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Institutionalising social learning: Towards systemic and adaptive governance

Raymond L. Ison [a,b,*], *Kevin B. Collins* [a], *Philip J. Wallis* [b]

[a] *Applied Systems Thinking in Practice Research Group, Engineering & Innovation Department, The Open University, UK*

[b] *Systemic Governance Research Program, Monash Sustainability Institute, Monash University, Clayton, Victoria, Australia*

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ABSTRACT

This paper critically examines how public policy makers limit policy and other institutional design choices by a failure to appreciate (i) how situations may be characterised or framed; (ii) how practices that generate neologisms (invented terms or concepts) or reify (make into a thing) abstract concepts can displace understandings, and (iii) the epistemological bases of governance mechanism choices. An inquiry into the coining of the neologisms 'wicked' and 'tame' problems is reported and the implications for research and policy practice explored. As practices, neologising, reifying, categorising and typologising have unintended consequences – they remove us from the primary experiences and underlying emotions that provided the motivation for formulating these concepts in the first place. The failure to institutionalise the understandings and experiences that sit behind the invention of the terms 'wicked' and 'tame' problems (or similar framing choices such as 'problematique', 'messes', 'lowland real-life swamps', 'resource dilemmas' or 'complex adaptive systems') present systemic constraints to institutionalising social learning as an alternative yet complementary governance mechanism within an overall systemic and adaptive governance framework. Ultimately situations usefully framed as 'wicked',' such as water managing and climate change are problems of relationship – of human beings with the biosphere. Re-framings, such as institutions as social technologies and other research and praxis traditions concerned with the breakdown of relationships may offer ways forward in the purposeful designing and crafting of more effective institutions.

1. The problematique

Thompson and Warburton (1985) once sensibly set out to find out what was wrong with the Himalayas, acknowledging that the problem was to know what the problem was. Underlying their work (see also Thompson, 1993) was an appreciation that scientific research and policy options incorporate social constructions of reality based on certain sets of assumptions that frame how a situation is understood. It follows that a particular framing, a perspective for making sense of a situation (Schön and Rein, 1994), leads to particular sets of acceptable practices and actions offered as suitable responses or 'solutions'. This is perhaps nowhere more evident than in

* *Corresponding author at*: Systemic Governance Research Program, Monash Sustainability Institute, Monash University, Clayton, Victoria, Australia. Tel.: +61 404 308 180.
E-mail addresses: Ray.Ison@monash.edu (R.L. Ison), Kevin.Collins@open.ac.uk (K.B. Collins), Phil.Wallis@monash.edu (P.J. Wallis).
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climate change debates. While there is growing agreement globally that climate and thus water, health, food security and the like are 'problems', their nature and scope and the means of engagement with, and 'solutions' to, them are highly contested (Hulme, 2009; Hussey and Dovers, 2007; Giddens, 2009; Warner, 2007). Tompkins et al. (2008) argue that "*the complexity of the climate change problem and the uncertainty about the timing, severity, magnitude and type of impacts makes planning for climate change a challenge*" (p. 1580). 'Climate change adaptation' and the 'global water crisis' are, in many respects, the new Himalayas.

Consistent with Thompson and Warburton's (1985) conclusion that institutional innovation is central to transforming complex issues, we address the conceptual foundations of, and politics involved in, purposeful institutional change to effect transformations towards more systemic governance of social–biophysical systems. We employ the distinctions systemic, meaning pertaining to a whole, and systematic meaning linear, sequential or step-by-step. In line with the purpose of this special issue we understand institutional change to involve the deliberate, or purposeful, replacement of existing formal and informal institutions or the creation of new institutions in a socially desired way (Thiel et al., 2015). In other words, changing institutions is a form of praxis (theory-informed practical action); this praxis can be understood as *crafting or designing institutions*. But we will argue that transformation towards governance regimes that are more systemic and adaptive is more than crafting the new; crafting also requires innovations in understandings and practice of those who do crafting. Crafting may also involve clearing the situation of old, constraining institutions and appreciating extant institutional complexity (Wallis and Ison, 2011). Institutions mediate the relational dynamics between a social and biophysical system (*cf.* Ison et al., 2007) and also act as a form of 'understandascope' on the world we experience because institutions tend to contain (reify) understandings that were prevalent when the institutions were first invented. As in metaphor theory (Ison et al., 2013), institutions can be understood to have theoretical entailments that influence how people think and act. A good example is how the mainstream, 'common', understanding of 'performance management' institutions (e.g., key performance indicators) survive and flourish despite theoretical and evidence-based assessments which argue against their use (Lowe, 2013).

Using the metaphor of the Himalayas is a form of framing (Schön and Rein, 1994). How situations are framed is a choice that can be made. This applies also when framing a situation as 'a problem', rather than say 'an opportunity', or 'contested issue'. Framing choices, knowingly or not, direct thinking and practice. For example, the so called 'problems' of food security and global water managing have, when grounded in specific situations, many of the features attributed to complex and uncertain social planning situations that systems scholars experienced in the 1960s and 1970s. These scholars coined particular neologisms (invented terms) as a means of describing and explaining the situations they experienced. Turkish cybernetician, Hasan Ozbekhan, introduced the idea of the 'problematique' to refer to the 'bundle of problems' that the Club of Rome wished to address in the late 1960s; this concept subsequently became central to *The Limits to Growth* report (Moll, 1991). The 'problematique' came to represent the special character of the problems the Club of Rome intended to investigate:

> "First, these problems could not be solved within electoral cycles because of their long-term characteristics; second, they could not be solved within individual countries because of their global scale; third, these problems could not be considered separately, because they constituted interacting 'clusters of problems'. The 'problematique' thus summed up this inextricable net of long-term and global-scale problems" (Blanchard, 2010, p. 97)

Latterly, the term 'resource dilemmas' was coined to describe uncertain and contested natural resource management (NRM) situations (discussed in Ison et al., 2007). Earlier systems scholars coined other terms to describe similar situations. These include 'wicked problems' (Rittel and Webber, 1973), 'messes' (Ackoff, 1974a,b), or the 'swamp of real-life issues' (Schön, 1995). What these scholars also did was to recognise that some situations were much more tractable and more open to the tools of traditional engineering and science and they named these situations as 'tame problems', 'difficulties' and the 'high ground of technical rationality', respectively. But, knowingly or not, what Rittel, Webber, Ackoff and Schön did was to create a classificatory system based on their personal experiences as well as invoke a set of distinctions that have been widely interpreted as dualisms. A dualism is a self-negating pair, much like the concepts objective and subjective. A dualism leads to an either/or choice in which the act of making the choice is a negation of the other. In contrast a duality is a pair that together forms a whole, such as the concepts predator/prey. Unfortunately, in science, the act of naming through a neologism creates a noun, and thus a 'thing', out of a description or explanation. The noun becomes a form of shorthand, but one which is devoid of the experience that is embedded in the description, to all those who follow and use it. Institutions that are based on typologies or classificatory schemas often exacerbate the effects of reifying nouns, e.g., the Millennium Ecosystem Assessment exercise (Hubert and Ison, 2011).

The practice of inventing neologisms continues with, for example, 'complex adaptive systems' (Cilliers, 1998) and 'social–ecological systems' (Holling, 1973). Another neologism is 'social learning' which is used in many, often contested ways but which Ison et al. (2013) understand as a combination of both process and entity, i.e., a duality that combines the dynamics of practice with a governance framing that is supportive of the practice. We will argue, in terms of systemic governance, that dualisms are unhelpful. Instead we raise the possibility of new forms of governance praxis by exploring framing choices that act as a duality rather than a dualism. The pair systemic/systematic understood as a duality in relation to practice is, we contend, more suited to managing a co-evolutionary dynamic such as that between humans and the biosphere (Collins and Ison, 2009a,b; Ison, 2010). Our use of co-evolution of social and biophysical systems is a framing choice which we think has contemporary relevance because of the systemic, relational dynamics such a framing reveals. We

draw on early conceptions such as that of Norgaard (1981) who said 'agricultural development can be thought of as a co-evolutionary process between a social system and an ecosystem' (p. 238) but temper this perspective with an understanding of the structural coupling of two systems as when two systems mutually influence each other over time but retain their own structural integrity as in, say, a marriage (Maturana and Verden-Zoller, 2008).

In seeking to appreciate what might be involved in crafting institutions in aid of developing a praxeology (a science of practical action) for systemic governance we critically examine in this paper what Rittel and Webber (1973) did when they coined the terms wicked and tame problems. As scholars concerned about social, particularly planning, issues they had observed, and probably participated in, the failure of what they called 'systems approaches of the first generation' characterised as:

> "…'systems analysis' [which meant] attacking problems of planning in a rational, straightforward, systematic way, characterized by a number of attitudes which a systems analyst and designer should have" (Rittel, 1972, p. 390).

Their insight was that:

> "The systems-approach 'of the first generation' is inadequate for dealing with wicked-problems. Approaches of the 'second generation' should be based on a model of planning as an argumentative process in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgment, subjected to critical argument." (p. 162)

In many ways Rittel and Webber (1973) foreshadow the deliberative governance turn outlined in, say, Hajer and Wagenaar (2003).

We understand governance as a cyber-systemic concept (one that draws on cybernetic and systems theories) that operates at multiple levels from projects to government ministries and involves crafting institutions and associated praxes that perceive, interpret and respond to feedback processes so that actions can be taken that affect the quality of the relationship between social and biophysical systems. This conception is not new (see Blunden and Dando, 1994) but seems to have been lost in contemporary scholarship. Governance, or more aptly, governing, is thus in our terms also a form of praxis.

In any purposeful activity such as governing, or researching or implementing policy, initial starting conditions may be created that preclude transformations that improve, or systemically govern, complex situations. Practices associated with the coining, acceptance and reification of new concepts can also produce unintended consequences. We thus explore (i) some of the implications of neologising and reifying, or institutionalising, concepts, or explanations and (ii) how neologising and reifying practices might constrain systemic governing, particularly the formulation of policies and other institutional arrangements that can facilitate social learning (Ison et al., 2013). We raise these issues as part of research into how changes in practices and understandings might give rise to institutions and behaviours based on a co-evolutionary ethic. The inquiry is a precursor to grounding these understandings in a research design for situations associated with water catchment governing and managing, of which climate change adapting is regarded as a sub-system.

In the next section we start to look at the reprisal of 'wicked problems' in the discourse about public sector capability and governance practices.

1.1. *Reprising "wicked problems"*

The Australian Public Service Commission (APSC, 2007) in a thoughtful review of 'wicked problems' described them as problems that:

> "…go beyond the capacity of any one organisation to understand and respond to, and [where] there is often disagreement about the causes of the problems and the best way to tackle them." (p. 1)

They go on to say that

> "wicked problems…pose challenges to traditional approaches to policy making and programme implementation". (p. 1)

In a foreword to the APSC paper, the Commissioner of the APS makes the very powerful point that:

> "It is important, as a first step, that wicked problems be recognised as such. Successfully tackling wicked problems requires a broad recognition and understanding, including from governments and Ministers, that there are no quick fixes and simple solutions". (p. iii)

This statement does not mince words; it challenges the very ways our democracies and associated bureaucracies function and can be seen as a call to action in the light of climate change, water crises and the like.

Despite this encouraging development and a spate of recent papers about 'wicked problems' (e.g., Allan, 2009; Levin et al., 2012; Seager et al., 2012) three issues stand out: (i) there is limited evidence that understandings about "wicked problems" have been incorporated into governance practices (including institutional innovations); (ii) it is questionable as to whether there is widespread capability to engage with, let alone improve, situations understood as 'wicked' and (iii) most authors that engage with Rittel and Webber's concepts fail to appreciate, in a reflexive, systemic manner what Rittel and Webber did when they coined these terms and the consequences that follow. Being reflexive we understand as examining one's own understandings – a form of reflection on reflection.

Rittel and Webber (1973) presented their distinction between 'wicked' and 'tame' problems to the Panel on Policy Sciences, American Association for the Advancement of Science, in Boston in December 1969, though the terms appeared earlier in a reference by Churchman (1967) in regard to a (then) recent seminar by Horst Rittel. Horst Rittel was a design theorist and Melvin Webber an urban designer at the

University of Berkeley in California. They had observed that there was a whole realm of social planning problems that could not be successfully treated with traditional linear, analytical approaches. Ritchey (2013) provides further background and context for the emergence of Rittel and Webber's concerns about complex social problems. In this inquiry we start by looking at what Rittel and Webber did when they named 'wicked' and 'tame' problems over forty years ago to see if this might reveal insights into why these terms have been so poorly taken up (institutionalised) in policy circles.

In the next section, our initial focus is on the practices of neologising and reifying, common to much research. To ground our arguments we start with the Rittel and Webber (1973) paper but we then turn to Rittel (1972) a paper cited infrequently which was presented at a ''Systems Analysis Seminar'' in Karlsruhe in 1971 run by the European Association of National Productivity Centres.

1.2. *What do we do when we do what we do?*

We draw attention to two practices that are poorly understood yet important to the question: what is it that we do when we do what we do? The first is the practice of neologising, using or coining new words or expressions. Someone who does this is a neologist and the result of their particular practice is a neologism. The second practice is the act of reifying, or creating a 'thing'. Wenger (1998, p. 58) draws attention to the implications of reification in his work on communities of practice. He describes reification as the practice of ''making into a thing'' which is something we do all the time although the implications of this practice are not well understood. It has particular implications when an abstraction, such as justice, is treated as a concrete material thing (Wenger offers the example of the common statues of a blindfolded woman who **is** justice). Wenger (1998) says: ''*we project our meanings into the world* [through living in language] *and then we perceive them as existing in the world, as having a reality of their own*'' (p. 58). Wenger goes on to use the abstract concept of reification to refer to ''*the process of giving form to our experience by producing objects that congeal this experience into 'thingness'*'' and he points out that he is introducing reification ''*into the discourse because he wants to create a new distinction to serve as a point of focus around which to organise* [his] *discussion*'' (p. 58). In other words Wenger, in his coining of 'reification', is creating a neologism.

Our purpose here is to focus on the practice – thus reifying. In trying to answer the question what is it that Rittel and Webber did when they did what they did, we find it insightful to ask: what experiences did they have that led them to coin these neologisms? This is a different question to asking: 'what are the characteristics of wicked problems?' which, we suggest, can result in more attention on labels rather than understanding the underlying epistemology of the neologism. Drawing on their paper, Rittel and Webber's (1973) main concerns were:

i. ''There seems to be a growing realization that a weak strut in the professional's support system lies at the juncture where goal-formulation, problem-definition and equity issues meet (p. 156). Goal-finding (central to planning) is turning out to be an extraordinarily obstinate task.'' (p. 157)
ii. ''We are now sensitized to the waves of repercussions generated by a problem-solving action directed to any one node in the network, and we are no longer surprised to find it inducing problems of greater severity at some other node. And so we have been forced to expand the boundaries of the systems we deal with, trying to internalize those externalities.'' (p. 159)
iii. ''We are calling them 'wicked' not because these properties are themselves ethically deplorable. We use the term 'wicked' in a meaning akin to that of 'malignant' (in contrast to 'benign') or 'vicious' (like a circle) or 'tricky' (like a leprechaun) or 'aggressive' (like a lion, in contrast to the docility of a lamb). We do not mean to personify these properties of social systems by implying malicious intent. But then, you may agree that it becomes morally objectionable for the planner to treat a wicked problem as though it were a tame one, or to tame a wicked problem prematurely, or to refuse to recognize the inherent wickedness of social problems.'' (pp. 160–161)
iv. ''The difficulties attached to rationality are tenacious, and we have so far been unable to get untangled from their web. This is partly because the classical paradigm of science and engineering – the paradigm that has underlain modern professionalism – is not applicable to the problems of open societal systems.'' (p. 160)

The following insights emerge:

i. The authors are explicitly concerned with the process of problem formulation – by naming ''equity'' they are aware, it seems, of who participates in formulating ''problems'' and how and by whom goals are articulated (notice they say goal finding, not goal setting);
ii. In what might be regarded as an early appreciation of the nature of networks they recognise that action at one node may induce unintended consequences at another node. They are implicitly referring to positive and negative feedback processes, the idea of unintended consequences that arise through interconnectedness (interdependence) or its breakdown, and that many boundary judgments fail to account for relevant externalities;
iii. They use the term wicked in a playful way, exploring different metaphors, whilst at the same time recognizing the seriousness of such situations;
iv. They claim there is no logic in the wicked problem situation which defines when a solution has been reached – the planner/designer stops for considerations that are external to the problem e.g., money, time, thus engaging in satisficing rather than optimising praxis (Simon, 1969); this suggests a co-evolutionary dynamic of praxis unfolding over time with context.
v. They raise three main implications for practice: (a) avoiding treating 'wicked problems' as tame ''*or to tame a wicked problem prematurely, or to refuse to recognize the inherent wickedness of social problems*'' (p. 161); (b) the need to develop a second generation systems approach that operates deliberatively in language (as an argumentative process) amongst stakeholders to form an image of the problem as ''*a product of incessant judgement, subjected to critical argument*'' (p. 162) and (c) that ''*one should try to settle*

the problem on as high a level as possible'' (p. 165) which leads them to argue against a policy of incremental design ''*on the grounds that successfully solving low-level problems (an increment) may make it more difficult to deal with higher level problems*'' (given their systemic interdependence and the propensity for members of organizations to only see problems on levels below their own) (Cross, 1975, p. 31);

vi. They recognise a very difficult context for the 'adoption' of their understandings, claiming rational approaches to be tenacious, unhelpful and supported by ''*the classical paradigm of science and engineering – the paradigm that has underlain modern professionalism [which] is not applicable to the problems of open societal systems*''.

Like many academic papers, Rittel and Webber's is written in a style that uses abstraction to become removed from the situation. They do not, for example, ground any of their claims in personal experience, though one is left in no doubt that they have had relevant experiences. They also say relatively little about practice. Horst Rittel was much more forthcoming about praxis in his 1972 paper where he outlined 10 principles of praxis for systems approaches of the second generation (Table 1). From our perspective these remain relevant today. But why were they not taken up and institutionalised?

It is tempting to conclude that because of the failures to institutionalise little has changed since 1969 – the classical paradigm remains pervasive (though human-induced climate change could act as a tipping point) and, as yet, a second generation systems approach has not taken hold in policy and governance circles, i.e., systems explanations and hence practices are not valued in this context. Humberto Maturana (pers. comm.) makes the point that when we accept a different explanation our world changes. But one can only assume that Rittel and Webber's distinctions have done little to change the worlds of policy makers and practitioners.

Next we ask what is the relationship between a neologism (such as 'wicked problem') and an explanation and how might the dynamics of change in this situation be better understood?

1.3. *Innovation through the displacement of understandings?*

One might argue that much progress could be made if situations such as climate change were more frequently framed as a mess, or a wicked problem, or a practice situation more like the swamp than the high ground. It is known from 40 plus years of teaching Systems and Design at the UK Open University that the mess/difficulty and wicked/tame distinctions have great utility for most students (see Chapman, 2004; Cross et al., 1974).[1] In many ways the practice response seems clear; recognise these situations for what they are. But is this a trap awaiting the unwary? Are there traps that can produce unintended consequences arising from the practices of neologising and reifying, and associated with these, of categorising and typologising? The act of categorisation is very common; in research practice the development of typologies is also a frequent form of practice. Although sometimes useful, the act of reification and the circulation of the products of reification in academic discourse in particular leads us to lose sight of how these 'things' came into existence and, further, the validity or viability in contemporary circumstances, of their on-going use (one only has to reflect on the ways in which some of these concepts are taught, and thus experienced by learners – the experience may be a far cry from the experiences of those who coined the neologism). This in turn can blind us to the choices we can make, and thus the responsibility we have, for how we engage with situations. Schön (1967) notes that ''*the situations we conceive in a certain way can be conceived in an infinite variety of ways as well*'' (p. 7).

At its simplest we can choose to engage with a situation as if it were a tame or wicked problem, a mess, difficulty, complex adaptive system, etc., but each choice brings with it different consequences. Experience shows that engaging with situations as a 'difficulty' when they might be better understood as 'messes' has the effect of exacerbating the mess. Yet without the distinction mess/difficulty, we may be blind to the dynamics and thus possibilities in the situation. This, however, is a first order dynamic which is probably most obvious if one considers the type of understanding and underlying emotioning (a verb form of 'emotion', attributed to Maturana – see Maturana and Poerksen, 2004) that might arise when a student is exposed to the wicked/tame distinction and their features in a typical lecture format, followed by a traditional form of assessment (i.e., the 'learning' may be characterised by ability to recall the features, or characteristics, of a mess, rather than the experiences of having to do something about a 'mess'). Of course this dynamic, and the degree to which it is a first, or second-order dynamic will depend on the history of experiences of the student or policy maker.

Having embarked on this inquiry we found that Donald Schön has, in part, been there before us. His work initially published as *The Displacement of Concepts* (1963) and then re-issued as *Invention and the Evolution of Ideas* (1967) is illuminating. For example, he makes the point (1967, p. 7) that ''*when we identify something as an instance of a concept already given we do nothing to modify our conceptual scheme, we simply order experienced things in terms of it.*'' He goes on to say that:

> ''. . .once having resolved a problematic area of experience, once having found a way of looking at (and therefore dealing with) a situation which was at first novel and puzzling, our impulse to stick with it is overwhelmingly powerful. We have ''adapted to it, and through it''. (p. 8)

Schön's insight was that a human's concept-forming apparatus operates under a categorical imperative of 'let well enough alone'. Rittel (1972) was clearly aware of this, or a similar, phenomenon operating through what he called 'objectification' (p. 394). For Rittel, objectification was the process of making one's judgments transparent and communicable (not the same as making something objective, the more common interpretation of this word). Rittel's aspiration

[1] The concepts of wicked and tame problems were incorporated in Open University (UK) teaching material (T262 Man Made Futures. Design and Technology) in 1974 (see Cross et al., 1974) and that of mess and difficulty in 1980 (T243 Systems Organization: The Management of Complexity).

Table 1 – A comparison of praxis elements in Rittel's (1972, pp. 394–395) account of principles contributing to second generation systems approaches with systemic governing praxis developed within the SLIM (Social Learning for the Integrated Management of Water, EU Framework 5 Project 2000–2004) research lineage and some possible implications for the praxes of crafting and designing institutions.

Second generation systems praxis after Rittel (1972)	Second generation systems praxis in the SLIM social learning tradition	Possible implications for designing and crafting institutions
1. *The knowledge needed is not concentrated in a single head*: involve those affected but who are not the experts	Rittel's position is understood; recognise and value multiple partial perspectives and design processes and stakeholder engagement accordingly	See policy as praxis, not prescription; Recognise the limitations of expertise and those fully committed to rationalistic/ scientistic evidence building?
2. *Nobody should be planned at*: invite people who are being affected to participate in the planning process	Linked to frameworks of power–power over, power with and power to and researcher position, i.e., as observer, facilitator or co-inquirer	Reframe policy maker, planner, etc. roles as systemic crafter and designer of institutions?
3. *Use methods which make all steps in the planning process communicable and transparent*: as at every step in engaging with a wicked problem there is a judgement involving an 'ought to be' claim	Systems diagramming is used extensively to reveal underlying mental models, causality and epistemological commitments; Ulrich's critical systems heuristics can be used explicitly to contrast 'is' and 'ought' modes and make boundary judgments transparent (Ulrich and Reynolds, 2010)	Develop praxis and associated methods that tease out judgments in relation to historical, contemporary and future institutions?
4. *Make explicit and communicable the basis of all judgments*: by bringing the foundations of judgement into deliberation	Seek accommodations of difference rather than consensus and explore meaningfully the differences that make a difference (Blackmore et al., 2007)	As above; recognise that crafting and designing institutions is not enough–other factors also constrain or enhance transformation?
5. *Recognise that there is no such thing as scientific planning*: dealing with wicked problems is always political	Scientific understanding is recognised as necessary but not sufficient–scientific results can be used to design learning systems or mediating objects	Recognise the limitations of all forms of expertise but particularly scientific and economic; invent new modes of praxis (see Ison et al., 2011)
6. *A practitioner's role is to bring about problems*: rather than offer solutions	Having broken out of the historical trap of seeing systems as ontologies rather than epistemologies attention is paid to framing of situations and issue construction (*cf.* problem structuring concerns in contemporary operations research)	Beware of the metaphorical entailments of the verbs crafting and designing–ask in every context how they are understood and enacted?
7. *A practitioner makes careful, seasoned 'respectlessness'*: in which casting a doubt becomes a virtue	Understand practice as an emotioning and languaging process which starts with an uncertain situation (Ison, 2010)	Abandon certainty and its underlying emotion as well as institutions that demand certainty *a priori* as part of engaging with uncertain situations, e.g., log frames, etc.
8. *Maintain moderate activism and optimism*	Enthusiasm is a key aspect of practice innovation (Ison, 2010)	Be responsive to the emotional dynamics of praxis and be aware how emotions can be manipulated?
9. *Use a conspiracy model of planning*: find people who will share the risk of the venture or adventure; collaborate	Join up people with common enthusiasms for action (Russell and Ison, 2007)	Consider the practices that contribute to enthusiasm when designing and crafting – e.g., listening, experiencing, etc.?
10. *Understand the planning process as an argumentative process and make it explicit*: one of raising questions and issues upon which different positions can be taken	Create process designs based on distinctions between debate and dialogue-based communication; tease out deliberatively distinctions between what, why and how so that participants are not talking at crossed purposes	Do not avoid conflict, but facilitate it, allow it to emerge but have time to deal with it; do not seek premature agreement; tease out difference and test assumptions systemically?

was for the systems researcher of the second generation to enable "*better mutual understanding of the bases of judgement of others*" (p. 394) in ways that does not "*make it less likely that people come to an agreement. More deliberation does not lead to agreement but it may lead to understanding*" (p. 394). Rittel and Schön's insights taken together suggest a fruitful line of inquiry for moving towards systemic governance through praxis innovation.

2. What does this inquiry reveal?

So how do these insights illuminate the dynamics of the wicked/tame distinctions, and their entailments, in social and professional discourse and practice over the last forty years? If we stand back from the specifics of Rittel and Webber's paper, some interesting questions emerge such as: how, if at all, have wicked and tame problems become reified? An alternative question would be: how have they entered our understandings and practices? Unfortunately we have not undertaken or seen a study that sets out to answer these questions in a systematic way. The APSC paper referred to earlier can be seen as part of a lineage of attempts to reify understandings about 'wicked' and 'tame' problems in policy and governance discourse. But surely this has been tried before? New elaborations on the wicked and tame distinctions have also emerged (Brown et al., 2010). Levin et al. (2012) claim that some problems, for

example climate change, are 'super wicked' and demonstrate four features in addition to the ten proposed by Rittel and Webber (1973), including: (1) ''time is running out'', (2) ''those seeking to end the problem are also causing it'', (3) there is ''no central authority'', and (4) ''policies discount the future irrationally''. They propose a forward-focused analytical frame to help policy-makers address, and not exacerbate, super wicked problems. Likewise, Head and Alford (2013) argue that provisional solutions can be found to some wicked problems.

It is probably too simplistic to claim that progress could be made if only more people were aware of the understandings that the distinctions mess/difficulty or wicked (or super-wicked)/tame problem evoke. It is a start but not enough. Schön's work can help; his primary concern is with innovation; the displacement of old concepts by new. But is the wicked problem issue really a failure of innovation (i.e., a failure of displacement), and thus a form of repression or suppression, a failure to be open to, and responsible for, our circumstances? If so, then a question might be: why has the concept of wicked problems (or messes) not displaced other problem metaphors, whether called 'tame', 'difficulties' or just plain old 'problems'? Have wicked and tame just become part of a disembodied classificatory system for types of problems? Is it that the underlying 'problem' metaphor does not have the right affordances, especially in multi-stakeholder contexts (i.e., features that invite actions or reactions that are readily apparent to a user)? Perhaps it is these factors which lie behind the growing popularity of the 'complex adaptive system' (CAS) metaphor (Rammel et al., 2007), although as noted elsewhere (see Ison and Schlindwein, 2006), the users of this neologism perpetuate many of the same mistakes made by systems practitioners over the last fifty years, including creating or reifying CASs as things or objects.

Neologising, reifying, categorising and typologising have unintended consequences – they remove us from the primary experiences and underlying emotions that provided the motivation for formulating these concepts in the first place. As a result the non-reflexive use of these terms, and the absence of appropriate institutional and governance settings, appear to inure users of the concepts to epistemic shifts, emotional transformations, ego release, identity expansion, reflexivity and the abandonment of certainty. Thus when scoping conditions for methods for purposeful institutional change it will be important that any attempts to typologise, such as generating categories or rules for framing choices, are presented within a praxis framework that conveys their systemic implications and keeps open reflexive possibilities.

Wenger (1998), in the context of communities of practice, has come to understand reification of practices as part of a duality, constituting a whole with participation. It is through participation that the historical consequences of reification can be undone. However, as we outline elsewhere (Collins and Ison, 2009a), in multi-stakeholder situations participation is necessary but not sufficient. We would reframe Wenger's duality to comprise (i) institutional reification through crafting and designing with (ii) systemic governing, as an alternative duality that subsumes the participation/reification duality.

By being more aware of what we do (i.e., reifying) when we bring forth a thing or an object it might be possible to devise practices to deal with the unintended consequences – such practice might be characterised by forms of contextual deconstruction, including practices such as metaphor analysis (Ison, 2002; Ison et al., 2013; McClintock et al., 2004, 2003) or building narrative-network coalitions (see Ingram et al. 2014) that conserve stories of subjugated discourses, e.g., historical attempts to purposefully frame situations as wicked. Schön (1967), for example, claims that what he calls the displacement of concepts is ''*simply another word for the process of metaphor*'' (p. 57). Ironically Rittel (1972) through the process of 'objectification' illuminates the trap that has emerged. Whenever the reified category is used in discourse, i.e., '**it is** a wicked problem' then the language game in the Wittgensteinian sense too often moves away from addressing the question: On what basis would I choose to frame this situation as if it were a wicked problem'? – a question that makes the basis of judgement about framing transparent and communicable – to a debate or claim over classification.

Let us exemplify. In work reported in Ison (2002, also see 2010) policy makers responsible for a new 'knowledge transfer strategy' were engaged through a process of exploring their metaphors in use. In the language of this paper the policy proposed was designed to treat wicked problems as tame. It was Ison's action of being highly critical of the policy in a public forum that led to his invitation to meet and speak with the Ministry officials. This dynamic is important – it is what we call the 'politics of invitation' (see High et al., 2008) – as it creates the underlying emotional dynamic that unfold in inquiry processes. We do not recount here what was done other than to say that the method led, as hoped, to a very authentic conversation (see Lincoln and Guba, 1985), one that was highly reflexive, and thus unusual among the five or so people involved. This event was not, however, framed by any institutional arrangements that made it ongoing – it was not a project, nor did it become one. From a follow-up evaluation it was evident that the approach had been effective in triggering reflexivity but it did not trigger any on-going relationship or set of activities.

Boxelaar et al. (2007) make the point that interventions that merely offer a critique that challenges the prevailing narrative settings can increase uncertainty (and one might surmise, cognitive dissonance). They argue for practices that create ''*an alternative narrative space in which people can place themselves*'', particularly practices that ''*provide a space for people to perform and enhance their identities within a context of change*'' (p. 174). It is not clear however, what practices can achieve this, nor do they give consideration to the effects of powerful institutional arrangements that may get in the way such as the 'project', i.e., our manner of living in a projectified world (see Ison, 2010; Ison et al., 2007). In other words, there is a need to move beyond understanding 'institutions' as 'things' – as particular reifications.

As outlined in Ison (2010) an institution can be reframed as a social technology particularly when procedures and rules designed to standardise behaviour are reified or institutionalised, and used routinely without awareness of the origins and implications of the use of such techniques. Reframing institutions as social technologies opens up or reveals questions relating to the technological mediation of practice and thus experience. The theoretical shift to the phenomenology of

technology has, we suggest, implications for the praxis of crafting, a concern of this special issue. Crafting is the work of 'making skilfully' but unless what is made is understood in terms of what it mediates, facilitates, or offers affordances to (e.g., a meeting design based on dialogue rather than debate; see Isaacs, 1993; Kersten and Ison, 1998), then crafting remains a praxis devoid of purpose and the potential for the transformation of experience.

So what contribution can this inquiry make to the design of practical action in a situation that might usefully be described as a 'wicked problem' or a mess and how does this relate to the praxis of crafting institutions that are fit for purpose? We explore this in the next section with examples grounded in water governance.

3. Reframing water governance

Many countries at the moment are enacting water governance experiments in their attempts, knowingly or not, to govern (in the cyber-systemic sense) water catchments as social–biophysical systems co-evolving in response to feedback. These are experiments in that many of the concepts and associated practices remain untested in situations where stationarity needs to be abandoned (i.e., the idea that natural systems fluctuate within an unchanging envelope of variability, which has become a foundational concept that permeates training and practice in water-resource engineering – see Milly et al., 2008). In this section we draw upon 13 years of research on 'social learning' in the context of the sustainable managing of water catchments and climate change adaptation within Europe, South Africa, Australia and China (Collins et al., 2009; Colvin et al., 2014; Ison et al., 2011, 2007; Wallis et al., 2013; Wei et al., 2011). Our research has been concerned with the question: 'Can systems-based social learning research provide a theoretical and praxis framework capable of dealing with the challenge of institutionalising systemic governance?' Our question can also be understood as: 'Can social learning and systemic praxis approaches effect social and institutional transformations that are viable and sustainable in situations usefully framed as natural resource dilemmas or 'wicked problems'?' An answer to these questions could be the further development of the second-generation systems approaches that Rittel and Webber (1973) identified as needed (Table 1; Colvin et al., 2014; Ison et al., 2011; Rittel, 1972).

As outlined by Collins and Ison (2009a, 2006), while the 'social' in social learning refers to the collective process that can take place through interactions among multiple interdependent stakeholders who are given proper facilitation, institutional support and a conducive policy environment, our research findings suggest that social learning can be understood as one or all of the following (SLIM, 2004):

1. The negotiation of purpose, success criteria and ways of knowing leading to more accurate mutual expectations and the building of relational capital. If social learning is at work, then convergence (through accommodations of difference) and relational capital generate agreement on concerted action for integrated catchment managing and the sustainable use of water. Social learning may thus result in on-going sustainable resource use.
2. The process of co-creation of knowledge, which provides insight into the causes of, and the means required to transform, a situation. Social learning is thus an integral part of the make-up of concerted action.
3. The change of behaviours and actions resulting from understanding something through action ('knowing') and leading to concerted action. Social learning is thus an emergent property of the process to transform a situation.
4. The title for a governance mechanism which policy makers can employ particularly in contexts usefully framed as 'wicked' (Fig. 1).

A central starting condition of our research on social learning and water catchment managing was our framing of 'sustainability' and thus effectiveness of practice responses as an emergent property of social interaction rather than a technical property of a biophysical system. Conceptually we understand all practice as situated (Fig. 1a) and involving choices, made knowingly or not, about engaging with situations through framing choices (Fig. 1b). Here we compare key praxis elements that have informed and resulted from our research with those outlined by Rittel (1972) – see Table 1 and Fig. 1.

Contemporary Australian, European, South African and Chinese water governance situations might usefully be understood as 'wicked problems', but our experience is that most are framed, in Rittel and Webber's (1973) terms, as 'tame' situations (Fig. 1b). Entailments of a 'tame' framing include: (i) acceptance that a problem exists independently of the processes of its formulation; (ii) that once named, a problem is, or can be, fixed (i.e., a version of stationarity; Milly et al., 2008); (iii) that traditional environmental governance mechanisms can be applied (i.e., education, information, fiscal measures, including markets, and regulation; Ison et al., 2007). Unless one asks, one is never sure if a situation is framed as 'tame' knowingly, or not. In contrast, a purposeful choice to frame a situation as 'wicked' immediately opens up more choices because the practitioner has the distinction 'wicked/tame' at their disposal. However, labelling situations as 'wicked' does not guarantee that others will agree or that practices in relation to the situation will change even though the social choices available to practitioners increases when a 'wicked' framing is adopted (pathways W1a, W1b; W2, W3 and F (feedback) in Fig. 1c). The policy pathways increase when 'wicked' and 'tame' are understood as a duality (a systemic whole) rather than a self-negating pair (a dualism). This is because awareness of choices and their implications are embedded in practice. The pathway choices increase further when a 'wicked' framing is followed by a choice of a systemic approach to governance, such as social learning (Ison et al., 2013). We propose that the act of being aware of framing choices and governance choices are central to systemic governance as are the feedback implications (learning and adaptation) depicted in Fig. 1c. On the other hand, those who unknowingly frame situations as 'tame' and employ, non-reflexively, the traditional governance mechanisms, engage in systematic rather than systemic water governance.

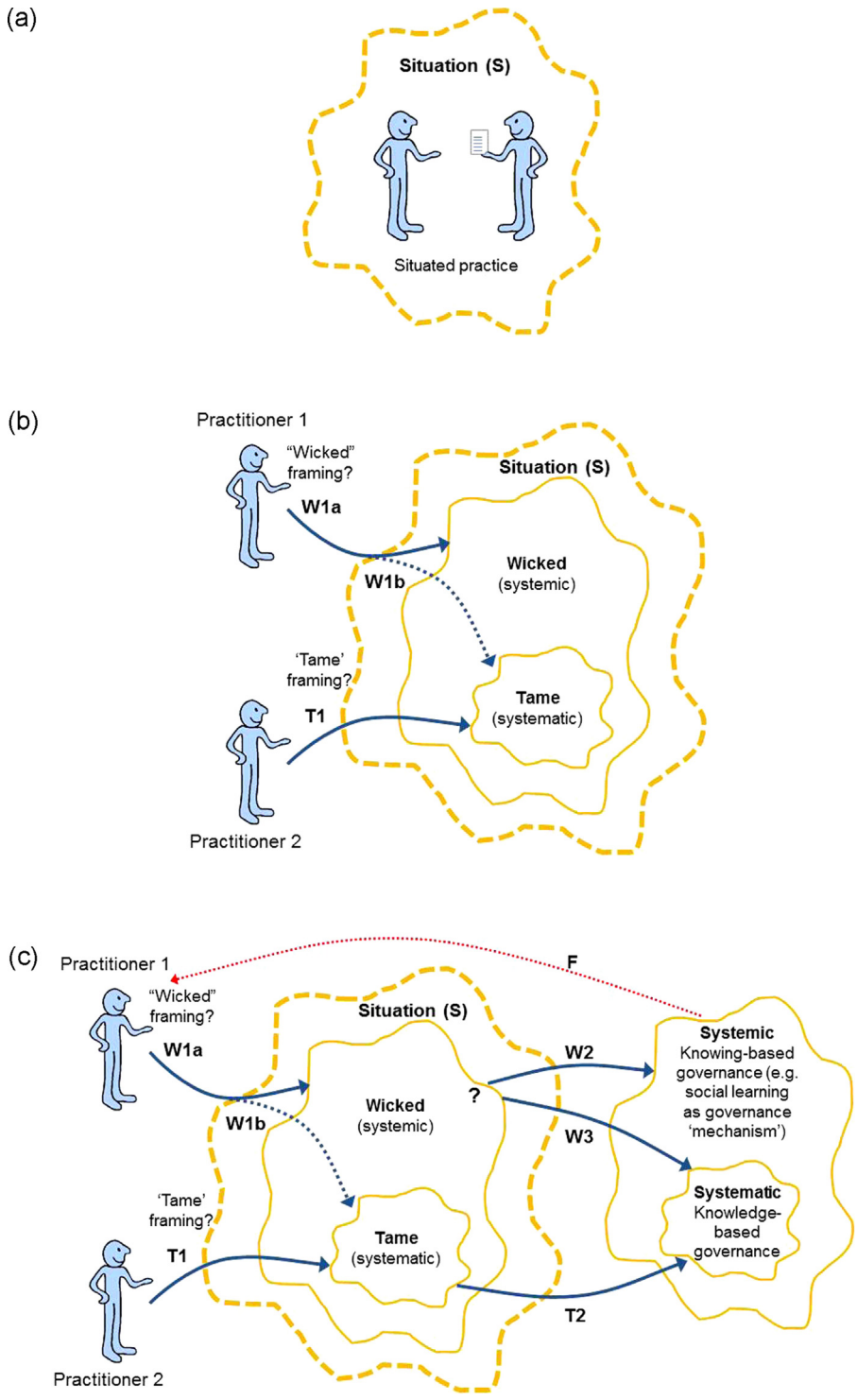

Fig. 1 – The consequences of framing choices (wicked or tame situations) for systemic governance based on social learning. All practice is understood as situated (a). In (b) practitioner 1, aware of the distinction wicked and tame has a framing choice (pathway W1a or W1b); practitioner 2, not aware of the distinction wicked/tame has fewer choices and generally resorts to systematic governance mechanisms (pathway T2 in (c)). Coupling a wicked framing with a systemic governance mechanism based on processes of knowing (not reified knowledge) opens up further choices and possibilities for co-evolutionary adaptation of practice with situation (c: Source adapted from Ison et al., 2007).

Based on this inquiry, a key question would seem to be: 'How can the circumstances be created such that an explanation of the situation as a 'wicked situation' is accepted by the most powerful stakeholders and the consequences enacted? In other words, how could political legitimisation be built into the process so that social learning can operate effectively? The case of the APSC (2007) review referred to earlier, written from the heart of government, could be seen to exemplify systemic failure because purposeful framing choice praxis has yet to be institutionalised into governance activities. On the other hand there is evidence of systemic governance initiatives emerging in water governance in the UK through processes of knowledge co-production. This raises the question of how framing processes might be designed so as to contribute to systemic governance innovation.

In earlier work (see Russell and Ison, 2004) we have drawn on Maturana's concept of conversation as the braiding of emotion and language as a framework-for-action. In that work we follow Maturana's claim that learning and change take place in a relational space, over time, and as a consequence of engagements shaped by the participants' emotions. Thus, in the purposeful design of an innovative governance system, or systems, a number of choices seem apparent: (i) a rational, evidence-based approach; (ii) a small 'p' political approach-based say, on relationship building and opening up spaces for invitations that create the possibility for personal transformation in emotions; (iii) building a discourse (e.g., Krippendorff, 1995) or, (iv) combinations of all three. We already have empirical evidence for enacting governance arrangements based on social learning, as depicted in Fig. 1, in Europe, Australia, China and South Africa. But what we do not have evidence of is the purposeful choice to invest in social learning as an alternative or complementary governance mechanism, i.e., a failure of investment in governance-institution design and crafting. Our empirical evidence, rather than just constituting part of a rational argument thus becomes a mediating object which opens up spaces for learning and, hopefully, institutional innovation. In Europe the discourse about social learning, though not yet institutionalised, seems stronger than in Australia because of more social learning R&D and the characteristics of the European Water Framework Directive (WFD) which create some 'demand pull'. Undoubtedly well designed experiential activity delivers the best conversation and opens up more possibilities for the choreography of the emotions, but as outlined in High (2002) this requires practices which also open up engagement opportunities.

The choices that are outlined in Fig. 1 can be understood through a key element of systemic practice – that of making boundary judgments to a system of interest. Thus a tame framing choice could be understood as a choice to bound a system of interest in a restricted way but with awareness that the 'tame elements' could be understood as a sub, or sub-sub system of a larger system (i.e., a 'wicked' framing). Conceptualising framing choices in systemic terms is one means of bringing systemic coherence to practices ranging from reductionist experimentation, to modelling, to scenario building. As referenced in Table 1, Ulrich's critical systems heuristics can be used explicitly to contrast 'is' and 'ought' modes and make boundary judgments transparent (Ulrich and Reynolds, 2010). Equally, Fig. 1 draws attention to the duality between framing choice and governance arrangement so crafting institutions independently of a governing praxis may not secure the forms of social transformations desired.

4. Concluding comments

Given the above review and our commitment to ongoing inquiry, it would be inconsistent to present a set of definitive conclusions as a final statement of our position. Instead we offer some reflections on future directions and emerging implications. A systemic, reflexive inquiry approach to research practice was undertaken by asking what Rittel and Webber (1973) did when they coined the terms 'wicked' and 'tame' problems. Theirs is a specific example of a generic form of practice amongst scientists with, we suggest, profound implications for policy development and governance innovation more generally. In relation to the concept of 'wicked problem', and similar framings, there has clearly been on-going institutional failure, including a failure of governance innovation due to the persistence of practices that conserve 'technical rationality' – a condition that gave rise to the neologism 'wicked problem' in the first place. This example clearly has implications for how the praxis of crafting institutions needs to be considered (Table 1).

This inquiry evidences how awareness of the distinctions wicked and tame can enable more choices for practical action, which in turn can be enhanced if these choices are considered within an overall governance context (Fig. 1). However, the processes of transforming understandings and practices upon which social learning rests, can be hampered by (i) the way in which language acts as a social technology and (ii) arrangements that preclude novel configurations in the flow of emotioning, crucial to epistemic and identity shift (Boxelaar et al., 2007; Ison et al., 2011; Salner, 1986). Practices associated with the coining, acceptance and reification of new concepts and institutions can produce unintended consequences. In any purposeful activity such as researching this may create initial starting conditions that preclude transformations that improve complex situations. Ultimately situations such as water governing and climate change adapting are problems of relationship – of human beings with the biosphere – so perhaps other research traditions concerned with the breakdown of relationships, such as systemic family therapy, or performance theory that concerns itself with the relational dynamic with an audience, may offer ways forward, particularly if social–biophysical systems are understood as the co-evolution of on-going structural coupling of two systems, the social with the biophysical (Collins and Ison, 2009b).

Our paper is organised in four areas: a problematique, a critical inquiry, an investigation into how water governance can be reframed and concluding comments. This structure mirrors how praxis in relation to situations, such as water governance, usefully framed as wicked, might be organised. As Fig. 1 demonstrates policy-makers aware of their own agency in framing choice together with a need to consider governance context, open up more choices for action. We argue that 'wicked' or 'tame' problems are framing-choices that can be made by a practitioner rather than a class of

problem that exists independently of its social construction. Situations that warrant a 'wicked'' (or similar) framing are pervasive and when used demand alternative governance approaches such as social learning. The key need that social learning addresses is how to orchestrate effective performances amongst multiple stakeholders in situations usefully framed as 'wicked'. This involves the transformation of complex situations to improved situations through changes in understanding and practices of those involved which in turn requires the participation of multiple-stakeholders (Collins and Ison, 2009b). But, as our research reveals, history, and thus initial starting conditions, including framing, conducive institutions, the active building of stakeholding (the act of holding a stake), good facilitation and the surfacing of hidden epistemological assumptions are all needed to build effective performances (Steyaert and Jiggins, 2007; Table 1).

As a policy instrument 'social learning' can be understood as a duality (a governance mechanism and a social dynamic, just like a concert orchestra) rather than a dualism (Ison et al., 2013). Cross (1975) in course material relating to wicked and tame problems makes the point that 'the problems of science are concerned with 'what appears to be' whereas design problems are concerned with 'what ought to be': now is the time to invest in the second generation deliberative, systemic praxis envisaged over 40 years ago. What Rittel (1972; Table 1) imagined and what we practice and advocate encompasses a 'design turn' (Jones, 2014) that moves beyond the restrictive and dated view that systems science is merely a tool for describing a problem (Robin et al. 2013, p. 521).

The onset of the global water crisis, peak oil and anthropogenic climate change at much the same time together with growing population and consumerism bring a new type of attention to our circumstances – the situations in which we find ourselves. If human beings (along with other species on which we impact) wish to continue to co-evolve with the earth then we have little choice but to understand and act differently to that of the past. Following Ison (2010) we are tempted to conclude that human beings are yet to understand the implications of living in language, or put another way, have failed to see how language can act as a social technology that mediates our understandings and practices and thus our relationship with the biophysical world. Or, following Maturana (pers. comm.), we have failed to realise that we do not use language but that language uses us in ways we are yet to appreciate and master.

REFERENCES

Ackoff, R.L., 1974a. The systems revolution. Long Range Plan. 7 (6) 2–20.

Ackoff, R.L., 1974b. Redesigning the Future: A Systems Approach to Societal Problems. Wiley, New York.

Allan, C., 2009. Reviewing adaptive management through a wicked lens. In: Lane, M., Robinson, C., Taylor, B. (Eds.), Contested Country: Local and Regional Natural Resources Management in Australia. CSIRO Publishing, Collingwood, Australia, pp. 215–226.

APSC, 2007. Tackling Wicked Problems: A Public Policy Perspective. Australian Public Service Commission, Canberra.

Blackmore, C.P., Ison, R.L., Jiggins, J., 2007. Social learning: an alternative policy instrument for managing in the context of Europe's water. Environ. Sci. Policy 10 (6) 493–498.

Blanchard, E.V., 2010. Modelling the future: an overview of the Limits to Growth debate. Centaurus 52 (2) 91–116.

Blunden, M., Dando, M., 1994. Rethinking public policy-making. Questioning assumptions, challenging beliefs. Essays in honor of sir Geoffrey Vickers on his centenary. Am. Behav. Sci. 38 (1) 1–192.

Boxelaar, L., Paine, M., Beilin, R., 2007. Change management and complexity: the case for narrative action research. J. Agric. Educ. Ext. 13 (3) 163–176.

Brown, V.A., Harris, J.A., Russell, J.Y., 2010. Tackling Wicked Problems Through the Transdisciplinary Imagination. Earthscan, London/Washington, DC.

Chapman, J., 2004. System Failure: Why Governments Must Learn to Think Differently. Demos, London.

Churchman, C.W., 1967. Wicked problems. Guest editorial. Manage. Sci. 14 (4) 141–142.

Cilliers, P., 1998. Complexity and Postmodernism: Understanding Complex Systems. Routledge, London.

Collins, K.B., Colvin, J.C., Ison, R.L., 2009. Building learning catchments for integrated catchment managing: designing learning systems and networks based on experiences in the UK, South Africa and Australia. Water Sci. Technol. 59 (4) 687–693.

Collins, K.B., Ison, R.L., 2006. Dare we jump off Arnstein's ladder? Social learning as a new policy paradigm. In: Proceedings of the PATH (Participatory Approaches in Science and Technology) Conference, 4th–7th, Edinburgh.

Collins, K.B., Ison, R.L., 2009a. Jumping off Arnstein's ladder: social learning as a new policy paradigm for climate change adaptation. Environ. Policy Gov. 19 (6) 358–373.

Collins, K.B., Ison, R.L., 2009b. Living with environmental change: adaptation as social learning. Environ. Policy Gov. 19 (6) 351–357.

Colvin, J., Blackmore, C., Chimbuya, S., Collins, K.B., Dent, M., Goss, J., Ison, R.L., Roggero, P.P., Seddaiu, G., 2014. In search of systemic innovation for sustainable development: a design praxis emerging from a decade of social learning inquiry. Res. Policy 43, 760–771.

Cross, N., 1975. Man-made futures. In: Design and Technology, Section 3: Social Problems and Technological Solutions (T262). The Open University, Milton Keynes.

Cross, N., Elliot, D., Roy, R., 1974. Man-made futures. In: Readings in Society and Design: Hutchinson Educational in Association. The Open University, London.

Giddens, A., 2009. Politics of Climate Change. Polity, London.

Hajer, M.A., Wagenaar, H., 2003. Deliberative Policy Analysis: Understanding Governance in the Network Society. Cambridge University Press, Cambridge.

Head, B.W., Alford, J., 2013. Wicked problems: implications for public policy and management. Adm. Soc., http://dx.doi.org/10.1177/0095399713481601.

High, C., 2002. Opening up spaces for learning: A systems approach to sustainable development. (Unpublished Ph.D. dissertation)The Open University, Milton Keynes, UK.

High, C., Ison, R.L., Blackmore, C., Nemes, G., 2008. Starting off right: reframing participation though stakeholder analysis and the politics of invitation. In: Proceedings of Working Group 13. The OECD's New Rural Paradigm, XII World Congress of Rural Sociology, Seoul, Korea.

Holling, C.S., 1973. Resilience and stability of ecological systems. Annu. Rev. Ecol. Syst. 4, 1–23.

Hubert, B., Ison, R.L., 2011. Institutionalising understandings: from resource sufficiency to functional integrity. In:

Kammili, T., Bernard, H., Tourand, J.-F. (Eds.), A Paradigm Shift in Livestock Management: From Resource Sufficiency to Functional Integrity. Cardère éditeur, Lirac, France, pp. 11–16.
Hulme, M., 2009. Why We Disagree About Climate Change: Understanding Controversy, Inaction and Opportunity. Cambridge University Press, Cambridge.
Hussey, K., Dovers, S., 2007. Managing Water for Australia. CSIRO Publishing, Canberra.
Ingram, H., Lejano, R., Ingram, M., 2014. From Discourse Coalitions to Narrative-Networks: Uncovering Networks in the Deliberative Process, APSA 2014 Annual Meeting Paper. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2452641 (accessed 20.10.14).
Isaacs, W.N., 1993. Taking flight: dialogue, collective thinking and organisational learning. Org. Dyn. 22 (2) 24–39.
Ison, R.L., 2002. Some reflections on a knowledge transfer strategy: a systemic inquiry. In: Proceedings of the Fifth IFSA European Symposium, Farming and Rural Systems Research and Extension, Florence, pp. 8–11.
Ison, R.L., 2010. Systems Practice: How to Act in a Climate Change World. Springer, London.
Ison, R.L., Blackmore, C.P., Iaquinto, B., 2013. Towards systemic and adaptive governance: exploring the revealing and concealing aspects of contemporary social-learning metaphors. Ecol. Econ. 87, 34–42.
Ison, R.L., Collins, K.B., Colvin, J.C., Jiggins, J., Roggero, P.P., Seddaiu, G., Steyaert, P., Toderi, M., Zanolla, C., 2011. Sustainable catchment managing in a climate changing world: new integrative modalities for connecting policy makers, scientists and other stakeholders. Water Resour. Manage. 25 (15) 3977–3992.
Ison, R.L., Röling, N., Watson, D., 2007. Challenges to science and society in the sustainable management and use of water: investigating the role of social learning. Environ. Sci. Policy 10 (6) 499–511.
Ison, R.L., Schlindwein, S., 2006. History repeats itself: current traps in complexity practice from a systems perspective. In: Proceedings of the 12th Australia New Zealand Systems Society (ANZSYS) Conference, Sustaining Our Social and Natural Capital. pp. 3–6.
Jones, P.H., 2014. Systemic design principles for complex social systems. In: Metcalf, G.S. (Ed.), Social Systems and Design. Springer, Tokyo, pp. 91–128.
Kersten, S., Ison, R.L., 1998. Listening, interpretative cycles and dialogue: process design for collaborative research and development. J. Agric. Educ. Ext. 5 (3) 163–178.
Krippendorff, K., 1995. Redesigning design – an invitation to a responsible future. In: Tahkokallio, P., Vihma, S. (Eds.), Design: Pleasure or Responsibility. University of Art and Design, Helsinki, pp. 138–162.
Levin, K., Cashore, B., Bernstein, S., Auld, G., 2012. Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. Policy Sci. 45 (2) 123–152.
Lincoln, Y.S., Guba, E.G., 1985. Naturalistic Inquiry. SAGE, California.
Lowe, T., 2013. New development: the paradox of outcomes – the more we measure, the less we understand. Public Money Manage. 33 (3) 213–216.
Maturana, H., Poerksen, B., 2004. From Being to Doing: The Origins of the Biology of Cognition. Carl-Auer, Heidelberg.
Maturana, H., Verden-Zoller, G., 2008. The Origin of Humanness in the Biology of Love. Imprint Academic, Exeter.
McClintock, D., Ison, R.L., Armson, R., 2003. Metaphors of research and researching with people. J. Environ. Plan. Manage. 46 (5) 715–731.
McClintock, D., Ison, R.L., Armson, R., 2004. Conceptual metaphors: a review with implications for human understandings and systems practice. Cybern. Hum. Know. 11 (1) 25–47.
Milly, P.C.D., Betancourt, J., Falkenmark, M., Hirsch, R.M., Kundzewicz, Z.W., Lettenmaier, D.P., Stouffer, R.J., 2008. Stationarity is dead: whither water management? Science 319 (5863) 573–574.
Moll, P., 1991. From Scarcity to Sustainability: Futures Studies and the Environment: The Role of the Club of Rome. Peter Lang Pub Incorporated, Frankfurt am Main.
Norgaard, R., 1981. Sociosystem and ecosystem coevolution in the Amazon. J. Environ. Econ. Manage. 8 (3) 238–254.
Rammel, C., Stagl, S., Wilfing, H., 2007. Managing complex adaptive systems – a co evolutionary perspective on natural resource management. Ecol. Econ. 63 (1) 9–21.
Ritchey, T., 2013. Wicked problems: modelling social messes with morphological analysis. Acta Morphol. Gen. 2 (1) 1–8.
Rittel, H.W.J., 1972. On the planning crisis: systems analysis of the 'first and second generations. Bedriftsokonomen 8, 390–396.
Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a general theory of planning. Policy Sci. 4 (2) 155–169.
Robin, L., Sörlin, S., Warde, P., 2013. Commentary. Mike Hulme, "Reducing the future to climate (2011)" In: Robin, L., Sörlin, S., Warde, P. (Eds.), The Future of Nature: Documents of Global Change. Yale University Press, New Haven, pp. 520–525.
Russell, D.B., Ison, R.L., 2004. Maturana's intellectual contribution as a choreography of conversation and action. Cybern. Hum. Know. 11 (2) 36–48.
Russell, D.B., Ison, R.L., 2007. Enthusiasm: developing critical action for second-order R&D. In: Ison, R.L., Russell, D.B. (Eds.), Agricultural Extension and Rural Development: Breaking out of Knowledge Transfer Traditions. Cambridge University Press, Cambridge, UK, pp. 136–160.
Salner, M., 1986. Adult cognitive and epistemological development in systems education. Syst. Res. Behav. Sci. 3 (4) 225–232.
Schön, D.A., 1963. Displacement of Concepts. Tavistock, London.
Schön, D.A., 1967. Invention and the Evolution of Ideas. Social Science Paperbacks, London.
Schön, D.A., 1995. The new scholarship requires a new epistemology. Change 27 (6) 27–34.
Schön, D.A., Rein, M., 1994. Frame Reflection: Toward the Resolution of Intractable Policy Controversies. BasicBooks, New York.
Seager, T., Selinger, E., Wiek, A., 2012. Sustainable engineering science for resolving wicked problems. J. Agric. Environ. Sci. Ethics 25 (4) 467–484.
Simon, H.A., 1969. The Sciences of the Artificial. MIT Press, Cambridge.
SLIM, 2004. SLIM Framework Social Learning for the Integrated and Sustainable Management of Water. Available at: http://slim.open.ac.uk.
Steyaert, P., Jiggins, J., 2007. Governance of complex environmental situations through social learning: a synthesis of SLIM's lesson for research, policy and practice. Environ. Sci. Policy 10 (6) 575–586.
Thiel, A., Mukhtarov, F., Zikos, D., 2015. Crafting or designing? Science, politics and conditions for intended institutional change in social ecological systems. Environ. Sci. Policy 53, 81–86.
Thompson, M., 1993. Good science for public policy. J. Int. Dev. 5 (6) 669–678.
Thompson, M., Warburton, M., 1985. Decision making under contradictory certainties: how to save the Himalayas when you can't find out what is wrong with them. J. Appl. Syst. Anal. 12, 3–34.

Tompkins, E.L., Few, R., Brown, K., 2008. Scenario-based stakeholder engagement: incorporating stakeholders preferences into coastal planning for climate change. J. Environ. Manage. 88 (4) 1580–1592.

Ulrich, W., Reynolds, M., 2010. Critical systems heuristics. In: Reynolds, M., Holwell, S. (Eds.), Systems Approaches to Managing Change: A Practical Guide. Springer and The Open University, London, pp. 243–292.

Wallis, P.J., Ison, R.L., 2011. Appreciating institutional complexity in water governance dynamics: a case from the Murray-Darling Basin, Australia. Water Resour. Manage. 25 (15) 4081–4097.

Wallis, P.J., Ison, R.L., Samson, K., 2013. Identifying the conditions for social learning in water governance in regional Australia. Land Use Policy 31, 412–421.

Warner, J., 2007. Multi-Stakeholder Platforms for Integrated Water Management. Ashgate Publishing Ltd., Aldershot.

Wei, Y.P., Ison, R.L., Colvin, J.D., Collins, K.B., 2011. Reframing water governance in China: a multi-perspective study of an over-engineered catchment. J. Environ. Plan. Manage. 55 (3) 297–318.

Wenger, E., 1998. Communities of Practice: Learning, Meaning, and Identity. Cambridge University Press, Cambridge.