

Wicked problems – resilience, adaptation and complexity

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1 Introduction

This chapter draws together an overall understanding of the social-natural-technical-policy frameworks within which emBRACE work can be considered. It explains why deciding upon policy interventions to support community resilience presents us with both a ‘wicked’ and a ‘messy’ problem, and one which we will argue – both here and in other chapters (see ‘The Need to Structure Qualitative Data’) – calls for ‘clumsy’ policy solutions and interventions. Notwithstanding, the chapter argues that the structured, multi-sectoral, and multi-level approach anticipated by – and piloted in – the emBRACE project allows us to deal with the necessary complexity in planning. Further, we also need a multi-stressor, multi-exposure approach (*cf.* Kelman, Gaillard and Mercer 2015).

Given that considerable complexity is represented, there are further questions about dynamics of complexity which are particularly relevant for us in emBRACE: these are to do with the complexities of the natural-environmental systems (*e.g. cf.* Gunderson and Holling 2001); the actual dynamics of social complexity (*e.g. cf.* McLennan 2003); the interplay between social and natural sciences and engineering involved in planning and responses (*e.g. cf.* Donaldson, Ward and Bradley 2010); the complexity of our responses to these complex situations (*cf.* Ramalingam and Jones 2008) and also the unpredictability involved (*cf.* Longstaff 2006). Answering these questions also starts untangling the factors important for how resilience changes over time and what it might mean to the members of real communities in real places.

2 A Brief History of Policy ‘Mess’ and ‘Wickedness’

The terms ‘wicked’, ‘mess’, and ‘clumsy’ are old terms in the context of policy analysis. ‘Wicked’ was first used by Rittel & Webber to describe policy problems which are not amenable to simple answers or optimal solutions, often due to conflicting interests: they note that ‘there are no “solutions” in the sense of definitive and objective answers’ (1973: 155). Rittel and Webber may not have been the first to use this term but they were the first to give it a formal definition. The term ‘mess’ was used by Ackoff a year later who noted the essential complexity of such problems. Arguing against reductionist understanding, he said: ‘Every problem interacts with other problems and is therefore part of a set of interrelated problems, a *system of problems*.... I choose to call such a system a mess’ (1974: 427).

Ackoff argued for four principles of planning in order to meet the needs of messy policymaking. These are that planning should be *participative* (this, we hope, speaks for itself); *coordinated*, in that ‘all aspects of a system should be planned for simultaneously and interdependently’; *integrated* (*i.e.* across levels of scale); and *continuous* by which he means ‘updated, corrected and extended frequently’ (*op.cit.*: 435). Ackoff, Rittel and Webber were undoubtedly influenced by Lindblom who described policy solutions to complex problems as ‘muddling through’ (1969). Lindblom suggested ‘successive limited comparisons’ as a means to deal with conflicting interests, goals, objectives and ideals. Further, in 1988, Shapiro devised the notion of ‘clumsy

solutions' to describe the problem of judicial selection in the United States. He suggested that if you think that judges should reflect community values you would elect them; on the other hand, if you think that judges should have some special interpretative capacity to understand the law you would appoint them administratively. Shapiro noted that, in fact, both happen: some judges in the US are elected, not to the Federal bench but certainly at the state and local level. Rayner describes this as 'a sort of egalitarian, hierarchical and competitive way of dealing with the issue of judicial selection' (2006). What, of course, Shapiro was pointing out, Rayner tells us, is that societies and individuals can be committed to apparently conflicting goals. Rayner argues that in relation to wicked problems it is extremely important to keep this inconsistency over time: he says 'You don't want to push one particular value set - the hierarchical, egalitarian or competitive - out of the picture because they all have something to bring to the table in terms of solutions' (Rayner 2006: 10).

Finally, Rayner notes three challenges for making clumsy solutions to wicked problems work, to which we shall add a fourth. The first is that 'the media and voters expect policymakers to fix problems'. In other words trying to sell – for example – the idea that we need a complex (and complicated) mix of qualitative and quantitative indicators rather than one apparently uncomplicated headline indicator is not one which is easy to communicate at the ballot box or in soundbites. Secondly, we need to overcome the apparent 'success of rational choice theory in solving more straightforward problems' and explain why that it is not going to happen this time: this means challenging the dominance of cost-benefit analysis and simple numerical democracy. It means all voices should be heard. Finally, Rayner tells us such new democratic solutions to wicked policy problems are 'a challenge to the imagination' (2006: 11) by which we understand that we are not following 'business-as-usual'. The fourth challenge takes us back to Ackoff's four principles of planning: how can we make planning disaster-risk adaptations participative, coordinated, integrated, and continuous.

2.1 'Super-wicked' problems

Going over the ground laid by Rayner, climate change has been characterized as a 'super-wicked' problem (Levin *et al.* 2012): that is, having additional complexities compared to wicked problems. *Climate change adaptation* (CCA), from the point of view of wicked problems/messy systems, is part of a response that is consistent with Ackoff's articulation of 4 principles of planning. Initially a secondary concern to climate mitigation, adaptation has gained more recognition in recent years, to a point where adaptation and mitigation are both considered necessary parts of our response to climate changes that are already occurring. This change has occurred 'arising from the realisation that the reduction in emissions would be too little too late and it was therefore necessary to anticipate the potential impact of climate change and to enhance the adaptive capacities of populations at risk.' (Thomala *et al.* 2006: 42).

Climate change is widely recognised to be putting populations and their livelihood systems at potential risk, leading to resource degradation, disasters and threat to human development (through incremental change and extreme events). To some it is an emerging threat; to others it is already a disaster happening. More often however, climate change is seen as an additional factor rather than as a separate driver triggering new social-ecological problems. Yet there is a growing literature on how climate change (natural and anthropogenic) interacts with existing risks: this recognition has already led to calls to integrate a climate change understanding and climate change action into the wider framework of development effort – mainstreaming climate change mitigation and adaptation into development. In pursuing similar goals, using similar concepts and encompassing a multiplicity of issues and actors, climate adaptation also interacts strongly with disaster risk reduction (DRR) and disaster risk management (DRM), a theme we shall revisit.

3 Resilient and Adaptive Responses to Mess

The ideas outlined above are now – sometimes overtly but always implicitly – influential in environmental, development and humanitarian efforts, as well as in community based assessment to disaster risk management interventions. It is well-accepted that in order to foster the good governance of natural disaster risk management – and mitigation – we need methods where the full complexity of understanding might be harnessed. The interconnected ‘knot’ of the emBRACE Framework (which will be discussed in a separate chapter) is one example of such. In particular, and as noted at the outset, this chapter is not concerned solely with the policy framework but with the social-natural-technical frameworks within which such interventions need to work. Thus, the interconnectedness; feedbacks; non-linearity; multiple solutions; are multiplied, making reality complex and complicated, as well as messy. Further, the need to include context-specificity is paramount, and the fact that we are dealing with human agents – who are highly heterogeneous and adaptive (that is self-organizing and with the capacity to learn) – is yet another complicator. It is for this reason also that we will see in latter chapters that stakeholder engagement has become critical.

Harnessing of the participatory process offers yet another level of complexity, but also offers a way to start to frame solutions that go wider than single discipline or sector ‘silos’. In this chapter the case will also be made that such methods need a way to present (frame/reframe) complex adaptive (social) systems and social-ecological and social-technical systems in ways that at once capture their complexity, but also make it clearly communicable, with structured and visual outputs. Despite its standing in other fields, the SES (social-ecological systems) framework is not as a matter of course applied to disaster risk management even though response to natural disasters is clearly a ‘social-natural system’ as described by Gunderson and Holling (2001: 178; see also Almedom 2013 who attributes the term ‘social natural systems’ to Bennett in 1996): or as White put it half a century earlier, if floods are ‘acts of God’, then ‘flood losses are largely acts of man’ (1945: 2).

One of the great proponents of SES was Ostrom. She describes them as ‘composed of multiple subsystems and internal variables within these subsystems at multiple levels’ (2009: 419). Any attempt to ‘silozed’ (separate) either the subsystems or the levels is both unnatural and unhelpful. The picture needs to be seen at all scales (Carpenter *et al.*, 2009). Further, an important point to come out of the SES-school of thinking is that resilience is an adaptive, constantly changing process. It is a fundamental tenet of the emBRACE project that the way to understand; facilitate; and if necessary create; community resilience is through a coupled understanding through which disaster risks needs can be managed by building ‘system resilience’ (e.g. see Deeming, Fordham and Gerger Swartling, 2014).

We are not saying that this approach is paramount, but we are saying that over the years the terminology largely started by Berkes and Folke (1998) has found a useful application in the field of human and societal resilience both theoretically and practically (e.g. see Brown, 2012; Dearing *et al.*, 2014; Friend and MacClune, 2013; Nelson, Adger and Brown, 2007; Walker *et al.*, 2006a & b). Further, as the emerging field of disaster risk management/reduction seeks to locate itself with other policy and practitioner areas the SES approach promises to be even more useful maybe not as a central framework but as an underlying one or as a heuristic device (*cf.* Kelman, Gaillard and Mercer, 2015; Matyas and Pelling, 2015; Miller *et al.*, 2010; Weichselgartner and Kelman, 2014).

The SES approach to understanding social resilience is not without its flaws. Keck and Sakdapolrak (2013) tell us that social resilience includes coping with adversity, is adaptive, and is transformative. They also warn us that social resilience is not only technical/environmental but also essentially political. Thus, they warn of taking a simplistic SES approach: it is even more complicated than understanding 'simple' ecological systems with the social considered almost as a static externality. Keck and Sakdapolrak feel that much of the 'technical' literature – including a lot of the social-ecological literature – depoliticizes social structure and largely underestimates human agency and social practices and, in response, they call for a [re]focus upon power & knowledge, and *perceptions* of risk as well as on technical risk, and turn us to the question of resilience of what (i.e. which aspect of the social) and for whom. This will, taken together, lead to a better future for social studies of resilience. The underlying emphasis upon social capital in much of emBRACE's work is indicative of this. Olsson *et al.* (2014) – correctly we would argue – see the idea of resilience as one which has to a degree been hijacked by the ecologists of the SES school. They see SES-inspired theory as sometimes 'prevent[ing] transitions—or rather, hinder the collapse of a productive system—[while] social theory commonly used in sustainability studies—from transition theory to political ecology—aims to locate and analyze multilevel or multiscale resistance against change while seeking to stimulate social transformation' (*op.cit.* 6). However, we would argue that within and on the fringes of the 'SES camp' there is a lot of useful work which is starting to make progress. But it is often still driven by the environmental-change professionals rather than by a truly transdisciplinary corps. This, we believe, is problematic. Regarding Welsh's contention (2014) that adoption of systems ideologies presents a problem for social sciences, we would rather argue that its *re-adoption* solves one problem for a social science that might be characterised as having lost its way (Savage and Burrows 2007).

Thus, social resilience remains an emergent concept; it shares much with the ideas of 'simple' SES but no proper consideration of social resilience can be deemed appropriate and sufficient if it does not engage with not only the importance of coupled systems but also the context and feedback within the social sphere and across levels of governance. We are thrown back upon SES+wicked (a.k.a. messy) problems as our underlying approach, leading to clumsy solutions as our essential response. We also argue that these solutions can provide policy support even though they are clumsy, or particularly *because* they are clumsy.

4 Clumsy solutions linking DRR/DRM and CCA: a mini case study

CCA is an area which has gained the attention of those researching natural hazards, disaster, and sustainable development, amongst other fields. Conceptually, it is possible to distinguish between 'anticipatory' and 'reactive' adaptation, where 'reaction means that one waits for the impact, and the potential damage, to be felt a first time before responding to it [... while a]dapting as anticipation requires an understanding of what might happen, and taking decisions before it happens in order to make the best out of it' Billé *et al.* (2013: 245). Consequently, 'it would always be wiser to adapt proactively. However, in practice it might not be rational because of opportunity costs' (*ibid*). Further, an 'ongoing challenge is framing climate change in research, policy, and practice to try to avoid the difficulties resulting from narrow views of vulnerability and resilience or too much focus on a single phenomenon such as climate change' (Kelman Gailard and Mercer 2015: 24).

Adaptation is an important response to particular natural hazards, as well as working in support of resilience building. Schipper and Pelling state: '[t]he unpredictability generated by climate change places more emphasis on the need to identify and support generic adaptive capacity along with hazard-specific response capacity' (2006: 29) and this type of preparedness is said

to include 'win-win' or 'no regrets' measures. Addressing both current vulnerabilities and development needs in parallel increases resilience to existing shocks and events, this type of approach can develop sufficient flexibility to allow for uncertain future scenarios to be taken into account. As O'Brien *et al.* (2006) put it: 'climate change is multidimensional (from local to global) hazard that has short-, medium- and long-term aspects and unknown outcomes'. Billé *et al.* (2013) hypothesize six responses to uncertainty, of which 'no regrets' is one, with the overall goal of supporting informed decision-making *under uncertainty*. Uncertainty has been a barrier to CCA not only in the international arena, but at national, provincial, and local levels where it needs to take place (and learn from). Another empirical problem is the potential conflicting views generated by applying lenses at different levels to complex/wicked problems. For example, Mercer concludes that 'there is an inherent danger of over-focusing upon a need to adapt to climate change due to its prominence in the international arena, rather than focusing on vulnerable conditions identified by communities themselves' (2010: 260). Thomalla *et al.* note 'Natural hazards and climate change impacts affect numerous natural, economic, political and social activities and processes. Hence, these challenges need to be addressed in a holistic and integrated manner at all scales and on all political levels and involve all sectors of society' (2006: 45). Thus, the thrust of our argument is the need to avoid over-simplification of both the problem and the solutions.

However, CCA and DRR/DRM share a common aim, that of reducing the impacts of shocks (especially where those shocks are causes or exacerbated by the effects of CC) or gradual/creeping changes (like drought, desertification, and salination). They both anticipate risks and address vulnerabilities and thus are tied to wider development objectives. Schipper and Pelling (2006) argue that CCA and DRR need to focus on reducing vulnerability in the context of development efforts. Further, according to O'Brien *et al.* disaster reduction must now aim at 'a comprehensive approach to risk management which would integrate natural hazards mitigation, 'routine' development efforts ... and efforts to address climate change' (2006: 69). Climate policy integration only is relatively well developed over the decade or so: Mitchell and van Aalst (2008) tell us that climate change adaptation has much more visibility, funding and political momentum than disaster reduction. This presents an opportunity for DRR/DRM to be linked with a larger climate change agenda, which in terms of its problematization is more advanced (e.g. having mechanism for international negotiations, having legally binding accord, financing in place, etc.). Closer integration would also help insure that climate change action is not undermining existing risk reduction efforts, and conversely risk reduction is not leading to further emissions or hampering adaptation planning. But for this to happen, the issues also need to be better linked in research. Schipper and Pelling (2006) suggest that development and climate change research and policymaking have a tendency to operate in silos and note how little one refers to the other. However, there are clear parallels between CCA and DRR, particularly in the paradigms employed, the concepts in use and the language employed. As disaster management shifts from response orientation to risk management (Thomalla *et al.* 2006), there is a shift to integrate 'command-and-control' measures with more holistic approaches towards understanding root causes and reducing vulnerability. Other research (e.g. Mercer 2010) shows that these interconnections are recognized by communities themselves. In practice, however, community resilience – which is the focus of emBRACE – must integrate both and adopt a holistic approach to planning. As suggested by O'Brien *et al.* (2006), this requires accountable, democratic government institutions, financial support, political will and the trust of civil society. Thus it required a unified approach, a 'clumsy' approach. However, clumsy does not necessarily mean overly complicated, as shown from one practical and empirical approach depicted in Fig 1.

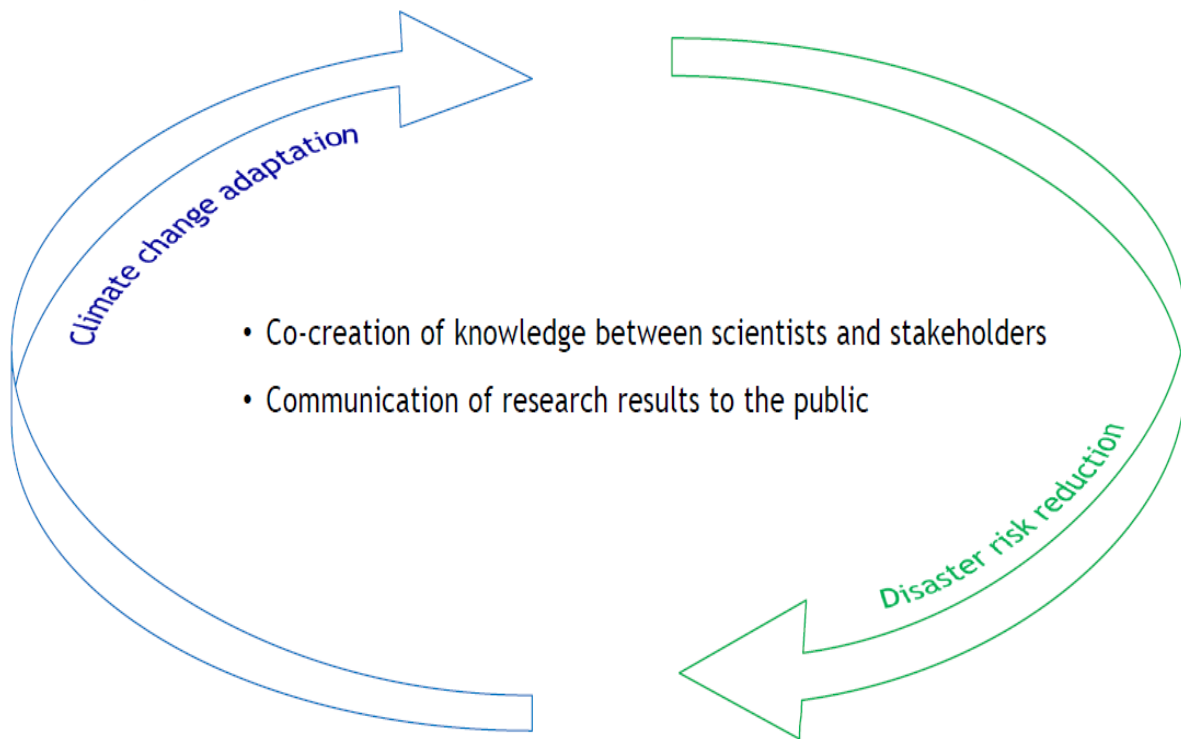


Figure 1: An elegant depiction of a clumsy solution... (diagram: Lydia Pedoth, EURAC)

Recent work looks at CCA and DRR in a synergistic way (e.g. adaptive capacity is a key concept in DRR research). CCA research has always had a clear future-orientation, whereas there has similarly been a shift in thinking in disaster management to forward-looking and longer-term strategy making for anticipating and managing risk (Thomala *et al.* 2006). Looking forward, Kelman, Gaillard and Mercer suggest that 'a prudent place for climate change would be placement within disaster risk reduction' (2015: 21), identifying three factors why this would be reasonable and desirable: 1) climate change is one contributor to climate risk amongst many; 2) climate change is one incremental environmental change amongst many; 3) climate change has become politically important, in human development efforts.

These linkages are recognized internationally in disaster policy support. An ISDR's briefing note states that DRR is 'tailor-made to help counteract the added risks arising from climate change' (2008: 7). However, as the shaping of the Hyogo Framework successor draws to a conclusion in 2015, Kelman, Gaillard and Mercer express regret that the CC, DRR and sustainable development policy discourse continue to be pursued separately: 'Having three separate streams for international negotiations duplicates efforts and disperses energy' (2015: 26). In their DfID study, Mitchell and van Aalst summarize the situation as follows: 'So far there has been limited integration of DRR and adaptation despite the two agendas sharing similar goals and conceptual overlaps [...] at stake is policy coherence and effective use of resources' (2009: 1) as '[f]ew bilateral or multilateral donors have integrated their support for DRR and

adaptation [and] Many DRR programs are funded from humanitarian budgets and coordinated from humanitarian aid departments' (*op.cit.*:8).

The larger picture is that the set of development 'problems' that need to be tackled necessitate mainstreaming both DRR and CCA – screening development activities and portfolios for climate and disaster risk (which according to Schipper and Pelling (2006) makes engaging in CCA more holistic). O'Brien *et al.* argue that 'Investments and development activities are almost never risk-neutral [but i]t is at the nexus between sustainable development and policy that the aims of the disaster, development and climate change communities intersect', continuing, '[r]isk reduction is the shared objective, but it is the promotion of resilience that offers the opportunity for more holistic and proactive responses' (2006: 70). This demands an integrated response as depicted in Fig 1.

There are caveats: 'role played by humanitarian assistance in addressing disaster relief [...] may be associated with dependency and short-term strategies that fail to generate autonomy incentives and ultimately deplete the resource base in conflict with development and vulnerability reduction' (Schipper and Pelling 2006: 33) thereby increasing the possibility of chronic disasters. '[P]ost-disaster recovery programmes [may] rush to re-establish the status quo ante without any evaluation of whether the earlier development activity itself was a factor that increased disaster vulnerability' (O'Brien *et al.* 2006: 74) or simply fail to include situated, social learning (Ensor and Harvey 2015). However, if these *are* addressed, it leads to a focus on prevention and planning which is a defensive and effective (albeit sometimes clumsy) long-run response to hazards.

XX.5 An emBRACE model of complex adaptive community resilience

The way of analyzing resilience propounded in much of the literature herein is rooted in complex systems theory; particularly von Bertalanffy's 'open systems' theory (1968). It is this that ties together the approaches of Lindblom, Ackoff, Rittel and Webber, and Schapiro with Rayner, SES and the emBRACE approach outlined. We believe that community resilience must include each of these. It is this consideration of open systems – whose resilience?, and resilience to what? (*cf.* Almedom 2013) – which takes us into the realm of clumsy solutions and participative, coordinated, integrated, and continuous planning and gets us away from the 'simple' idea that decreasing technical risk increases community resilience simply by default and which can be seen growing out of the emergent DRR-CCA 'nexus'. A fundamental critique of resilience must be kept in mind: whether improving resilience is return to normal or addressing issues such as 'poor development, poverty, vulnerability' and 'build a better future' (Kelman, Gailard and Mercer 2015: 21) is important. The argument that '[p]art of this strategy entails deepening our approach to vulnerability and resilience in order to step beyond standard approaches that have proven counterproductive to the common 2015 goals' (*op.cit.*:22) is critical. It could also be said that we are about not just maintaining lives but maintaining a *way of life*, and figuring out what it is that is good in that way of life and preserving that while getting rid of some of the inequities. Thus the emBRACE approach thus involves not only better integration but also greater participation. The idea of complex adaptive community (Miller and Page 2007) is not new, nor indeed is adaptive management within complexity (*e.g.* Armitage, Berkes and Doubleday 2007) but we believe it has much to offer DRM and the legacy of emBRACE. It has been influenced by several seminal contributors as follows.

Almedom (2013) describes for us what social/community resilience really is when she says it is 'an emergent attribute of individuals and communities who may have undergone ... transformation ... where key functions and core identity and integrity are sustained' (*op.cit.*:15).

Further, and also as with emBRACE's work, social systems are treated as open complex systems, and Almedom also applies twin lenses of theoretical and applied research. For us, Almedom makes the useful distinction between cognitive and structural components of human resilience (and this will be dealt with at greater length in the chapter in this book on qualitative and quantitative indicators for resilience). Finally, and addressing to our mind the caveats and warnings of Keck and Sakdapolrak, Almedom usefully discusses the difficulty of reducing complexity for policy- and decision-makers, making the point well that community resilience cannot be created – or recreated after a hazard event – by outsiders and external experts (2013: *passim*) and we can only help communities create the conditions that are conducive to self-organizing and self-governing. Community resilience remains an emergent property of the community. Cote and Nightingale (2011) presaged Keck and Sakdapolrak's caution of the 'traditional' applications of SES. Indeed, nothing could mark Cotes and Nightingale as being more different from traditional SES fare as the authors' use of the term 'socio-ecological' (rather than 'social-ecological' (Folke 2006)) when referring to SES. This marks them as more 'socio' than ecological. Importantly, though, Cote and Nightingale also espouse the aim of SES research to be trans- and interdisciplinary while the authors do critique SES – as it is practiced – using a 'social theoretical lens'. Their particular insights relate to social institutional dynamics – it is important to remember that here 'institution' means 'social institution' which is a wide-ranging term including social groupings (such as community/family/church/and so on) as well as more formal institutional groupings such as found in politics and economics. Like Keck and Sakdapolrak two years later, Cote and Nightingale conclude that, although useful, the 'narrow' SES approach is 'inadequate' because it underestimates the social (especially political economy) and overestimates the technical/ecological (2011: 478) and this is still being echoed now (*e.g.* Olsson *et al.* 2015). Notwithstanding their own caveats, Cote and Nightingale can strongly support the role of 'resilience thinking' in bringing together academic disciplines to help understand the 'messiness' of SE systems, and also helping to find a middle ground between science and policy. They conclude that 'a key reason why the conceptualization of social change in SES research is so problematic' (*op.cit.*: 484) is that it is too functional. In other words, as it is currently applied to ecological systems with humans in them, what might be described as the psycho-social (norms, values, meanings) are missing. If this is true – and we believe it is, then we in emBRACE by including social-psychological, and 'subjective controlling social variables' (*cf.* Armitage *et al.*, 2012) have gone some way to address this 'flaw' in SES research and its applicability to disaster resilience.

Armitage and colleagues (2012) specifically link SES with the idea of wellbeing, thus bringing in a much more anthropological and subjective social element into the more systems-understanding of social-ecological resilience and making the systems approach more appropriate for management and to contribute towards policy action. This challenges several of the main drawbacks of SES resilience thinking when it tries to contribute towards policy-makers (and sometimes also the general public). However, the benefits of including such an understanding into the systems approach include the recognition of the interdependence of social and biophysical/ecological/environmental systems as a systems approach is less likely to fail to anticipate 'undesirable surprises or thresholds' (*op.cit.*:5). They also argue that resilience (remember they mean social-ecological resilience) 'results from the interaction between nested cycles of change (adaptive cycles) and the impact of slow- and fast-moving variables in different systems and at different scales' (*op.cit.* 8). They list several categories of 'controlling variables' which are both fast and slow. These include 'material'; 'relational'; and 'subjective' variables. The subjective variables were usefully included by us in emBRACE and include identity; perceptions and aspirations; beliefs, values, and norms; as well as satisfaction (*op.cit.*:9).

Finally, Walker and Westley conclude with one of the underpinning tenets of the emBRACE project that 'there are interesting synergies between work on anticipating disasters and work in social-ecological resilience' (2011: 4). Specifically, they suggest that time is critical: we need to understand who benefits from a community being in a 'disturbed state' and factor this into our understanding (*op.cit.*:1). Notwithstanding this insight, we also need to avoid quick fixes based on superficial understanding. Secondly, we need to understand the difference between specific 'resilience' (i.e. resilience to specific risk) and general resilience. Making a system very resilient to a specific risk may not necessarily give it more 'general resilience' (*op.cit. passim*). General resilience, they tell us, is often more politically unpopular as it is more vague, may cost a great deal in resources, and often difficult to quantify (*op.cit.*:2). Political systems favor outputs which can be measured and, thus, usually focus on resilience to the 'last crisis' or the 'known knowns' rather than planning for longer-term and more complex general social resilience. Further, political systems prefer (economically) 'efficient' systems: but there is a tradeoff between efficiency and resilience. Finally, Walker and Westley's third main point is that the level of governance is critical. Community resilience is something which happens at the community level but needs the input and support of local and regional governance. They say that it is better to 'push power down to the local community level where sense-making, self-organization, and leadership in the face of disaster were more likely to occur if local governments felt accountable for their own responses' (2011: 4) and they make the observation that in order for this to happen it may become necessary to create 'a safe space for a temporary suspension of rules and of accountability assessment' (*ibid*).

Thus, within emBRACE – and DRM at large – we have started creating integrative planning tools that can render planning participative, coordinated, integrated across scale, and continuous (from Ackoff); but also deliver outputs that are complex yet grounded, communicable, and convincing (from Rayner); and also deal with interlinked, open systems (from von Bertalanffy). Put simply, tools need to be able to help us 'appreciate the mess' (Donaldson, Ward and Bradley, 2010; Forrester *et al.* 2014), by which we mean understand it and appreciate how to deal with it. Current social science methods are poor at doing this (Savage and Burrows 2007, Taylor *et al.* 2014; Forrester *et al.* 2015).

Also, we needed a social theory which allows us to engage with ongoing complexity-inspired research and practice. Here Zeitlyn and Just's 'merological anthropology' (2014: 5-8) is perfectly designed as a theoretical framing. Zeitlyn (2009) describes merological anthropology as 'partial' (in the sense of describing part of the system well, but also from a particular standpoint). Thus we can have good confidence in that bit of the system which we do know, and structuring our understanding – for example through application of structured-subjective approaches and tools – allows us to organize, reduce, and select (after Zeitlyn 2009: 211) what 'facts' we have confidence in. Zeitlyn gives us the theory to 'bash' good social scientific understanding into a systems approach and the bigger picture (Carpenter *et al.* 2009) without losing our confidence in its social reality.

Thus multiple methods can be used to integrate stakeholder views and present rich pictures which not only to present data which is true to source but which is 'defragmented' (Carpenter *et al.* 2009). The use of such 'messy' empirical data gathering methods – within the Framework – in emBRACE show how such approaches offer benefits for resilience and adaptation by allowing clarification and discussion across disciplinary and sectoral silos; allowing critical reflection amongst stakeholders; and, helping justify clumsy solutions to wicked problems. In practice, such methods allow stakeholders to create partial mirrors of their systems to be used collaboratively to think better about gaps, problems, and come up with new strategies for adaptive and resilient communities.

1.6 In conclusion

We believe that our approach offer an opportunity for integration different types of knowledge (i.e. technical, traditional, local) and – with the participation of different stakeholders – reality-checking and elicitation of preferences. Thus we feel we are addressing Ackoff's 4 principles. In the best case, our approach allows different actors to 'play' with some representations of community resilience, on the basis of including different knowledge frames, to generate shared understandings and co-learning. The structured methods outlined elsewhere support stakeholders by providing tools to structure knowledge; using graphical elements to reduce complexity; and building bridges between theoretical and scientific concepts and practitioner's mind-sets and language. Some of the 'wickedness' is tamed by looking at the system from the top down and also from the bottom up – for one example see the Chapter on South Tyrol and the use of social network maps. Further, this will need both qualitative and quantitative understandings and it will need social and natural scientists to stop arguing about the meaning of resilience and produce useful empirical work that can support it at the ground level. This does not require throwing out theory, but it requires messy empirical practice within a structured Framework such as propounded by emBRACE. Our 'Celtic knot' Framework is – at the very least – a useful heuristic tool in meeting the needs of discussions around wicked problems.

References

- Ackoff, R. (1974) *Redefining the Future*, London & New York, Wiley.
- Almedom, A. (2013) Resilience: outcome, process, emergence, narrative (OPEN) theory. *On The Horizon* **21**(1), 15-23.
- Armitage, D., Berkes, F. and Doubleday, N. (2007) *Adaptive Co-Management: Collaboration, Learning, and Multi-level Governance*. Vancouver: University of British Columbia Press.
- Armitage, D., Béné, C., Charles, A., Johnson, D. and Allison, E. (2012) The interplay of well-being and resilience in applying a social-ecological perspective. *Ecology and Society* **17**(4), article 15 [online].
- Berkes, F. and Folke, C. (1998) Linking Social and Ecological Systems for Resilience and Sustainability. In Berkes, F. and Folke, C. (eds) *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge, UK, Cambridge University Press.
- Billé, R., Downing, T., Garnaud, B., Magnan, A., Smith, B. and Taylor, R. (2013) Adaptation strategies for the mediterranean. In Navarra, A. and Tubiana, L. (eds) *Regional Assessment of Climate Change in the Mediterranean: Volume 2: Agriculture, Forests and Ecosystem Services and People*. Springer, Netherlands, pps 235-262.
- Brown, K. (2012) Social Ecological Resilience and Human Security. In O'Brien, K., Wolf, J. and Synga, L. (eds) *The Changing Environment for Human Security: New Agendas for Research, Policy, and Action*, Routledge.
- Carpenter, S., Folke, C., Scheffer M. and Westley, F. (2009) Resilience: Accounting for the Noncomputables. *Ecology and Society* **14**(1): article 13 [online].
- Cote, M. and Nightingale, A. (2012) Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. *Progress in Human Geography* **36**, 475-489.

- Dearing, J., Wang, R., Zhang, K., Dyke, J., Haberl, H., Hossain, M., Langdon, P., Lenton, T., Raworth, K., Brown, S., Carstensen, J., Cole, M., Cornell, S., Dawson, T., Doncaster, C., Eigenbrod, F., Flörke, M., Jeffers, E., Mackay, A., Nykvist B. and Poppy, G. (2014) Safe and just operating spaces for regional social-ecological systems. *Global Environmental Change*, **28**, 227–38.
- Deeming, H., Fordham, M. and Gerger Swartling, Å. (2014) Resilience and Adaptation to Hydrometeorological Hazards. In Quevauviller, P. (ed.) *Hydrometeorological Hazards: Interfacing Science and Policy*. Wiley-Blackwell, 291-316.
- Donaldson, A., Ward, N. and Bradley, S. (2010) Mess among disciplines: interdisciplinarity in environmental research. *Environment and Planning A*, **42**(7), 1521-1536.
- Ensor, J. and Harvey, B. (2015) Social learning and climate change adaptation: evidence for international development practice. *WIREs Climate Change*, early view online [23Jun15].
- Folke, C., 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, **16**(3), 253–67.
- Forrester, J., Cook, B., Bracken, L., Cinderby, S. and Donaldson, A. (2015) Combining participatory mapping with Q-methodology to map stakeholder perceptions of complex environmental problems. *Applied Geography* **56**, 199-208.
- Forrester, J., Taylor, R., Greaves, R. and Noble, H. (2014) Modelling Social-Ecological Problems in Coastal Ecosystems: A Case Study. *Complexity* **19**(6), 73-82.
- Friend, R. and MacClune, K. (2013) *Climate Resilience Framework: Putting Resilience Into Practice*. Boulder, Colorado: Institute for Social and Environmental Transition.
- Gunderson, L. and Holling, C. (2001) *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, Island Press.
- ISDR (International Strategy for Disaster Reduction) (2008) *Climate Change and Disaster Risk Reduction*. Briefing Note 01. Geneva, UNISDR.
- Keck, M. and Sakdapolrak, P. (2013) What is Social resilience? Lessons learned and ways forward. *Erdkunde – Archive for Scientific Geography* **67**(1), 5-19.
- Kelman, I., Gaillard, J-C. and Mercer, J. (2015) Climate Change's Role in Disaster Risk Reduction's Future: Beyond Vulnerability and Resilience. *International Jnl Disaster Risk Science*, **6**, 21–27
- Levin, K., Cashore, B., Bernstein, S. and Auld, G. (2012) Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Policy Science* **45**, 123-152.
- Lindblom, C. (1969) The Science of 'Muddling Through'. *Public Administration Review*, **19**(2), 79-88.
- Longstaff, P. (2006) Building trust in unpredictable systems: The case for resilience. In *Annual Review of Network Management and Security, Volume 1*. International Engineering Consortium (IEC), pps 67-74.
- Matyas, D. and Pelling, M. (2015) Positioning resilience for 2015: the role of resistance, incremental adjustment and transformation in disaster risk management policy'. *Disasters* **39**, s1–s18.
- Mercer, J. (2010) Disaster risk reduction or climate change adaptation: are we reinventing the wheel? *Journal of International Development* **22**, 247-264.

- McLennan, G. (2003) Sociology's Complexity. *Sociology* **37**, 547-564.
- Miller, F., Osbahr, H., Boyd, E., Thomalla, F., Bharwani, S., Ziervogel, G., Walker, B., Birkmann, J., van der Leeuw, S., Rockström, J., Hinkel, J., Downing, T., Folke, C. and Nelson, D. (2010) Resilience and vulnerability: complementary or conflicting concepts? *Ecology and Society* **15**(3): 11. [online]
- Miller, J. and Page, S. (2007) *Complex Adaptive Systems: an Introduction to Computational Models of Social Life*. Princeton N.J.: Princeton University Press.
- Mitchell, T. and van Aalst, M. (2008) Convergence of disaster risk reduction and climate change adaptation. A review prepared for DfID (UK Dept. for Intl. Development).
- Nelson, D., Adger, W. and Brown, K. (2007) Adaptation to Environmental Change: Contributions of a Resilience Framework. *Annual Review of Environment and Resources*, **32**(1), 395–419.
- Olsson, L., Jerneck, A., Thoren, H., Persson, J. and O'Byrne, J. (2015) Why resilience is unappealing to social science: Theoretical and empirical investigations of the scientific use of resilience. *Science Advances* **1**(4), [online]
- O'Brien, G., O'Keefe, P., Rose, J. and Wisner, B. (2006) Climate change and disaster management. *Disasters*, **30**(1), 64-80.
- Ostrom, E. (2009) A General Framework for Analyzing Sustainability of Social Ecological Systems. *Science* **325**(5939), 419-422.
- Ramalingam, B., and Jones, H. with Reba T. and Young, J. (2008) *Exploring the science of complexity: Ideas and implications for development and humanitarian efforts*. ODI Working Paper 285.
- Rayner, S. (2006) 'Wicked problems: Clumsy solutions – diagnoses and prescriptions for environmental ills' Jack Beale Memorial Lecture on Global Environment, UNSW Sydney, Australia.
- Rittel, H. and Webber, M. (1973) Dilemmas in a General Theory of Planning. *Policy Science*, **4** (2), 155 – 169.
- Savage, M. and Burrows, R. (2007) The Coming Crisis of Empirical Sociology. *Sociology* **41**(5), 885-899.
- Schipper, L. and Pelling, M. (2006) Disaster risk, climate change and international development: scope for, and challenges to, integration. *Disasters* **30**(1), 19-38.
- Shapiro, M. (1988) Introduction: Judicial Selection and the Design of Clumsy Institutions. *Southern California Law Review*, **61**, 1555–1563.
- Taylor, R., Forrester, J., Pedoth, L. and Matin, N. (2014) Methods for integrative research on community resilience to multiple hazards, with examples from Italy and England. *Procedia Economics and Finance*, **18**: 255-262.
- Thomala, F., Downing, T., Spanger-Siegfried, E., Han, G. and Rockström, J. (2006) Reducing hazard vulnerability: towards a common approach between disaster risk reduction and climate adaptation. *Disasters* **30**(1), 39-48.
- von Bertalanffy, K. (1968) *General System theory: Foundations, Development, Applications*. New York, George Braziller.

- Walker, B., Anderies, J., Kinzig, A. and Ryan, P. (2006a) Exploring resilience in social-ecological systems through comparative studies and theory development: introduction to the special issue. *Ecology and Society* **11**(1): article 12. [online]
- Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S. and Schultz, L. (2006b) A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society* **11** [online].
- Walker, B. and Westley, F. (2011) Perspectives on resilience to disasters across sectors and cultures. *Ecology and Society* **16**(2): article 4. [online]
- Weichselgartner, J. and Kelman, I. (2014) Geographies of resilience: Challenges and opportunities of a descriptive concept. *Progress in Human Geography*, **39**, 249-267.
- Welsh, M. (2014) Resilience and responsibility: governing the world in a complex world. *the Geographic Journal*, **180**(1), 15-26.
- White, G. (1945) *Human Adjustment to Floods: a geographical approach to the flood problem in the United States*. (Research Paper No. 29). Department of Geography, Chicago: The University of Chicago.
- Zeitlyn, D. (2009) Understanding anthropological understanding: For a merological anthropology. *Anthropological Theory*, **9**, 209-231.
- Zeitlyn, D. and Just, R. (2014) *Excursions in Realist Anthropology: A Merological Approach*. Newcastle-upon-Tyne, Cambridge Scholars Publishing.