. The attributes of resource dilemmas

The age of the environment refers to the realisation that the context of human society has changed in quite specific ways. We call this context a resource dilemma. SLIM is predicated on an effort to elucidate this dilemma quite specifically as a prelude to proposing and testing human responses for dealing with it. We have done this not for the global level, but for the level of resource bundles, such as water catchments, lake fisheries, and other common pool resources. We define these as ‘resources (i) for which joint use involves subtractability; that is, use by one user will subtract benefits from another user’s enjoyment of the resource system, and (ii) for which exclusion of individuals or groups involves high transaction costs’ (Steins, 1999, p. 3). Most natural resources have become common pool resources. A typical example is the dialogue started up by FAO (Food and Agriculture Organisation of the United Nations), WWF (World Wide Fund for Nature), IWMI (International Water Management Institute) and some other partners upon discovery that their long-term sectoral plans for water use for respectively agriculture, nature conservation and urban household and industry needs all counted on using the same limited amount of freshwater that can be expected to be available for such purposes worldwide (http://www.iwmi.cgiar.org/dialogue/; Röling and Woodhill, 2001).

Resource dilemmas have specific characteristics. Subtractability causes them to be marked by conflict and controversy, later referred to as ‘competing claims’ by Giller et al. (2005), and inter-dependence, in the sense that achieving one’s objectives is predicated upon others reaching theirs. Jiggins et al. (2007) and Collins et al. (2007) show how difficult it can be for stakeholders in a resource dilemma to accept such interdependence and its consequences. Resource dilemmas are further marked by the multiple perspectives held by the different stakeholder groups, each with their own optimisation strategies, theories and life-worlds.

Resource dilemmas do not lend themselves easily to scientific analysis and solutions. In fact, they are complex in that a great many factors, biophysical, social, economic and political, interact in processes that are only partially path-dependent and usually unpredictable. Their outcomes depend on socially constructed realities and human reasons which make them highly uncertain. But that uncertainty is also inherent in the anthropogenic ecological imperatives that humans have unleashed.
3.3. The catchment as a resource dilemma

Historically, water catchments have been regarded as biophysical entities governed by hydrological characteristics and defined as a ‘basin or area from which rainfall flows into a river’ (Fowler and Fowler, 1961). In other parts of the world, ‘watershed’ is used synonymously with ‘catchment’ (e.g. Sabatier et al., 2005). With the advent of the WFD in Europe there is also a tendency to refer to ‘river basins’ without being clear whether these refer to hydrological features of the landscape or to a combination of hydrological feature and administrative area. Within all of these understandings, ‘catchments’ are seen as definable, pre-existing entities that require managing (Barraque, 2003; Pahl-Wostl, 2006). This understanding is then commonly institutionalised (sensu North, 1990) as, for example, in the New South Wales (NSW) government’s Catchment Management Authorities Act 2003 (State of New South Wales, 2006).

Institutions, and the process of institutionalising, are possibly the most significant factors characterising contemporary understandings of water catchments. We use the term institution to describe an ‘established law, custom, usage, practice, organisation, or other element in the political or social life of a people’; ‘a regulative principle or convention subservient to the needs of an organised community’ (The Oxford English Dictionary). Institutions can be policies and objectives, laws, rules, regulations, organisations, policy mechanisms; norms, traditions, practices and customs. They influence how we think and what we do (North, 1990, 2005; SLIM, 2004a). Institutionalising is an active process the outcomes of which are the stabilisation or reification of an institution. An example is the creation of a ‘river basin district’ as required by the WFD or the reification of particular definitions of a catchment in legislation, as described above.

Another view, which will be elaborated upon in the next section, is that water and its physical and social characteristics creates interdependencies that must be taken into account by humans who then conceptualise particular ways of understanding water—it is through this process that some societies or professional groups come to speak of ‘catchments’ or ‘watersheds’ or ‘wetlands’. Each of these terms has different meanings in particular social and professional settings and each seeks to bound the dynamics of water in a particular way, i.e. different groups make different boundary judgments (Ulrich, 2002) on what constitutes their ‘catchment system’. This shift entails an evolution in understanding of catchments from biophysical to socially constructed entities and has implications for policy makers, water managers and researchers. In claiming that there are advantages to understanding catchments as if they were socially constructed, we are drawing on a well established intellectual tradition (Berger and Luckman, 1967) and, in particular, understandings which concern the biological basis of social constructivism (e.g. Maturana and Varela, 1992; Maturana and Poerksen, 2004). These understandings have wider ramifications than simply understanding changes in catchments as being human, and thus socially, induced e.g. through land use practices.

3.4. The contours of societal responses to resource dilemmas

Awareness, definition and understanding of the resource dilemma slowly emerged in the last quarter of the last century. What asked for special attention was: how do we deal with it? It was obviously amenable to regulation only to a limited extent. The market seems to largely fail in resolving resource dilemmas as exemplified by market failure in the face of climate change (Stern, 2006). In fact, resource dilemmas arise when the externalities of rational choices of one set of actors spoils their use by another set. At the time the SLIM proposal was conceived, ideas about possible ways of dealing with resource dilemmas had begun to emerge. They all focused on the facilitation of the process by which people with multiple interests come to engage in concerted action with respect to the sustainable management of natural resources.

The ‘tragedy of the commons’ (Hardin, 1968) was a resource dilemma with a vengeance. Rational economic behaviour was shown to inescapably cause the destruction of a common pool resource such as an open access grazing land. The aftermath of this article saw a frantic search for explanations, not in the least for common pool resources that had been sustainably managed. The research of Ostrom (1992) and her colleagues (e.g. Dietz et al., 2003) showed that institutions limiting membership of the group using the common pool resource, regulating access and off-take, as well as interaction, surveillance and sanctions, were essential for sustainable management of the resource. Facilitation of the interaction of, and negotiation among, multiple stakeholders in a resource became an important challenge. In research in Wageningen, the formulation of the notion of a ‘platform for decision making about ecosystems’, a networking site for organisations concerned with a resource dilemma, such as a board or a committee, emphasised the importance of the ‘soft side of land use’ for sustainable natural resource management (Röling, 1994); other work with pastoralists in semi-arid Australia adopted a systemic and social constructivist perspective (CARR, 1993).

An important factor for the formulation of the SLIM proposal was exposure to two experiences that reflected a point of departure in natural resource management. The first was the farmer field school (FFS) for Integrated Pest Management in rice (e.g. Pontius et al., 2002; van de Fliert, 1993). Instead of transfer of technology by extension workers talking to farmers, the FFS emphasised discovery learning by groups of farmers, group decision making on the basis of it, and facilitation of the whole process by skilled trainers who remained in the background. A visit to a field school makes an unforgettable impression because of the enthusiasm and empowerment of the farmers participating in it.

The second major experience was exposure to Landcare in Australia. For example, during one visit to Western Australia, people involved in writing the SLIM proposal witnessed the approach of a facilitator, who had been trained at Hawkesbury College for exactly this kind of work. She was engaged with a group of farmers in a catchment seriously threatened by erosion and salination. After agreeing on the resource categories they would use (e.g. a soil typology), these farmers were asked to each make a resource map of their properties.
Afterwards these maps were digitalised and a mosaic map of the entire catchment was put together from the individual maps. Of course, many mistakes had been made. Soil types changed at property boundaries, and so forth. But in the end, all farmers agreed on the map and also agreed on the vulnerable soils in the catchment. These spanned several properties. In turn this required a collective management plan. The fences of paddocks, which had so far all been entirely designed for optimal land use within the property, now were redesigned for sustainable land use across properties. The map making had helped change individual perspectives, i.e. new understandings, to a shared perspective that allowed, through new practices, concerted action.

The concrete experiences with farmer field schools in Indonesia and Landcare in Australia underpinned the notion of social learning, as concerted action, as the core concept for SLIM. The empirical evidence also demonstrated that alternative approaches to the dominant ‘transfer of technology’ approach could work.

4. Coordination mechanisms: towards research questions and research practice

4.1. The new context demands new forms of coordination

Because water catchments have been conventionally understood as biophysical, ‘hard’ systems, practices, including policy prescriptions and governance mechanisms, which reflect these understandings have been enacted. These practices would not be the same, we argue, if catchments were understood as resource dilemmas, i.e. situations of complexity, uncertainty, interdependence, multiple perspectives and controversy (SLIM, 2004b). In the traditional paradigm, problems are addressed through instrumental interventions, typically through engineering works or the measurement of biophysical or ecological indicators in isolation from their social context. To the extent that the sustainable management or regeneration of water catchments requires changes of behaviour of stakeholders in the catchment, use is made of strategic reasoning. Intervention typically is attempted through imposed ’hierarchical policies’, a term coined by political scientists (e.g. Powell, 1994), or through self-regulation of the market. Both attempt to impose control on human behaviour. The former comprise regulatory measures, usually of practices as well as providing information or education (Fig. 1). Consider, for example, the following quote from the EU environment commissioner of the time: ‘The 6th Environment Action Programme [of the EU] promotes environmental development using all instruments available: legislation and penalties, grants for improvements and innovations, research and information.’ (Wallström, 2003).

4.2. Coordination mechanisms

Understanding resource dilemmas as anthropogenic in nature gives rise to a need to better understand the coordination and governance of human affairs. Instrumental approaches using supply-driven technological change and market liberalisation policies based on the assumption of rational choice, and of beneficial societal outcomes of market-propelled development, are increasingly questioned, not in the least within the economics discipline itself (e.g. Stern, 2006). Table 1 provides a summary of the characteristics of these policy mechanisms, identified in various social science discourses, including that of a ‘third way’ of coordinating activity described by Powell.

<table>
<thead>
<tr>
<th>Discourses</th>
<th>Use instruments of power</th>
<th>Assume rational choice</th>
<th>Rely on emergence from interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forms of rationality (Habermas, 1984)</td>
<td>Instrumental</td>
<td>Strategic</td>
<td>Communicative</td>
</tr>
<tr>
<td>Basis for individual behaviour change (Kelman, 1969)</td>
<td>Compliance</td>
<td>Identification</td>
<td>Internalisation</td>
</tr>
<tr>
<td>Preferred ways of arranging human affairs (Hood, 1998)*</td>
<td>Hierarchy</td>
<td>Individualism</td>
<td>Egalitarianism</td>
</tr>
<tr>
<td>Coordination mechanisms (Powell, 1994)</td>
<td>Hierarchy</td>
<td>Market</td>
<td>Network</td>
</tr>
<tr>
<td>Causes of ‘wealth of nations’ (Bowles and Gintis, 2002)</td>
<td>Resources (such as power or natural resources), state power</td>
<td>Invisible hand of market forces</td>
<td>Social capital, trust, community</td>
</tr>
<tr>
<td>Innovation model</td>
<td>End of pipe outcome of technology transfer and diffusion</td>
<td>Induced by changes in relative factor prices; market-propelled outcome of farmers on the treadmill (Cochrane, 1958)</td>
<td>Emergent property of multi-stakeholder interaction (e.g. social learning; innovation systems; Hall et al., 2006)</td>
</tr>
</tbody>
</table>

* Mary Douglas (e.g. 1986), on whose work Hood (1998) is based discerns a fourth dimension, fatalism, where the sense of belonging to a group is weak, but the domination by rules is strong.
Table 2 – Processes distinguishing coordination mechanisms (adapted from Röling, 2002)

<table>
<thead>
<tr>
<th>Properties</th>
<th>Hierarchy</th>
<th>Market</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamics</td>
<td>Causation</td>
<td>Rational choice, invisible hand</td>
<td>Exchange of meaning, sense making, interdependence</td>
</tr>
<tr>
<td>Mechanism behind effect</td>
<td>Power, legitimation, technology</td>
<td>Utility functions; satisfying preferences</td>
<td>Learning processes communication, cooperation, negotiated agreement, reciprocity</td>
</tr>
<tr>
<td>Origin of welfare</td>
<td>Access to resources, power, technology</td>
<td>Autonomous market forces</td>
<td>Social capital, trust, community, concerted action</td>
</tr>
<tr>
<td>Purpose</td>
<td>Control</td>
<td>Win, gain advantage</td>
<td>Equity, resolve resource dilemmas</td>
</tr>
<tr>
<td>Intervention mechanisms</td>
<td>Regulation, coercion, engineering</td>
<td>Laissez faire, fiscal policy, deregulation</td>
<td>Process facilitation</td>
</tr>
<tr>
<td>Criteria for success</td>
<td>Realisation of formal goals</td>
<td>Satisfaction of individual needs</td>
<td>Common meanings, concerted action, institutional change</td>
</tr>
<tr>
<td>Conditions for failure</td>
<td>Lack of information, no legitimation</td>
<td>Market failure</td>
<td>Inequality in power relations</td>
</tr>
</tbody>
</table>

1. How does the resource dilemma manifest itself in the concrete water catchment studied? Sub-questions are:
   a. What is the nature of the competing claims and interdependence that emerged? What are the boundaries that have been created around the resource dilemma? What stakeholders are involved?
   b. What evidence is there of the need for an alternative policy approach?
2. What new governance mechanisms have emerged? Sub-questions focus on forms of stakeholder participation, and the nature of the interaction among them, including the creation of platforms, conflict resolution, negotiation, learning, and deciding on concerted action.
   a. What circumstances exemplify when ‘social learning’ is needed and likely to be advantageous?
   b. What new governance mechanisms have emerged? Sub-questions focus on forms of stakeholder participation, and the nature of the interaction among them, including the creation of platforms, conflict resolution, negotiation, learning, and deciding on concerted action.
3. What process facilitation, if any, took place? Sub-questions focused on the nature of the facilitators, facilitation and learning, the approaches they used, and the nature of the monitoring and evaluation involved.
   a. What were enabling or constraining institutional frameworks and policy contexts?
   b. How can the insights gained be translated into policy briefs and training curricula?
4. What were enabling or constraining institutional frameworks and policy contexts?
5. How can we develop a way of researching social learning which is congruent with espoused theory?

An implication for SLIM in researching these questions was that the practice of research must of necessity become a form of social learning. SLIM had to be interactive. SLIM researchers had to become stakeholders in the very processes they were researching and social learning had to become an operational concept used by all stakeholders in the process. This fundamental point of departure became operationalised in the approach that was elaborated among the SLIM partners. A special methodology team was set up to develop and share
Table 3 – Comparison between transfer of technology and farmer field school based on a number of dimensions (following Röling and van de Fliert, 1994), later adapted as SLIM variables in the SLIM research proposal (Ison et al., 2000)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Transfer of technology</th>
<th>Farmer field school</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actors (later stakeholders)</td>
<td>Ultimate users of science-based component technologies</td>
<td>Small-scale farmers who are experts</td>
</tr>
<tr>
<td>Desirable practices</td>
<td>Use of productivity enhancing innovations</td>
<td>Sustainable management of the agro-ecosystem on the basis of regular observation and understanding</td>
</tr>
<tr>
<td>Learning process involved</td>
<td>Adoption and diffusion of innovations</td>
<td>Discovery learning based on observation and experimentation by farmers, and group discussion and decision making</td>
</tr>
<tr>
<td>'Extension approach'/</td>
<td>Delivery or transfer of technology through demonstrations, presentation, pamphlets</td>
<td>Facilitation of learning process by farmers</td>
</tr>
<tr>
<td>facilitation required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional framework conditions</td>
<td>Linear and supply-driven configuration of research, delivery and utilisation</td>
<td>Decentralised network of expert and highly skilled facilitators and farmer trainers</td>
</tr>
<tr>
<td>Policies</td>
<td>Price policies, subsidies, and investments that stimulate the innovation treadmill, market liberalisation to stimulate agri-business development</td>
<td>Removal of subsidies on pesticides, banning of class I and broad spectrum pesticides, certification, development of Integrated Pest Management methods</td>
</tr>
<tr>
<td>Ecological imperatives</td>
<td>Focus on food, externalisation of environmental costs to the environment</td>
<td>Focus on maintaining a broad range of ecological services, such as control of pests through natural enemies</td>
</tr>
</tbody>
</table>

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this approach and to develop use of appropriate research tools and techniques within the SLIM community.

Coordination of our own research actions in this relatively complex research design was achieved by a set of empirically grounded ‘research variables’.

4.4. **The SLIM variables**

The SLIM project proposal was designed on a simple logic, viz.: (a) Designated Stakeholders engage in (b) Desirable Practices, which require (c) Learning based on (d) Facilitation made possible by (d) Institutional Support embedded in a (e) Conducive Policy Context. Table 3 provides a comparison of technology transfer and farmer field schools on (a) through (e). The table shows that (a) through (e) provide a simple ‘coat hanger’ to examine specific approaches to the coordination of human affairs based on empirical evidence; in this case technology transfer and farmer field schools. All relevant aspects of a coordination mechanism seemed to be covered by (a) through (e), and the assumption of their internal consistency allows one to ‘see’ where the application is incoherent and weak. The set of aspects (a) through (e) became the original ‘SLIM variables’.

This structure was useful in that it provided entry points for the research and suggested a search for systemic coherence in complex situations. The comparative case studies (see Fig. 1 in the opening editorial) sought to follow this logic in terms of (i) case study choice and (ii) research approach, but did not follow ex ante blueprints. This original heuristic informed our research design and evolved based on additional theoretical and research findings, e.g. the addition of an ‘ecological constraints’ variable (Table 3) and a ‘history of the situation’ variable, not depicted in Table 3 (Steyaert and Jiggins, 2007).

The original heuristic was also used as a focus for the outputs from the interactive workshops (work packages) which were central to SLIM’s design. State-of-the-art thematic papers were developed by cross-country authoring groups on (i) desirable practices and ecological constraints to the sustainable use of water; (ii) stakeholders and stakeholding; (iii) conducive institutions; (iv) facilitation; (v) conducive policies; (vi) learning processes. These in turn have been transformed into a full set of policy briefings (PBs), with an additional PB describing capacity building needs for social learning, for use by policy makers and water managers (see http://slim.open.ac.uk).

SLIM case studies were also chosen on the basis of an appreciation of the notion of research and researcher-in-context. This means that historical factors as well as relational factors were often key considerations. For example, case studies in France and Italy grew out of extant relationships associated with the historical location of the research organisations and researchers (Steyaert et al., 2007; Toderi et al., 2007). In the UK and the Netherlands, case studies were mainly originated de novo. In all, 15 case studies were completed and have been written up in 12 case study monographs (CSMs, see http://slim.open.ac.uk).

In this introduction to the special issue it is not our purpose to describe all of our findings but to focus on how the initial starting conditions gave rise to a research design for social learning. The remaining papers in this issue describe how that design was realised in country-specific settings (papers 3–6 of this issue) and in the project as a whole; the main outcomes for SLIM are described in Steyaert and Jiggins (2007) and in Ison et al. (2004).

5. **Some challenges to society and the practice of science in natural resource management**

The problems of sustainable water management apply broadly to most natural resource management situations.
Campbell (1992), working in the Australian Landcare programme, the Forest Ecosystem Management Team working on the crisis in the management of the vast publicly owned forests in the USA (FEMAT, 1993), and Backhaus (1991) working on planning land use in Thailand all came to the same conclusion: it is basically a socio-economic task not a scientific or technical one. It can be claimed that this realisation is part of a broader social re-contextualisation of science.

In retrospect SLIM can be seen as part of a broader set of actions within the research community with similar experiences and motivations to our own, but which are not yet ‘mainstream’. This historical move presents particular challenges to the doing of science, its role in society, and the expectations we can, or might, have of citizens (e.g. Wilsden et al., 2005). One of the emergent outcomes of our research was the realisation that despite a rigorous design and many common experiences among the research team, when it came to implementation we had to pay particular attention to our different traditions of understanding and how these related to research praxis, understood as theory informed action. This realisation holds particular challenges for ‘research practice’ and associated epistemological awareness.

Another major factor with the potential to constrain use of a ‘social learning approach’, which our research highlights, is the limited human resource capacity for enacting social learning approaches. We now consider these two challenges.

5.2. Educational implications for capacity building

The question of education, for enacting social learning in natural resource management situations, raises the issue of education of whom for what tasks? Several broad, overlapping groups can be distinguished: (i) society at large; (ii) primary stakeholders such as land managers, e.g. foresters and farmers but also communities of interest as represented for example by environmental and recreational NGOs; (iii) researchers and scientists, especially science-trained staff in government agencies; and (iv) “practitioners”, the growing number of people such as project officers managing water, forests or other natural resources at the “ecosystem level”.

Because dialogical processes are at the core of social learning, arising through joint action, then constraints to effective dialogue need to be taken into account when identifying educational needs. Based on the SLIM experience, constraints extend across differences in worldviews between and within groups, confusion over the functions of science and technology, and deficiencies in key skills within certain groups (SLIM, 2004c).

Differences in worldviews extend into ‘models of the systems’ being managed, and more fundamentally, into philosophies of relationship with the natural world (Sterling, 2001). Environmental managers with a science background for example see water functioning basically in the classical hydrological cycle, but many of the public operate on the basis of simple linear models, especially in the growing urban populations with little direct contact with natural processes. This gap extends into subjects such as systems of land tenure. Pressures on ecosystems bring new, emergent land uses for water catchments, landscape, and wildlife conservation to the fore replacing mono-functional land use so that multiple land use, or multi-functionality, becomes the basic paradigm. Since emergent land uses often reflect public goods in land and other natural resources, and hence public rights in these, concepts like outright private ownership in land are challenged. Cultures with a strong sense of public or common goods in land adjust more easily to this emergent situation than those with a stronger emphasis on absolute rights in land ownership.

Within many societies divergences in basic values and relationships with regard to the natural world are often expressed as conflicts within the dialogue. Pina and Covington (1993) for example, compared the values of scientists, “restoration ecologists” and Navajo Indian traditionalists in their approach to sustainable ecosystems. They concluded that many of the values of “restoration ecologists” were closer to the Navajos’ than to their western scientist colleagues. Differences in public reaction to major flood incidents often reflect, on the one hand, a view that natural forces are entirely manageable by human society and hence flooding stems from a failure of governance, and on the other that natural forces
are only partially manageable, have their own dynamics that may or may not serve societal interests, and must partially at least be lived with.

In the context of these dynamics there is a need for practitioner skills. Modern trends in rural and agricultural development have been driven forward on the basis of three skill sets: soft systems thinking, rapid appraisal, and participative approaches supported by techniques such as semi-structured interviewing. All are carried on the back of skills of facilitation based on effective process management (Wals et al., 2004). SLIM’s experience was that these skills were highly variable and could not be assumed which led to our recommendation that they should be significant strands in training in environmental management. Wildemeersch (1999) researching the reflectivity of environmental groups in the Netherlands found that most groups focus on the product or content of their activities and pay little attention to the process. Such skills are acquired through practice, with guidance from an experienced facilitator and are rarely among the outcomes of environmental management courses of institutes of higher education.

What are the implications of the above situation for the broad groups identified? The differences in models, values, philosophies of relationships to the natural world, and lack of clarity on acceptable risk define a broad societal need that few governments or agencies address. Weaknesses in environmental management education may well reflect the gulf between the social and “hard” sciences described by Newby in his presidential address to the British Sociological Society some 15 years ago (Newby, 1991). The confusion between environmental science and environmental management is more recent. The rules of evidence and of decision making in each are different and the functions of science have changed. But there is still a need for more negotiation (e.g. regarding roles) among hard-science trained staff and others, that recognizes the need for process management skills in environmental management. For other practitioners, including researchers, the lack of an apprenticeship scheme for training in process management and techniques is a major constraint to more interventionist approaches such as those practised in the SLIM project. Subsequent papers touch on issues of capacity building but it is an area requiring more attention.

6. Concluding comment

Jasanoff (1999), giving an account of how risk is socially constructed, the product of deeply held cultural values and beliefs, reflects our own arguments in relation to water catchments. Built on her analysis is the claim that ‘environmental regulation calls for a more open-ended process, with multiple access points for dissenting views and unorthodox perspectives’ (p. 150). Fig. 1 can be interpreted as a response to this claim that also involves widening how ‘regulation’ is understood, i.e. as the deployment of complementary coordination mechanisms as well as epistemological awareness or humility. Historically water catchments and their sustainable management have not been treated as resource dilemmas characterised by connectedness, complexity, uncertainty, conflict, multiple stakeholders and thus, multiple perspectives. Nor have catchments been regarded as if they are socially constructed. In addition, the main coordination mechanisms have been hierarchical and market-based (Fig. 1). Command and control are at the core of hierarchical mechanisms; they have been found wanting in different ways for dealing with resource dilemmas, not least being that they are expensive to administer and enforce. Market-based mechanisms are of course subject to market failure.

We do not claim to be the only ones seeking new ways of researching complex social and biophysical phenomena, nor do we claim to be the only research group motivated to research social learning. What we now have however is a history of collaboration based on concerns about:

1. How to develop concerted action to address the collective impact of humans as a major force of nature.
2. Understanding and responding to the resource dilemma as a specific challenge for dealing with anthropogenic phenomena.
3. Developing new coordination mechanisms that focus on voluntary concerted and distributed action based on a common process of knowing that we have called social learning (ison, in press).
4. Developing new approaches, including capacities, for process facilitation, new forms of institutional support and new types of conducive policies.
5. Paying more attention to supporting existing social practices that have widespread legitimacy, rather than to developing expensive solutions to replace them (e.g. Collins et al., 2007).

We submit that social learning, in concert with other coordination mechanisms, has application in research and practice in natural resource management in general and more broadly in response to the current global environmental crisis, but it needs to be better understood and institutionalised. Purposeful use of social learning, with associated investment, has major implications for roles, skills and research practice that will generate important educational and training needs at a general societal as well as at a formal educational level.

REFERENCES


Hubert, B., 2002. La pratique de recherche en écologie dans une réserve naturelle: les relations entre connaissance disciplinaire et connaissance pour l'action. Questions de B. Hubert à L. Marion. Natures, Sciences et Sociétés 10 (2), 70–75.


Steins, N.A., 1999. All Hands on Deck. An Interactive Perspective on Complex Common-Pool Resource Management Based on Case Studies in Coastal Waters of the Isle of Wight (UK), Connemara (Ireland) and the Dutch Wadden Sea. Wageningen University, Published Doctoral Dissertation. Wageningen, NL.


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