

Patterson, J.J.; Lukaszewicz, A.; Wallis, P.J.; Rubenstein, N.; Coffey, B.; Gachenga, E. and Lynch, A.J.J. 2013. Tapping fresh currents: Fostering early-career researchers in transdisciplinary water governance research. *Water Alternatives* 6(2): 293-312



Tapping Fresh Currents: Fostering Early-Career Researchers in Transdisciplinary Water Governance Research

James J. Patterson

University of Queensland, St Lucia, Queensland, Australia; james.patterson@uq.edu.au

Anna Lukaszewicz

Charles Sturt University, Albury, New South Wales, Australia; alukaszewicz@csu.edu.au

Philip J. Wallis

Monash University, Clayton, Victoria, Australia; phil.wallis@monash.edu

Naomi Rubenstein

Monash University, Clayton, Victoria, Australia; naomi.rubenstein@monash.edu

Brian Coffey

Deakin University, Warrnambool, Victoria, Australia; brian.coffey@deakin.edu.au

Elizabeth Gachenga

University of Western Sydney, Parramatta, New South Wales, Australia; e.gachenga@gmail.com

A. Jasmyn J. Lynch

University of Canberra, Canberra, Australian Capital Territory, Australia; jasmyn.lynch@canberra.edu.au

ABSTRACT: Water governance is an important, yet complex and contested field. A central challenge for researchers is to engage with multiple understandings and perspectives that can shape water governance, and to move towards more transdisciplinary approaches. These challenges are magnified for early-career researchers (ECRs), and while the need for transdisciplinary approaches and better support for ECRs is increasingly recognised, there remains a lack of understanding of how to achieve this within the wider research community. Thus, this paper investigates through an auto-ethnographic inquiry the practical experiences and challenges faced by a diverse group of ECRs engaging in water governance research. Reflecting on our own endeavours and relevant literature, we identify a range of path-finding experiences and challenges, and explore strategies employed by ECRs to navigate the 'uncharted waters' of evolving career pathways in water governance research. 'Communities of Practice' are identified as a promising opportunity to support ECRs by enhancing opportunities for reflection and learning. Overall, we argue that there is significant merit in enhancing the way in which water governance research is understood, and improving the means by which ECRs are supported to build capability and contribute in this field.

KEYWORDS: Research practice, auto-ethnography, pathways, community of practice, interdisciplinary, water governance

INTRODUCTION

It is widely accepted that current patterns of water use and management are unsustainable in many parts of the world and that current problems are likely to be exacerbated by population growth, climate change and further catchment disturbance (Vörösmarty et al., 2010). However, sustainable water governance is difficult due to the dependence of human and ecological systems on water in a multitude of ways, institutional fragmentation and mismatches, the socially and contextually embedded nature of water issues, and change in human and ecological systems over time (Ison et al., 2007, 2011; Ingram, 2008; Huitema et al., 2009; Engle et al., 2011).

Water has diverse environmental, social, economic and cultural values, and is influenced by many social, institutional, economic and political processes. Thus water governance involves steering human activity in relation to water in linked human and ecological systems. It encompasses normative, communicative and strategic dimensions (Ulrich, 1988), and provides the institutional arenas within which more day-to-day management activities and operations are pursued. In the words of Pahl-Wostl (2009), while management entails "the activities of analysing and monitoring, developing and implementing measures to keep the state of a resource within desirable bounds", governance "takes into account the different actors and networks that help formulate and implement environmental policy and/or policy instruments". This encompasses formal and informal institutions, actor networks, multi-level interactions, and governance modes including hierarchies, markets and networks (Ison et al., 2007; Pahl-Wostl, 2009). It also involves shaping policy, framing of problems and institutional change. 'Governance' is much broader than 'government' (Tropp, 2007), and water governance encompasses the roles and relationships of a diversity of actors across sectors and levels.

We argue that it is worthwhile identifying 'water governance' as a distinct field of research (following authors such as: Huitema et al., 2009; Engle et al., 2011; and Ison et al., 2011). It is nevertheless connected with a range of other emerging areas of governance research, including environmental governance (Lemos and Agrawal, 2006), adaptive governance of social-ecological systems (Folke et al., 2005; Lebel et al., 2006), and transition management for governance of socio-technical systems (Loorbach, 2009; Farrelly and Brown, 2011). All of these are concerned with understanding patterns of behaviour of multiple actors across sectors and scales in linked human and ecological systems, with an emphasis on change, learning and adaptation (e.g. Folke et al., 2005; Pahl-Wostl, 2006; Blackmore, 2007; Ison et al., 2007; Jiggins et al., 2007; Collins et al., 2009; Pahl-Wostl, 2009).

In practice, water governance has a wide remit that encompasses political, social, economic, and institutional dimensions and spans "different levels of society" (Rogers and Hall, 2003), in order to influence interactions between society and water. Nevertheless, conceptualisations of water governance are evolving and remain contested, such that identifying a single definition of water governance is unlikely. We suggest that what is most important is a shared working understanding in any particular situation that suitably encompasses different possibilities, and the recognition that in the context of a plurality of perspectives, processes of learning and negotiating shared understanding are vital.

Water governance research

From a research perspective, water governance cuts across a range of disciplines. However, different disciplines view water governance through different frames and lenses (Wouters, 2008). Since there are diverse ways of understanding water, both its meaning and management, it is clear that water governance research would benefit from approaches that engage with a diversity of traditions and disciplinary perspectives. Transdisciplinary water governance research is one way of progressing this, and can be understood as an attempt to transcend the disciplinary boundaries that traditionally inform academic research.

We distinguish transdisciplinary research from interdisciplinary research to emphasise its uniqueness in not just seeking to integrate across different existing disciplines (interdisciplinary), but also to move beyond existing disciplines to new higher-level synthesis – i.e. to "invent new science" (Gray, 2008). This is significant because water governance cuts across and beyond a range of disciplines, as well as the research-policy-practice nexus (Ison et al., 2011). As Funtowicz and Ravetz (1993) posited, different kinds of research are appropriate for answering different types of questions, in different situations. When decision stakes and uncertainty are high, it is less likely that research focused on applied science or technical consultancy will prove useful. Instead, research that draws upon wide participation, multiple forms of knowledge and ways of knowing (Blackmore, 2007), and recognition of values (Ioris, 2012) is more likely to address disparate stakeholder concerns. This can only be achieved meaningfully through approaches that are more transdisciplinary in nature.¹

Therefore we posit water governance research as a transdisciplinary, rather than an interdisciplinary endeavour, although the distinction between these is nevertheless blurry. Our focus in this paper is on 'transdisciplinary', but we are also pragmatically inclusive of both. Transdisciplinary research is grounded in 'real' problem situations, involves stakeholder collaboration in research, and involves more fluid and evolving methodologies than traditional academic research (Pregernig, 2006; Wickson et al., 2006). It also has multiple goals, including generating peer-reviewed knowledge (the traditional goal of academic research), as well as influencing the actual problem or practice itself, while potentially also fostering some form of mutual or transformative learning (Mitchell and Willets, 2009). Thus, it goes beyond building academic knowledge alone, and involves a perspective of research as active and embedded within problem situations. Consequently, doing this type of research can be challenging in working across traditional disciplinary boundaries and in linking research and practice (Max-Neef, 2005; Carew and Wickson, 2010; Oberg, 2010). While there is increased recognition of both the need for transdisciplinary research in water governance and natural resource management more broadly (Attwater et al., 2005), as well as the challenges involved in doing this, there remains limited guidance available on achieving it in practice,² and these challenges are particularly substantial for early career researchers (ECRs).

The purpose of this paper

This paper promotes more transdisciplinary water governance research,³ through a joint-inquiry by the authors (who are all ECRs including doctoral students, post-doctoral researchers, and others with limited experience in this field). It critically reflects on: (i) the need for transdisciplinary water governance research, (ii) experiences, challenges and pathways in pursuing transdisciplinary research as ECRs, and (iii) strategies that may assist in overcoming existing barriers and creating a more supportive research context for ECRs entering the field of water governance research. Hence we are reflecting on our practice in the context of water governance research; how water governance research has given rise to our practice, and how our practice can, in turn, influence this context.

We draw on our experiences as a group of ECRs (who met at a workshop on water governance for ECRs in April 2011) with a diversity of career backgrounds and academic pathways to reflect on the challenges and opportunities for ECRs in this field. This reflection is important because identification as

¹ There is a need for a substantial transdisciplinary contribution and involvement in the field of water governance, with research that is not transdisciplinary situated within broader transdisciplinary contexts.

² However, some useful resources that are available include: Mitchell and Willets, 2009; Bolitho and McDonnell, 2010; and Oberg, 2010.

³ We specifically use the term 'more transdisciplinary' to acknowledge that transdisciplinary research is not the only type of research that is of value in society, but for water governance research we believe that it is important to move further in this direction than has traditionally been the case. Furthermore, not all of our own research is transdisciplinary, but through our overall research practices we are seeking to build our own capabilities to support such a shift in the broader field.

a transdisciplinary researcher has potential consequences for career trajectories, research framing, networking and academic reward. Furthermore, ECR experiences are rarely documented in the literature (some exceptions are: Morse et al., 2007; and Vázquez et al., 2011) and are generally poorly understood. Therefore, in this paper we aim to contribute to: (i) building a richer understanding of ECR experiences, (ii) 'making sense' of the diversity of pathways that may be taken into the field of water governance, (iii) supporting other ECRs involved in transdisciplinary research by documenting our experiences and offering guidance on overcoming barriers, and (iv) contributing to the conversation regarding fostering transdisciplinary skills and capacities among water governance researchers.

METHODOLOGY AND ANALYSIS

We have framed the research as an exploration of ECR experiences and pathways, which we see as potentially influenced by a range of factors including the activities, choices and opportunities of an individual ECR as well as of their embeddedness within institutional, social, and cultural contexts.

Methodology

To explore this situation, we adopted an auto-ethnographic approach (Ellis and Bochner, 2000). This focused on in-depth self- and group-reflection on our (the authors; n=7) experiences within the professional contexts of our research practices. We also reflected on our experiences and the similarities and differences between them, and interpreted these experiences in a way that has relevance for others with an interest in transdisciplinary water governance research.

Our initial approach was informed by the open objective of exploring our perspectives and understandings of water governance research. This uncovered a diverse range of experiences and perspectives. It subsequently evolved into ongoing dialogue and group learning, and coalesced during the development of this paper and activities to establish a 'Community of Practice' of ECRs in water governance research.

To begin a structured approach to self-reflection, we focused initially on answering a series of self-directed questions (Box 1) and collective discussion of themes, to explore different aspects of our experiences with water governance research. These questions were developed with the input of an experienced researcher versed in social learning theories, with the purpose of providing a starting point for our enquiries. Our responses provided data from which we were able to investigate patterns and idiosyncrasies within the group. Subsequently, we decided that the questions sufficiently spanned key dimensions uncovered through ongoing dialogue and reflection, and generated useful data for our intended purpose of "abductive reasoning" (Mason, 2002) which involves engaging in a 'dialectic relationship' between theory, data generation and data analysis.

Our backgrounds span the social and biophysical sciences, although we are all currently engaged (in different capacities and roles) with questions relating to water governance. Current roles include masters, PhD and postdoctoral research, and wider involvement in research communities and professional practice within Australia. Areas of research span systems thinking, climate change adaptation, law and regulation, institutions and policy, social justice, science-policy relations and ecosystem management. The strength of this approach lies in the ability to tap into 'real' experiences of ECRs in an emerging and evolving field of research. By reflecting on our individual experiences we created opportunities for developing a richer understanding of ECR experiences and needs 'from the inside'.

Box 1. Self-directed questions.

1. What were formative experiences that led you to be involved/interested in water governance research?
2. How, if at all, has your framing of water governance and water governance R&D changed since these formative experiences?
3. What theoretical questions have you posed and mastered/not mastered?
4. What methodological questions/approaches have you attempted and why? (or wish to attempt)?
5. How conducive is the institutional setting you are in for pursuing water governance research as you understand it? How ought it to be?
6. Are you aware of your own epistemological commitments? What are the implications of your answer for water governance research?
7. Based on your experience what features would you claim are essential for the design of a learning system for ECRs in water governance research?
8. What is your formal training, other experiences and current focus of research?
9. What have been some of the challenges you encountered in entering the field of water governance research?
10. What are some of the solutions of, or ways of overcoming, the challenges you described? Have they worked for you? Are they effective?
11. What would you like to see done (and by whom) to further water governance research?
12. Do you feel you have significant 'knowledge gaps' that hamper your effectiveness as a water governance researcher? What are they?

Analysis and interpretation

Themes identified from our reflections on the questions posed include: research training and career experiences, types of research interests and activities, institutional influence, researcher self-reflection, and needs and recommendations for the field more widely. Together, the themes of analysis and the self-directed questions form a framework for analysis. Each theme is explored in different ways with multiple questions which allow for richer data to be uncovered. For this paper, we have de-identified our responses and denoted them with the codes R1-7. We synthesise our findings as 'path-finding' experiences and challenges.

FINDINGS: PATHWAYS AND CHALLENGES IN WATER GOVERNANCE RESEARCH**Path-finding experiences**

We identified a range of formative or path-finding experiences that have been important for us in coming to water governance research, including training and career-related experiences, as well as cognitive, emotional and personality-related factors that contributed to shaping our research choices and pursuits (Table 1).

Table 1. Path-finding experiences influencing engagement with transdisciplinary water governance research.

Type of experience	Examples	Influence
Formal training	Tertiary education; postgraduate training; research induction	Shaping initial intellectual perspective
Experiments with theoretical and methodological frameworks	Undergraduate, postgraduate or postdoctoral research projects; reading peer-reviewed literature; involvement in interdisciplinary or transdisciplinary research projects	Exposure to new theoretical perspectives; initial experiences of research
Unstructured training or experiences	Participating in workshops, conferences, seminars, professional networks, or other forums; learning from peer-reviewed literature; mentoring	Exposure to unexpected ideas and perspectives; engaging with new networks
Professional experiences	Professional projects and experiences e.g. working at intersections between science, policy, and community	Intellectual and ethical engagements and dilemmas in practice prompting reflection
Shifts in perspective	Gradual broadening or change to personal framings or interests in response to various experiences; developing new skills or expertise (e.g. through new job opportunities)	Re-framing of problems; new or broadening interests over time
Emotional encounters	Dealing with feedback from peer-review (e.g. of either 'hard' or 'soft' approaches); frustrations in framing, understanding and doing water governance research; excitement of new research possibilities and horizons when exposed to new perspectives	Strengthening or weakening motivation and commitment to step outside 'comfort zone'
Personality attributes	Personal motivations, values and interests (e.g. concern for sustainability and motivation to influence social change); preference for linear (e.g. cause-effect) or open-ended systemic (e.g. complex adaptive systems) thinking; epistemological bias towards positivist or constructivist perspectives; curiosity and passion regarding water issues	Shaping the types of issues and approaches pursued; affecting willingness and ability to work in complex, ambiguous and multi-perspective settings
Reflexive practice	Engaging in deliberate consideration of 'what you are doing when you do research' e.g. questioning problem framings, questioning one's role in a research situation, (particularly when the research problem is embedded in 'real' contested situations)	Deepening one's awareness and understanding of other perspectives; developing awareness of one's own epistemological commitments

Formal training represented a major formative experience for all of us. Common experiences of coursework programmes were that water and environmental issues were largely treated through a biophysical sciences framing, focusing on engineering, environmental sciences or ecology, with very little specific training in areas of management and governance. Thus these programmes privileged biophysical over social sciences, and often adopt unacknowledged bias towards instrumental rationality and positivist epistemology. Some authors have experienced programmes moving towards a more integrative environmental science (R3, R4); however, it was perceived that even these programmes can often treat biophysical and social sciences separately. Together, this lack of opportunities to gain richer formal training may limit opportunities for developing skills and capabilities necessary for water governance research.

We have all experimented with various theoretical and methodological frameworks, which we see as an important path-finding experience because it exposes individuals to different perspectives, and creates opportunities to reflect on complementarities and tensions between different approaches. We have employed a variety of theoretical frameworks and methodological approaches, including: critical systems heuristics (e.g. Ulrich, 1987), social learning (e.g. Steyeart and Jiggins, 2007), systems thinking (e.g. Ison, 2010), soft-systems methodology (e.g. Checkland and Scholes, 1999), social justice framework (e.g. Syme et al., 1999), critical discourse analysis (e.g. Fairclough, 1992; Wodak and Meyer, 2009), law as practical reason (e.g. MacCormick, 2009), social-ecological resilience and adaptive governance (e.g. Berkes et al., 2003; Folke et al., 2005), and systems ecology (e.g. Odum, 1964). Varieties of qualitative and quantitative techniques have also been used in our individual research.

Less formal experiences, such as workshops, informal conversations and reading, have been a major source of inspiration and making distinctions about water governance research for all of us. For example, at a workshop, R1 experienced a shift in thinking about sustainability from 'policy and management' to a conceptualisation of people and their interactions with the environment as social-ecological systems. During a PhD milestone seminar, R2 (originally from a biophysical science and engineering background), was questioned about whether they "tended to see governance situations as free of power dynamics", which challenged them to engage more with the issues of power, culture and values in their work. R7 has found that knowledge gained through conference and workshop attendance, as well as informally through new job roles, has provided new tools useful in a water governance context. Thus these 'unstructured' experiences can not only be very influential but also unpredictable and idiosyncratic, and need to be recognised as important for ECR pathways.

Professional experiences can have a strong role in shaping understanding. For example, tensions arising in professional settings regarding complex and conflict-laden water issues triggered shifts in perspective for R2. Similarly, R3 identified that:

The most important experiences that have shaped my understanding of water- scarcity issues have been through research projects that involved interviewing and speaking to landholders across [the Australian states of] Victoria and New South Wales. I began to appreciate the complexity of the cultures, values, economics and politics, and how these are set within a range of individual, community, national and global pressures that they must also contend with.

Some authors (R2, R3, R5, R7) reported a gradual broadening of their perspective and framing. R3 described this as "a journey of becoming more aware and committed to the role of social science, both methodologically and theoretically". This is significant because we see that identification as a water governance researcher requires drawing our epistemological commitments and theoretical perspectives into conversation (Ison, 2007). Other shifts in perspective can occur when new theoretical perspectives are discovered that resonate with personal experience. For example, R5 found a new language and perspective with which to explore their experience through the political theory of Dryzek, particularly the idea that:

While real problems exist, our interaction with them can only ever be through culturally constructed lens – meaning that we can never know nature, except through the interpretive mechanism of culture, which means all perspectives are partial and contestable (Dryzek, 1997: 10).

Positive or negative emotional encounters were another type of influential experience, which may arise from supportive or unsupportive interactions with other researchers. For example, engaging with the diverse approaches within water governance can be daunting and confidence sapping, or it can be rewarding: opening up new horizons and opportunities. Overcoming these difficulties may include conversing and building networks with other ECRs (R5, R6), regrounding in one's primary discipline (R7), and pursuing learning and skill-building opportunities such as undertaking postgraduate research, reading literature, and continuing interdisciplinary engagement (R1, R2, R4, R6, R7).

Other attributes such as personality characteristics and motivations are also important. Transdisciplinary research demands different types of skills, and researchers need to be more comfortable with open-ended, systemic, and 'wicked' research problems. Each of us also has strong personal concerns regarding social and environmental issues, which perhaps serve as motivation for persisting with the challenges of this research field.

The act of engaging in reflexive research practice has been crucial for all of us, which we understand as making a deliberate choice to continually learn from research experiences (Schön, 1983; Kolb, 1984). For example, R1 stated that "what has been most useful to me is learning through the experience of doing"; however, the experience of making these lessons 'stick' has "taken other forms of communication (seminars, workshops) to make key distinctions about what I've been doing (when I've been doing it)". This type of experience was seen to go beyond the other path-finding experiences by striving to think about research and practice situations beyond one's own perspective.

Identification of these path-finding experiences highlights a substantial diversity of path-finding experiences. These experiences can impact on career pathways gradually or abruptly. Each individual's path has been a unique and evolving combination of experiences. Therefore, it is important that a diverse range of possible path-finding experiences is recognised as relevant to developing ECR pathways and capabilities.

Challenges faced by early career researchers

Reflecting on our experiences and those documented in the literature, we have collated different types of challenges faced by ECRs in water governance: professional, philosophical and methodological, project-related, and personal (summarised in Table 2). These challenges stem from the transdisciplinary nature of water governance research.

Professional challenges

The professional environment in which an ECR is situated is important in supporting transdisciplinary research engagement, networking and building ECR capabilities. For example, we concur with Becher and Trowler (2001) that academic and research institutions are often culturally and sometimes physically fragmented along disciplinary lines which can constrain opportunities that cut across traditional disciplines. Nevertheless, some (although not all) of us within this group have been fortunate to have enjoyed institutional settings relatively supportive of interdisciplinary and transdisciplinary research. For example, two authors stated that: "my present institutional setting is probably better than that of most, as I am in a non-faculty institute, which permits (and encourages) interdisciplinary research. However, my perception is that this is probably a fairly unique and uncommon setting for most researchers" (R1); and: "The environment I'm in is perfect because I get to see first-hand scientists of all persuasions who work on water, and are struggling to become more interdisciplinary and struggling to comprehend what that means" (R4). However, another author situated within a more traditional university department has experienced: "a lack of a collaborative and learning organisational

Table 2. Types of challenges posed by transdisciplinary water governance research, in comparison to more disciplinarily-bounded research.

Type of challenge	Explanation	Examples
Professional	Challenges related to the professional settings in which ECRs are embedded	Structures of research institutions often remain fragmented along disciplinary lines Difficulty in identifying opportunities for relevant networking and professional development Difficulty in publishing transdisciplinary research in prestigious journals Measures of professional performance that are discipline-oriented can affect job security (e.g. limited perceptions of research quality)
Philosophical and methodological	Challenges related to philosophical and methodological issues and tensions raised when doing transdisciplinary research	Difficulties in understanding, employing and integrating relevant but diverse theories, methodologies, methods and findings Lack of epistemological awareness within individuals and research teams Overcoming communication difficulties due to discipline-specific terminology and jargon
Project-related	Challenges related to establishing and conducting transdisciplinary research projects	Generating adequate funding and institutional support for transdisciplinary research Designing projects appropriately (e.g. building shared understanding and commitment regarding aims and approaches, appropriate involvement of different perspectives) Structures and processes of projects (e.g. adequate investment of time and resources in ongoing re-framing of problems, evolving methodologies, and collaboration) Narrow evaluation measures by external parties in assessing project 'success', and the goals of transdisciplinary research Narrow evaluation measures used by external parties in assessing project 'success', and the goals of transdisciplinary research
Personal	Challenges related to developing the personal attributes and reflexivity required to engage meaningfully in transdisciplinary research	Developing a tolerant, open-minded, yet critical attitude Overcoming inherited worldviews and mental models which may be held consciously or unconsciously Developing a deep recognition of the value of different perspectives

Based on Jeffrey, 2003; Bruce et al., 2004; Boulton et al., 2005; Campbell, 2005; Max-Neef, 2005; Wickson et al., 2006; Dewulf et al., 2007; Harris et al., 2009; Carew and Wickson, 2010.

culture, except for a few committed individuals that I'm very fortunate to be associated with (if it weren't for those individuals I don't know how I could have continued), and this makes transdisciplinary research very difficult" (R2). This raises questions about the role of institutions in enabling or constraining professional opportunities for ECRs and whether we would be capable of engaging with transdisciplinary water governance research if we were situated in more unsupportive settings, which appear to remain common in most universities.

The environment within which one is professionally situated can also open up or constrain networking opportunities and exposure to diverse issues relevant to water governance. For example, lack of professional mentors, peers and networks can be a major obstacle. We have all found that forms of 'unstructured' training, such as seminars and workshops, are particularly useful for stimulating interest or gaining an appreciation of different aspects of the field. However, opportunities to attend these can be idiosyncratic. For example, one author situated within a department perceived by that person to be poorly conducive to transdisciplinary research identified a major professional challenge as: "a lack of colleagues to have formal and informal conversations with about water governance, and lack of other opportunities for learning such as seminars" (R2). However, another author reflected that despite being situated in a department that is "fairly conducive for pursuing water governance research as I conceive of it. The main issue for me is probably a lack of peers with a similar interest" (R5). This indicates the importance of ongoing engagement with wider professional networks as a key issue in supporting ECRs in this field.

More widely, we also perceive a range of further professional challenges relating to employment and research opportunities. Transdisciplinary research offers fewer employment positions with tenure or other forms of long-term job security, fewer publishing opportunities and lower prestige for transdisciplinary research compared to discipline-based research. There also seems to be lower recognition and support from funding bodies, which can carry strong discipline-oriented perspectives of research quality and value.

Philosophical and methodological challenges

Engaging with transdisciplinary research raises philosophical and methodological issues and tensions. These relate to understanding, employing and integrating diverse theories and methodologies. Working across various biophysical and social sciences is especially difficult due to often vastly different epistemological foundations, methodologies, and methods (Bruce et al., 2004). This can lead to difficulties in understanding, employing and integrating relevant but diverse theories, methodologies and methods. For example, in moving from a 'harder' to a 'softer' perspective of water governance, one author has experienced difficulties in "identifying different traditions relating to water governance research, and unpacking different perspectives and how they do and don't overlap and borrow from each other; [and] getting my head around many different languages and discourses, which is still an ongoing challenge" (R2). Communication can also be difficult due to discipline-specific terminology and jargon that creates barriers to understanding between and within the biophysical sciences and social sciences, and between quantitative and qualitative researchers (Jeffrey, 2003; Boulton et al., 2005; Harris et al., 2009).

It is clear that different paradigms have legitimacy to different audiences, are strongly tied to values, and often make varying epistemological and ontological claims on biophysical and social aspects of problems. As ECRs, we have each experienced disciplinary divisions. R2 stated that: "I have found moving [from the biophysical sciences] into the social sciences very scary, especially getting my head around language, concepts and discourses". Importantly, this divide can be perceived in both directions. For example, R5 (from a social science background) has perceived an "overwhelming dominance of technical and economic approaches to water", while R2 (from a biophysical science

background) argued that "self-proclaimed constructivists have been dismissive of what they termed 'positivist' approaches and findings".

Development of transdisciplinary perspectives required shifts in our perspectives and an expanded research focus to become more inclusive of other relevant fields. The experience of R6 is typical in this regard: "the theoretical foundation I had hoped to build on in law is proving unsuitable to adaptive systems of water governance, leading me to challenge concepts of law and legal theories". On the other hand, R4's academic training was strongly multidisciplinary, focusing on analysing environmental and social dilemmas from multiple perspectives. While this contributed to a relatively smooth transition into water governance research, it did not provide concrete training or practical skills from which to draw: "I thought I had a great breadth of knowledge but totally no depth". The complexity of water governance was also highlighted by R7 who, in moving through short-term projects in different Australian states, experienced lack of local context and knowledge as a recurring challenge.

Thus, a range of philosophical and methodological mismatches, conflicts, and ambiguities can arise for ECRs engaging with water governance research. A range of path-finding experiences and practices may be useful in responding to these challenges. In particular, we have all experienced that 'unstructured' experiences, such as workshops and seminars combining different disciplines, can be very useful in exposing ECRs to different theoretical frameworks, framings, and terminology, and that these facilitate expanded awareness and understanding of the usefulness of other paradigms.

Project-related challenges

Many of the challenges previously discussed manifest in relation to establishing and conducting transdisciplinary research projects. Establishing these projects can be more difficult than conventional disciplinary projects in terms of generating appropriate funding and institutional support for the research, and designing projects appropriately in light of the likely need for stakeholder involvement, and the need to build shared understanding and commitment to a process that will likely be flexible and evolving (Campbell, 2005). Carrying out these types of projects requires time and resources for developing skills, building relationships and trust, ongoing re-framing of problems, evolution of methodologies, and collaboration within and beyond project teams (Wickson et al., 2006; Harris et al., 2009). There also needs to be awareness of potential power imbalances in the make-up of project teams, such as token inclusion of social scientists in biophysical science-oriented project teams (Campbell, 2005).

Another central attribute of transdisciplinary research is that it seeks to make contributions across multiple 'outcome spaces': peer-reviewed knowledge, problem resolution in practice, and transformative or mutual learning (Mitchell and Willetts, 2009). This goes beyond traditional academic research that focuses solely on generating peer-reviewed knowledge. However, it leads to the risk of being evaluated inappropriately by traditional measures of research quality that focus on assessing peer-reviewed knowledge alone (often with a fairly narrow perspective at that). Bruce et al. (2004) argue that peer-review evaluations of research proposals and publications should be made by panels reflecting wide-ranging disciplinary backgrounds and experience. Further, Carew and Wickson (2010) suggest the development and promotion of more appropriate evaluation frameworks as a way of addressing this (e.g. Mitchell and Willetts, 2009).

Personal challenges

The final type of challenges relate to developing the personal attributes required to engage meaningfully in transdisciplinary research. This is important because, as discussed previously, transdisciplinary water governance research differs from more conventional types of research. We argue that it necessitates additional capacities at a personal level, such as an ability to engage with and value different cognitive and epistemological perspectives. In this light, Bruce et al. (2004) argue that

the personality and attitudes of researchers are at least as important as their discipline base and specialisation. More deeply, it also requires awareness of epistemological commitments (Ison, 2008; Carew and Wickson, 2010), and the capacity for reflexive research practice across levels of ontology and epistemology, theoretical and methodological frameworks, and personal world-views and biases. Thus, this includes the capacity and willingness to examine one's inherited world-views and limitations in perspective, which is vital because unexamined attitudes and beliefs about one's particular perspective can be unconscious obstacles to learning (Harris et al., 2009).

R1, who has come to water governance research from a background in physical sciences, reflects this attitude of openness and self-examination in describing a personal strategy for engaging with multiple perspectives, involving:

Trying to be less judgmental about particular research traditions. Instead of having some kind of superiority (e.g. of biophysical science over social science, or vice versa) it helped to understand particular research traditions and the choices that a researcher can make (and their advantages and limitations). My only critique is that many water researchers are unaware of their (positivist) epistemology and (realist) ontology, which are positions that are fine to hold, and very practical, but I see no harm in being aware of these positions and stating them outright. I also feel that researchers with more of a social bent need to put themselves in the shoes of biophysical researchers, learn to speak their language and try to understand the realist view.

Collectively, we have found that having exposure to different disciplinary and cross-disciplinary perspectives and also encountering differing perspectives during practice can trigger reflections and shifts in our own perspectives and research orientation.

DISCUSSION

We now discuss our findings in terms of the role of institutional structures, and individual and social learning in shaping ECR pathways. We then discuss how we 'make sense' of ECR pathways in water governance research based on our experiences, and the implications this has for fostering ECRs in water governance research. Finally, we highlight some potential benefits to the field of water governance of developing ECRs that are literate in transdisciplinary research.

The influence of institutions

The institutional arrangements within which ECRs are embedded can enable or constrain research pathways and capabilities. These include formal organisational structures, such as those of a department or institute, the wider university, projects, as well as norms, rules, laws and available resources (Wallis and Ison, 2011). For example, arrangements for categorising research into 'field of research' codes, such as the Excellence in Research Australia scheme, both reflect and reproduce particular disciplinary and institutional framings of research (Gibson, 2012). Institutions, in this sense, systemically influence researcher experiences, whether on a project, in a training course, or within a workplace. They also influence opportunities available in particular instances; for example, in processes of project formulation and research management, in pursuing particular types of training courses or funding opportunities, or for cross-disciplinary networking and collaboration within and beyond workplaces and research groups.

Institutional arrangements influence multiple types of path-finding experiences (Table 1), and are also seem to have a strong role in shaping the professional and project-related challenges faced by ECRs (Table 2). Professional opportunities can be constrained by the types of jobs and roles available, and by wider norms and traditions, such as perceptions of the quality and value of transdisciplinary research within academia and funding bodies. This can further constrain opportunities for publishing research findings and career progression overall, especially in research areas that question existing conceptual

boundaries (Gibson, 2012). Regarding project-based research, institutional path-dependency influences the funding and organisational support available to ECRs and transdisciplinary researchers. This seems to be an area of significant potential mismatch because transdisciplinary research has differing needs compared to more traditional disciplinary research (e.g. greater time to build relationships, trust and shared understanding within project teams; tolerance of evolving methodologies; and valuing contributions to multiple 'outcome spaces'), and these must be recognised within wider structural contexts in order to create conducive research settings.

Constructing institutional platforms as innovations for supporting ECRs in key path-finding experiences is one strategy that research communities can pursue to build transdisciplinary research capacities. Woodhill (2010) claims that several key 'soft' capacities are needed for institutional innovation, including communication, building trust, networking and navigating complexity. However, this presents a somewhat paradoxical situation in that developing platforms for these capacities, requires that they already exist. One way that such situations could be progressed is through mentoring by more senior researchers to 'open up' spaces for new platforms to grow, and an increased focus on cross-disciplinary and transformative (Mezirow, 1997) learning, whether led by senior researchers or ECRs themselves (or perhaps both working together).

The role of learning

Reflecting on the influence of institutions alone however, does not entirely account for the changes in understanding and practice that we have experienced. Individual and social processes of learning also seem to play a key role in shaping ECR pathways.

For the individual researcher, what they know through learning is a function of how they came to know it (Bawden and Pretty, 2007). For example, the design of formal training is shaped by priorities of programme coordinators, who have their own research traditions and perspectives. In privileging knowledge over the experiences that give rise to knowing, such formal experiences can, at times, seem 'impoverished' (Cook and Wagenaar, 2011). However, while the instructional nature of structured university programmes may not always be conducive to critical reflection, an individual might be open to deeper learning opportunities nonetheless.

Individual learning through a range of other less formal path-finding experiences complementary to formal training appears to be vital, for example, through experimentation with new theoretical and methodological frameworks, 'unstructured' training and activities, and professional experiences. Through these multiple types of experiences, as well as through shifts in perspective and emotional encounters along the way, we believe that deeper shifts in the researcher's frame and perspective can be triggered through transformative learning (Mezirow, 1997). This happens through critical reflection on one's own research practice, which is central to transdisciplinary research practice (Wickson et al., 2006).

The deliberate choice to reflect on one's research practice transcends the 'mechanics' of engaging in the research practice itself. It involves questioning problem framings, questioning one's role in a research situation, deepening one's own understanding of multiple perspectives, and developing awareness of one's own epistemological commitments. For example, R1 and R3 described changes in personal framings and understandings over time driven by self-reflection on a variety of path-finding experiences:

My framing of water governance has shifted from a focus on 'what' can be done, to 'why' would I do it and 'how' would I do it. In other words, rather than just talking about doing more or better water governance, I think more about the purpose of reforms, and indeed how these are framed. My understanding of water governance is still evolving, but I think of it more as understanding sources of motivation, control, knowledge and legitimacy of those involved in water governance situations (R1).

I probably started out thinking about finding some kind of 'balance' between different competing discourses and needs (e.g. triple bottom line) outcomes. I have come to be more aware of the various forms of power (e.g. economic, symbolic, political) that influence decision-making, and that those decisions work in a very non-linear and complex way. I have become more attuned to framing water governance with more awareness of the idiosyncratic nature of each case, how particular cultural norms and practices influence situations, and not to have pre-conceived notions about how a community will respond to different pressures (R3).

These statements highlight the importance of reflexivity in one's own research practice. Many of the path-finding experiences are 'social' in the sense that they depend substantially on interactions between individuals that can trigger critical reflection and learning and push an individual 'outside their disciplinary comfort zone'. Hence, individual learning is embedded and strongly dependent on these interactional activities and arenas, and we claim that these social processes of learning are of particular importance for developing transdisciplinary capacities. Our collective experience is that interactions with others (including ECRs, other researchers, practitioners, and other types of actors) are vital for exposing ECRs to new perspectives, ideas and framings. Opportunities to engage in dialogue with these different actors can trigger new insights and pose new 'difficult questions' which are beneficial for stimulating deeper understandings, new ideas, and awareness of complexity. This highlights the need for a range of diverse 'interactional spaces' in which ECRs can be involved to enhance their opportunities for learning from and with others.

Navigating ECR career pathways

Based on the diversity and unpredictability of our experiences, a common characteristic of our pathways to water governance research is that there has been no pre-defined path. We have all engaged in different ways in navigating undefined territory to build our capabilities and overcome constraints in moving towards more transdisciplinary forms of research. This has involved idiosyncratic mixtures of path-finding experiences and responding to challenges and opportunities and over time, to shape pathways that have had no clear trajectory looking forward, but can be at least partly made sense of in retrospect. This lack of clear direction looking forward has been one of the most significant challenges we have all faced in navigating pathways as ECRs in water governance research, which may also apply to those involved in transdisciplinary research more generally.

We have all committed to ongoing engagement with new experiences and perspectives, and reflexivity in our own research practices over time. We believe that these are vital for any individual ECR looking to navigate a career pathway in water governance research, especially one that is transdisciplinary. Exposure to a variety of path-finding experiences is likely to be important, with enough 'positive' experiences to provide ongoing sources of motivation, even if other substantial challenges are also faced. Conducive personality attributes also seem important, including personal motivations and interests, skills in 'thinking systemically', willingness to question oneself deeply as well as others, and curiosity and passion to sustain enthusiasm in the face of difficulty and ambiguity. Therefore, while ECRs are embedded in institutional contexts that can be both enabling and constraining, through reflecting and learning from diverse experiences, pathways are built and emerge over time.

What does this mean for fostering ECRs in water governance research? Crucially, we see that there is interplay between institutional contexts, reflexivity and learning, and individual agency in shaping ECR pathways and capabilities. This implies a dual need to build more conducive and enabling institutional contexts, as well as encouraging reflexivity and social forms of learning. Interactional spaces that leverage the potential of social forms of learning have substantial potential, because transdisciplinary research can itself be seen as a form of social learning (Ison, 2008).

These interactional spaces can also be understood as opportunities to cross 'boundaries' (Cash et al., 2003), for example between different disciplinary research communities, and communities of water governance practitioners. Engaging in these interactional spaces can then become a form of boundary work (Clark et al., 2011), and also builds the capability of ECRs to engage in boundary work more widely. This is significant because, as Mollinga (2010) points out: "the notion of boundary work suggests that integration as a form of boundary crossing does not happen automatically but requires concerted effort". The need for boundary work is increasingly recognised as critical in order to "manage effectively the interfaces among various stakeholders engaged in harnessing knowledge to promote action" (Clark et al., 2010), which is vital in relation to complex water and NRM problems (Mollinga, 2010).

'COMMUNITIES OF PRACTICE' AS A STRATEGY FOR SUPPORTING ECRs

One platform for supporting the development of transdisciplinary ECRs in water governance is to build ECR-oriented 'communities of practice'. We see Communities of Practice (CoPs) as having particular potential to foster path-finding experiences and reflexivity, as well as for overcoming challenges faced by ECRs. The purposeful development of CoPs for enhancing mutual learning is an idea that has grown in popularity over recent decades, including within the water governance literature (Pahl-Wostl, 2006; Ison et al., 2011).

CoPs are social networks of individuals who come together around a shared history, set of beliefs, values and experiences, and who are actively involved and committed participants in a similar or overlapping endeavour (Barab et al., 2002). The distinguishing characteristic of CoPs is that members are actively involved in a similar practice; differentiating them from other forms of social learning such as networks of interest, or project groups, which may temporarily come together for a set time or around a particular goal or event, or as passive recipients of information. Wenger (2000) identifies three key elements of a CoP as mutual engagement, joint enterprise and developing a shared discourse. Particular advantages of a CoP for ECRs include new opportunities for dialogue and reflection, exposure to both explicit and tacit knowledge held within the group, a platform for joint activities such as putting forward new ideas to wider professional audiences, and forging a stronger identity as water governance researchers.

Reflections on a current 'Community of Practice' initiative

In light of the potential strengths and opportunities of CoPs, we have been attempting to generate an ECR CoP in water governance research in Australia. This was initiated through our meeting at a workshop for ECRs in water governance held in April 2011 in Melbourne under the National Climate Change Adaptation Research Facility (NCCARF). We (a subset of workshop participants) decided to maintain further contact which led to writing this paper and the emerging initiative to form a CoP. Due to our mutual engagement, working to develop a shared discourse and understanding, and joint enterprise in writing this paper, we already see ourselves as a CoP. However, we are also expanding beyond this core membership through a range of activities including establishing an online blog and network, and organising ECR-focused activities such as workshops. Through these initiatives, we aim to support ECRs in water governance research by identifying ourselves as a research community, providing an interaction space for sharing perspectives, reflection and mutual learning, and providing an entry point for researchers new to the field.

Benefits so far have been significant reflection and mutual learning regarding different perspectives on water governance and experiences of research in this field. Initially, we appeared to share similar understandings; however, deeper dialogue and reflection revealed a substantial diversity of perspectives. This in turn prompted lengthy and ongoing effort to develop shared understandings as well as to recognise points of difference. We all believe that our individual understandings of water governance research have developed enormously due to our involvement in this CoP. We have also

developed stronger identities as water governance researchers, and are using this platform to engage with other ECRs in this field and to advocate our ideas for better supporting ECRs more widely.

The main challenge so far has been the physical distance between members (we are spread geographically across eastern Australia), although we have used a range of technologies to meet communication needs (such as regular teleconferences, and web-based collaborative learning environments). This allows us to work together effectively, but does not fully overcome the lack of opportunity to develop more substantial personal relationships which we believe is an important social condition for continuing over the longer term. Nevertheless, we have met face-to-face beyond the initial workshop, and individuals also meet opportunistically at conferences and other events. We have been fortunate to receive access to external funding to allow us to hold a workshop and to meet in person during the writing of this paper. Another important factor has been the ability to draw on more experienced researchers; for example, in the early stages of developing the self-reflection questions (Box 1), and in reviewing drafts of this paper. We are also highly self-motivated in pursuing the wider activities of the emerging CoP.

These experiences indicate the importance of maintaining both professional and personal relationships between members, the significant enabling role of even small amounts of external resources to support activities, the central importance of sustained self-motivation and commitment, and the importance of being able to draw on supportive senior researchers for strategic guidance and feedback. Future challenges include sustaining commitment, bringing in new core members, and continued self-organisation if current members leave. Another consideration is whether the CoP remains focused on water governance, or broadens to include other problem domains (e.g. NRM, climate change adaptation, food security), or potentially refocuses itself on transdisciplinary research practice as the core binding feature. While we have articulated a clear focus on water governance, we have not actually limited ourselves by excluding other related issues (indeed, multiple individuals within the CoP have been exploring new problem domains such as those listed). Nevertheless, we have found that a focus on water governance has served as a useful 'boundary concept' (Mollinga, 2010) which we can all relate to from differing individual research perspectives. Regardless of the specific orientation of the CoP, a test of success over time will be sustaining a genuine ongoing 'community' that continues to be of benefit to its members. In our experiences to date, we have all found the current CoP extremely beneficial in developing our capabilities as water governance researchers.

CONCLUSIONS

This paper contributes to addressing the important need to better understand and support ECRs engaging in transdisciplinary water governance research. It identified a range of path-finding experiences and challenges as well as strategies and opportunities for supporting the development of ECR pathways and capabilities. This is critical for the continuity and development of a research community able to engage with the theoretical and practical challenges faced. More widely, the insights generated here may have relevance to ECRs in other transdisciplinary research fields.

We highlight the need to recognise and support a variety of types of path-finding experiences ranging from formal training, to 'unstructured' experiences, to building conducive personal attitudes and skills. These different aspects would each require different types of support, with some relating to academic institutions, others relating to changing research cultures and traditions, and others to opportunities for informal personal development. However, what is important is that this diversity of experiences and its collective significance for ECR development is recognised. A range of professional, philosophical and methodological, project-related and personal challenges were also identified.

ECR pathways unfold through the interplay of path-finding experiences, responding to challenges and learning over time. Navigating these pathways involves individuals engaging in 'uncharted waters' by drawing on a dynamic range of opportunities available to build relevant capabilities and pathways, in

the absence of clear precedent or professional traditions. In this light, we describe opportunities for building 'Communities of Practice' as a practical strategy for supporting ECRs in this field by enhancing opportunities for reflection and learning, and describe the progress of an initiative in which we have been involved.

Overcoming challenges and enhancing the opportunities available to build collective ECR capacity are not likely to be straightforward, due to the co-dependent roles of a variety of actors, including ECRs themselves, more senior researchers, policy-makers, practitioners, and research funders. This will require joint and concerted effort from these different actors over time; however the incentives to do so may vary substantially between them, which raises difficult questions about how to break out of entrenched ways of operating to forge such joint efforts. There is a dual need to overcome the systemic institutional challenges, as well as to create arenas conducive to reflection and interactive learning. In the shorter term, interactive learning is a key area where multiple actors can work together to great potential benefit. Overall, we argue that there is significant merit in enhancing the way in which water governance research is understood, and improving the means by which ECRs are supported to build capability and contribute to this field. Water governance research, and ultimately its praxis, will benefit from greater recognition and encouragement for the fresh currents of ECRs engaging in transdisciplinary and collaborative research activities.

ACKNOWLEDGEMENTS

The Early-Career Researcher workshop that brought us together was organised by the Water Governance Research Initiative, a theme of Australia's National Climate Change Adaptation Research Facility (NCCARF) Research Network for Water Resources and Freshwater Biodiversity. We sincerely thank Professor Ray Ison, Monash University, and Dr Catherine Allan, Charles Sturt University, for providing valuable feedback on an earlier version of this manuscript. We also thank Monash University for its institutional support and the hosting of a follow-up workshop we held in writing this paper.

REFERENCES

- Attwater, R.; Booth, S. and Guthrie, A. 2005. The role of contestable concepts in transdisciplinary management of water in the landscape. *Systems Research and Behavioral Science* 22(3): 185-192.
- Barab, S.; Barnett, M. and Squire, K. 2002. Developing an empirical account of a community of practice: Characterising the essential tensions. *The Journal of the Learning Sciences* 11(4): 489-542.
- Bawden, R.J. and Pretty, J. 2007. *Knowing systems and the environment. Sage handbook on environment and society*. London, UK: Sage Publications.
- Becher, T. and Trowler, P.R. 2001. *Academic tribes and territories*. Second edition. Buckingham, UK: The Society for Research into Higher Education and Open University Press.
- Berkes, F.; Colding, J. and Folke, C. 2003. *Navigating social-ecological systems: Building resilience for complexity and change*. Cambridge, UK: Cambridge University Press.
- Blackmore, C. 2007. What kinds of knowledge, knowing and learning are required for addressing resource dilemmas?: A theoretical overview. *Environmental Science & Policy* 10(6): 512-525.
- Bolitho, A. and McDonnell, M. 2010. *Interdisciplinarity in research at The University of Melbourne*. Melbourne Sustainable Society Institute. Melbourne, Australia: The University of Melbourne.
- Boulton, A.J.; Panizzon, D. and Prior, J. 2005. Explicit knowledge structures as a tool for overcoming obstacles to interdisciplinary research. *Conservation Biology* 19(6): 2026-2029.
- Bruce, A.; Lyall, C.; Tait, J. and Williams, R. 2004. Interdisciplinary integration in Europe: The case of the Fifth Framework programme. *Futures* 36(4): 457-470.
- Campbell, L.M. 2005. Overcoming obstacles to interdisciplinary research. *Conservation Biology* 19(2): 574-577.

- Carew, A. and Wickson, F. 2010. The TD wheel: A heuristic to shape, support and evaluate transdisciplinary research. *Futures* 42(10): 1146-1155.
- Cash, D.W.; Clark, W.C.; Alcock, F.; Dickson, N.M.; Eckley, N.; Guston, D.H.; Jäger, J. and Mitchell, R.B. 2003. Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences* 100(14): 8086-8091.
- Checkland, P. and Scholes, J. 1999. *Soft systems methodology in action*. Chichester, UK: John Wiley & Sons.
- Clark, W.C.; Tomich, T.P.; Van Noordwijk, M.; Guston, D.; Catacutan, D.; Dickson, N.M. and McNie, E. 2011. Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR). Special series of Inaugural Articles by members of the National Academy of Sciences. *Proceedings of the National Academy of Sciences*. www.pnas.org
- Collins, K.; Colvin, J. and Ison, R. 2009. Building 'learning catchments' for integrated catchment managing: Designing learning systems based on experiences in the UK and South Africa. *Water Science & Technology* 59(4): 687-693.
- Cook, S.D.N. and Wagenaar, H. 2011. Navigating the eternally unfolding present: Toward an epistemology of practice. *The American Review of Public Administration* 42(1): 3-38.
- Dewulf, A.; François, G.; Pahl-Wostl, C.M. and Taillieu, T. 2007. A framing approach to cross-disciplinary research collaboration: Experiences from a large-scale research project on adaptive water management. *Ecology and Society* 12(2): 14-38, www.ecologyandsociety.org/vol12/iss2/art14/
- Dryzek, J. 1997. *The politics of the Earth: Environmental discourses*. Oxford, UK: Oxford University Press.
- Ellis, C.S. and Bochner, A. 2000. Autoethnography, personal narrative, reflexivity: Researcher as subject. In Denzin, N.K. and Lincoln, Y.S. (Eds), *Handbook of qualitative research*, pp. 733-768. Thousand Oaks, USA: Sage Publications.
- Engle, N.L.; Johns, O.R.; Lemos, M. and Nelson, D.R. 2011. Integrated and adaptive management of water resources: Tensions, legacies, and the next best thing. *Ecology and Society* 16(1): 19, www.ecologyandsociety.org/vol16/iss1/art19
- Fairclough, N. 1992. *Discourse and social change*. Cambridge, UK: Polity Press.
- Farrelly, M. and Brown, R. 2011. Rethinking urban water management: Experimentation as a way forward? *Global Environmental Change* 21(2): 721-732.
- Folke, C.; Hahn, T.; Olsson, P. and Norberg, J. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30(1): 441-473.
- Funtowicz, S.O. and Ravetz, J.R. 1993. Science for the post-normal age. *Futures* 25(7): 739-755.
- Gibson, C. 2012. Cultural economy: Achievements, divergences, future prospects. *Geographical Research* 50(3): 282-290.
- Gray, B. 2008. Enhancing transdisciplinary research through collaborative leadership. *American Journal of Preventive Medicine* 35(2): S124-S132.
- Harris, F.; Lyon, F. and Clarke, S. 2009. Doing interdisciplinarity: Motivation and collaboration in research for sustainable agriculture in the UK. *Area* 41(4): 374-384.
- Huitema, D.; Mostert, E.; Egas, W.; Moellenkamp, S.; Pahl-Wostl, C. and Yalcin, R. 2009. Adaptive water governance: Assessing the institutional prescriptions of adaptive (co-) management from a governance perspective and defining a research agenda. *Ecology and Society* 14(1): 26, www.ecologyandsociety.org/vol14/art26
- Ingram, H. 2008. Beyond universal remedies for good water governance: A political and contextual approach. Paper presented at 6th Biennial Rosenberg Water Policy Forum, Zaragoza, Spain, 24-27 June 2008.
- Ison, A.R.R. 2012. The positioned construction of water values: Pluralism, positionality and praxis. *Environmental Values* 21(1): 143-162.
- Ison, R.L. 2007. Epistemological awareness: A systemic inquiry. *Cybernetics and Human Knowing* 14(2-3): 197-200.
- Ison, R. 2008. Methodological challenges of trans-disciplinary research: Some systemic reflections. *Natures, Sciences, Sociétés* 16(3): 241-251.
- Ison, R.L. 2010. *Systems practice: How to act in a climate-change world*. London, UK: Springer.

- Ison, R.; Röling, N. and Watson, D. 2007. Challenges to science and society in the sustainable management and use of water: Investigating the role of social learning. *Environmental Science & Policy* 10(6): 499-511.
- Ison, R.; Collins, K.; Colvin, J.; Jiggins, J.; Paolo Roggero, P.; Seddaiu, G.; Steyaert, P.; Toderi, M. and Zanolla, C. 2011. Sustainable catchment managing in a climate changing world: New integrative modalities for connecting policy makers, scientists and other stakeholders. *Water Resources Management* 25(15): 3977-3992.
- Jeffrey, P. 2003. Smoothing the waters: Observations on the process of cross-disciplinary research collaboration. *Social Studies of Science* 33(4): 539-562.
- Jiggins, J.; van Slobbe, E. and Röling, N. 2007. The organisation of social learning in response to perceptions of crisis in the water sector of The Netherlands. *Environmental Science & Policy* 10(6): 526-536.
- Kolb, D.A. 1984. *Experiential learning: Experience as the source of learning and development*. New Jersey, USA: Prentice Hall.
- Lebel, L.; Anderies, J.; Campbell, B.; Folke, C.; Hatfield-Dodds, S.; Hughes, T. and Wilson, J. 2006. Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society* 11(1): 19, www.ecologyandsociety.org/vol11/iss1/art19/
- Lemos, M.C. and Agrawal, A. 2006. Environmental governance. *Annual Review of Environment and Resources* 31(1): 297-325.
- Loorbach, D. 2009. Transition management for sustainable development: A prescriptive, complexity-based governance framework. *Governance: An International Journal of Policy, Administration, and Institutions* 23(1): 161-183.
- MacCormick, N. 2009. *Practical reason in law and morality*. New York: Oxford University Press.
- Mason, J. 2002. *Qualitative researching*. London, UK: Sage Publishing.
- Max-Neef, M.A. 2005. Foundations of transdisciplinarity. *Ecological Economics* 53(1): 5-16.
- Mezirow, J. 1997. Transformative learning: Theory to practice. *New Directions for Adult and Continuing Education* (74): 5-12.
- Mitchell C.A. and Willetts, J.R. 2009. Quality criteria for inter and trans-disciplinary doctoral research outcomes. Prepared for ALTC Fellowship: Zen and the Art of Transdisciplinary Postgraduate Studies. Sydney, Australia: Institute for Sustainable Futures, University of Technology, Sydney.
- Mollinga, P.P. 2010. Boundary work and the complexity of natural resources management. *Crop Science* 50(1): S1-S9.
- Morse, W.C.; Nielsen-Pincus, M.; Force, J.E. and Wulfhorst, J.D. 2007. Bridges and barriers to developing and conducting interdisciplinary graduate-student team research. *Ecology and Society* 12(2): 8, www.ecologyandsociety.org/vol12/iss2/art8/
- Oberg, G. 2010. *Interdisciplinary environmental studies: A primer*. Chichester, UK: John Wiley and Sons.
- Odum, E.P. 1964. The new ecology. *BioScience* 14: 14-16.
- Pahl-Wostl, C. 2006. The importance of social learning in restoring the multifunctionality of rivers and floodplains. *Ecology and Society* 11(1): 10, www.ecologyandsociety.org/vol11/iss1/art10/
- Pahl-Wostl, C. 2009. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change* 19(3): 354-365.
- Pregernig, M. 2006. Transdisciplinarity viewed from afar: science-policy assessments as forums for the creation of transdisciplinary knowledge. *Science and Public Policy* 33(6): 445-455.
- Rogers, P. and Hall, A.W. 2003. *Effective water governance*. TEC Background Papers No. 7. Sweden: Global Water partnership.
- Schön, D. 1983. *The reflective practitioner: How professionals think in action*. New York, USA: Basic Books.
- Steyaert, P. and Jiggins, J. 2007. Governance of complex environmental situations through social learning: a synthesis of SLIM's lessons for research, policy and practice. *Environmental Science & Policy* 10(6): 575-586.
- Syme, G.J.; Nancarrow, B.E. and McCreddin, J.A. 1999. Defining the components of fairness in the allocation of water to environmental and human uses. *Journal of Environmental Management* 57(1): 51-70.
- Tropp, H. 2007. Water governance: Trends and needs for new capacity development. *Water Policy* 9(S2): 19-30.

- Ulrich, W. 1987. Critical heuristics of social systems design. *European Journal of Operational Research* 31(3): 276-283.
- Ulrich, W. 1988. Systems thinking, systems practice, and practical philosophy: A program of research. *Systems Practice* 1(2): 137-163.
- Vázquez, C.; Aguilar, C.; Benet, H.; Carmona, R.; de la Vega, T.; Espinosa, H.; Flores, M.; Franco, P.; Frias, I.; Guzmán, J.; Hernández, A.; Licona, A.; Martínez, F.; Maymes, A.; Mondragón, M.; Montano, T.; Ojeda, L.; Ríos, A.; Rochín, E.; Rodríguez, L.; Rodríguez, N.; Romero, R.; Solís, F.; Valdés, S. and Velázquez, I. 2011. Twenty years of interdisciplinary studies: The "MEZA" Program's contributions to society, ecology, and the education of postgraduate students. *Ecology and Society* 16(4): 9, www.ecologyandsociety.org/vol16/iss4/art19/
- Vörösmarty, C.J.; McIntyre, P.B.; Gessner, M.O.; Dudgeon, D.; Prusevich, A.; Green, P.; Glidden, S.; Bunn, S.E.; Sullivan, C.A.; Reidy Liermann, C. and Davies, P.M. 2010. Global threats to human water security and river biodiversity. *Nature* 467(7315): 555-561.
- Wallis, P.J. and Ison, R.L. 2011. Appreciating institutional complexity in water governance dynamics: A case from the Murray-Darling Basin, Australia. *Water Resources Management* 25(15): 4081-4097.
- Wenger, E. 2000. Communities of practice and social learning systems. *Organisation* 7(2): 225-246.
- Wickson, F.; Carew, A.L. and Russell, A.W. 2006. Transdisciplinary research: Characteristics, quandaries and quality. *Futures* 38(9): 1046-1059.
- Wodak, R. and Meyer, W. 2009. *Methods of critical discourse analysis*. London, UK: Sage.
- Woodhill, J. 2010. Capacities for institutional innovation: A complexity perspective. *IDS Bulletin* 41(3): 47-59.
- Wouters, P. 2008. Global water governance through many lenses. *Global Governance* 14(4): 523-534.

THIS ARTICLE IS DISTRIBUTED UNDER THE TERMS OF THE CREATIVE COMMONS *ATTRIBUTION-NONCOMMERCIAL-SHAREALIKE* LICENSE WHICH PERMITS ANY NON COMMERCIAL USE, DISTRIBUTION, AND REPRODUCTION IN ANY MEDIUM, PROVIDED THE ORIGINAL AUTHOR(S) AND SOURCE ARE CREDITED. SEE [HTTP://CREATIVECOMMONS.ORG/LICENSES/BY-NC-SA/3.0/LEGALCODE](http://creativecommons.org/licenses/by-nc-sa/3.0/legalcode)