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1 Title Page

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

4

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17

18 *Abstract:*

19

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

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43 *Keywords:* social learning, water catchments, interactive social science; praxis;  
44 governance mechanisms.

## 45 1. Introduction

46 This first paper in the special issue examines how the SLIM project<sup>1</sup> emerged  
47 as a major European research project investigating social learning for the integrated  
48 management and sustainable use of water at catchment scale. SLIM's original  
49 research questions and conceptual framing arose from particular experiences  
50 associated with the formulation of a new perspective on resource dilemmas. As such,  
51 the paper is a study of the history of ideas that constitute the initial starting conditions  
52 for SLIM and that seem important for contextualising the papers that contribute to this  
53 volume.

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

## 69 2. The SLIM project starting conditions

70

71 SLIM was one of a series of European Union (EU)-funded investigations  
72 concerned with the socio-economic aspects of the sustainable use of water (see  
73 <http://cordis.europa.eu/fp5/src/ec-en7.htm>; <http://www.harmonicop.info/links.html>).

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<sup>1</sup> 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 5th Framework Programme for research and technological development, 1998–2002; SLIM ran for 42 months from 2001 to 2004.

74 SLIM's focus was on understanding the application of social learning as (i) a  
75 conceptual framework, (ii) an operational principle, (iii) a policy instrument, and (iv)  
76 a process of systemic change. By elucidating each of these we wished to provide  
77 evidence as to whether a new, complementary approach to water governance was  
78 desirable and feasible.

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

96 SLIM emerged in, and was implemented by, a group of researchers whose  
97 basic understanding of social change was influenced by work in agricultural research,  
98 rural development and extension education (Chambers and Jiggins 1987; Röling  
99 1988; Russell et al. 1989; Watson 1992; 1996; Russell and Ison 1993; Ison and  
100 Russell 2000; Bawden 1994; Röling et al. 1994; Röling and Wagemakers 1998;  
101 Röling and Jiggins 1998; Gibbon and Jakobson 1999; Roggero et al. 1996; Powell  
102 1996; Steyaert 2002; Hubert 2002; Leeuwis and Pyburn 2002). A majority had  
103 collaborated around common concerns in the LEARNING caucus of the European  
104 meetings of the International Farming Systems Association (IFSA) (LEARN Group  
105 2000). As researchers we had become aware of, and begun to contribute to, an  
106 emerging third approach to extend and complement the main governance mechanisms  
107 of (i) hierarchy, comprising regulatory and information providing practices, including

108 education and (ii) market (Powell 1994). This third approach has emerged in recent  
109 years in response to the frequent failure of instrumental and strategic reasoning based  
110 on the prevailing technical rationality on which water policies and practices are  
111 mainly built (Barraqué 2003; Pahl Wostl 2007). This ‘social learning’ (SL) approach  
112 is based on the idea that sustainable and regenerated water catchments are the  
113 emergent property of social processes and not the technical property of an ecosystem  
114 (Morris et al. 2007; Steyaert and Jiggins 2007). That is, desirable water catchment  
115 properties arise out of interaction (engaging in issue formulation and monitoring,  
116 negotiation, conflict resolution, learning, agreement, creating and maintaining public  
117 goods, concertation of action) among multiple, inter-dependent, stakeholders in the  
118 water catchment. We describe this overall set of interactions when it occurs in a  
119 complex natural resource arena as social learning.

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

125 Our starting position was that where such an interactive approach applies,  
126 centralised and objectified policy does not become irrelevant but can be encompassed  
127 within a broader understanding of how knowledge, and thus issues, are constructed  
128 and employed in policy processes. A ‘social learning approach’, we argued, provides  
129 a context for a dynamic local decentralised process, and, in the case of large  
130 watersheds, for concerted parallel local processes. ‘Social learning’ also rests on a  
131 different set of epistemological assumptions – that knowing occurs with the act, the  
132 process, of constructing an issue and seeking improvements (Blackmore 2007;  
133 Steyaert and Jiggins 2007). In contrast, the traditional policy instruments are built on  
134 an epistemological foundation of fixed forms of knowledge (i.e. reified  
135 understandings of the nature of the ‘problem’) as depicted in Figure 1. These two  
136 different foundations do not preclude their complementary use but such use requires  
137 awareness of the differences and of the implications for practice, whether in policy  
138 development, research or water management.

139 (Insert Figure 1 here)

140 At the time SLIM began there was growing interest in developing alternative  
141 approaches to water and catchment management. In North America Sabatier et al.

142 (2005) describe how in the past twenty years ‘the traditional approach has come under  
143 increasing criticism [in part reflecting] the increasing complexity and conflict in water  
144 resource issues.’ (p. 3). They point out that historically ‘decision-making has been  
145 quite technocratic, with public involvement usually relegated to public hearings and  
146 comment periods that fine-tune agency proposals. The scope of decision making has  
147 generally consisted of specific types of pollution sources or specific areas within a  
148 watershed (such as the coastal wetlands) rather than the watershed as a whole.’  
149 Similar initiatives were occurring in a range of developing country settings (e.g.,  
150 Carter 1998; Poats 2006; Chorlavi Group 2006).

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

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

172         For the purposes of this paper, and indeed the special issue, we emphasise that  
173 as our research ‘system’ (i.e. project) was non-deterministic, or non-linear, then its  
174 progress was sensitive to initial starting conditions and to the different traditions of  
175 understanding of those researchers who joined the project. For example, in order to

176 drive the internal process of learning within the SLIM team, a mid-term review of  
 177 country theory papers was organised and on two occasions process observers joined  
 178 team workshops (see Steyaert and Jiggins, 2007, this volume). This helped the project  
 179 to align its espoused theory with its theory in practice and hold team members  
 180 accountable to processes of adaptive management through shared learning. In this  
 181 process hard choices had to be made as to what recommendations to take on board  
 182 (e.g. following the mid-term review we paid more attention to the dynamics of power  
 183 in terms of social asymmetries, but were unable to meaningfully engage with gender  
 184 as an issue despite its known significance. Ison et al. (2004) discuss the management  
 185 of this process.

### 186 **3. The resource dilemma as a new context**

#### 187 3.1 Entering the age of the environment

188

189 The SLIM proposal was motivated by Jane Lubchenco when, in her maiden  
 190 speech as President of the American Society for the Advancement of Science<sup>2</sup>, she  
 191 claimed that ‘humans have become a major force of nature’ and backed this up with a  
 192 long list of the ways in which humans were transforming the face of the earth  
 193 (Lubchenco 1998). As an active member of the Resilience Alliance that includes  
 194 ecologists and ecological economists (e.g., Ostrom 1992) her concern was to  
 195 contribute to enhancing societies’ ability to retain their integrity in the face of shocks  
 196 and surprises. The conceptual concerns of the Resilience Alliance, particularly  
 197 ecological, economic, cultural and political principles of institutions for the  
 198 environment (Hanna et al. 1996), influenced the design of the SLIM proposal.

199 The Resilience Alliance was a response to the widely shared realisation that  
 200 the cyclical dynamics of ecosystems was incompatible with the linear growth pursued  
 201 by economic policies, a fact that would invariably lead to weakened ecosystems and  
 202 vulnerable societies, as Holling and his collaborators (Gunderson et al. 1995) phrased  
 203 it. Holling’s lemniscates model of the cyclic nature of ecosystems, later applied to  
 204 human organisations by Hurst (1995; see also Jiggins et al. 2007 and Toderi et al.  
 205 2007, this volume), was the basis for ‘adaptive management’, i.e. learning,  
 206 experimentation and careful probing, as a realistic approach to capturing human  
 207 opportunity. The Gunderson et al. (1995) volume explicitly mentions social learning,

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<sup>2</sup> Later she acted as an important contributor to the Millennium Ecosystem Assessment (UN 2006).

208 not in Bandura's (1977) sense of imitation, but in the sense of learning by a collective  
209 to engage in more appropriate concerted action (Parsons and Clark 1995).

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

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

236 SLIM was thus conceived from the realisation that we had entered a new age  
237 of the environment and that 'social science' had a contribution to make, although not  
238 in its traditional form. This realisation that a new, interactive form of social science  
239 was required had grown out of deliberations of the LEARN group (Hubert et al.  
240 2000). It is a position advocated by Law and Urry (2004) when they claim that social  
241 science methods enact nineteenth century realities and that researchers doing social

242 science now need to recognise that they create new realities. This position is more  
243 attuned to the recognition that human fate is no longer only a question of controlling  
244 nature, but especially also one of learning how to deal with ourselves. Within our  
245 milieu, this realisation was perhaps best formulated by Bawden and Packham (1993)  
246 of Hawkesbury College (now University of Western Sydney), with whom several  
247 prospective SLIM researchers actively collaborated at the time; they advanced the  
248 claim that sustainability is the emergent property of a soft system. In making this  
249 claim they drew on the work of Peter Checkland (1981; 1999 and with Scholes 1999),  
250 the ICI manager and chemical engineer who learned the hard way that human  
251 societies cannot be managed as 'hard systems' in which the goals can be assumed as  
252 given. Said Checkland: 'It is the goals that are the bone of contention'. His theoretical  
253 work on soft systems and the development of soft systems methodology, that itself  
254 relied heavily on the work of Geoffrey Vickers (Checkland and Casar 1986), has been  
255 influential in SLIM, not in the least because of the participation of members of the  
256 Open University's Systems Department. The group of people who later came together  
257 in SLIM actively participated in the international debate. Examples are Röling and  
258 Jiggins (2001) on adaptive management, Woodhill and Röling (1998) on social  
259 learning, and Russell and Ison (1993) on contextualised science.

### 260 3.2 The attributes of resource dilemmas

261 The age of the environment refers to the realisation that the context of human  
262 society has changed in quite specific ways. We call this context a resource dilemma.  
263 SLIM is predicated on an effort to elucidate this dilemma quite specifically as a  
264 prelude to proposing and testing human responses for dealing with it. We have done  
265 this not for the global level, but for the level of resource bundles, such as water  
266 catchments, lake fisheries, and other common pool resources. We define these as  
267 'resources (i) for which joint use involves subtractability; that is: use by one user will  
268 subtract benefits from another user's enjoyment of the resource system, and (ii) for  
269 which exclusion of individuals or groups involves high transaction costs' (Steins  
270 1999:3). Most natural resources have become common pool resources. A typical  
271 example is the dialogue started up by FAO (Food and Agriculture Organisation of the  
272 United Nations), WWF (World Wide Fund for Nature), IWMI (International Water  
273 Management Institute) and some other partners upon discovery that their long-term  
274 sectoral plans for water use for respectively agriculture, nature conservation and urban

275 household and industry needs all counted on using the same limited amount of  
276 freshwater that can be expected to be available for such purposes worldwide  
277 (<http://www.iwmi.cgiar.org/dialogue/>; Röling and Woodhill 2001).

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

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

292

### 293 3.3 The catchment as a resource dilemma

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

305 Institutions, and the process of institutionalising, are possibly the most  
306 significant factors characterising contemporary understandings of water catchments.  
307 We use the term institution to describe an ‘established law, custom, usage, practice,  
308 organization, or other element in the political or social life of a people’; ‘a regulative

309 principle or convention subservient to the needs of an organised community’ (The  
 310 Oxford English Dictionary). Institutions can be policies and objectives, laws, rules,  
 311 regulations, organisations, policy mechanisms; norms, traditions, practices and  
 312 customs. They influence how we think and what we do (North 1990; 2005; SLIM  
 313 2004a). Institutionalising is an active process the outcomes of which are the  
 314 stabilization or reification of an institution. An example is the creation of a ‘river  
 315 basin district’ as required by the WFD or the reification of particular definitions of a  
 316 catchment in legislation, as described above.

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

### 334 3.4 The contours of societal responses to resource dilemmas

335 Awareness, definition and understanding of the resource dilemma slowly  
 336 emerged in the last quarter of the last century. What asked for special attention was:  
 337 how do we deal with it? It was obviously amenable to regulation only to a limited  
 338 extent. The market seems to largely fail in resolving resource dilemmas as  
 339 exemplified by market failure in the face of climate change (Stern 2006). In fact,  
 340 resource dilemmas arise when the externalities of rational choices of one set of actors  
 341 spoils their use by another set. At the time the SLIM proposal was conceived, ideas

342 about possible ways of dealing with resource dilemmas had begun to emerge. They all  
343 focused on the facilitation of the process by which people with multiple interests  
344 come to engage in concerted action with respect to the sustainable management of  
345 natural resources.

346 The 'tragedy of the commons' (Hardin, 1968) was a resource dilemma with a  
347 vengeance. Rational economic behaviour was shown to inescapably cause the  
348 destruction of a common pool resource such as an open access grazing land. The  
349 aftermath of this article saw a frantic search for explanations, not in the least for  
350 common pool resources that had been sustainably managed. The research of Ostrom  
351 (1992) and her colleagues (e.g., Dietz et al. 2003) showed that institutions limiting  
352 membership of the group using the common pool resource, regulating access and off-  
353 take, as well as interaction, surveillance and sanctions, were essential for sustainable  
354 management of the resource. Facilitation of the interaction of, and negotiation among,  
355 multiple stakeholders in a resource became an important challenge. In research in  
356 Wageningen, the formulation of the notion of a 'platform for decision making about  
357 ecosystems', a networking site for organisations concerned with a resource dilemma,  
358 such as a board or a committee, emphasised the importance of the 'soft side of land  
359 use' for sustainable natural resource management (Röling, 1994); other work with  
360 pastoralists in semi-arid Australia adopted a systemic and social constructivist  
361 perspective (CARR 1993).

362 An important factor for the formulation of the SLIM proposal was exposure to  
363 two experiences that reflected a point of departure in natural resource management.  
364 The first was the Farmer Field School (FFS) for Integrated Pest Management in rice  
365 (e.g., Pontius et al. 2000; van de Fliert 1993). Instead of transfer of technology by  
366 extension workers talking to farmers, the FFS emphasised discovery learning by  
367 groups of farmers, group decision making on the basis of it, and facilitation of the  
368 whole process by skilled trainers who remained in the background. A visit to a Field  
369 School makes an unforgettable impression because of the enthusiasm and  
370 empowerment of the farmers participating in it.

371 The second major experience was exposure to Landcare in Australia. For  
372 example, during one visit to Western Australia, people involved in writing the SLIM  
373 proposal witnessed the approach of a facilitator, who had been trained at Hawkesbury  
374 College for exactly this kind of work. She was engaged with a group of farmers in a  
375 catchment seriously threatened by erosion and salination. After agreeing on the

376 resource categories they would use (e.g., a soil typology), these farmers were asked to  
 377 each make a resource map of their properties. Afterwards these maps were digitalised  
 378 and a mosaic map of the entire catchment was put together from the individual maps.  
 379 Of course, many mistakes had been made. Soil types changed at property boundaries,  
 380 and so forth. But in the end, all farmers agreed on the map and also agreed on the  
 381 vulnerable soils in the catchment. These spanned several properties. In turn this  
 382 required a collective management plan. The fences of paddocks, which had so far all  
 383 been entirely designed for optimal land use within the property, now were redesigned  
 384 for sustainable land use across properties. The map making had helped change  
 385 individual perspectives, i.e., new understandings, to a shared perspective that allowed,  
 386 through new practices, concerted action.

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

## 391 **4 Coordination mechanisms: towards research questions and** 392 **research practice**

### 393 4.1 The new context demands new forms of coordination

394         Because water catchments have been conventionally understood as  
 395 biophysical, ‘hard’ systems, practices, including policy prescriptions and governance  
 396 mechanisms, which reflect these understandings have been enacted. These practices  
 397 would not be the same, we argue, if catchments were understood as resource  
 398 dilemmas, i.e. situations of complexity, uncertainty, interdependence, multiple  
 399 perspectives and controversy (SLIM 2004b). In the traditional paradigm, problems are  
 400 addressed through instrumental interventions, typically through engineering works or  
 401 the measurement of biophysical or ecological indicators in isolation from their social  
 402 context. To the extent that the sustainable management or regeneration of water  
 403 catchments requires changes of behaviour of stakeholders in the catchment, use is  
 404 made of strategic reasoning. Intervention typically is attempted through imposed  
 405 ‘hierarchical policies’, a term coined by political scientists (e.g., Powell 1994), or  
 406 through self regulation of the market. Both attempt to impose control on human  
 407 behaviour. The former comprise regulatory measures, usually of practices as well as  
 408 providing information or education (Figure 1). Consider, for example, the following

409 quote from the EU environment commissioner of the time: ‘The 6th Environment  
410 Action Programme [of the EU] promotes environmental development using all  
411 instruments available: legislation and penalties, grants for improvements and  
412 innovations, research and information.’ (Wallström 2003).

#### 413 4.2 Coordination mechanisms

414 Understanding resource dilemmas as anthropogenic in nature gives rise to a  
415 need to better understand the coordination and governance of human affairs.

416 Instrumental approaches using supply-driven technological change and market  
417 liberalisation policies based on the assumption of rational choice, and of beneficial  
418 societal outcomes of market-propelled development, are increasingly questioned, not  
419 in the least within the economics discipline itself (e.g. Stern 2006). Table 1 provides  
420 a summary of the characteristics of these policy mechanisms, identified in various  
421 social science discourses, including that of a ‘third way’ of coordinating activity  
422 described by Powell (1994) as ‘networking’. In our context ‘social learning’ is a form  
423 of networking seen as an active process.

424  
425 (Table 1 about here)

426  
427 Table 2 characterises the major dimensions of the three coordination or  
428 governance mechanisms. We shall not go into further detail here, except to say that  
429 most societal outcomes are the result of a mix of all three mechanisms.

430  
431 (Table 2 about here)

432  
433 What is clear is that the third approach is not just another fad to be let loose on  
434 unsuspecting stakeholders in water catchments, but part of a global effort to learn how  
435 people can build a sustainable and liveable future. We recognise that this third  
436 coordination mechanism has not yet crystallised into simple language, or a consistent  
437 discourse, and still entails a plethora of terms such as social learning, social capital,  
438 networks, multi-stakeholder processes, soft systems, community, institutional  
439 development, and innovation systems, to describe its features. What all of these terms  
440 emphasise is that social outcomes also depend on agreement, negotiation, conflict,  
441 empathy, compassion, solidarity, reciprocity, power sharing, rules and collective  
442 wisdom. Human reasons for action are seen as important as are natural causes and  
443 rational choices. Markets provide a good example. They are not only the outcome of

444 supply and demand but also of institutions that emerge from history including  
445 negotiation, agreement, power games, corruption, pressure by industrial countries and  
446 multinational companies, rent seeking behaviour, and so forth. From among these  
447 possibilities our preference, a product of our history and traditions of understanding,  
448 was to focus on ‘social learning’.

#### 449 4.3 SLIM research questions

450 The juxtaposition of (i) the new context created by resource dilemmas,  
451 exemplified by water catchments, the sustainability of which can be seen as an  
452 emergent property of interaction among stakeholders, and (ii) the recognition that a  
453 complementary coordination mechanism, such as social learning, would be required  
454 to resolve resource dilemmas, generated research questions which are at the core of  
455 the SLIM design. Common to all SLIM case studies and country efforts were the  
456 following questions:

- 457 1. How does the resource dilemma manifest itself in the concrete water  
458 catchment studied? Sub-questions are: What is the nature of the competing  
459 claims and inter-dependence that emerged? What are the boundaries that  
460 have been created around the resource dilemma? What stakeholders are  
461 involved?
- 462 2. What new governance mechanisms have emerged? Sub-questions focus on  
463 forms of stakeholder participation, and the nature of the interaction among  
464 them, including the creation of platforms, conflict resolution, negotiation,  
465 learning, and deciding on concerted action.
- 466 3. What process facilitation, if any, took place? Sub-questions focused on the  
467 nature of the facilitators, facilitation and learning, the approaches they  
468 used, and the nature of the monitoring and evaluation involved.
- 469 4. What were enabling or constraining institutional frameworks and policy  
470 contexts?
- 471 5. How can the insights gained be translated into policy briefs and training  
472 curricula?

473 Our research questions did not just apply at country level through case study research.  
474 Another set of questions operated at a different conceptual level so as to elucidate  
475 how a shared capacity at all levels of policy making in EU countries could be

- 476 developed so as to create conducive contexts for local interactive processes for  
 477 sustainable management and regeneration of nested watersheds in Europe, viz:
- 478 1. What evidence is there of the need for an alternative policy approach?
  - 479 2. What circumstances exemplify when ‘social learning’ is needed and likely to  
 480 be advantageous?
  - 481 3. How can conceptual and practical tools to use social learning as a deliberate  
 482 (purposeful) policy instrument be provided to policy makers and water  
 483 managers?
  - 484 4. How can we develop a way of researching social learning which is congruent  
 485 with espoused theory?

486 An implication for SLIM in researching these questions was that the practice of  
 487 research must of necessity become a form of social learning. SLIM had to be  
 488 interactive. SLIM researchers had to become stakeholders in the very processes they  
 489 were researching and social learning had to become an operational concept used by all  
 490 stakeholders in the process. This fundamental point of departure became  
 491 operationalised in the approach that was elaborated among the SLIM partners. A  
 492 special methodology team was set up to develop and share this approach and to  
 493 develop use of appropriate research tools and techniques within the SLIM community.

494

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

#### 497 4.4 The SLIM variables

498 The SLIM project proposal was designed on a simple logic, viz: (a)  
 499 Designated Stakeholders *engage in* (b) Desirable Practices, *which require* (c)  
 500 Learning *based on* (d) Facilitation *made possible by* (d) Institutional Support  
 501 *embedded in a* (e) Conducive Policy Context. Table 3 provides a comparison of  
 502 technology transfer and farmer field schools on (a) through (e). The table shows that  
 503 (a) through (e) provide a simple ‘coat hanger’ to examine specific approaches to the  
 504 coordination of human affairs based on empirical evidence; in this case technology  
 505 transfer and farmer field schools. All relevant aspects of a coordination mechanism  
 506 seemed to be covered by (a) through (e), and the assumption of their internal

507 consistency allows one to ‘see’ where the application is incoherent and weak. The set  
508 of aspects (a) through (e) became the original ‘SLIM variables’.

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

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

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

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

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

542

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

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

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

564 **5.1 Research practice**

565 Beck (1992) highlighted how the institutionalised rationality of scientists and  
 566 experts has become a source of problems itself, rather than part of the solution. We  
 567 attribute this in part to lack of awareness about modes of research practice and  
 568 epistemology – the basis for claims to knowledge.

569 In undertaking SLIM we have found that developing action-oriented ‘social’  
 570 research, which complements science-based research, for policy development, brings  
 571 into question the relationship between research and concerted action. It is therefore  
 572 important to understand the role of researchers (and the knowledge claims they make)

573 in the transformation process towards concerted action. This realisation led us to  
574 distinguish three researcher positions R1, R2 and R3. The first, R1, concerns  
575 observing (O), for the researcher to reflect and understand (i.e. learn). The second  
576 (R2) concerns facilitating (F), through the use of tools, skills and data, the learning of  
577 others. The third (R3) involves co-constructing knowledge-in-action with stakeholders  
578 in a joint process with shared responsibility (CoR).

579         Recognising that scientists/researchers are no longer the only source of  
580 expertise and relevant knowledge in dealing with resource dilemmas a fourth position,  
581 R4 can be recognised. R4 is what emerges when self-organising stakeholders engage  
582 in concerted action as active citizens. Citizenship is an expression of stakeholding  
583 through action and can be a consequence of social learning. It is therefore embodied  
584 and active (in contrast to the passive, disaffected nature of current democratic  
585 procedures). These are all roles we ourselves have adopted or seen emerge. Our  
586 awareness of them has informed the design and conduct of our work packages which  
587 did not follow the traditional allocation of work packages to discrete groups. To some  
588 extent we have monitored our own learning throughout the SLIM project, and thus  
589 have additional experience and some data on our own evolution as a community of  
590 practice (see Gibbon and Jiggins, 2003; Wenger 1998). Steyaert and Jiggins (2007)  
591 return to this issue; the other papers in this issue describe and account for their own  
592 research practices.

## 593 5.2 Educational implications for capacity building

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

602         Because dialogical processes are at the core of social learning, arising through  
603 joint action, then constraints to effective dialogue need to be taken into account when  
604 identifying educational needs. Based on the SLIM experience, constraints extend  
605 across differences in worldviews between and within groups, confusion over the

606 functions of science and technology, and deficiencies in key skills within certain  
607 groups (SLIM 2004c).

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

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

633 In the context of these dynamics there is a need for practitioner skills. Modern  
634 trends in rural and agricultural development have been driven forward on the basis of  
635 three skill sets: soft systems thinking, rapid appraisal, and participative approaches  
636 supported by techniques such as semi-structured interviewing. All are carried on the  
637 back of skills of facilitation based on effective process management (Wals et al.  
638 2004). SLIM’s experience was that these skills were highly variable and could not be  
639 assumed which led to our recommendation that they should be significant strands in

640 training in environmental management. Wildemeersch (1999) researching the  
641 reflectivity of environmental groups in the Netherlands found that most groups focus  
642 on the product or content of their activities and pay little attention to the process.  
643 Such skills are acquired through practice, with guidance from an experienced  
644 facilitator and are rarely among the outcomes of environmental management courses  
645 of institutes of higher education.

646         What are the implications of the above situation for the broad groups  
647 identified? The differences in models, values, philosophies of relationships to the  
648 natural world, and lack of clarity on acceptable risk define a broad societal need that  
649 few governments or agencies address. Weaknesses in environmental management  
650 education may well reflect the gulf between the social and “hard” sciences described  
651 by Newby in his presidential address to the British Sociological Society some fifteen  
652 years ago (Newby 1991). The confusion between environmental science and  
653 environmental management is more recent. The rules of evidence and of decision  
654 making in each are different and the functions of science have changed. But there is  
655 still a need for more negotiation (e.g. regarding roles) among hard-science trained  
656 staff and others, that recognises the need for process management skills in  
657 environmental management. For other practitioners, including researchers, the lack of  
658 an apprenticeship scheme for training in process management and techniques is a  
659 major constraint to more interventionist approaches such as those practised in the  
660 SLIM project.

## 661 **6. Concluding comment**

662 Jasanoff (1999), giving an account of how risk is socially constructed, the product of  
663 deeply held cultural values and beliefs, reflects our own arguments in relation to water  
664 catchments. Built on her analysis is the claim that ‘environmental regulation calls for  
665 a more open-ended process, with multiple access points for dissenting views and  
666 unorthodox perspectives’ (p.150). Figure 1 can be interpreted as a response to this  
667 claim that also involves widening how ‘regulation’ is understood i.e., as the  
668 deployment of complementary coordination mechanisms as well as epistemological  
669 awareness or humility. Historically water catchments and their sustainable  
670 management have not been treated as resource dilemmas characterised by  
671 connectedness, complexity, uncertainty, conflict, multiple stakeholders and thus,  
672 multiple perspectives. Nor have catchments been regarded as if they are socially

673 constructed. In addition, the main coordination mechanisms have been hierarchical  
674 and market-based (Figure 1). Command and control are at the core of hierarchical  
675 mechanisms; they have been found wanting in different ways for dealing with  
676 resource dilemmas, not least being that they are expensive to administer and enforce.  
677 Market-based mechanisms are of course subject to market failure.

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

- 682 1. How to develop concerted action to address the collective impact of humans as a  
683 major force of nature;
- 684 2. Understanding and responding to the resource dilemma as a specific challenge for  
685 dealing with anthropogenic phenomena;
- 686 3. Developing new co-ordination mechanisms that focus on voluntary concerted and  
687 distributed action based on a common process of knowing that we have called  
688 social learning (Ison 2008);
- 689 4. Developing new approaches, including capacities, for process facilitation, new  
690 forms of institutional support and new types of conducive policies;
- 691 5. Paying more attention to supporting existing social practices that have widespread  
692 legitimacy, rather than to developing expensive solutions to replace them (e.g.,  
693 Collins et al. 2007).

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

701 **7. References**

702 Backhaus, C., 1991. Planning landuse together. ILEA Newsletter, December 1991  
703 pp.?

704

705 Bandura, A., 1977. Social Learning Theory. Prentice Hall, Englewood Cliffs, NJ.

706

707 Barraque, B., 2003. Past and future sustainability of water policies in Europe. Natural  
708 Resources Forum 27, 200-211.

709

710 Bawden, R. J., 1994. Creating learning systems: a metaphor for institutional reform  
711 for development. In: Scoones, I., Thompson, J., (Eds.), Beyond Farmer First: Rural  
712 people's knowledge, agricultural research and extension practice. Intermediate  
713 Technology, London.

714

715 Bawden, R.J., Packam, R., 1993. Systems praxis in the education of the agricultural  
716 systems practitioner. Systems Practice 6, 7-19.

717

718 Beck, U., 1992. Risk Society: Towards a New Modernity. Sage, New Delhi.  
719 (Translated from the German Risikogesellschaft published in 1986).

720

721 Berger, P.L., Luckman, T., 1967. The Social Construction of Reality. A treatise in the  
722 sociology of knowledge. Anchor Books, Middlesex.

723

724 Blackmore, C.P., 2007. What kinds of knowledge, knowing and learning are required  
725 for addressing resource dilemmas? – a theoretical overview. Environmental Science  
726 and Policy (this volume)

727

728 Bowles, S., Gentis, H., 2002. Social capital and community governance. Economic  
729 Journal, 112 (483), F419-F437.

730

731 Campbell, A., 1992. Landcare in Australia. In: Third Annual Report of the National  
732 Landcare Facilitator, National Soil Conservation Programme, November 1992

733

- 734 CARR (Community Approaches to Rangelands Research), 1993. Marketing of  
735 Middle Micron Wool. Researching with people on issues that make a difference.  
736 Monograph, University of Sydney & University of Western Sydney. 44pp.  
737
- 738 Carter, R. C., 1998. Prospects for sustainable water management policy in Sub-  
739 Saharan Africa, with special reference to the northeast arid zone of Nigeria. In:  
740 Vajpeyi, D.K., (Ed.), Water Resource Management: A Comparative Perspective.  
741 Praeger, New York, pp. 107-127.  
742
- 743 Chambers, R., Jiggins, J., 1987a. Agricultural research for resource-poor farmers I:  
744 Transfer-of-technology and farming systems research. *Agricultural Administration  
745 and Extension* 27, 35-52.  
746
- 747 Chambers, R., Jiggins, J., 1987b. Agricultural research for resource-poor farmers II: A  
748 parsimonious paradigm. *Agricultural Administration and Extension* 27, 109-128.  
749
- 750 Checkland, P.B., 1981. *Systems Thinking, Systems Practice*. John Wiley, Chichester.  
751
- 752 Checkland, P.B., 1999. *Soft Systems Methodology. A Thirty Year Retrospective*. In  
753 Checkland, P.B., Scholes, J., 1999. *Soft Systems Methodology in Action*. John Wiley,  
754 Chichester.  
755
- 756 Checkland, P.B., Casar, A. 1986. Vickers' concept of an appreciative system: a  
757 systemic account. *Journal of Applied Systems Analysis* 13, 3-17.  
758
- 759 Checkland, P.B., Scholes, J., 1999.. *Soft Systems Methodology in Action*. John  
760 Wiley, Chichester.  
761
- 762 Chorlavi Group, 2006. *Building a Social Learning Network. 1998 – 2005*. Rimisp  
763 Centro Latinoamericano para el Desarrollo Rural, Santiago, Chile.  
764
- 765 Cochrane, W.W., 1958. The agricultural treadmill, In Cochrane, W., *Farm Prices,  
766 Myths and Reality*. Univ. of Minnesota Press, Minneapolis, pp. 85-107.  
767

- 768 Collins, K.B., Blackmore, C., Morris, R.M., Seal, K., Watson, D., 2007. Rethinking  
769 policies and practices for multi-stakeholder managing of water catchments in the UK:  
770 A systemic approach. *Environmental Science & Policy* (this volume)  
771
- 772 Dietz, T., Ostrom, E., Stern, P.C. 2003. The struggle to govern the commons. *Science*  
773 302 (December 12), 1907–1912.  
774
- 775 Douglas, M., 1986. *How Institutions Think*. University of Syracuse Press, Syracuse  
776 (NY).  
777
- 778 EU [European Union], 2003. *Common Implementation Strategy for the Water*  
779 *Framework Directive (2000/60/EC) Guidance Document No 8, Public Participation in*  
780 *Relation to the Water Framework Directive*, European Commission, Brussels.  
781
- 782 Flannery, T., 2005. *The Weather Makers. How man is changing the climate and what*  
783 *it means for life on earth*. Grove Press, New York.  
784
- 785 FEMAT (Forest Ecosystem Management Team), 1993. *Forest Ecosystem*  
786 *Management: An Ecological, Social and Economic Assessment, Report*, USDA  
787 *Forest Service, (Place)?*  
788
- 789 Fowler, F.G., Fowler, H.W., 1961. *The Pocket Oxford Dictionary*. Clarendon Press,  
790 Oxford.  
791
- 792 Funtowicz, S.O., Ravetz, J.R. 1993. Science for the post-normal age. *Futures* 25 (7),  
793 739-755.  
794
- 795 Gibbon, D., Jakobsson, K.M., 1999. Towards sustainable agricultural systems. In:  
796 Dragun, A.K., Tidsell, C., (Eds.), *Sustainable Agriculture and the Environment*,  
797 Edward Elgar, UK, pp. 101 - 124.  
798
- 799 Gibbon, D., Jiggins, J., 2003. *SLIM's own learning processes*. SLIM Working Paper  
800 No. 7 (unpublished).  
801

- 802 Gilbert, N., Troitzsch, K., 1999. *Simulation for the Social Scientist*. Open University  
803 Press, Buckingham.
- 804
- 805 Giller, K., Milgroom, J., Leeuwis, C., 2005. The role of social and technical  
806 innovation in resolving competing claims on natural resources. Unpublished Research  
807 Proposal, Wageningen University, Wageningen.
- 808
- 809 Gunderson, L.H., Holling, C.S. Light, S.S. (Eds) 1995. *Barriers and Bridges to the*  
810 *Renewal of Ecosystems and Institutions*. Colombia Press, New York.
- 811
- 812 Habermas, J., 1984. *The Theory of Communicative Action*. Vol. 1: Reason and the  
813 Rationalisation of Society. Beacon Press, Boston.
- 814
- 815 Hall, A., Janssen, W., Pehu, E., Rajalahti, R., 2006. *Enhancing Agricultural*  
816 *Innovation: How to go beyond strengthening research systems*. World Bank,  
817 Washington.
- 818
- 819 Hanna, S.S., Folke, C., Mäler, K.G., 1996. *Rights to Nature. Ecological, Economic,*  
820 *Cultural, and Political Principles of Institutions for the Environment*. Island Press,  
821 Washington, D.C.
- 822
- 823 Hardin, G., 1968. The tragedy of the commons. *Science* 162, 1243-1248.
- 824
- 825 Hurst, D.K., 1995. *Crisis and Renewal. Meeting the crisis of organisational change*.  
826 Harvard Business School Press, Boston (Mass.).
- 827
- 828 Hood, C., 1998. *The Art of the State. Culture, Rhetoric and Public Management*.  
829 Clarendon Press, Oxford.
- 830
- 831 Hubert, B., Ison, R.L., Röling, N., 2000. The 'problematique' with respect to  
832 industrialised country agricultures. In LEARN, (Eds.) *Cow up a Tree. Knowing and*  
833 *Learning for Change in Agriculture. Case Studies from Industrialised Countries*.  
834 INRA (Institut National de la Recherche Agronomique) Editions, Paris. pp. 13-30.
- 835

- 836 Hubert, B., 2002. La pratique de recherche en écologie dans une réserve naturelle : les  
837 relations entre connaissance disciplinaire et connaissance pour l'action. Questions de  
838 B.Hubert à L. Marion. *Natures, Sciences et Sociétés*, 10 (2), 70-75.
- 839
- 840 Ison, R.L., 2008. Systems thinking and practice for action research. In: Reason, P.,  
841 Bradbury, H., (Eds.). *Handbook of Action Research* (2nd ed.). Sage Publications,  
842 London.
- 843
- 844 Ison, R.L., Russell, D.B., (Eds.), 2000. *Agricultural Extension and Rural*  
845 *Development: Breaking Out of Traditions*. Cambridge University Press, Cambridge,  
846 UK. 239p.
- 847
- 848 Ison, R.L., Roling, N., Watson, D., 2000. SLIM (Social Learning for the Integrated  
849 Management and Sustainable Use of Water at Catchment Scale). Project Proposal,  
850 DG Research, Brussels (accessible at <http://slim.open.ac.uk>).
- 851
- 852 Ison, R.L., Steyaert, P., Roggero, P.P., Hubert, B., Jiggins, J., 2004. Social Learning  
853 for the Integrated Management and Sustainable Use of Water at Catchment Scale  
854 (EVK1-2000-00695SLIM). Final Report, DG Research, Brussels (accessible at  
855 <http://slim.open.ac.uk>).
- 856
- 857 Jasanoff, S., 1999. The songlines of risk. *Environmental Values* 8, 135-152.
- 858
- 859 Jiggins, J., van Slobbe, E., Röling, N., 2007. The organisation of social learning in  
860 response to perceptions of crisis in the water sector of the Netherlands. *Environmental*  
861 *Science and Policy* (this volume)
- 862
- 863 Kaïka, M., 2003. The Water Framework Directive: a new directive for a changing  
864 social, political and economic European framework. *European Planning Studies* 11  
865 (3), 299-316.
- 866
- 867 Kaïka, M., Page, B. 2003. The EU Water Framework Directive Part 1: European  
868 policy-making and the changing topography of lobbying. *European Environment* 13  
869 (6), 314 - 327.

870

871 Kelman, H., 1969. Processes of opinion change. In: Bennis, W., Benne, K., Chin, R.,  
872 (Eds.), *The Planning of Change* (Second Edition). Holt, Rinehart and Winston,  
873 London, pp. 222-230.

874

875 Kuhn, T. S., 1970. *The Structure of Scientific Revolutions*, 2nd. ed., Univ. of Chicago  
876 Press, Chicago.

877

878 Law, J., Urry, J., 2004. Enacting the social. *Economy and Society* 33 (3), 390–410.

879

880 LEARN Group [Cerf, M., Gibbon, D., Hubert, B., Ison, R., Jiggins, J., Paine, M., .  
881 Proost, J., Röling, N. Eds], 2000. *Cow up a Tree. Knowing and Learning for Change*  
882 *in Agriculture. Case Studies from Industrialised Countries*. INRA, Paris.

883

884 Leeuwis, C., Pyburn, R., Eds 2002. *Wheelbarrows Full of Frogs. Social learning in*  
885 *rural resource management*. Koninklijke van Gorcum, Assen, the Netherlands.

886

887 Lubchenco, J., 1998. Entering the century of the environment: A new social contract  
888 for science. *Science* 279, 491-496.

889

890 Maturana, H.R., Varela, F.J., 1992. *The Tree of Knowledge, the biological roots of*  
891 *human understanding*. Shambala Publications, Boston (Mass.).

892

893 Maturana, H., Poerkson, B., 2004. *From Being to Doing. The Origins of the Biology*  
894 *of Cognition*. Carl-Auer, Heidelberg.

895

896 Morris, R.M., Roggero, P.P., van Slobbe, E., Watson, D., 2007. Ecological factors,  
897 social learning and sustainable use of resources at catchment scale. *Environmental*  
898 *Science and Policy* (accepted).

899

900 Newby, H., 1991. *One world, two cultures: Sociology and the environment*. Lecture  
901 to the British Sociological Council, February 1991.

902

- 903 North, D., 1990. *Institutions, Institutional Change and Economic Performance*.  
904 Cambridge University Press, Cambridge.
- 905
- 906 North, D., 2005. *Understanding the Process of Economic Change*. Princeton  
907 University Press, Princeton.
- 908
- 909 Ostrom, E. 1992. *Governing the Commons. The Evolution of Institutions for*  
910 *Collective Action*. Cambridge University Press, New York.
- 911
- 912 Ollivier, G. (2004) *An analytical understanding of the Water Framework Directive*  
913 *questioning its potential to enable sustainable management of water, SLIM (Social*  
914 *Learning for Integrated Management and Sustainable Use of Water at Catchment*  
915 *Scale) Case Study Monograph 9* (available at <http://slim.open.ac.uk>).
- 916
- 917 Pahl-Wostl, C., 2002. *Towards sustainability in the water sector - The importance of*  
918 *human actors and processes of social learning*. *Aquatic Sciences* 64, 394-411.
- 919
- 920 Pahl-Wostl, C., 2006. *The importance of social learning in restoring the*  
921 *multifunctionality of rivers and floodplains*. *Ecology and Society* 11(1), 10. [online]  
922 URL: <http://www.ecologyandsociety.org/vol11/iss1/art10/>
- 923
- 924 Pahl-Wostl, C., 2007. *The implications of complexity for integrated resources*  
925 *management*. *Environmental Modelling and Software*, 22 (5), 561-569.
- 926
- 927 Parson, E.A., and Clark, W.C., 1995. *Sustainable development as social learning:*  
928 *theoretical perspectives and practical challenges for the design of a research program*.  
929 In: Gunderson, L.H., Holling, C.S., Light, S.S., (Eds.), *Barriers and Bridges to the*  
930 *Renewal of Ecosystems and Institutions*. Columbia Press, New York. pp 428-461.
- 931
- 932 Pierce, F., 2006. *State of Denial*. *New Scientist* Nov. 4, 2006, 18-21.
- 933
- 934 Pina V.Y., Covington W.W., 1993. *Conservation biology, restoration ecology and a*  
935 *Navajo view of nature*. In: *Sustainable Ecological Systems: Implementing an*

- 936 Ecological Approach to Land Management, USDA General Technical Report RM-  
937 247.
- 938
- 939 Poats, S.V., 2006. Collaborative management of natural resources in Andean  
940 watersheds in Northern Ecuador. Final Technical Report, Mar. 2003 - Sept. 2005.  
941 Corporación Grupo Randi Randi, Quito, Ecuador. 21 p.
- 942
- 943 Pontius, J. Dilts, R., Bartlett, A., 2002. From Farmer Field Schools to Community  
944 IPM. Ten Years of IPM Training in Asia. FAO, Regional Office for Asia and the  
945 Pacific, Bangkok.
- 946
- 947 Powell, N., 1996. Biodiversity conservation strategies: An assessment of the impact in  
948 regions occupied by nomadic land users; Working Paper 1996.13, Centre for  
949 Development and the Environment, University of Oslo, Norway
- 950
- 951 Powell, W., 1994. Neither market nor hierarchy: Network forms of organisation. In:  
952 Thompson, G., Frances, J., Levavcic, R., Mitchell, J. (Eds.), Markets and Hierarchies  
953 and Networks: The Co-ordination of Social Life. Sage, London, pp. 256-277.
- 954
- 955 Roggero, P.P., Porqueddu, C., Sulas, L., Caredda, S., 1996. Relationships between  
956 land use and water run-off and soil erosion in a Mediterranean environment.  
957 Proceedings of the V<sup>th</sup> International Rangeland Congress, Logan, USA, pp. 481-482.
- 958
- 959 Röling, N., 1988. Extension Science. Information Systems in Agricultural  
960 Development. Cambridge University Press, Cambridge.
- 961
- 962 Röling, N., 1994. Platforms for decision-making about ecosystems, In: Fresco, L.O.,  
963 Stroosnijder, L., Bouma, J., van Keulen, H., (Eds), The Future of the Land:  
964 Mobilising and Integrating Knowledge for Land Use Options, John Wiley and Sons  
965 Ltd, Chichester, pp. 385-393.
- 966
- 967 Röling, N., van de Fliert, E., 1994. Transforming extension for sustainable  
968 agriculture: the case of Integrated Pest Management in rice in Indonesia. Agriculture  
969 and Human Values 11 (2+3), 96-108.

- 970
- 971 Rölöing, N., Wagemakers, A., (Eds.), 1998. Facilitating Sustainable Agriculture.  
972 Participatory learning and adaptive management in times of environmental  
973 uncertainty. Cambridge University Press, Cambridge.
- 974
- 975 Rölöing, N., Jiggins, J., 1998. The ecological knowledge system. In: Rölöing, N.,  
976 Wagemakers, A., (Eds.), Facilitating Sustainable Agriculture. Participatory learning  
977 and adaptive management in times of environmental uncertainty. Cambridge  
978 University Press, Cambridge, pp. 283-307.
- 979
- 980 Rölöing, N., Woodhill, J., 2001. From Paradigm to Practice: Foundations, Principles  
981 and Elements for Dialogue on Water, Food and Environment. Background Document  
982 for National and Basin Dialogue Design Workshop, December 1, 2001, Bonn.  
983 Germany.
- 984
- 985 Rölöing, N., 2002. Beyond the aggregation of individual preferences. Moving from  
986 multiple to distributed cognition in resource dilemmas. In: Leeuwis, C., Pyburn, R.,  
987 (Eds.), Wheelbarrows Full of Frogs. Social Learning in Natural Resource Management.  
988 Koninklijke Van Gorcum, Assen, pp. 25-28.
- 989
- 990 Russell, D.B., Ison, R.L., Gamble, D.R., Williams, R.K., 1989. A Critical Review of  
991 Rural Extension Theory and Practice. Australian Wool Corporation/ University of  
992 Western Sydney (Hawkesbury). 67pp.
- 993
- 994 Russell, D.B., Ison R.L., 1993. The research-development relationship in rangelands:  
995 an opportunity for contextual science. Proc. IV<sup>th</sup> International Rangeland Congress,  
996 Montpellier, 1991. Vol. 3, pp. 1047 - 1054.
- 997
- 998 Russell, D.B., Ison, R.L., 2000. The research-development relationship in rural  
999 communities: an opportunity for contextual science. In: Ison, R.L., Russell, D.B.,  
1000 (Eds.), Agricultural Extension and Rural Development: Breaking out of Traditions.  
1001 Cambridge University Press, Cambridge, UK, pp. 10-31.
- 1002

- 1003 Sabatier, P.A., Focht, W., Lubell, M., Trachtenberg, Z., Vedlitz, A., Matlock, M.,  
1004 2005. Collaborative approaches to watershed management In: Sabatier, P.A., Focht,  
1005 W., Lubell, M., Trachtenberg, Z., Vedlitz, A., Matlock, M., (Eds.), Swimming  
1006 Upstream: Collaborative Approaches to Watershed Management. MIT Press, Boston.  
1007
- 1008 SLIM, 2004a. Developing Conducive and Enabling Institutions for Concerted Action.  
1009 SLIM Policy Briefing No. 3. SLIM (available at <http://slim.open.ac.uk>). 4p.  
1010
- 1011 SLIM, 2004b. SLIM Framework: Social Learning as a Policy Approach for  
1012 Sustainable Use of Water, SLIM (available at <http://slim.open.ac.uk>). 41p.  
1013
- 1014 SLIM, 2004c. Guidelines for Capacity Building for Social Learning in Integrated  
1015 Catchment Management and the Sustainable Use of Water. SLIM Policy Briefing No.  
1016 7. SLIM (available at <http://slim.open.ac.uk>). 4p.  
1017
- 1018 State of New South Wales, 2006. Catchment Management Authorities Act 2003  
1019 (Accessed at:  
1020 [http://www.austlii.edu.au/au/legis/nsw/consol\\_act/cmaa2003316/s4.html#natural\\_resource\\_management](http://www.austlii.edu.au/au/legis/nsw/consol_act/cmaa2003316/s4.html#natural_resource_management)  
1021 [urce\\_management](http://www.austlii.edu.au/au/legis/nsw/consol_act/cmaa2003316/s4.html#natural_resource_management) 3 August 2006.  
1022
- 1023 Steels, L., 1990. Towards a theory of emergent functionality In: From Animals to  
1024 Animats, Proceedings of the First International Conference on Simulation of Adaptive  
1025 Behavior. Bradford Books (MIT Press), Cambridge, MA & London, England, pp.  
1026 451-461.  
1027
- 1028 Steins, N.A., 1999. All Hands on Deck. An Interactive Perspective on Complex  
1029 Common-Pool Resource Management Based on Case Studies in Coastal Waters of the  
1030 Isle of Wight (UK), Connemara (Ireland) and the Dutch Wadden Sea. Wageningen  
1031 University, Published Doctoral Dissertation, Wageningen (NL).  
1032
- 1033 Sterling, S., 2001. Sustainable Education. Re-visioning Learning and Change.  
1034 Schumacher Briefing No 6. Green Books, Dartington, 94p.

- 1035  
1036 Stern, N. (2006) *Economics of Climate Change*. HM Treasury, London.  
1037
- 1038 Steyaert, P., 2002. How to deal with agricultural change for sustainable management  
1039 of French Atlantic coastal wetlands? *Proceedings of an Interdisciplinary Dialogue:*  
1040 *Agricultural Production and Integrated Ecosystem Management of Soil and Water,*  
1041 *Ballina, NSW, Australia 12-16 November 2002. OECD and NSW Agriculture.*  
1042
- 1043 Steyaert, P., Jiggins, J., 2007. Governance of complex environmental situations  
1044 through social learning: a synthesis of SLIM's lessons for research, policy and  
1045 practice, *Environmental Science and Policy* (this volume)  
1046
- 1047 Steyaert, P., Barzman M.S., Brives H., Ollivier, G., Billaud, J.P., Hubert B., 2007.  
1048 The role of knowledge and research in facilitating social learning among stakeholders  
1049 in natural resources management in the French Atlantic coastal wetlands.  
1050 *Environmental Science and Policy* (this volume).  
1051
- 1052 Syme, G., 2005. Integration initiatives at CSIRO: Reflections of an insider. *Journal of*  
1053 *Research Practice* 1 (2), Article M3.  
1054
- 1055 Toderi, M., Powell, N., Seddaiu, G., Roggero, P.P., Gibbon, D., 2007. Combining social  
1056 learning with agro-ecological research practice for more effective management of nitrate  
1057 pollution. *Environmental Science and Policy* (this volume).  
1058
- 1059 Ulrich, W., 2002. Boundary critique. In: Daellenbach, H.G., Flood, R.L., (Eds.), *The*  
1060 *Informed Student Guide to Management Science*, Thomson, London,;pp. 41-42.  
1061
- 1062 UN (United Nations), 2006. *Millennium Ecosystem Assessment (Synthesis Report).*  
1063 *UN Foundation, Washington.*  
1064
- 1065 van de Fliert, E., 1993. *Integrated Pest Management Farmer Field Schools Generate*  
1066 *Sustainable Practices: A case Study in Central Java evaluating IPM training.* WU  
1067 *Papers 93-3, Published Doctoral Dissertation, Wageningen Agricultural University,*  
1068 *Wageningen.*

- 1069  
1070 Wallström, M., (2003) Margot Wallström. Commissioner for the Environment. Key  
1071 Issues (Accessed at  
1072 [http://europa.eu.int/comm/commissioners/wallstrom/index\\_en.htm](http://europa.eu.int/comm/commissioners/wallstrom/index_en.htm) 25th July, 2004).  
1073
- 1074 Wals, A., Caporali, F., Pace, P., Slee, B., Sriskandarajah, N., Warren, M., 2004.  
1075 Education and Training for Integrated Rural Development, Elsevier, the Netherlands.  
1076
- 1077 Watson, R.D., 1992. The Use of Soft Systems Approach and Rapid Rural Appraisal  
1078 for Studying Agricultural Knowledge Systems. Handbook for the International  
1079 Agricultural Centre, Wageningen, the Netherlands.  
1080
- 1081 Watson, R.D., 1996. Integrated Catchment Management - the human dimension.  
1082 Unpublished Paper, for the Aberdeen Research Consortium, Aberdeen..  
1083
- 1084 Wenger, E., 1998. Communities of Practice: Learning, Meaning and Identity. Cambridge  
1085 University Press, Cambridge.  
1086
- 1087 Wildemeersch, D., 1999. Paradoxes of social learning: Towards a model for project-  
1088 oriented group work. In: Jensen, H.J., Olesen, H.S., (Eds.), Project Studies – A late  
1089 modern university reform Roskilde University Press, Roskilde, pp. 38-57.  
1090
- 1091 Wilsden, J., Wynne, B., Stilgoe, J., 2005. The Public Value of Science. Or how to  
1092 ensure that science really matters. DEMOS, London. 66p.  
1093
- 1094 Woodhill, J., Röling, N., 1998. The second wing of the eagle: the human dimension in  
1095 learning our way to more sustainable futures. In: Röling, N., Wagemakers, A., (Eds.),  
1096 Facilitating Sustainable Agriculture. Participatory learning and adaptive management  
1097 in times of environmental uncertainty. Cambridge University Press, Cambridge, pp.  
1098 46-69.

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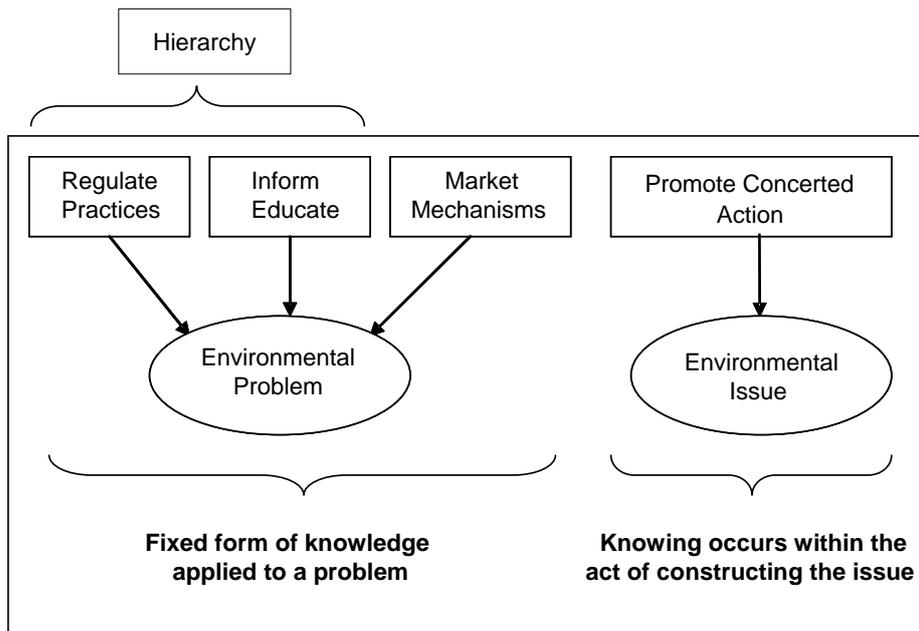
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1123 **Figure**

1124

1125 Figure 1. Policy coordination mechanisms compared (i) within the current paradigm  
 1126 of environmental management comprising hierarchy and the market used to address  
 1127 pre-determined environmental problems based on a fixed form of knowledge and (ii)  
 1128 social learning for concerted action based on the process of knowing.  
 1129



1130

1131 **Tables**

1132

1133 Table 1: Three dimensions of human coordination recognised in various discourses

<i>Discourses</i>	<i>Use instruments of power</i>	<i>Assume rational choice</i>	<i>Rely on emergence from interaction</i>
<b>Forms of rationality (Habermas 1984)</b>	Instrumental	Strategic	Communicative
<b>Basis for individual behaviour change (Kelman 1969)</b>	Compliance	Identification	Internalisation
<b>Preferred ways of arranging human affairs (Hood 1998)<sup>3</sup></b>	Hierarchy	Individualism	Egalitarianism
<b>Coordination mechanisms (Powell 1994)</b>	Hierarchy	Market	Network
<b>Causes of 'wealth of nations' (Bowles and Gintis 2002)</b>	Resources (such as power or natural resources), State power	Invisible hand of market forces	Social capital, Trust, Community
<b>Innovation model</b>	End of pipe outcome of technology transfer and diffusion	Induced by changes in relative factor prices; Market-propelled outcome of farmers on the treadmill (Cochrane 1958)	Emergent property of multi-stakeholder interaction (e.g. social learning; innovation systems; Hall et al. 2006)

1134

<sup>3</sup> 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.

1135 Table 2: Processes distinguishing coordination mechanisms (Adapted from Rölöing et  
 1136 al. 2002).

1137 **Coordination Mechanism**

<b>Properties</b>	<b>Hierarchy</b>	<b>Market</b>	<b>Network</b>
<i>Dynamics</i>	Causation	Rational choice, Invisible hand	Exchange of meaning, Sense making, Interdependence
<i>Mechanism behind effect</i>	Power, Legitimation, Technology	Utility functions; Satisfying preferences	Learning processes Communication, Cooperation, Negotiated agreement, Reciprocity
<i>Origin of welfare</i>	Access to resources, Power, Technology	Autonomous market forces	Social capital, Trust, Community, Concerted action
<i>Purpose</i>	Control	Win, Gain advantage	Equity, Resolve resource dilemmas
<i>Intervention mechanisms</i>	Regulation, Coercion, Engineering	Laissez faire, Fiscal policy, Deregulation	Process facilitation
<i>Criteria for success</i>	Realisation of formal goals	Satisfaction of individual needs	Common meanings, Concerted action, Institutional change
<i>Conditions for failure</i>	Lack of information, No legitimation	Market failure	Inequality in power relations

1138

1139

1140 Table 3: Comparison between transfer of technology and farmer field school based on

1141 a number of dimensions (following R ling and van de Fliert 1994), later adapted as

1142 SLIM variables in the SLIM research proposal (Ison et al., 2000)

1143

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

1144

1145