The Research Journey: Travels across the idiomatic and axiomatic towards a better understanding of complexity

INTRODUCTION

Many contemporary societal challenges are characterized by a degree of messiness and/or interconnectedness that defies traditional reductionist scientific analysis (Costanza 2009; Chapin et al 2008). Complex systems theory (e.g., Von Bertalanffy 1972; Odum 1983) has emerged to address difficult problem domains that span social, ecological, and technological matters and as such defy the competencies and scope of individual academic disciplines or methodologies. Discipline-bounded analysis is simply a poor fit for complex systems and situations (Homer-Dixon, 1995; Roe, 1998; Turner & Carpenter, 1999; Gunderson and Holling, 2002; Taylor, 2005; Young et al, 2006; Gotts, 2007; Aboelela et al, 2007). Hence, there needs to be "a more integrative style of inquiry" (Scoones, 1999, 497) that can reconstitute a whole system (Newell, 2000) and use different disciplines together to better conceive of the processes that transcend traditional conceptual boundaries (Gunderson & Holling, 2002). Tackling complexity necessitates a portfolio or broad toolkit of analytical methods, including statistical analysis, case study research, and participatory action research (Young et al, 2006); this requires breaking down traditional barriers between academic disciplines, but also the inclusion of different bodies of knowledge and ways of knowing, such as lay, local and indigenous expertise.

In this paper, we propose an adaptive approach – the research journey – where the researcher employs a range of methods to understand and synthesize the emergent properties and general dynamics of the complex systems. The process we describe follows Vayda's (1983) "progressive contextualization," where researchers follow problems through progressively denser and/or thicker contexts, revising research questions and methods as understanding of the problem domain changes. The researcher follows a path laid out by the evidence as it emerges. In contrast, the research journey underlines the breadth of options researchers follow to appreciate and engage with that complexity – it is a formalization of complexity research methods.

As interdisciplinary researchers engaged in what some have called "post normal science" (Funtowitz & Ravetz, 1990), we need to rebuild our capacity for synthesis and intuition (Klein, 1996; Lacutta, 2001). We argue that the concept of the research journey facilitates this process, where researchers knowingly move across a "landscape" where different research methods are located according to where they fall across two enduring tensions. The first tension is between (1) the search for general trends or broad explanatory studies and (2) academic projects focused on specific problems rooted in specific or grounded observation. The second tension is between (1) knowledge collected through a formalized academic process characterized by falsification, and (2) co-created knowledge between the researcher and subject(s), including traditional knowledge and ways of knowing associated with a long-term relationship with place.

The researcher, we argue, must explicitly and deliberately function between the

axiomatic and idiomatic, and between the academic and the practical or practiced expert (see figure 1).

Figure 1. The Research Landscape

Several factors influence a researcher's trajectory over the research landscape: the researcher's entry point (such as the defined problem, research question, intellectual background), the research team's composition, emergent aspects of the problem and the boundaries of the question. The tools and ideas researchers bring to their project effect the research journey's direction. Additionally, problem domain(s) can present obstacles to the researcher throughout their investigation that demand methodological experimentation and therefore a move around the research landscape.

The research journey is an iterative process, unique in each journey's individual trajectories, and this paper does not propose one type of journey over others, but illustrates the benefit of a research journey in engaging with complex systems and problems. We present seven research projects in different origin disciplines with variant questions that travelled across the research landscape throughout the project's lifetime. We caution that it is ever important to remember Korzybski's adage, "the map is not the territory" (quoted in Bateson, 1972: 455) – while the research journey can help researchers understand where they are and where they are going, the journey is not itself a method of inquiry.

BACKGROUND

The authors of this paper began collectively discussing these issues in a workshop organized over two days in February of 2011. At this workshop, we had participants representing virtually every discipline related to the study of social - ecological relations. These included earth system modelers who normally use large-scale data sets to assess the impact of modern society on the biosphere all the way through to cultural anthropologists who normally use in-depth and qualitative methods such as ethnography.

Many of us were also steeped in such "new" theoretical paradigms as complexity theory (Bar-Yam, 1992, Kauffman, 1995, Gunderson and Holling, 2002) or heterodox / ecological economics (Common and Stagl, 2005, Costanza, 1991). Hence, most of the participants were familiar with issues such as power, place, and the need to integrate multiple perspectives to better understand global problems. We came together to find a middle ground between our various approaches that would help each of us do better, more complete, and more socially-relevant research on linked social-ecological systems. In short, we, like the vast majority of people working in this field, are motivated by a normative impulse to do work that will somehow make the world a better place.

We began by discussing an extremely predicable list of topics – how to use data, how and when it is appropriate to infer causality, how to include stakeholders, how to integrate different types of knowledge, the importance of research that is sensitive to local contexts, and the need to integrate social-economic factors into biophysical models. Out

of these conversations emerged a number of core tensions that revealed the extremely divergent opinions present in the room.

After considerable discussion, it was decided that we could reduce these tensions onto two core dimensions. The first was focused on the purpose of research. Some bodies of scholarship emphasize research that results in general explanations or theories that "…are typically probabilistic and quantitative in nature…" (York and Clark, 2007 p. 714). Generally speaking, philosophers of science argue that this sort of research is "nomothetic," after the Greek meaning of proposition of the law, and that such a paradigm results in research that provides a generalized understanding of problems or phenomena. Nomothetic research lends itself to making predictions about the future (such as the outputs of an earth biosphere model). But this work is quite different to "idiographic" research where research results in explanations of problems that "…emphasize the uniqueness of individual cases…" (York and Clark, 2007 p. 715). Hence, ideographic research tends to be diagnostic in nature, explaining how or why a specific event occurred without trying to extrapolate broader trends.

Broadly speaking, the tension between nomothetic and ideographic research is similar to the tension that underscores debates between "modernist" versus "post-modernist" approaches to scholarship in the social sciences more generally. While there is a vast literature devoted to this topic (key authors include Thomas Kuhn (Kuhn, 1962) and Karl Popper (Ackermann, 1976, Popper, 1994)), we draw from this huge body of work that there continues to be a healthy debate among those who view science and research as a way of observing the "real" world, those who argue that science is nothing more than a socially constructed discourse, and those who choose to skirt the issues altogether in favor of using the institution and practice of science towards meeting societal needs (Ahl and Allen, 1996; Giampietro et al., 2006).

The second tension that dominated our conversation has to do with the role of data in research. Traditionally, researchers treat data as a passive "thing" to be gathered and analyzed as the primary way for explaining phenomena. But for many scholars working today, data are seen as something that can (and should) be co-produced through partnerships between researchers and subjects and used as a way of empowering groups to lobby for change. The traditional approach to data is found in traditional or "normal" scientific disciplines that go back to the Scientific Revolution of the Early Modern Period. Authors speaking from the newer perspective, however, approach data from a range of fields such as soft-systems methods (Checkland and Winter, 2006), adaptive management (Holling, 1978), and the study of "post-normal" science (Funtowicz and Ravetz, 1990). While the literature associated with these three bodies of work is also enormous, a number of key features stand out. In particular, we take from these authors that in linked (and often complex) social ecological systems the outcome of specific management practices is often unknown. Hence, we need to establish processes that link scientists, policy makers, and resource users in a way that allows policy to be experimented with, changed, and slowly developed through long iterative conversations between relevant

parties, as unknowns become known, and other unknowns emerge.

By the end of the workshop, the participants resolved that, while incomplete, enough of the issues raised in our debates were captured by these two core dimensions that these could be used to develop a 2x2 framework that we call the "research landscape" (figure 1). We believe that a range of different perspectives and approaches to research can be mapped onto this framework (see quadrants in figure). Finally, when we paused to reflect on our own research projects, we also observed that each of us had implicitly embarked on a "research journey" across this landscape where we moved from phases of work that made use of data and research solely as a way to explain trends, develop theories and make predictions (upper left hand quadrant) through to phases of our work that were much more applied and embedded in the lived experience of different communities (lower right). The rest of this paper unpacks the metaphor of the research journey as a way of explicitly guiding researchers as they seek to grapple with the difficulties of doing work on social-ecological systems.

THEORY & PRACTICE: The Research Journey

Klein (1989) argues for a research approach that begins with a specific question, from which partnerships can be decided upon, frameworks described and maintained through communication networks, data can be gathered, integrated and collated. Newell offered two processes: the first (1998) stitches multiple disciplines' perspectives on a problem at hand; the second (2001) begins with seeking conflicts between disciplinary perspectives, building towards a new common ground and new construction of the problem itself. Daily and Ehrlich (1999) proposed researcher collaborations, where committed and established senior people involve bright young scholars, with funders who believe in interdisciplinary research, and there is a shared toleration of risk. Naiman (1999) argued interdisciplinary work depends both on training and on personal qualities not traditionally associated with research, as "it demands personal values related to patience, trust, responsibility, and honesty" (292). Turner and Carpenter (1999) argued there is "no 'cook book' of procedures" for trans/interdisciplinary research. Klein (2008) suggested the sheer heterogeneity of research projects across the interdisciplinary/transdisciplinary spectrum makes the crystallization of "a single best procedure for research performance or evaluation" potentially a quixotic quest (p. 117).

How might a researcher of team or researchers decide what ought to be included? While the results of inter- or transdisciplinary work may present a holistic picture of the system or landscape under examination, the process of bringing together different theories and methods is often treated like the production of sausage – messy and best considered only as a result. Hence the importance of the research journey. The journey is a self-conscious discussion of decision-making during the research process – why researchers shifted focus, recruited different participants and introduced new methods.

The CATWOE (client, actors, transformation, worldview, owner, environmental constraints) method demands the researcher consider these six perspectives, and what

impact their work (and methodological choices) may have (Checkland, 1981). This concern is reflected in methodological philosophies such as critical systems thinking, which underlines the embeddedness of the observer in the observed system, the need to understand the origins and implications of any theoretical/methodological choice, and the need to be aware of the impact of research (what Midgley calls emancipation) (Midgely, 2000). The research journey is a series of iterative, perpetual pre-analytical steps, as per Giampietro et al (2006), asking "what is observed and how" (p. 307) repeatedly over the course of a research project. As Ahl & Allen (1996) described their discussion of hierarchy theory, "the scientist who uses hierarchy theory is often less interested in what is 'really' happening in the material system, and focuses more on finding a powerful point of view" (11); taking a research journey is about exploring multiple points of view as the research question(s) evolve(s) over time, to build up to that ultimately powerful narrative that is not reductionist but holistic, not mechanistic but reflects the alive and complex qualities of a whole system.

Embracing the Tension

The research journey is essentially a confidence landscape, across which many research methods can be located; no one method is sufficient to appreciate the dynamic, emergent, multi-scale behaviour of complex systems (Rosen, 1987). The first tension noted above occurs with respect to the purpose of the research itself. The pull between general theory and the specific case is a tension between the desire to illustrate explanatory trends and themes, whereas the latter seeks to understand in depth a specific phenomenon (bounded in time, in geography, and/or by agents). The expert-participant tension reflects the expanding understanding of relevant participants in research; at the far left in figure 1, "expert", falsifiable information is gathered by experts to explain (data exist and are collected) and at the far right, "participant" information is co-produced between researchers and erstwhile subjects, usually to empower the community or participant group in question to act outside of strict academic work (data are created).

A method's location on the grid is based on *how* data are collected, and *for what purpose* that data are used. For example, a theory about a type of behaviour observed across the whole of a society would be located in the upper left-hand corner of figure 1 (either through statistical analysis or narrative/meta-analysis), and a historical biography (a single, in depth case) of a particular agent would be found in the lower left hand. Conversely, a study where researchers and participants partner to collect data on a relevant question to the community (e.g. local health conditions) would fall in the upper-right hand of the grid, and community oral history collections would be located on the lower right-hand of the grid.

While the tensions that create the grid above are often considered as oppositional, to approach complex issues we must consider these methodologies located on different points of this grid as complementary within one larger project. Systems that are complex, that span or link traditionally separate social, ecological, economic and political spheres and who are alive with autopoesis (self-creating), feedback loops, adaption and

emergence, require the researcher to use a range of methodological approaches, which may be scattered across a broad portion of the above grid – the grid is a landscape in itself.

The researcher's background and entry question, initial methodological choices, skills and experience determine their entry point to the grid. As the stories below indicate, the limitations of that starting point to address relevant elements of the research question or complexity of the situation under examination require the researcher to shift focus, employ a new methodology *in addition to* their earlier choice. This may require the expansion of the research team, or the researcher to educate themselves in new methods. Additionally, new participants or new discoveries may shift the view and needs of the project itself; researchers must be prepared to accommodate the emergent qualities of a complex system.

As researchers attempt to navigate complex systems, appreciate emergence, account for discontinuities and perceive the roles of feedback loops, they face obstacles in their research. Different methodological options are therefore tools to manage these obstacles. As researchers move from one methodological choice to another, they move over this landscape – that is the research journey. The detailed research journeys of experienced academics below display that this is a never-ending process, where the researcher takes as much from their experiences as they bring to the projects on which they worked.

RESEARCH JOURNEYS

The research journeys included here cover different fields of environmental-social interaction. Some, such as Evan Fraser and Rinku Chowdhury, chronicle a journey across several years and sub-projects focused on a specific question. Others, such as Philip Loring's needs assessment project, Kathleen Weathers' sabbatical work and Michele-Lee Moore's doctoral research, illustrate how one project may require multiple views, approaches and angles. Flor Avelino explains how transition management can incorporate many elements of the research journey grid, based on her doctoral research. These research journeys illustrate the researchers' openness to emergence in the field. New participants to projects present their own unique problems, or perspectives that can redirect researchers' efforts, redefine relevant data points, and even redirect research goals. The worlds with which researchers engage (historical or contemporary, locally-defined or globally-understood) are composed of complex systems, and behave in ways and include actors that the researcher(s) could not have anticipated.

Evan Fraser: On Food Security

Over the next two generations, the globe faces an enormous human security challenge. We must adapt to rapid economic and climate change by creating a food system that provides adequate and appropriate nutrition for 9 billion people. We must also do this in a way that does not compromise vital ecosystem services including biodiversity conservation and carbon sequestration. Within the broad area of "global food security in the 21st century," I have spent my professional life developing a

multi-disciplinary research program – a journey – on the links between food security, land use, and global environmental/economic change.

The first phase, "specific–expert" (Point 1), employed qualitative methods to assess cases where relatively small environmental shocks had massive consequences for food security. For example, I studied the Irish Potato Famine (1845-1848) when a rainy year created ideal conditions for a fungal blight to destroy the potato crop. Rainy years, fungal blights and the failure of the potato crop were all common in the decades leading up to the Famine, but it was only in 1845 that these combination of factors triggered massive suffering (Fraser, 2003). Therefore, the Irish Potato Famine is a useful case to understand the processes by which a society's food system becomes vulnerable to environmental problems.

Studying the specifics of such case studies led me to phase two of my research, to try and establish general theories about the "pathways of vulnerability" that explain how environmental problems can trigger food security crises, "general-expert" (Point 2), using a mixture of qualitative and quantitative methods. A key result was that socio-economic and institutional factors are usually more important in determining the way a climatic shock affects food security than the actual shock itself (Fraser, 2007). This research allowed me to start building theories about the preconditions that make food systems vulnerable to climate change (Fraser, Available online). This led to a "general-expert" phase (Point 3), using quantitative methods to test the models and theories developed under phase two. More specifically, the question we asked was "what are the socio-economic and institutional factors that make harvests vulnerable to drought?" We tackled this question using statistical methods and used agricultural, meteorological and socio-economic data at a range of spatial and temporal scales to develop adaptive capacity models (Fraser et al., 2008; Simelton, 2009).

This modeling revealed a number of problems with established theories. For example, we noted that middle income households and countries are more vulnerable to drought than rich or poor regions (Simelton et al., In review). The implications of this finding are huge: if poor countries become wealthier, then we can expect them to become more vulnerable to drought. But while our quantitative work presented us with these sorts of insights, we have no real idea as to why or what accounts for such trends.

This led to a place-based "participatory-specific" phase (Point 4) where we undertook a series of very specific case studies to explore these issues from the bottom up (Dougill et al., 2010; Fraser et al., In Press; Manez Costa et al., In press). This revealed that policies to address power, gender and land tenure may help empower people and this empowerment may be more important at dealing with climate change than plant breeding, agricultural extension work or other methods designed to boost productivity. In short, food crises tend to emerge when people become either scared that a food crisis is looming or feel morally outraged that "merchants" or "governments" are profiting from rising food prices (Fraser and Rimas, 2011). My current hypothesis is that empowering farmers to feed local populations and maintaining viable local food systems is important not so much

for the calories such farms provide but as a mechanism that provides a psychologically feeling of food sovereignty. However, exploring this issue is quickly forming as the next phase of this ongoing research.

Figure 2. Fraser's Research Journey

Rinku Roy Chowdhury: Methodological diversity and approaches to socio-ecological complexity: Journeying through landscape change and farmer land management in the southern Yucatán peninsular region, Mexico

In the southeastern corner of Campeche, one of Mexico's most impoverished and bio-diverse states, lies the nation's largest protected forest. The Calakmul Biosphere Reserve (CBR) was established in 1989 amidst community owned lands (*ejidos*), linking conservation and development priorities in this international hotspot of biodiversity and deforestation. I have been conducting research on aspects of landscape change, social structure, decision dynamics and ecological impacts in the area since 1997, and how these domains intersect to shape socio-ecological system vulnerability and resilience.

My initial research question integrated institutional theory with landscape ecology, and sought to advance knowledge of the institutional dynamics of land use/cover change (LUCC): How do institutional property regimes (reserve and community) affect land cover, landscape pattern and ecological community composition? My approach was broad-scale, deductive-scientific, quantitative, and generalization-seeking *(*Point 1). It was also interdisciplinary by design, combining remote sensing and spatial science with landscape and ecological research (e.g., analyses of forest fragmentation and landscape structure), and social science research for characterizing land management within reserve vs. *ejido* jurisdiction/regimes. While this targeted an understanding of land use, it was not initially participatory, nor was it primarily driven by insights/concerns of community members or conservation personnel.

In implementing the above research agenda, three problems emerged: (1) regimes (reserve, community) could not be easily spatially extricated/separated; they overlapped in space, time and decision domains; (2) most (though not all) "management" by reserve and *ejido* structures filtered through the actions of individual smallholding households, who were incredibly diverse, and could variably amplify or dampen the regimes' land cover "signatures", and (3) the property institutions in question were often superseded by policy institutions (e.g., post-NAFTA agricultural policy instruments) that strongly influenced local land management, and eventually regional landscape impacts.

Negotiating the multi-scalar, complex socio-ecological relations emergent through the interactions of conservation regimes, community structures, local smallholding households and local ecosystems required a more flexible approach, with logically but loosely articulated components. On one hand, the focus on conservation regimes expanded to the broader set of international and national conservation institutions (e.g., NGOs) in the region, and their individual and collective actions/programs. This entailed in-depth qualitative interviews with conservation decision-makers and participant observation of community conservation programs, workshops, training and fieldwork (Point 2). A few

conservation leaders also held strong social capital and relations of trust in local communities. Those individuals became key informants, leading to snowball sampling of local community leaders that were key players in local land conservation as well as social development-land rights movements. Research took a turn to documenting the environmental history of Calakmul, tracing the evolution of conservation regimes and local socio-environmental movements since the 1970s, well before the CBR was established. Institutional research further expanded to consider the impacts of policy institutions emerging from the liberalization of national agricultural, forestry and conservation sectors after NAFTA, and their implications for institutional structures as well as local agency in Calakmul.

Most significantly, the research deepened to include, and eventually came to center upon, the decisions and agency of local land managers, smallholding households in *ejidos*. This work included in-depth interviews as well as semi-structured household and land use surveys, participatory mapping, landscape ethnographic methods, and GPS-assisted ground-truthing of satellite imagery as well as farmer recall of forest/parcel use histories, and accounts of farmer perceptions of local environment, post-NAFTA policies, local and regional conservation regimes and community land tenure institutions. This research combined theoretical concerns of structure-agency interactions in geography with quantitative as well as qualitative research (Point 3). Quantifiable components of surveys allowed for statistical and spatial modeling of structure-agency interactions (and their implications for parcel land use as well as landscape-scale land cover), frequently utilizing variable definitions driven by farmers. Qualitative insights lent depth and validity to the interpretation of such results, and helped guard against spurious causation.

Emergent research directions include scaling back up from participatory, qualitative insights to ascertain which socio-ecological relation may be generalized, and at what spatial scales, and ascertaining the resilience or vulnerability of the socio-ecosystem. For instance, scaling up from household perceptions and variation in land use to identifying broad regional clusters/groupings of households based on land portfolios, the socio-ecological factors that explain group membership, and the implications of aggregate household-group actions for a regional-scale forest transition. Research is also turning to investigating the relative adaptive capacities of smallholder agro-ecological management systems (e.g., focused on hybrid vs. landrace maize varieties) under projected scenarios of rainfall variability on the one hand, and market liberalization on the other. Finally peninsular-scale rural-urban migration, linked land abandonment and shifting mosquito vector habitats are altering the spatial patterns and relative burdens of dengue and malaria in the region—to be investigated using landscape epidemiological, climate science and demographic research. These new thematic research areas entail combinations of deductive and inductive approaches in collaboration with larger teams of social, entomological, health, agronomic and remote sensing scientists.

Figure 3. Chowdhury's Research Journey

Kathleen Weathers: The Interaction of Citizen Scientists and the Lake/Watershed

Community

My research journey occurred during a sabbatical leave that I took to work with a forward-looking lake association (and its board-of-trustees) whose mission identifies having the best possible science underpin their education, outreach and actions. Yet they – and we, the scientific world—are quite vague about what that means. I decided to catalyze the process through holding a series of topical workshops, where we were able to bring together the regional scientific community, and the association personnel as well as educators to understand better what each was doing in the region regarding water and watersheds. As a result of these meetings, I co-initiated a scientific advisory committee (SAC) for the Lake Association.

While this SAC's purpose was to better connect experts in the field to the association, it also served to let the research community know what some of the major issues were that lake association personnel observed as up-and-coming. One significant upshot was that the association members identified, in 2004, that their clear water, nutrient poor lake was experiencing cyanobacteria blooms. This is considered to be an unusual ecological phenomenon because there are not many nutrients in the lake. While these blooms are common in nutrient rich, pea-soup lakes, they have been considered to be unusual in nutrient poor lakes. So, a significant ecological issue was identified (Point 1). I was able to match a student who expressed interest in an internship with me (serendipity--she had heard from a mutual acquaintance that I was on sabbatical in an area that was close to her undergraduate college), and who was a budding algal ecologist, with an issue that was completely opaque to the research community, but of significant interest to the local community. The student project led to engagement by local researchers (catalyzed by me, the lake association, and the dynamics of the student's thesis committee) and we further engaged the expertise of other relevant researchers in exploring the phenomenon, which we have now documented as a regional issue (Point 2). We now have NSF research support to understand the role this "biotic key to a Pandora's Box" might play in affecting ecosystem services (e.g., Cottingham et al, in revision). There is currently significant engagement, refining of the question(s), information exchange, and interaction with the lay citizens group through the process, so we are dancing back and forth (Point 3 & 4) along the continuum. This, and many associated spinoffs are work very much in progress.

Figure 4. Weathers' Research Journey

Michele-Lee Moore: A methodological journey into networked governance

As a PhD candidate, my dissertation focused on two ideas: 1) how global level organizations involved in water governance were connected to domestic, non-transboundary river basin organizations and the implications of those interactions, and 2) whether social network analysis (SNA) was a useful tool in a water governance study.

But I struggled. I wanted to conduct meaningful research, that practitioners could use. Yet, I spent 2-3 years meeting other researchers, asking colleagues in government and

international organizations, “cold calling” and “cold emailing”, all as a means to find THE question, without a clear case or problem emerging. Reflecting back, I realize that may have been a consequence of the complexity of water governance. Expecting anyone working in this field to be able to articulate a clear research question actually meant that I was expecting someone to simplify the complexity for me, reducing it down to a single, feasible, dissertation-type question. Instead, I was left to use the literature, my experiences from global level conferences such as the 5th World Water Forum, and my previous work experiences in government to formulate a question, a plan, and a budget. Therefore, I started the research on the expert side of the research journey, even though I was anxious about needing to be on the participatory side (Point 1).

I conducted research with three different river basin organizations – the Murray Darling Basin Authority (Australia), the Prachinburi River Basin Committee (Thailand), and the Fraser Basin Council (Canada). In each river basin, I was overwhelmed by data on the specifics of each case and the range of participants’ perspectives on that data. My initial intention was to focus on social network analysis, bolstered with interview data using a grounded theory approach (Point 2). I quickly came to realize that SNA was inadequate for capturing the complex interactions and exchanges across multiple ecological, organizational, and governance scales that participants’ perceived as critical to water governance in their basin. Moreover, robust SNA tests require “closed” populations – a near impossible task when addressing global level networks and their interactions in a river basin. Ultimately, a grounded theory approach provided a more robust tool to systematically investigate the complexity of the global-local networked interactions in water governance (Point 3). Fortunately, I had selected a mixed method approach from the beginning and both my institution’s Research Ethics and my dissertation committee approved this approach. The alternative – switching methods and re-submitting the proposed research activities for approval part way through a field season on the other side of the world – would have had significant time and financial consequences for field research. The experience highlighted the difficulty of completing complexity-based research in a dissertation. Switching methods as the journey unfolds is not always encouraged and may depend on the interdisciplinary sympathies of committee members. Likewise, engaging with multiple methodological approaches underlines the benefits of research teams – another approach not typically encouraged for an individual dissertation.

[Points 4-6] Using an iterative method of collecting and analyzing data to develop conceptual codes and the core concepts that would comprise the grounded theory findings, I oscillated between engaging with participants on the technical, context-specific details of their work and network relationships to exploring broader theoretical and conceptual explanations for the emergent patterns revealed by the research. The research findings showed that an individual’s intrinsic motivations for learning can affect global network structure. Furthermore, complex social-ecological challenges – rife with issues of ethics, competence, large scale ecological disturbances, and tensions between the various actors engaged in water governance – affect each of the watersheds studied and

locally-developed, transformative governance changes are occurring, whether deliberately designed or not. Consequently, this project explored abstract spatial scales – examining the "global" network and the "local" basin – and concrete ones, such as how patterns in one basin added richness or variation to the concepts or codes from another basin. The network relationships analysis also showed that I needed to examine both the scale of the organization, and the scale of the individual people within those organizations, in order to have a rigorous understanding of networked governance in water. Thus, I repeatedly moved from the general to the specific, from expert to participatory and back to expert again.

Figure 5. Moore's Research Journey

Jan Sendzimir: On the Tisza River

My research journey began in the Hungarian reach of the Tisza river basin in 2003. A regional meeting in a remote village, Nagykörü, on how to make river management more flexible convinced me that a critical mass of stakeholders and scientists were independently trying to develop the basis for adaptive management of the Tisza river. Adaptive capacity is of increasing interest in Central Europe given the potential for increased frequency of extreme weather events (floods, droughts) under climate change. Zsuzsana Flachner, the scientist-activist leading the discussion, agreed to partner in participatory science projects to deepen the regional dialogue by integrating it with field research. We brought this nexus of science, governance and local practice to the European Commission as a research proposal. My journey merged with theirs, for they were acting as a Shadow Network (*sensu* Olsson et al. 2006) to use a series of disastrous floods and cyanide spills between 1997 and 2001 (Sendzimir et al. 2007, 2008) to expand the scope of inquiry and management options for river SESs facing uncertainty from economic and climate change. We linked with Claudia Pahl-Wostl, a prominent social scientist interested in adaptive management and water resource governance, who directed a large network of academics that was able to secure research contracts at EU scales. In 2004, Pahl-Wostl united 37 organizations partners in the 14 million euro NeWater project, entitled New Approaches to Adaptive Water Management under Uncertainty.

Our research contract under the EU 6th Framework required we adopt a conceptual framework that favors policy over theory so as to "practically" deal with issues critical to formulating and implementing EU policy. Theories about change (resilience, transition) and structure (hierarchy) underpinned our examination of whether river management policy was or could become adaptive under the Water Framework Directive. Our team objectives were to: learn-by-doing participatory science, we and local partners mutually developed skills to analyze and communicate complex ideas and formulate policy, to study the factors influencing the dynamics of transition from a 'command-and-control' to a more adaptive regime.

Collaboration between scientists and stakeholder activists improved as we acknowledged our starting assumptions and re-negotiated our research goals. We started on the wrong foot with the Shadow Network by trying to deliver *not* what they

sought for but what was contractually promised. The stakeholders wanted to understand the basis of increased resilience to drought in meadows ringed by forest and for the productivity potential of fisheries in floodplains. Testing such questions demanded spatially explicit models to look at how flood pulses enhanced water and nutrient dynamics – an effort beyond our means to collect data or calibrate the models. Our progress was delayed until we came to an agreement on questions we could mutually pursue using conceptual models, e.g. the barriers and bridges to transition. So we shifted focus to the pathological rigidity of the current managing regime, which sustained its identity under stress (chronic disturbances) while suppressing experiments with alternative policies, i.e. adaptive capacity. However, this re-negotiation was hindered by the stakeholders' starting assumptions, which were deeply influenced by the impetus from their research journey. We had to defend our integrity as scientists by insisting that we embrace uncertainty through exploratory research rather than simply validating traditional lifeways. We redefined the research goals as the examination of the factors that aided (bridges) or hindered (barriers) our capacity to experiment, learn, and adapt, a goal well served by participatory modeling.

Conceptual modeling allowed us to define the structure of interactions (webs, feedback loops, delays) that we posited would influence how conventional agricultural and river management policies combined to inhibit adaptive capacity even as they increasingly failed to mitigate flooding damage. This modeling effort was done using a 'focus group' of experts (activists with strong science backgrounds). Regional audiences criticized the resulting models through interactive seminars and role-playing games. The games offered us the first chance to see how farmers deliberate as they competed with each other amidst floods and droughts.

We realized there were many additional possible explanations for why transition to an adaptive regime was stalled. Our models reflected mostly *egalitarians'* perspectives, and that similar efforts were needed with other views, e.g. *hierarchists* and *individualists* (*sensu* Cultural Theory, see Douglas and Wildavsky (1983) and Thompson (1997)). Specifically, neither the modeling nor the role-playing games had input from the industrial agriculture proponents (large farmers, Ministry of Agriculture officials) whose vision and practice strongly depended on water and agricultural policy conventions.

To examine how aggregate patterns of social interaction may have influenced the policy process, we applied a Management Transition Framework or MTF (Pahl-Wostl et al. 2010) building on Ostrom's (1990) IAD framework. We used MTF to look at how the dynamics of linked action situations might have influenced what knowledge was used to generate which institutions (Sendzimir et al. 2010) all of which generated new action situations. The analysis showed the importance of leadership: when one 'champion' resigned from a key parliamentary committee, the policy process reverted to the conventional policies that had previously been rejected. Leadership and asymmetrical power relations in networks influence in this policy reversal suggests network analysis' potential usefulness to analyze future dynamics of the policy process.

The entry to our research landscape had an inductive frame due to the EU focus on policy and stakeholder focus on floodplain ecology. We began with a small group of local experts (Point 1) with focus group discussion to align our goals and methods, such that we could use conceptual modeling to explore the barriers and bridges to transition between management regimes. We used participatory seminars to critique these models or to explore their assumptions in social simulation (role-playing) designed on the basis of the models (Point 2). Repeating these at several places in the basin helped us to see if model assumptions were general to the region. We then used expert focus groups to apply the MTF framework in examining how over time the interplay between action situations, knowledge, institutions and operational outcomes influences policy processes (Point 3). This exercise helped us examine patterns of interaction from the local to national level, so the level of generality increased with each step.

Figure 6. NeWater Scientists & the Shadow Network of activist-scientists' research journey (2005-2009).

Philip Loring: The Social Vulnerability of Alaskan Coastal Communities

As a researcher on the "Social Vulnerability of the Alaska's Coastal Communities to Extreme Weather and Climate Change" (SOVACC) project, a NOAA funded research project, one of my primary goals was to perform a needs assessment of people working in the commercial fisheries of the Bering Sea and Aleutian Islands (BSAI) region, home to the largest commercial fishing port in the US and one of the largest and most productive ground-fish and crab fisheries in the world. Climate change is already having a variety of dramatic impacts on storminess, weather, and ocean conditions in the BSAI (ACIA 2005); high storm and wave activity can have impacts on the distribution and abundance of fish species, and can also create significant hazards for fishers and fishing communities (Atkinson et al. 2011). The fishing lifestyle in this region is already popularly known as the "Deadliest Catch," and, while it is unclear whether a warming climate will increase storm activity, increase the intensity of storms, make storm activity more unpredictable, or all of the above (Atkinson 2005), the research team believed that increased risks to the health and safety of these fishers would be a primary concern. We had to identify patterns of vulnerability at multiple levels, including for the individual fisher, fishing vessel, and fishing community, and then to identify climate information products that might help to reduce those vulnerabilities.

We set out armed with historic climate data, climate downscaling models, and modeling capacity to learn collaboratively how we could best provide new weather and climate information to the people working in these fisheries. The intent was to use local historical accounts of extremely dangerous weather events to inform our models such that we could make projections regarding the frequency such dangerous events in the future. While our team had extensive knowledge of both fisheries and climatological systems, we did not, however, have experience with commercial fishing. Nor did we posses knowledge regarding what wind speeds and other at-sea conditions would be considered hazardous. The size of vessels in this diverse fishing fleet was also expected to be an

important factor in what conditions would be considered especially dangerous, and who would be most vulnerable (Berns 2011). This first step of seeking out place-based knowledge in order to create accurate vulnerability assessments that can inform effective responses to change, is a hallmark of an iterative and adaptive approach to research (Point 1).

Surprise is a hallmark of an adaptive approach to research, and we were surprised to discover that fishers were not overly concerned about future changes in storminess and at-sea conditions. This was because recent changes in fisheries policy had significantly increased fishers' flexibility to decide when and where to fish (Loring et al. 2011). Many of the fisheries in the BSAI had for years been managed under a "derby" style of fishing, wherein the fisheries were opened for only very short (e.g., 18 hour) periods at a time. Fishers had to race to make their catch limits, regardless of conditions. Over the past decade, however, the majority of the commercial fisheries in this region had been converted to quota-based management systems such as IFQs, in which fishers had periods of eight to nine months to fill catch their limits (Fina 2005). While there has been an important and continuing debate regarding the negative social impacts of these changes (Carothers et al. 2010), several fishers reported that issues of personal safety had indeed been significantly reduced.

(Point 2) Two of the researchers working on this project, myself included, had also been working in the interior region of the state, where changes in climate are increasing obstacles to hunting and fishing and risks to human health and safety. The subsistence systems of Interior Alaska are quite different from the commercial fishing enterprise in Dutch Harbor, but both are experiencing significant changes in the variability and predictability of environmental conditions, but with rather opposite outcomes in respect to the viability of the harvest. Thus, a comparative exercise was identified, one intended to test the role of governance as an intervening variable driving the different outcomes across the two systems.

Using a framework for ecosystem services analysis based on path dependence-path creation theory (Loring et al. 2008), we deployed a new interview protocol to ask in both regions, keyed to several concepts of how governance arrangements and policy implementation and enforcement influence individual options and patters of behavior in response to environmental variability (Point 3). The exercise proved rather fruitful in that we gained some generalized knowledge about the adaptability of governance systems to climatic variability and change at a pan-Arctic scale (Abdeladi et al. 2010) (Point 4); it also allowed us to contribute place-based information and recommendations that met the needs of our collaborators in the Interior, who are struggling with food insecurity in part as a result of wild fish and game management systems that are not designed to respond to fast environmental changes (Loring et al. 2011).

Figure 7. Loring's Research Journey:

Flor Avelino: Methodological Journeys in Transition Management

Flor Avelino: Exploring Power in Transition in the context of Sustainable Mobility

The research journey underlying my PhD-thesis (Avelino 2011), was grounded in two fields: (1) social theories of political power (Haugaard 2002), and (2) sustainability transitions research, an interdisciplinary field of research that focuses on long-term processes of societal transformation (Grin et al. 2010, Markard et al. 2012). I was faced with three challenges: (i) theoretically conceptualizing the role of power in sustainability transitions, (ii) empirically analyzing power struggles in the transition towards sustainable mobility, and (iii) formulating the implications of power for transition management (Rotmans et al 2001, Loorbach & Rotmans 2010).

First, I tackled the theoretical challenge through a purely deductive approach (step 1), by studying various classical theories of power (e.g. Arendt 1969, Clegg 1989, Parsons 1967, Lukes 1974, Foucault 1977,1980,1982, Giddens 1984) and integrating these with concepts in transition theory, in particular the Multi-level Perspective (Geels 2005, Schot & Geels 2008) and complex systems perspectives on transition dynamics (De Haan & Rotmans 2011). This resulted in a first conceptualization of power-in-transition (Avelino & Rotmans 2009, 2011).

In a separate, parallel trajectory (step 2), I started to tackle the empirical challenge through a highly inductive, ethnographic journey through the empirical field (the Dutch transport sector). This meant an "immersion" in anything mobility related, including virtual newsletters, meetings, debates, platforms, informal conversations with transport professions etc. Over time, this empirical journey consolidated itself in four focused case-studies of specific programs/projects that aimed to transform the Dutch transport system into a more sustainable one. For these case-studies, I applied various methods of data-collection, using triangulation to safeguard multidimensionality by using a diversity of means to observe phenomena under study (Yanow & Schwartz-Shea 2006). This included document reviews, interviews, participant observation and action research (Greenwood and Levin 1998).

The first phase of case-study data-collection (step 3) was characterized by an intense and close involvement in the cases, including action research activities such as helping to prepare and organize meetings and providing advice on how insights on transitions could be applied in the programs/projects under study. This allowed me to experience power relations rather than just observing them, and to design the research in such a way that it could be helpful for the participants, rather than merely the other way around. However, such strong involvement also had disadvantages, in terms of time-consuming activities and the risk of losing a critical distance. As such, I decided to limit action research to a certain (sub)project or project-phase, followed by taking a critical distance through other methods (i.e. unobtrusive observation, document reviews, and interviews). In total, I conducted participant observation at 140 meetings, held 67 interviews and analyzed 65 case documents in a period of 3-4 years. I transcribed and structured all my field notes and observations in a digital data-base. This was an awfully time-consuming task and by far the most tedious part of the entire journey, but it proved

its worth as it greatly facilitated data-analysis later on.

In the meantime, the deductive theoretical and conceptual development (still step 1) had continued in parallel. Besides classical social and political theories on power and transition, I dove into organizational psychology to find an operationalization of empowerment in terms of intrinsic motivation (Thomas & Velthouse 1990). This lead to a first phase of data-analysis (step 4), in which I used concepts of empowerment to analyze three of the cases under study (Avelino 2009).

The next challenge was to integrate concepts of transition, power and empowerment into a comprehensive set of operationalized typologies and empirical questions to be asked about the cases (step 5). After doing so, I then used this set of typologies and questions to analyze the empirical case-studies and to write the respective empirical narratives (step 6). That also included a second phase of empirical data-collection, focused on seeking missing information through document reviews and/or occasional interviews.

During the empirical analysis, I was confronted with various conceptual gaps and analytical inconsistencies in my initial conceptual framework. On this basis, I significantly adapted and elaborated the conceptual heuristic (step 7), resulting in the "multi-level power-in-transition framework" (Multi-PIT) (Avelino 2011). Last but not least, I used the empirical narratives and the new heuristic, to formulate "power and empowerment lessons and principles" for transition management (step 8). On that basis, I also proposed a design for a participatory "power mapping tool" and "empowerment tool" (step 9).

In my research journey overall, I followed an explorative and interpretative research design, hence adhering to specific criteria of scientific quality, such as thick description, reflexivity, triangulation and phronèsis (Yanow & Schwartz-Shea 2006, Fischer 2006,2007, Hajer 1995, Geertz 1973, Flyvbjerg 2001,2004). Rather than 'testing' predefined hypotheses, the aim was to generate hypotheses on the role of power in sustainability transitions, and to provide a heuristic framework on how to research this role. Although this interpretative research is partly inspired by a 'postmodern' tradition, I distanced myself from merely 'deconstructive' approaches. While deconstructive analysis is important – and also formed a substantial part of my data-analysis – I argue that researchers have a responsibility to provide reconstructive suggestions to accompany deconstructive critique. As such, I tried to combine my deconstructive and critical analysis of transition management and sustainability discourses, with reconstructive management suggestions and participatory 'tools'. Moreover, I aimed to develop an interdisciplinary and transdisciplinary framework that could be useful for both interpretative as well as (neo)positivistic, quantitative research. At times, this epistemological heterogeneity led to misunderstandings and disagreements with other academics. These tensions led me to dedicate a significant part of my PhD-thesis to explaining the epistemological positioning and choices in my research. This was challenging but at hindsight also one of the more exciting parts of my journey.

Challenges for future research, following up on my PhD-thesis, are; (1) to further

improve the Multi-level Power-in-transition framework through further theoretical development, and through empirical testing by longitudinal analysis of social change, and (2) to further develop and test the participatory tools in stakeholder processes.

Figure 8. Avelino's research journey

CONCLUSION

An awareness of, and willingness to engage in a research journey better equips the researcher or research team to engage with complex systems and problem domains. The above research journeys were however largely emergent or inadvertent; researchers adjusted their work according to the evolving question or emergent realities of the projects on which they worked. We must be more aware of the need for a journey when approaching complex systems.

The willingness and preparedness to undertake such a journey has implications for short-term and long-term realities. In the immediate future, we need to create platforms to facilitate cooperation between researchers with similar interests and different skill sets. Research teams are better equipped to handle moves across the research landscape as new obstacles emerge. These teams do not need to be permanently defined around the project itself, but means of collaboration (both flexible and formal partnerships) between those with complementary skill sets can facilitate the multi-disciplinary approaches necessary to study complexity in all its discipline-breaking aliveness.

Over the long term, we need to train new scholars to be prepared to take research journeys in their various projects. There are several direct implications of this choice: first, is to emphasize training in multiple methodologies and epistemologies, and an early encouragement of partnerships and collaboration, and, second is the balancing of the need to create scientifically valid research in an environment marked by emergence. This latter concern means an awareness of the researcher's relative position in the field, as an individual who does not uniquely observe but also interacts with and must react to the circumstances in which they find themselves. We must be prepared to be constantly learning from each research journey, perpetual students of complexity.

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