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Examining resilience and vulnerability as concepts conditional upon human values: a review

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Abstract

Whilst there has been progress in understanding the role that values play in determinations of vulnerability and resilience, I suggest some key points continue to be overlooked. I offer three propositions to describe how values underpin such concepts, summarised as ‘no fixed characterization’, ‘no fixed relationships’ and ‘no fixed trends’. These propositions are not new and have been made in other contexts. Based on a literature review of vulnerability and resilience in the global environmental change area, I elaborate on how these propositions are not adequately accommodated, in particular in relation to ideas of biophysical and social vulnerability, specified versus general resilience, and assignments of desired trend direction (increasing resilience or decreasing vulnerability). I conclude that irrespective of the concept label, characterisations and assessments of ecosystems and their attendant change are inescapably dependent on values.

1.0 Introduction

A recent review by Nelson (2010) highlights how the concepts of vulnerability and resilience are relative newcomers to climate change adaptation science and policy in Australia. According to Nelson and colleagues, to date, adaptation science in Australia has been built on a hazard and impact modeling tradition[1]. They suggest that this hazard-impact approach is too narrow and technical, and propose that there is an urgent need to broaden this application to include what they regard as more 'integrated and holistic' concepts such as how they perceive vulnerability and resilience. In a later work in which they apply these concepts, they suggest that continued reliance on a hazard/impact modeling approach alone can lead to misleading conclusions about vulnerability, with the potential to misdirect policy (Nelson, et al. 2010) .

Studies that have applied the concepts of vulnerability and resilience to evaluate ecosystem change, particularly those applied to policy-making, are still few (e.g. Luers 2005; Adger 2006; Eakin and Luers 2006; Nelson, et al. 2007; Walker, et al. 2009; Nelson, et al. 2010). The development of appropriate metrics remains an on-going research need (Adger 2006; Nelson, et al. 2010).

In the spirit of suggesting how these concepts might be further introduced into climate change adaptation science and policy in Australia, I offer some observations on established definitions and applications of these concepts to date in the global environmental change area. I highlight the critical importance of the role of values in underpinning the characterization of ecosystems and any attendant changes. Based on a literature review, I propose that despite progress made on understanding how values underpin these concepts, some key points continue to be overlooked. I offer three propositions to describe how values underpin such concepts. These propositions are not

[1] A hazard or impact modelling approach is described by Nelson, R., Kokic, P., Crimp, S., Martin, P., Meinke, H., Howden, S. M., de Voil, P. and Nidumolu, U. (2010) 'The vulnerability of Australian rural communities to climate variability and change: Part II-Integrating impacts with adaptive capacity', *Environmental Science & Policy* 13/1 (Feb): 18-27. as 'continuing to pursue greater predictive skill over longer time horizons using new generations of global climate models' (p 8), and, as working 'inductively from a hazard to investigate who and what is affected, how they are affected and to what extent. The hazard forms the primary unit of analysis, followed by the physical infrastructure potentially affected by hazards, and lastly the socioeconomic impacts on communities dependent on this infrastructure. Biophysical or macroeconomic models are often used to model the risk of exposure of an asset or community to a specific hazard, and the risk of damage or sensitivity to that hazard. Viewing vulnerability as the end-point of the analysis tends to focus assessment on technical solutions to cope with predicted impacts of risk in well-defined systems. Vulnerability in systems assumed to be closed or at least well-defined is often analysed using modelling approaches that predict impacts in terms of proxies such as mortality' (p 11).

new, and have been made in other contexts (e.g. Allen and Hoekstra 1992; de Chazal 2002; Allen, et al. 2003; Carolan 2006; de Chazal 2010). I elaborate on how these propositions are not adequately accommodated, in particular in relation to ideas of biophysical and social vulnerability, specified versus general resilience, and assignments of desired trend direction (i.e. increasing resilience or decreasing vulnerability). I finish with some suggestions toward better accommodation of multiple and often conflicting values into vulnerability and resilience frameworks, as well as how to achieve a more substantive integration of the natural and social sciences within this domain.

By values I mean individual or collective judgments concerning desired ecosystem states or goals of management. I choose to use the word ecosystem over the more popular term 'social-ecological' system. Although I support aspirations and efforts to consider social and ecological systems jointly (e.g. Berkes, et al. 2003; Turner II 2010) I suggest that terms such as 'human-environment' or 'socio-ecological' can in fact work to separate these domains. I use the term ecosystem in its original sense as first proposed by Tansley (1935), and as embodied in the work of Allen and Hoekstra (1992) and Allen et al. (2003). Ecosystem is therefore a term to characterize interactions between a set of biological and physical components, where humans and their artifacts can be members, and where these interactions lead to some emergent properties that contribute to distinguishing the 'whole'.

2.0 Three propositions concerning the role of values

No fixed characterisation

Vulnerability and resilience are concepts that are conditional on human values and as such cannot be defined in a way that fixes them into relationships that are universal. Both concepts are therefore relative, where values underpin the characterization of the system at hand (people, system variables, and drivers of change), determinations of what is considered undesired change, and choices about appropriate response to change.

Much has been written about the nature and use of normative concepts used in ecology (e.g. Wicklum and Davies 1995; Lackey 2001; de Chazal 2002; Allen, et al. 2003; Carolan 2006; de Chazal 2010). Typically, there is a tendency to seek universal, precise definitions when in fact there are none to be had (de Chazal 2002; de Chazal 2010). Concepts are often taken as self-evident, and so are not defined. Often terms are used to represent objective states of nature (e.g. ecosystem health – see de Chazal 2002) where in fact they mask implicit value statements. Value judgments therefore become implicitly bound up in descriptions and assessments of relationships between people and environment.

The role of values run deeper than just framing definitions. A number of authors note that values permeate every step of characterising an ecosystem and any attendant change (e.g. Allen and Hoekstra 1992; de Chazal 2002; Ratze, et al. 2007; de Chazal, et al. 2008). For example, in the introduction to 'Toward a Unified Ecology', Allen and Hoekstra (1992, p 11) explain in relation to fixing a scale:

> 'All ecological processes and types of ecological structure are multiscaled. Each particular structure relates to a particular scale used to observe it such that, at the scale of perception, the entity appears most cohesive, explicable and predictable. The scale of the process becomes fixed only once the associated scaled structures are prescribed and set in their scaled context. Scaling is done by the observer; it is not a matter of nature independent of observation'.

The role of the observer is also paramount in choosing the ecological processes and types of ecological structures. As Allen and Hoekstra (1992 p 10) elaborate:

> 'However at a given scale it is possible to recognize many different types of things. Which types are recognized and which are ignored comes from the observer's decisions as to what is to be considered important. 'Criteria for observation' is the name we give to whatever it is that makes something important enough to be recognised in an observation or set of observations'.

Ratze et al. (2007) distinguish what they term as an 'ontological' meaning of scale, representing the size of something. They view this aspect of system characterisation as 'invariant' from the observer. I disagree with this standpoint, as it overlooks important arguments that underscore observer dependency in empirical undertakings (e.g. Latour and Woolgar 1986; Russell 2010). Ratze et al. (2007) however raise some interesting points and I include them here for the sake of completeness of description.

> 'The ontological meaning of scale refers to the notion of characteristic (or inherent or intrinsic) scale of an object (entity, process or phenomenon), i.e. to the effective size or measure of the object and/or its properties and attributes...For example, properties such as size, mass, volume of entities such as cell, leaf or tree remain scale invariant when multiplying the observations in their specific scale domain, before disappearing outside of the scale domain. The intrinsic scale of existence of an entity determines its proper window of interaction within its environment. The phenomenon grain corresponds to the minimum spatio- temporal size at which an object reacts to the external dynamics, and the extent as the reach or span of its interactions...' (Ratze, et al. 2007, p 15).

No fixed relationships

Relationships between resilience and vulnerability, or any other concepts (e.g. sustainability, adaptation) will never be fixed. Following from proposition one, these relationships will depend on how each concept is characterized, this in turn fixing the relationships between them. I have explored this in relation to characterizations of climate change, land-use change and biodiversity, and illustrated that different characterizations greatly influence estimates of projected changes in biodiversity under each or both of these drivers (de Chazal and Rounsevell 2009).

No fixed trend

Determination of what represents a desired trend (increasing or decreasing) in either resilience or vulnerability is predicated on values and will therefore never be fixed. What are selected as indicators, and in turn, trends, depends on the characterization. I have explored this in relation to ecosystem health (de Chazal 2002) and argued that proposed indicators of 'ecosystem distress syndrome' (Rapport, et al. 1985) are problematic as they fix a universal direction to the set of indicators. In doing so value judgments are masked on what is considered to be a 'healthy' state.

3.0 Vulnerability and resilience

A large number of authors have reviewed the concepts of vulnerability (e.g. Adger 2000; Kelly and Adger 2000; Brooks 2003; Schroter, et al. 2005; Adger 2006; Eakin and Luers 2006; Fussel and Klein 2006) and resilience (e.g. Carpenter, et al. 2001; Walker, et al. 2002; Walker, et al. 2004; Folke 2006; Manyena 2006; Nelson, et al. 2007).

These reviews describe separate evolutions of each concept, with recent efforts directed at bringing the two fields together (Vogel 2006; Nelson, et al. 2007; Turner II 2010). Resilience is understood as emerging from ecology, principally based on ideas by Holling (1973). Vulnerability is understood as having emerged from several traditions in the social and biophysical sciences. Adger (2006) groups these traditions as 'absence of entitlements', 'natural hazards', 'pressure and release' and 'human/political ecology'. These traditions were originally distinct, however recent efforts have worked to bring them together (Turner, et al. 2003; Turner, et al. 2003; Liu, et al. 2007; Turner II 2010).

In the climate change arena, the Intergovernmental Panel on Climate Change (IPCC) definition, framing vulnerability in terms of exposure, sensitivity and adaptive capacity is the most commonly used (Fussel and Klein 2006).

In the resilience area, the definition by Walker et al. (2004), framing resilience as 'the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks', and close derivatives proposed by Berkes et al. (2003) and Gunderson and Folke (2002), are often cited.

4.0 No fixed characterisation

Definitions and frameworks

A range of definitions and frameworks for vulnerability or resilience have been found in the literature (e.g. Carpenter, et al. 2001; Turner, et al. 2003; Walker, et al. 2004; Metzger, et al. 2005; Eakin and Luers 2006; Fussel and Klein 2006; Brand and Jax 2007; Fussel 2007; Nelson, et al. 2007; O'Brien, et al. 2007; Ionescu, et al. 2009). This diversity of definitions is typically seen as leading to confusion, misunderstanding or impeding scholarly progress (Fussel and Klein 2006; Brand and Jax 2007; Fussel 2007; Ionescu, et al. 2009). Several authors regard these terms as so broad that they are only useful in a rhetorical or metaphorical sense (e.g. Timmermann 1981). The implication of such sentiments is that the concepts are considered as inherently vague and can never put to good use, or otherwise beg a consensus on definitions and frameworks. Other authors regard the diversity of definitions as a strength (Adger 2006) and as necessary to address the 'full complexity of the [vulnerability] concept' (Eakin and Luers 2006, p 366).

Vulnerability

In the vulnerability area, a number of generally applicable frameworks have been proposed (e.g. Metzger, et al. 2005; Schroter, et al. 2005; Fussel 2007; de Chazal, et al. 2008; Ionescu, et al. 2009). Although this perspective has evolved through time (Fussel and Klein 2006), rather than seeking a single, universally applicable definition, these frameworks understand vulnerability as being a relative concept. Frameworks are orientated around making explicit key dimensions that are understood to determine vulnerability. Fussel (2007) presents six dimensions he considers key, four of which he identified as being common to a number of earlier frameworks reviewed (Table 1). de Chazal et al. (2008) and Ionescu et al. (2009) add an additional dimension, that takes into account contrasting (positive or negative) judgments on change in the identified system of interest.

Some authors reviewed hint at seeking definitive definitions of vulnerability. For example, although Barnett et al. (2008) understand vulnerability as being 'about values and who holds those values' (p

104), they introduce vulnerability as being an 'imprecise term'. Similarly Nelson et al. (2010, p 11) seek specifications of vulnerability and associated concepts so they can be analysed in ways that are 'objective and repeatable'. The term imprecision suggests something capable of being made precise. In a generic sense, vulnerability can never be precise. Precision only comes from explicating the particular context upon which the term is applied.

Biophysical versus social vulnerability

A distinction is often made between biophysical and social vulnerability (e.g. Adger 2000; Brooks 2003; Fussel 2007; Liu, et al. 2007; Turner II 2010), including studies that consider biophysical and social dimensions jointly (e.g. Liu, et al. 2007; Turner II 2010). For example, Fussel (2007, p 158) distinguishes between socioeconomic and biophysical (or 'natural') vulnerability. Socioeconomic factors are seen as those that 'relate to economic resources, the distribution of power, social institutions, cultural practices, and other characteristics of social groups typically investigated by the social sciences and the humanities'. Biophysical factors are understood as 'related to system properties investigated by the physical sciences'. This classification can obscure the fact that determinations of ecological vulnerability are as much a question of value judgements as determinations of social vulnerability. Fussel, for example, portrays physical vulnerability as a state determined by science, rather predicated on a point of view. He links his determinations of biophysical vulnerability with Turner's et al. (2003) notion of 'sensitivity' and environmental conditions/influences and Hewitt's (1997) risk elements of 'intervening conditions of danger' and 'hazard'. Both of these author's classifications suggest that biophysical vulnerability represents a 'state of nature', existing independent from a human perspective. Turner II (2010, p 3) provide a related example. He separates 'environmental or ecological services' (sensu (Daily 1997)) from 'human outcomes' in his description of coupled human-environment systems. His account suggests that environmental services, in particular those that directly benefit 'nature' are not predicated on human values. In a similar vein Nelson et al. (2007) although stating 'from an ecological perspective there is no presumption that any state is more desirable than another' (p 401), distinguish between social dimensions (e.g. improving irrigation technology and increasing agricultural subsidies) and an ecological perspective (e.g. the ecological impacts of increased farming and groundwater pumping). Like Turner, Nelson and others appear to distinguish between perspectives that benefit humans and those that benefit 'ecology' – ie other species or habitats. Social is made distinct from ecological. Moreover ecological is typically implicitly aligned with 'nature', whereby an ecological perspective represents 'nature's perspective'. The mistakes here are two fold. The first is that humans are separated from ecology. This is an age old separation (e.g. Head 2007) and one that these more recent vulnerability approaches state as aspiring to overcome. The second is that an ecological perspective tells you nothing about which particular species and habitats are referred to. Even if the term nature was substituted, this doesn't assist. What represents 'nature' is predicated on a particular perspective, and as such needs to be spelt out. What is missing here is an acknowledgement that all perspectives, whether they are of benefit to humans or other species are human derived. Their identification is predicated on values. Biophysical vulnerability therefore might be considered as a focus on biophysical components only, and/or vulnerability from a nominated (non-human) species or habitat's perspective. Social vulnerability might considered to be a focus on strictly human artifacts (e.g. money, apartment blocks), and/or from a perspective that directly benefits humans. Even these distinctions as laid out can be blurred, but I suggest that this might be a more productive distinction than separating humans from what is considered ecological, and further, states of ecosystems predicated on values versus states that are not.

Resilience

In the resilience area, it is less clear whether the concept is understood as a relative concept or otherwise. Resilience as described by some proponents suggest that resilience indeed is considered as relative (Carpenter, et al. 2001; Walker, et al. 2002; Walker, et al. 2004; Folke 2006). Carpenter et al. (2001, p 767) suggest that in order to characterize resilience 'we must begin by clearly defining resilience in terms of what to what'. Walker et al. (2002) expand on this and state that resilience 'is the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions' and 'needs to be considered in a specific context'. They consider establishing the 'resilience of what?' as including identification of 'key ecosystem services used by, and of concern to people in the socio-ecological system'. What do they value?' Walker et al. (2004) in their elaboration of 'stability landscapes' speaks of desired and undesired 'basins of attraction'. Lebel et al. (2006) adds another dimension to Carpenter's call for specification 'of what, to what' by adding 'for whom'. In doing so they highlight the importance of making explicit whose interests and perspectives count in identifying desired system configurations or basins of attraction.

Specified versus general resilience

Recent elaborations of resilience distinguish between 'specified' and 'general' resilience (Walker and Salt 2006; Walker 2009; Walker, et al. 2009). The Resilience Alliance workbook (Walker 2009) states that 'specified resilience deals with the resilience of what to what (e.g., the resilience of crop production to a drought)'. General resilience 'does not consider any particular kind of shock, or any particular aspect of the system that might be affected' and further, 'general resilience applies to the system as a whole'. Walker et al. (2009) elaborate further and distinguishes specified resilience as the 'resilience of what is considered to be of value in the region to the identified shocks and other changes', and general resilience as 'capacity to cope, generally, with unidentified shocks'.

This separation of specified and general resilience suggests that resilience is considered to also have meaning in an absolute sense. Indeed, indicators of general resilience are suggested. The workbook suggests that 'general resilience involves such things as diversity (natural and social), openness (flows in and out of the system – social and biological), reserves, tightness of feedbacks, modularity and redundancy' (Walker 2009). Walker et al. (2009) suggests that 'general resilience could be increased by building and deploying human and social capital (including political influence), fostering experimentation and learning, investing in response diversity ('redundancy') and reserves of resources, maintaining or increasing options, and increasing spatial heterogeneity and ecological connectivity'.

As introduced above, any characterization of a 'system' is predicated on a particular point of view. Choices are made to determine where boundaries are set that separate systems and scales, what variables are selected to describe the system and its dynamics. What is understood as 'the system', even the 'whole system' only emerges after a point of view has been identified. Indeed, Tansley (1935) defines ecosystems in the same vein, describing them as convenient 'isolates' (p 300). Identifying drivers of change (or 'shocks' in Walker and other's language) is a fundamental part of this system characterization. By not 'considering any particular kind of shock, or any particular aspect of the system that might be affected' (see above) the system remains incompletely defined. General resilience, therefore, is, also inescapably specified. It may be general however, in the sense that it is orientated around maintaining a suite or a general set of goals. In this sense it might be distinguished from specified resilience, relating to a single or a narrower set of goals.

A related distinction is alluded to in Nelson et al. (2007). They distinguish vulnerability and resilience in terms of representing 'actor- or system-orientated views' respectively. However, both views are actor orientated, as specifications of desired ecosystem states, including those that underpin ideas of resilience are predicated on social goals and desires.

Descriptive versus normative

In a similar vein Brand and Jax (2007) distinguish between descriptive and normative definitions of resilience. They see the 'original descriptive and ecological meaning of resilience' as being diluted through a 'vague and malleable' use of the term as a 'boundary object[2]'.

Here again, the notion that resilience can be descriptive only obscures the fact that it is always a value-laden concept. Moreover, the notion of an ecological perspective emerges again here. What is meant by an 'ecological perspective' typically masks hidden values about deemed desired ecosystem states. There is no ecological perspective without an assignment of a desired state.

[2] A boundary object is defined following Star, S. L. and Griesemer, J. R. (1989) 'Institutional Ecology, translations and boundary objects - amateurs and professionals in Berkeleys-Museum of Vertebrate-Zoology, 1907-39', *Social Studies of Science* 19/3: 387-420. Brand, F. S. and Jax, K. (2007) 'Focusing the meaning(s) of resilience: Resilience as a descriptive concept and a boundary object', *Ecology and Society* 12/1. summarize Starr's definition as 'a term that facilitates communication across disciplinary borders by creating shared vocabulary although the understanding of the parties would differ regarding the precise meaning of the term in question'.

Interestingly, although I agree with Brand and Jax (2007) that a distinction can made between more particular characterizations of resilience over more general, I think the definition of a boundary object as presented works quite well for all characterisations of the concept. As already suggested, aspirations to arrive at a definitive preciseness in definition for both resilience and vulnerability are mistaken. Precision can only emerge after a particular context is specified, definitions that remain general are all that can ever be achieved for each of these concepts.

5.0 No fixed relationships

A number of authors have compared definitions and applications of resilience and vulnerability and described their relationships (e.g. Adger 2006; Eakin and Luers 2006; Gallopin 2006; Janssen, et al. 2006; Nelson, et al. 2007; Cutter, et al. 2008). Views range from understanding the concepts as opposites (e.g. Young ; O'Brien, et al. 2004; Folke 2006; Barnett, et al. 2008), resilience as a component of vulnerability, typically aligned with adaptive capacity (Gallopin 2006; McLaughlin and Dietz 2008), or as representing different but complementary concepts (e.g. Adger 2006; Nelson, et al. 2007,Eakin, 2006 #513; Turner II 2010).

Resilience and vulnerability are often described as converging around the concept of sustainability (Walker, et al. 2002; Turner, et al. 2003; Adger 2006; Eakin and Luers 2006; Cutter, et al. 2008; Turner II 2010). As noted by a number of authors (e.g. Allen, et al. 2003; de Chazal 2010; Smith and Stirling) what constitutes sustainability is also predicated on values. Sustainability is often used to evoke ideas of biophysical limits to human activity, set at the very least by a core set of human needs. These biophysical limits are also often conceived around ideas of limits to modification of 'nature'. However, what constitutes core human needs and considered adequate delivery will always be up for negotiation, and hence sustainability will never be an absolute (Allen, et al. 2003; de Chazal 2010). Similar ideas are explored by Dessai et al. (2004) in relation to defining what represents a 'dangerous' degree of climate change and by Adger (2009) in relation to examining social limits to adaptation.

I suggest there can be no definitive or true relationships between resilience and vulnerability. It simply depends on how they are characterised. Adger (2006) quotes Berkes and Folke (1998), who notes 'there is no single universally accepted way of formulating the linkages between human and natural systems'. I agree with this statement though would substitute 'appropriate' for 'accepted'. This is to shift any emphasis away from seeking verity towards establishing context.

6.0 No fixed trends

Major proponents note that resilience is not good or bad per se (Walker, et al. 2002; Walker, et al. 2004; Folke 2006; Walker, et al. 2009). Together with increasing resilience in some settings, decreasing resilience may also be desirable to shift a system out of a deemed undesired state or configuration of states (Walker, et al. 2002; Walker, et al. 2004; Folke 2006; Walker, et al. 2009). This shift might include creating an entirely new system through promoting capacity for transformation (termed 'transformability').

Folke (2006) and Smith (2010) note that a lot more work has been directed at ways of increasing resilience over decreasing resilience. To add to this, I suggest that the majority of resilience studies also present resilience as something that is only desirable to be increased (e.g. Tompkins and Adger 2004; Langridge, et al. 2006; Prato 2008; O'Brien, et al. 2009; Serrat-Capdevila, et al. 2009; Wolf, et al. 2010). For example Langridge (2006, p 1) state: 'It is widely acknowledged that resilience is a desirable characteristic of social and ecological systems that confront a variety of stresses'. Similarly Tompkins and Adger (2004, p 1) begin with: 'Emerging insights from adaptive and community-based resource management suggest that building resilience into both human and ecological systems is an effective way to cope with environmental change characterized by future surprises or unknowable risks'. Wolf et al. (2010, p 44), summarising the IPCC 2001 report, state 'generally, the aim of adaptation to climate change is to reduce vulnerability and increase resilience to impacts'. Titles such as 'Navigating social-ecological systems: building resilience for complexity and change' (Berkes, et al. 2003) and ‘Resilience - now more than ever’ (Gunderson and Folke 2005) further add to this style of characterisation.

This characterization of resilience as something that only is to be increased tells a partial story, and fails to satisfactorily account for circumstances where it may be desirable to decrease resilience. As Smith and Stirling (2010) note in the context of what they term as socio-technical systems, attention in this arena is more directed at system transformation than at maintaining resilience in existing systems. They note ‘where existing regimes are judged to be unsustainable, for instance in energy, food, transport, water or housing sectors, the point is that socio-technical resilience is an undesirable property’. ‘The aim of socio-technical resilience is thus usually focused on explaining and overcoming this negative resilience’. In the same manner, one could conceive of a large number of other cases where reducing resilience is desirable, for instance in relation to prevailing agricultural, forestry, and urban systems. Rather than perceiving resilience as something to be increased as a consequence of climate change (e.g. Prato 2008), one could equally understand resilience as something to be decreased, in order to not ‘flip’ ourselves out the current domain of attraction. It all depends on the context upon resilience is defined.

I suggest that the focus on increasing resilience only can be traced back to its historical roots in ecology. Ideas of resilience were developed around ideas pertaining to the maintenance of ‘natural’ ecosystems, particularly in relation to how resilience related to notions of ecosystem stability, diversity and functioning (e.g. Adger 2000; Scheffer, et al. 2001). The loss of resilience was equated with the loss of ‘nature’. Resilience was therefore seen as something that must be increased, in order to prevent these systems flipping into alternative ‘degraded’ state. As discussed above, determinations of desired ecosystem states goes far beyond those that are considered ‘natural’.

This characterization of resilience is influencing how resilience is popularly understood and applied. For example Jerneck and Olsson (2008, p 175) in a review of resilience in the development area, conclude that ‘a fundamental problem with resilience as we see it, is the implicit normative assumption of preservation of the system and thus resistance to change'. In a key Australian climate change adaptation policy document (Council of Australian Governments 2007) resilience is exclusively characterized in terms of building or increasing resilience only.

Interestingly, vulnerability appears to be something where it is exclusively understood as being desirable to be decreased. However, given that what is considered to be vulnerable is dependent on context, the same lines of argument apply, where there could equally be cases where the desired goal might be to increase vulnerability. For example, increasing the vulnerability of the rich may be deemed desirable in order to reduce economic inequity. For those who understand vulnerability as the inverse of resilience, cases for increasing vulnerability are already implied. Adger et al. (2009, p 341) already suggests cases in relation to adaptation: 'some agents adaptation concerns conservation of the status quo – for others the current situation is undesirable and hence adaptation is about progress'. 'The goal of adaptation will likely depend on who or what is adapting'. It is a logical step to apply this to vulnerability.

7.0 Toward better accommodation of values

In the light of points raised in the previous sections, how might progress be made to better accommodate the three propositions describing the roles of values? The importance of values is well established with a common call being made for their better accommodation (e.gEakin and Luers 2006; Nelson, et al. 2007; Adger, et al. 2009; Smith and Stirling 2010). Accommodation is typically sought via (1) the development of assessment schemes that incorporate diverse and often conflicting values, and (2) better integration of the social and natural sciences.

I raise some points for consideration in relation to these two areas.

Developing frameworks

Although still few, several studies propose assessment schemes that work to incorporate diverse and often conflicting values (e.g. Luers 2005; de Chazal, et al. 2008; Eakin and Wehbe 2009; Walker, et al.

2009). For example, the Vulnerability of Ecosystem Services to Land-use Change in Traditional Landscapes (VISTA) framework for vulnerability assessment distinguished itself from other frameworks through the capacity to incorporate multiple and shifting stakeholder values on the same or different ‘ecosystem service(s)’ (de Chazal, et al. 2008). The framework uses five matrices to move from projected ecosystem changes under several scenarios of land-use change through to judgments about changes in ecosystem services (Figure 1). These matrices provide a tractable means of laying out the relationships between stakeholder assigned values on selected ecosystem services and the underlying ecological attributes that deliver those services.

Adger et al. (2009) raises several tradeoffs as they see it between the goals of building resilience and reducing vulnerability. In doing so they note that there are range of possible goals of adaptation, where divergence of objectives results in some inevitable tradeoffs and incommensurabilities. Nelson et al. (2007) raise similar issues in relation to tradeoffs between what they term as ‘adaptedness’ and ‘system’ resilience. Adaptedness is defined as ‘a state in which a system if effective in relating with the environment and meets the normative goals of the stakeholders’ (Nelson, et al. 2007, p 400). Adaptedness is understood to have the potential to reduce system resilience via decreasing resilience in another location or region, or become highly resilient to one ‘shock’ while become vulnerable to other shocks.

Given that both increases and decreases in resilience and vulnerability may be deemed desirable however, the situation can be more complicated than this. Convergences, divergences and tradeoffs in identified goals of adaptation are further mediated by whether increased or decreased resilience and/or vulnerability are considered desirable.

O’Brien and Leichenko (2003) examines the notion of winners and losers in the context of climate change. They note that policy makers are often more reluctant to identify or acknowledge winners over losers as such discussions are considered detrimental to promoting global mitigation action. The emphasis placed on increasing resilience or decreasing vulnerability over the reverse trends may reflect this style of thinking. To increase vulnerability or decrease resilience may seem counter-intuitive, given the choice of language typically used to describe the phenomenon. Terms such as 'hazard', 'shock', 'stressor', or 'disturbance' are commonly used to describe drivers of change (e.g. see Brooks 2003; Fussel 2007; Walker, et al. 2009). These concepts already carry an implicit value judgment that the change is universally undesired, reinforcing ideas that there can only ever 'losers'. In this circumstance, working to reduce vulnerability or increase resilience would appear to be the obvious response. It obscures the fact however that not only are there ever not only losers, if there were, reducing vulnerability or increasing resilience might not be always be considered desirable. Eakin and Wehbe (2009, p 359) note that the resilience concept as characterized by Folke (2006) accommodates undesired impacts at local scales in order to achieve a more resilient system at broader scales. O'Brien and Leichenko (2004) make a similar point in relation to vulnerability, noting that determinations of vulnerability depend on the spatial scale of analysis, and may be different at different scales. This is an important aspect, highlighting the imperative of context in assessment determination. If we bring in other contingencies, such as differing determinations of vulnerability or resilience at the same scale, different choice of variables of interest for different parties, and differing assignments of desired trends at the same or different scales then assessment determination quickly become quite complicated. As noted by Adger et al. (2009) in relation to adaptation decisions, values that are brought to bear on what is deemed as appropriate response gets more diverse and contradictory as you move up the scales. I suggest this trend extends to all aspects where values underpin determinations of resilience and vulnerability.

In a similar spirit, several authors note that high scale indexes (e.g. Barnett, et al. 2008) or knowledge making at a global scale (e.g. Hulme 2010; Jasanoff 2010) conceals these diverse and often contrasting perspectives. Hulme (2010, p 6) suggests:

> 'A geography of global environmental change knowledge therefore demands, rather paradoxically, that attention turns away from the globalising instincts that so easily erase difference and which seek consensus. Instead, attention should focus on understanding the changing relationships between

> knowledge-making, institutional practice and human culture in evolving places. We need kinds of knowledge which are 'liquid' – i.e. mobile and responsive – rather than 'brittle' – i.e. thin and flat'.

Better integration of the social and natural sciences.

Despite a range of efforts directed toward better integration of the social and natural sciences (e.g. Turner, et al. 2003; Liu, et al. 2007; Turner II 2010), a number of commentators suggest that barriers still exist (e.g. Eakin and Luers 2006; Nelson, et al. 2007; Evely, et al. 2008; Giller, et al. 2008; Smith and Stirling).

Two identified barriers are the limited attention paid to others ways of knowing the world in addition to science (e.g. Gadgil, et al. 2003; Giller, et al. 2008; Petheram, et al. 2010) and limited acknowledgement of philosophical differences underpinning different research disciplines (e.g. Evely, et al. 2008; Miller, et al. 2008; Colyvan, et al. 2009).

Paying greater attention to these aspects could well significantly assist integration. However, out of the articles reviewed, there appeared to be a limited appreciation of the role that values play in characterization of ecosystems and attendant change. I elaborate on articles by (Evely, et al. 2008; Giller, et al. 2008; Miller, et al. 2008) to illustrate this limited appreciation.

Giller et al. (2008) in outlining a methodology for what they term 'interactive science' contend that different often conflicting perspectives on valuing natural resources calls for a shift in how scientific knowledge is understood in society. They argue that competing perspectives require an approach that (1) integrates the social and natural sciences and (2) in contrast to understanding scientific knowledge as neutral, views science as value-laden and as such something to be 'negotiated'.

I am sympathetic to viewpoints that understand scientific knowledge as not objective or value-free (e.g. Jasanoff and Wynne 1998; Carolan 2008; Hulme 2009). I also support efforts that encourage negotiation and deliberation between the identified actors as part of the formulation of the problem and its possible solution. However, it does not follow that acknowledgement of competing perspectives on how ecosystems are valued means that scientific knowledge is therefore value-laden and 'contested'. What is overlooked by Giller et al. (2008) is that assignment of values on resources was never a matter for science in the first place. Competing values offer no more of a challenge to the objectivity of scientific knowledge that an agreement on value. Scientific knowledge can still be understood as objective and value-free while also acknowledging that there are multiple perspectives on values of ecosystems. What Giller et al. (2008) describes is a case of negotiating values that are clearly distinct from any issues concerning negotiating science. Whether the science is also up for negotiation is a separate and likely equally important matter, but it is not fundamental to the points raised by Giller et al. (2008).

On a related note Miller et al. (2008) and Evely et al. (2008) contend that the accommodation of a range of perspectives on how knowledge is produced and gains credibility will significantly assist in more effective integration between the social and natural sciences. Both authors suggest that employing science as the only analysis tool is too restrictive and results in an 'incomplete' understanding of the issues. They suggest that taking a diversity of approaches will lead to a more 'complete' assessment. I agree that it is very important to appreciate that there are a range of different perspectives on how one might approach knowing the world. However I suggest that taking a diversity of approaches does not mean that a complete or definitive description of the world can be reached. There can be never be a single definitive description, as multiple and likely shifting values pervade so many steps, together with constraints on our ability to know the world entirely (Jasanoff and Wynne 1998; Russell 2010). Russell (2010) provides a comprehensive treatment of this point, elaborating on aspects relating to the fundamental partiality, plurality and provisionality of knowledge.

As a last point, as noted by Fussel and Klein (2006), a primary aspiration for integrating the social sciences into the natural sciences has been to include non-biophysical variables and drivers of change into what have been traditionally been exclusively biophysical assessments. However I think there is also a tendency for natural scientists to look to social science in order to identify values (e.g.

Colyvan, et al. 2009). For example, Colyvan et al. (2009) suggest that environmental ethics can assist progress in ecology through guiding choices for what particular features of the environment are 'the bearers of environmental value (or are the features of the environment that it is appropriate for us to value)'. This point of view overlooks the critical point that values are not something that are inherent in nature, to be discovered through empirical investigation, but are something that are assigned by the observer(s). Social science can no more identify what are considered to important values than science. What are deemed as important values is a task that everyone can engage in. This point has prompted further calls for including the humanities as part of this integration (e.g. Hulme 2009; Kagan 2009). I think that if these points were more comprehensively taken up, a significant step could be made toward more productive knowledge integration.

8.0 Conclusion

I have suggested that insufficient attention has been paid to how values inescapably underpin any characterization of ecosystems and attendant change within the domains of vulnerability and resilience. I have drawn attention to some mistaken distinctions that obscure this critical point, such as biophysical and social vulnerability, descriptive and normative definitions of resilience, specified and general resilience, and a universal assignment of desired trend direction (increasing resilience or decreasing vulnerability). I have suggested that this point is also overlooked in descriptions of frameworks that aim to incorporate diverse and often conflicting values, as well as in calls for better integration of the natural and social sciences.

All points raised coalesce around a continued separation of nature and culture (e.g. Robertson, et al. 1996; Braun and Castree 1998; Head 2007; Szerszynski and Urry 2010). This separation is not unique, but symptomatic of a wider view pervasive in ecology and wider global environmental change.

As Head (2007, p 837) somewhat provocatively writes:

> 'Doesn't the IPCC know that it should be talking about hybrids and networks rather than the dualisms of 'natural and human environments'? Don't they realize the profound

> contradiction of the term ‘human impact’; that it positions humans as outside the system under analysis, as outside nature, even as their evidence shows how deeply entangled humans are in the fabric of the earth and its processes? Are the science and humanities conversations about culture and ecology again passing like ships in the night? Hasn’t the IPCC read Latour?’

Whether the IPCC has or might read Latour is not for me to judge. However, I do think that greater reflection on the fundamental role that values play in whatever terms we choose to characterize ecosystems and attendant change would represent significant progress in our efforts to describe, assess, and respond to global environmental change.

Tables and Figures

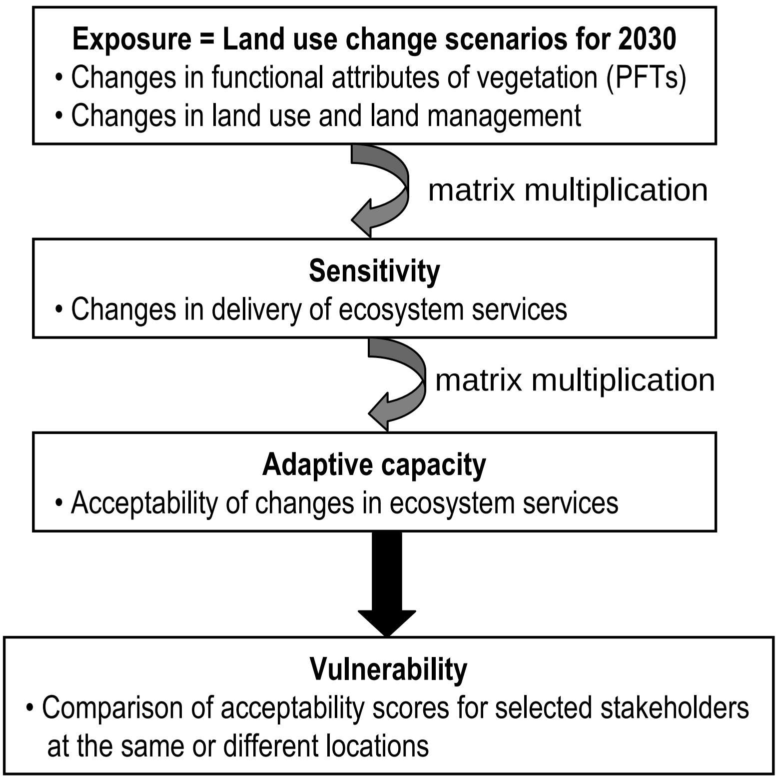
Table 1

Fussel's (2007) six dimensions considered key to a generally applicable conceptual framework of vulnerability.

Temporal reference: current vs. future vs. dynamic.
Sphere: internal vs. external vs. cross-scale.
Knowledge domain: socioeconomic vs. biophysical vs. integrated.
Vulnerable system
Attribute of concern
Hazard

Figure 1

Diagram giving an overview of the VISTA framework (from de Chazal et al., 2008, Figure 1). Vulnerability is represented in terms of the three commonly used components of 'exposure', 'sensitivity' and 'adaptive capacity'.



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