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Disaster Vulnerability and Resilience: Theory, Modelling and Prospective

Commissioned Review

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Disaster Vulnerability and Resilience: Theory, Modelling and Prospective

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Introduction

Underpinning analysis of disasters rests a basic question regarding uncertainty and shocks, a question of how communities engage with risk. Many disciplines have grappled with this question, framing it as a technical issue of outcome probability and effect severity (Lichtenstein *et al.* 1978 cited in Sjöberg, 2000), a function of individual heuristics and biases (Tversky and Kahneman 1974), as a subset of broader normative debates on social organisation (Douglas and Wildavsky 1982) or as a reflection of modernity (Beck 1986; Giddens 1999). In social development theory and practice, the importance of uncertainty and risk associated with natural hazard has been acknowledged only by specific areas of study (e.g. rural development) and many challenges remain to integrate disaster risk reduction into sustainable development regimes (UNDP 2004; UN 2005 cited in Birkmann 2006; Gaillard 2010; IPCC 2012). In the disaster management and climate change traditions this question is articulated through the concepts of vulnerability and resilience. How fit are these concepts to represent how communities currently engage with risk, and how useful are they in determining how communities can better engage with risk in the future?

The Foresight report employs the following definitions of vulnerability and resilience:

- Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard [UNISDR]

- Resilience: The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions [IPCC]

The aim of this workpackage is to make clear the core elements of vulnerability and resilience that can inform thinking about disaster risk in the future. When discussing vulnerability, we include exposure to hazard and capacity to cope/adapt, alongside susceptibility. This framing serves as a short hand with the social determinants of exposure, susceptibility and capacity often referenced generically (though how these work out will be specific to the task at hand). Where we are interested specifically in exposure, susceptibility or capacity, this distinction is

explicit in the text. The structure of the report is as follows: Section 1 provides a conceptual overview of vulnerability and resilience; Section 2 explores key dimensions and determinants of vulnerability; Section 3 introduces the Resistance, Resilience and Transformation Framework for Disaster Risk Reduction, an analytic lens for approaching incremental to transformational choices and changes; Section 4 looks to the future of vulnerability and resilience, exploring methodologies, changing landscapes and how choices made now will influence future generations; finally, Section 5 outlines key high-level conclusions.

Section 1: Definitions and Conceptual Analysis

1.1 Introduction

This section provides an overarching discussion of vulnerability and resilience to illustrate the conceptual debates that they rest upon. Vulnerability is approached through livelihoods, political ecology, and the hazard-of-place perspective. Resilience through a discussion of the multiple origins of this concept in engineering, psychology and disaster studies as well as providing an introduction to social-ecological systems perspectives which have become the primary influence in climate change adaptation. From this starting point a number of unresolved gaps related to vulnerability and resilience are noted and taken forward in the following sections of this report.

1.2 Defining Vulnerability and Resilience

In academic work the profusion of definitions for vulnerability and resilience illustrates their wide appeal across disciplines and problem areas and their context dependent nature (see Manyena 2006 or Birkmann 2006). Policy communities have also yet to reach a common cross-cutting definition of these terms. Even in disaster risk management and climate change, two increasingly allied fields of policy, existing definitions differ in emphasis. The IPCC has shifted from understanding vulnerability to climate change as "…the degree to which systems are susceptible to, and unable to cope with, adverse impacts of *climate change* including *climate variability* and extremes." (IPCC 2007, p.883) to "the propensity or predisposition to be adversely affected" (IPCC 2012, 32). The significant difference between these definitions is the relationship between vulnerability and physical events. While in the former vulnerability is dependent on exposure, in the later vulnerability is considered independently of the physical event. This shift is an important conceptual transition. It allows for a different (if not deeper) understanding of contextual factors and lends itself to an alternative set of policy interventions (O'Brien *et al.* 2007). It also reflects a departure from how the concept is usually portrayed in climate change circles and an effort to align more closely with the disaster tradition and the thinking of the ISDR (IPCC 2012).

Greater synergy between climate change and disaster management definitions is welcomed. It may be that input variables and management contexts differ, but a common framework will

support cross-tradition learning and avoid the transactions costs of translation. This is especially important for donor organisations seeking to support change on the ground where distinctions between the management of disaster and climate change extremes and associated strategies, such as community based solutions, are even smaller and the integration of long-term climate change and variability into development planning can benefit from (and also add value to) a broader risk management approach.

1.3 The Conceptual Origins of Vulnerability

Focusing on disaster studies we review three major schools of thought on vulnerability associated in turn with livelihoods, political ecology and spatial analysis.

Livelihood Perspectives

The livelihood perspective provides an actor-centred conception of vulnerability that originates in development studies and builds on entitlements theory (Sen 1981; Sen 1984; DFID 1999) with a rural bias (Chambers, 1983). Departing from conceptions of rural lives that focus on agriculture as the principle source of income, this perspective recognizes a variety of means through which an individual (or more often a household) can earn a living. Here, vulnerability is connected conceptually to external stresses and shocks and internal coping capacity (Chambers and Conway 1992).

In this perspective, a livelihood is understood as a composite of a household's capitals, activities and access, framed by institutional context. The five capitals often cited in the livelihoods literature are physical, human, financial, social and natural (Ellis, 2000). Activities can be unpaid, like sharecropping and subsistence farming, or paid, such as factory work and farm labour. In theory, a household facing a shock should have the ability to reorient (switch) its activities or exchange its capitals. The flexibility of this interchange, however, must be recognized as being moderated by value considerations and contestations (Arce 2003 in de Haan and Zoomers 2005), property relations and configurations of power in the institutional context (de Haan and Zoomers 2005). The potential of livelihood switching, and the structures that underpin it, will be explored in greater detail in section 2.

Ultimately, the strengths of the livelihoods approach are its ability to recognize and articulate the agency of individuals and households to manage resources when facing shocks and to express how these dynamics play out at the local level. For instance, this perspective opens

questions regarding trade-offs between various capitals, the prospect of exhausting assets, and the possibility of a household spiralling into collapse (Swift 1989). From a diminution of savings to an erosion of productive capital, the livelihoods approach can help to express the 'ratchet effect,' wherein each new hazard event (or the progression of a slow-onset event) increases the vulnerability of those affected to future events (Chambers 1989; Rahmato 1991). The limitations of the livelihoods approach are that it tends to neglect political and structural forces (de Haan and Zoomers 2005), overlook the interaction of household agency with these forces, and not account for physical and ecological dimensions of risk. Generally, these omissions continue to influence contemporary understandings of vulnerability.

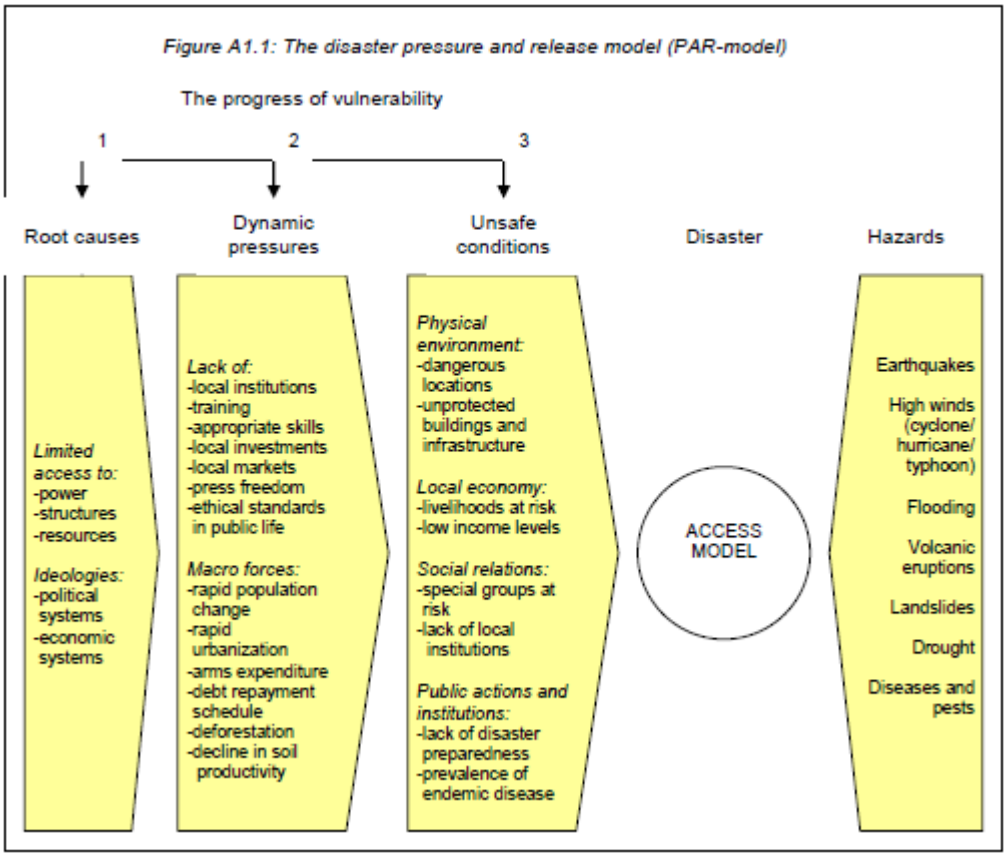
Political Ecology

Political ecology places explanatory emphasis on both the structural relations that underpin vulnerability, and the environmental systems generative of hazard and opportunity. It presents an attempt to bring both perspectives together in analysis and accept that neither operates independently. It is also a response to both the physicalist bias of the hazards management approach and the structural orientation of the political economy school (Hewitt, 1983) that emerged as its critique in the 1980s (Pelling, 2001). In an effort to incorporate issues of power and politics into a domain dominated by technical explanations, this perspective seeks to explain why certain groups live in more exposed areas, experience different impacts from shocks, have disparate capacities to cope with/adapt to hazardous events and are impacted differently by external disaster response and risk reduction efforts (Gaillard, 2010).

One critique of the political ecology approach is that its descriptions of inequalities are somewhat generic. With difficulty distinguishing between different susceptibilities to harm, disparities in resource distribution and opportunity are expressed with relatively low resolution (Eakin and Luers 2006). Another important critique of political ecology relates to the issue of agency. Early versions of this perspective had a propensity to concentrate on structural dimensions of vulnerability (Cuny 1983 for instance). This focus downplayed actors' capacities to cope with and adapt to shocks and thus tended to infer vulnerable people as passive or incapable victims (Wisner *et al.* 2004; Bankoff 2003). Building on the livelihoods perspective, however, more recent models have worked to integrate understandings of agency into the political ecology framework (Cannon *et al.* 2003; Wisner *et al.* 2004 for instance). Box 1 presents the Pressure and Release model, a central contribution of this approach shows local expressions of vulnerability to be a product of scaled processes of development, and disaster

risk to derive from the conjunction of vulnerability with hazard so that increases in either can worsen disaster risk and loss.

Box 1: The Pressure and Release Model



The PAR model presents a 'progression of vulnerability', consisting of root causes, dynamic pressures and unsafe conditions (Blaikie *et al.* 1994; Wisner *et al.* 2004). Root causes represent broad structural forces, like economic systems or political processes, which broker how power is accessed and determine how resources are distributed. Dynamic pressures refer to forces that are capable of converting root causes into unsafe conditions. Rapid population change, deforestation, or lack or press freedom, for instance, compound those underlying dynamics leading to more local expressions of endangerment. Unsafe conditions, finally, are specific temporal and spatial expressions of the interaction of root causes with dynamic pressures. In this framework, the absence of disaster preparedness, the existence of unprotected buildings and infrastructure, or the persistence of low-income levels, is not so much a source of vulnerability as it is a vulnerability revealed. Though the PAR model does not

account for agency in itself, Wisner *et al.* (2004) propose the Access Model as a conceptual counterpart intended to incorporate this dimension.

Sources: Blaikie *et al.* 1994; Wisner *et al.* 2004

Spatial Perspectives

Hazard-of-place emphasises the spatial conjunction of hazard exposure and susceptibility in the production of vulnerability (Cutter 1996). Using a variety of methods including, historical, descriptive, empirical and geographic information systems (GIS), hazard-of-place offers a flexible, place-based means of analysing multiple hazards and contrasting contexts. With GIS, for instance, environmental threat indicators and social characteristics can be layered to construct spatial representations of vulnerability (Cutter *et al*. 2000). Though hazard-of-place analysis has tended to focus on areas in the United States, the approach has applicability in developing countries as well. In these contexts, however, the power/knowledge disparity between expert/technocratic and local conceptions of vulnerability may be particularly acute (Mustafa, 2005), highlighting the need for a co-production of indicators. The hazard-of-place perspective has also been critiqued for tending to overlook dimensions of vulnerability that exist across spatial scales (Mustafa, 2005) and by conceptualising exposure as a component of vulnerability, making it more difficult to separate this variable for analysis and policy.

1.4 Conceptual Origins of Resilience

The conceptual origins of resilience are arguably more diverse than for vulnerability and more problematic as they include contradictory perspectives. Engineering, psychology, disaster studies and social ecological systems have all contributed important interpretations of resilience that continue to influence contemporary understandings of the term and each is discussed below.

Engineering Resilience

Engineering resilience, from where the ‘bounce back’ analogy is derived from, is more closely related to what other resilience communities understand as resistance (e.g. Gordon 1978). It assumes a linear system, or at least one in which a linear approximation is appropriate, and focuses on the time it takes a displaced variable to return to a particular equilibrium (Pimm

1999; Ludwig *et al* 1997 cited in Folke 2006). The omission of multiple possible equilibria and the assumption that it is indeed possible for a variable to return to a particular equilibrium, are both problematic in a social context. These problems will be elaborated in greater detail in Section 2.

Psycological Resilience

The psychological interpretation of resilience was first discussed in the 1940s (Waller, 2001; Johnson and Wielchelt, 2004 cited in Manyena 2006), though gained currency from the 1970s based on studies in child development (Werner *et al*. 1971; Garmezy 1985), health, war and terrorism, military, life and personality adaptation, psychiatry, sociology and natural disaster management (Chang Seng 2012). In this conception, resilience relates to the capacity to choose a vital and authentic life, the process of overcoming the negative effects of exposure (bouncing back), the ability to cope successfully with traumatic experiences (resistance) and avoiding the negative trajectories associated with risks (emBRACE 2012). While psychological resilience has tended to focus on functional persistence, and the return to a particular steady state, it is capable of envisioning improved psychological health and well-being. Concepts like the resilience core—a set of five essential characteristics proposed to enable a person to structure their life in a resilient way (1) Meaningful life, 2) Perseverance, 3) Self-Reliance, 4) Equanimity and 5) Coming home to yourself –existential aloneness (Gail 2010 cited in emBRACE))—and positive emotions—promoting flexibility in thinking and problem solving—can contribute to these transitions or transformations. While originally focussed somewhat statically on the individual and their internal capacities, the attention of psychological resilience has broadened to include more dynamic external contextual factors and multi-level perspectives. In the disasters field specifically, psychological factors have been recognized as an important component of more general resilience (Gow and Paton 2008). There is scope for greater integration and emphasis on emotional and psychological health post-disaster, as well as in informing determinants for risk reducing behaviour.

Disaster Resilience

In the disasters tradition, the term resilience began to be employed in the late 1970s and gained visibility following the approval of the Hyogo Framework for Action (2005-2015) (Torry 1979; Birkmann 2006; Gaillard 2010). Resistant to the negative connotations of vulnerability, resilience was presented as a positive reflection of the same set of issues. Though many interpretations of the term abound in the disasters tradition, this understanding of resilience as

the inverse of vulnerability has proven to be a persistent, though problematic conceptualization. Presenting them as opposites leads to circular reasoning wherein something is vulnerable because it is not resilient and not resilient because it is vulnerable (Klein, Nicholls and Thomalla 2003 in Manyena 2006). Furthermore, as Paton notes, there are characteristics that can make us vulnerable while simultaneously affecting our capacity to adapt (Paton correspondence from Manyena 2006). Most recently, the disasters tradition has recognised these conceptual constraints and begun adopting understandings of resilience more akin to climate change adaptation – but importantly explores the application of these ideas to geophysical hazard related vulnerabilities and loss, opening scope for multi-hazard assessment and policy that can include technological as well as natural hazard drivers.

Social-Ecological Systems Resilience

Taking its cue from systems theory, as worked out through ecology (Holling 1973), and drawing from natural hazards and political ecology (Adger 2006), social-ecological systems theory (SES) seeks to understand the dynamic, cross-scale interactions of coupled human-environment systems. It provides a variety of heurists related to these systems including the notion of an adaptive cycle, panarchy, adaptability, transformability and, perhaps most importantly, resilience (Walker *et al*. 2006). Though the SES conception of resilience is firstly descriptive, it does offer considerable scope for enhanced policy through themes like scale, functional persistence, self-organisation, social learning, and flexibility. These core themes proposed by SES contribute to our understanding of resilience in several key ways and, given their roots in general systems theory approaches, can be applied independently of a full SES framing—where focussed attention on social or environmental sub-systems is considered more appropriate.

This view emphasises the importance of scale in understanding resilience. It allows for an acknowledgement of disparities at different scales, the impact and direction of interaction between scales, and the role of feedbacks. Functional persistence represents an outcome of the SES conception of resilience. Though it is not the only possible outcome, it has been the focus of considerable attention; others including system collapse and transformation. Self-organisation and social learning are both processes that can lead to resilience. While the later constitutes a key focal point of contemporary resilience discourse, the former has been somewhat neglected in recent years. Finally, flexibility represents a means of interpreting the

elements of resilience. These themes and their ability to add to our thinking on resilience going forward will be elaborated on in section 2.

Despite providing the most holistic interpretation of resilience, the SES perspective, as currently expressed, does have some significant weaknesses. Four critiques of the perspective are that it does not account for politics (Scoones and Jan-Peter Vos in Leach 2008), lacks a consideration of agency (Brown and Westaway 2011), and that its application has not yet engaged with emotions or with the opportunities that open for development when systems resilience collapses (Pelling, 2011).

Integrated Approaches for Disaster Resilience

The diversity of approaches that present resilience as a useful concept in analysing how social relations deal with stress is extensive. Recently a number of integrative frameworks have emerged that draw from across this range of literature and are oriented to particular problem sets. They are not all comprehensive, however, and there are many disagreements between them. Cutter *et al*. (2010), for example, suggest that ecological elements cannot be included in resilience due to the prominence of poor data quality, and that critical infrastructure approaches are difficult to transfer into the community resilience realm because of their dynamism. Significantly, these approaches increasingly position resilience as an orientation of decision-making rather than as a policy outcome; an understanding we develop further in section 3. As Norros *et al*. (2008: 130) argue: resilience is

> "a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance… we carefully did not equate resilience with the *outcome*, but rather with the *process* linking resources (adaptive capacities) to outcomes (adaptation)".

Below, we focus on three examples of integrated approaches to resilience. While the basic components of these approaches are transferable, they are generally orientated towards disaster risk reduction and (with the exception of the UK Cabinet Office) have a focus on low and middle income countries.

Focusing on critical infrastructure as the backbone of resilience, the UK Cabinet Office suggests that "critical national infrastructure in the UK should not be disrupted by a flood event

with an annual likelihood of 1 in 200" (2011 p.28). This framework focuses on resilience as the ability to anticipate, adapt, absorb and recover, and emphasises components of resilience such as systems resistance, reliability, redundancy, response and recovery. It supports designing for resilience, the importance of information sharing, trade-offs in decision-making and integrated governance which brings together local and national structures including civil society.

Twigg's (2009) guidance note on 'Characteristics of a Disaster Resilient Community' has been influential for the humanitarian sector. This formulation emphasises governance generally, with particular attention to planning, regulation, integration, institutional systems, partnerships between civil society, government and the private sector, and accountability for disaster risk. This focus is important in a positioning of resilience as a state of governance, indicated through, but not determined by, the social and physical structures that result. As with the Cabinet Office (2011) approach, Twigg's guidance note stresses integrated governance. Additionally, it also acknowledges the capacity of those experiencing risk to critically reflect, generating an important feedback loop for learning.

Reflecting its mandate, the International Federation of the Red Cross (IFRC, 2008) presents a strongly community centric understanding of resilience. This understanding is structured to align with the priorities of the UN-ISDR Hyogo Framework for Action but also shares much with Twigg (2009)—emphasising the value of local knowledge (including access to science), decentralised decision-making and resource access. In addition, IFRC proposes that resilience is legitimised when it adds to the wellbeing and life chances of those at risk, privileging these characteristics over higher level (e.g. national) and coarser (e.g. GDP growth) indicators of development.

While the social resilience oriented approaches (IFRC 2008 and Twigg 2009) are widely transferable and inspired by a range of resilience thinking, they have tended to overlook one particularly important element: redundancy. It seems that redundancy has been difficult to communicate as a core component of resilience in contexts where physical infrastructure is prioritised over social factors (despite their fundamental interdependence for human wellbeing). Going forward, it will be important to explore why redundancy in social systems is not prioritised, and if opportunities to build and monitor resilience are being lost because of lack of integration across the physical and social systems.

1.5 Key Unresolved Issues

As we will see in sections 2 and 3, some of the conceptual debates behind vulnerability and resilience have come to a head, giving clear indication of ideas to take forward going into the future. Others, however, have yet to be determined. These ongoing debates will be introduced in the remainder of this section.

Cultural Values/Emotions

An important gap in discussions of vulnerability and resilience is the role of cultural values and emotion. These factors can add specificity to our understanding of how vulnerability is felt, as well as determining who is vulnerable. Effectively, culture can help to unpack collective decisions about what to fear and what not to fear (Douglas and Wildavsky 1982). From the perspective of action and intervention, cultural values can constrain or enable the spectrum of available responses. In the short term, as previously discussed, cultural values can impede actors from switching activities or capitals, thus limiting coping capacity (Arce 2003 cited in de Haan and Zoomers 2005). In the longer term, reluctance to grapple with underlying cultural values can seriously limit the scope of adaptation/resilience policy (Handmer and Dovers, 1996, O'Brien 2011, Pelling 2011). Important connections can be drawn here with discussions of identity (see the Foresight Future of Identity project).

Specific vs. General Resilience

Should resilience making be directed towards the individual components of a system or the system itself (Carpenter *et al*, 2001, Walker 2009)? Awareness of the differences between these two types of resilience and the interaction between them is essential, particularly for policy development. Resilience is not necessarily a positive sum game. Building the resilience of one component can simultaneously reduce the resilience of another component or of the system as a whole (Miller *et al*. 2010), or of neighbouring systems – with potentially global effects.

Resilience as a Normative Concept

Particularly, in the dominant social ecological systems perspective resilience is fundamentally a descriptive concept. While it is capable of observing system stability, it is not capable of making

normative judgements about that stability, and accordingly, it needs to be coupled with other frameworks to determine whether that stability is good or bad (Adger cited in Leach 2008) and explore options for provoking systems collapse as well as its stability (Pelling, 2011). Taking a more specific view on resilience, however, systems provide ecosystem and generate outcomes that may be desirable or undesirable for different components of the system (Adger cited in Leach 2008). From this perspective, resilience is not only normative, but deeply implicated in issues of power and politics.

Moving from Theory to Practice

The empirical, academic evidence on how resilience understanding is adopted and applied by practitioners, managers, community leaders and policy makers in disaster risk management is limited (Olsson *et al*. 2004; Gunderson and Holling 2002; Berkes *et al*. 2003; Walker and Salt 2006). While it is possible to learn from other policy areas, most notably natural resource management, it is unclear how applicable these lessons will be in contexts where risk and uncertainty are involved. Furthermore, the case studies on resilience and shocks that do exist tend to be based in North America and Europe, leading to questions about the transferability of knowledge when applied to emerging economies/polities in the developing world. This limited geographic scope, however, is rapidly expanding as as experiments with resilience continue elsewhere in the world and ongoing policy is reframed in the language of resilience.

Tension between Technical Solutions and the Deep-Rooted Nature of Vulnerability

The Pressure and Release Model's (Blaikie *et al*. 1994; Wisner *et al*. 2004) analysis of root causes, dynamic pressures and unsafe conditions helps to expose what is and what is not possible within the status quo. This understanding highlights another unresolved tension between the deep-rooted causes of vulnerability and an impetus to resolve them using technical solutions. Given the real political and economic costs of tackling the root causes of vulnerability, the majority of policy interventions fail to engage in processes of critical consciousness (reflexivity) (Freire 1969) and tend to focus instead on creating change at the margins (Handmer and Dovers 1996). These interventions may tackle unsafe conditions but simultaneously reproduce risk (if not in the same place, then elsewhere), leading to an accumulation of 'vulnerability as development failures' (Gaillard 2010).

Section 2 Vulnerability

2.1 The Process of Vulnerability

Before considering the determinants of vulnerability, it is worthwhile to elaborate on the processes of vulnerability that reflect the agency of actors engaging with shocks. This is best represented through a parallel discussion on the differences between coping strategies and adaptation. While the debate of whether coping capacity should be conceived as a part of vulnerability or as a separate feature remains unresolved (Birkmann 2007), coping capacity and adaptation are certainly implicated in vulnerability and resilience, highlighting action and capacity instead of simply victimhood (as we saw in Section 1, adaptation has been conceived as a component and outcome of resilience).

The distinction between coping and adaptation is often confounded. The IPCC SREX (2012) presents this as a difference between the utilisation of existing resources, assets, capitals and entitlements to confront a perceived risk or respond the hazard impacts–described as coping – and acts of critical reflection, reorganisation and reprioritisation of resources based on anticipated or experienced dynamism in hazard and risk—described as adaptation. This is a useful distinction and one that allows adaptation to be applied beyond climate change to geophysical hazard related events. Recognizing the importance of critical reflection, it also indicates a connection between adaptation and resilience (in contrast to coping where resilient outcomes are less clear).

With coping strategies, the conversion of savings and productive or reproductive goods for the fulfilment of basic needs is rarely optimal. It may be difficult, impossible or imprudent to liquidate some assets, the widespread (i.e. covariate) nature of shocks may drastically reduce the value of assets during negative periods, and years after a shock, assets employed for coping may still not have returned to pre-shock levels (Dercon 2002). Coping may also exhaust resources that could be employed for more strategic adaptation (O'Brien and Leichenko 2000). Furthermore, if the resources employed in coping degrade key ecosystem services, coping may undermine sustainability, be implicit in the generation of hazards, and/or be implicated in issues of inter-generational justice (Handmer and Dovers 1996). Conversely, adaptation has the potential to reorganize or reorient a community's resources and priorities in such a way so as to limit the need for future coping. Though coping and adaptation are useful categories, it

must be noted that the differences between them are often blurred. Rather than dichotomous, they are more appropriately understood as part of a continuum (Ellis, 1998). Certainly local actors rarely distinguish between coping and adaptation.

Box 2 Livelihood Diversification and Switching

Faced with uncertainty and the prospect of negative shocks, households can engage in livelihood diversification as a strategy for coping with risk (Ellis 2000, Ellis and Freeman 2005). This strategy will often involve the construction of "an increasingly diverse portfolio of livelihood activities and assets in order to survive or improve living standards" (Ellis 2000 p.15 in Kien). The idea is that during a shock, a household will be able to switch from one strategy to another. Facing a drought, for instance, a household whose primary activity is farming may send some family members to seek paid labour in the city or to work on a farm in an unaffected part of the country. In relation to drought and vulnerability to climate change, this strategy has proven beneficial (Eriksen, Brown and Kelly 2005; Smith *et al*. 2001).

Livelihood diversification and switching aligns with resilience principles of flexibility and diversity (Pelling and Mustafa 2012). It also illustrates how, in the face of a shock, a household may reorganize their assets/strategies, effectively transitioning to a different equilibrium (the idea of multiple equilibria will be elaborated upon in section 3). However, despite the benefits of livelihood switching, there are limitations to this strategy and obstructions to its implementation.

As a short-term coping strategy, livelihood switching may be implicated in poverty traps and obstruct the possibility of longer-term adaptation (or transformation). Depending on the context, diversification may be an inferior coping strategy to specialisation (Kien 2011), particularly if the additional social surplus generated can be invested in risk transfer (insurance) or in reducing susceptibility (education) or exposure (housing). Rich and poor households may employ diversification for quite different ends—the former for development and wealth accumulation and the later for survival (Carswell 2000 in Kien). It must also be acknowledged that shocks often affect incomes in diverse and seemingly unrelated sectors, thus diminishing the effectiveness of

diversification. A drought, for instance, may lead to a collapse in demand for local services, thus negatively affecting crop income as well as non-farm incomes (Czukas *et al*. 1998; Sen 1981).

Even in cases where diversification is advisable, however, such a strategy might not be possible. There can be significant entry-constraints to diversification such as working capital or skills (Dercon 2002). While a richer household may be able to afford the higher entry costs to effective risk-spreading activities, poorer households will typically enter into activities with lower entry costs and lower effectiveness in risk-spreading (Dercon and Kirshnan 1996). The commitment of households to particular livelihoods may also be non-material. Norms, taboos and cultural values can be implicated in the decision to follow particular livelihood pathways and can constrain the prospects of switching to others (Arce 2003 in de Haan and Zoomers 2005). For instance, the erosion of cultural identification associated with specific livelihoods may be perceived as too high a price to pay for adaptation. Moreover, property relations, configurations of power and other institutional factors may limit the ability of household's to switch strategies (de Haan and Zoomers 2005). Though flexibility may certainly add to resilience, it can often be obstructed by the institutional context.

2.2 Indicators and Drivers of Vulnerability

2.2.1 Determinants of Vulnerability

What are the key determinants of vulnerability? Across scales, where can these determinants be aggregated and where is aggregation difficult or impossible?

There is a huge literature on vulnerability to natural hazards. The strategy taken here is to focus the discussion around vulnerability indicating and indexing approaches. This allows greater discussion of key material and benefits from the rigour forced by indicator methodologies. The section begins by outlining some technical critiques of vulnerability indicators and indices. Following an introduction to the issue of scale, a table is presented with key national, sub-national and local level vulnerability determinants. This table illustrates the instances where determinants at different scale converge, areas where they diverge and the

conceptual differences that underpin these disparities. It also illustrates the dynamic cross-scale pressures that act upon vulnerability determinants.

General Technical Critiques of Vulnerability Indicators

The search for robust indicators and determinants of vulnerability is constrained by a variety of technical challenges. To begin, indicator selection and their aggregation may be guided by deductive theory-driven approaches, inductive data driven approaches, or approaches that combine the two (Diener and Suh 1997; Niemeijer 2002 cited in Ball 2007). While deductive indices suffer from the subjective interpretation of the index creator or creators, inductive approaches may be limited by unavailable or incompatible data sets (Tapsell *et al*. 2010), the decay of data over time (Gall 2007), or the forced selection of limited indicators. Furthermore, and significantly for futures research, inductive indices rarely incorporate modelling and thus capture present and short-term vulnerability without accounting for longer term variability and changing vulnerabilities (Füssel 2009).

Introducing the Issue of Scale

Beyond the technical challenges involved with creating effective vulnerability indices, deeper-set conceptual issues persist. Scale, in particular, is both a technical and a conceptual issue for vulnerability assessments (Fekete *et al*. 2008). From our analysis in Section 1, we know that an important dimension of vulnerability is that it is place-based, operating at particular spatial scales (Cutter 1996; Turner *et al*. 2003). We also know that dynamic, cross-scale forces influence vulnerability at a given scale (MEA 2003 cited in Fekete et a 2008) and that it can be nested and teleconnected in complex and nonlinear ways (Adger *et al*. 2008). Furthermore, there are feedback loops manifest between and within the system at multiple scales. At different scales, how successful have vulnerability assessments been at capturing these dynamics?

At the national scale, considerable theoretical, methodological and empirical weaknesses have been noted in existing vulnerability assessments (Eakin and Kelly's 2007). One multi-criteria evaluation has suggested that none of the existing indices are particularly robust means of measuring or comparing vulnerability, and that the human development index (HDI), though weak itself, is the most effective means of measuring vulnerability (Gall 2007). The technical issues described above (data-quality, decay and availability, data-driven vs. theory driven means of selecting indicators, subjectivity and the issue of weighting) are all particularly

pronounced at this scale. Furthermore, assessments at this scale tend to express vulnerability solely in terms of mortality rates or GDP, illustrating a significant limitation of the national scale for expressing the complexities, dynamics and feed-backs of vulnerability (Birkmann 2007).

At the local scale, there is considerable emphasis placed on the agency of actors. The resolution of analysis here provides a singular opportunity to convey the complex, and at times contradictory, root causes of vulnerability as well as the extent of individual (or household) coping capacities. Employing participatory and qualitative techniques, there is also more scope at this scale to unpack the influence of cross-scale forces. Despite this detail of analysis, however, the nuances at this scale are extremely difficult to upscale. Opinions or other specific information may be lost and spatial generalisations may occur (Fekete *et al*. 2010). While in isolation, the local scale may not tell us much about the broader vulnerability of the system, it can be coupled with national and sub-national approaches to validate their findings (Fekete *et al*. 2010).

The meso, including urban, scale has been underrepresented when compared with the national and local. This under-representation persists despite the large number of urban assessments undertaken by local government, community based groups etc. The challenge is to connect this scale of analysis to the local and national. In recent years research agendas on vulnerability have started to shift to this scale. The Belmont Challenge, for instance, an initiative inspired by a meeting of representatives from the US National Science Foundation (NSF), the UK Environment Research Council (NERC), major international global change research funding agencies and the International Council for Science (ICSU), urges the international scientific community to “develop and deliver knowledge in support of national and international government action to mitigate and adapt to global and regional environmental change with an emphasis on regional hazards” (ICSU 2010 p.7). Conducting analysis at the sub-national scale, looking at different counties for instance, may be useful for disaggregating vulnerability in relation to large-scale events. Assessing the vulnerability of people and communities to smaller events, however, will remain difficult at this scale (Fekete *et al*. 2008).

Table 1. Pros and Cons for Vulnerability Assessments on Different levels in Comparison to the other Levels

Level	Pros	Cons
Local	More detailed information can be included Complexity can be better captured Certain methods to collect data (e.g. participatory approach) can only be applied on local level Data availability for one place is mostly high	Transferability of the approach to another level or region implies loss of information Mapping of a whole river system is severely constrained by data availability Some data are very local specific and therefore complicated to compare with other cities or a region
Sub-national	Large-scale patterns and processes can be identified Intermediate level of analysis facilitates the incorporation of data from other spatial levels Data at regional level often available for whole country Less complex approaches are more applicable	Important vulnerability components can hardly be captured as e.g. perception or thresholds ⇒ tendency of simplification Dependency on available data as own collection is constrained Validation is difficult to carry out Variations in nature are difficult to capture
National/global	Meets the demand of allocating funds for parts of the world most affected by natural hazards or by social insecurity	Detection of root causes or holistic insights over patterns of vulnerability is limited

Source: Fekete *et al*. 2010

In trying to identify the key determinants of vulnerability, it is clear that no one scale of analysis is sufficient. Exploring the indicators of vulnerability at different scales, however, we are also confronted with conceptual disparities that hamper any attempt to aggregate indicators into a single universal list of vulnerability determinants. Disparate scales ask distinct questions of vulnerability, and ultimately reveal different dimensions of it.

Methodology and Explanation of the Vulnerability Determinants Table

Annex 1 presents the indicators that several scaled assessments have employed to express vulnerability. These have been categorised according to seven vulnerability sites: lenses through which vulnerability can be generated (i.e. we are interested in the social processes that describe vulnerability, not in society as an object that might be vulnerable): social, demographic, infrastructural, environmental, institutional/governance, economic and cultural. While the sites are comprehensive, the indicators are meant to simply illustrate how vulnerability has been articulated at particular scales. The assessments selected are ones that have been critically evaluated and/or widely employed. At the national scale, these include the UNDP's Disaster Risk Index (DRI) (2004), Brooks *et al*.'s Predictive Indicators of Vulnerability

(PIV) (2005), Vincent's National Adaptive Capacity Index (NACI) and IADB's Prevalent Vulnerability Index (PVI) and Risk Management Index (RMI) (2004). At the sub-national scale, Cutter's Social Vulnerability Index (SoVI) (2003) is presented. Though focused on the United States, it provides an effective depiction of the types of indicators that could be used at the sub-national scale. At the local scale, the GTZ's Community Based Risk Index (CBDRM) (2006) is presented for the community level and Hahn *et al*.'s Livelihood Vulnerability Index (LVI) (2009), Vincent's Household Adaptive Capacity Index (HACI) (2007) and Christiaesen and Subbaro's assessment of vulnerability in Kenya (2004) are put forward for the household level. There are numerous local and urban level assessment methods and approaches but a full review of them is far beyond the scope of this paper; the aim here is not to be comprehensive but illustrative of the core elements of vulnerability as revealed through the selected indicator projects.

The indicators used in the various assessments are proxies for particular dimensions of vulnerability. Sensitive to the distinction between factors correlated with vulnerability and those causally related to it, these indicators have been analysed in Table 2 to reverse-engineer four scaled lists of vulnerability determinants. For a variety of technical and conceptual reasons, there are gaps in the vulnerability indices where important determinants of vulnerability have not yet been captured by indicators. Homelessness and individual emotional and psychological states, for instance, are both common omissions from vulnerability assessments, especially those applied in low- and middle-income country contexts (Wisner 1996). In these instances, the determinants derived from the indicators in Annex 1 have been supported by theoretically derived variables. Another major difference between Annex 1 and Table 2 is the addition of a column listing vulnerability determinants for the international scale. The lack of attention to the global scale in Annex 1 possibly reflects the current governance of disaster risk—which tends to fall to national governments and is determined by bilateral relationships—and the perception that disasters tend to be contained within national boundaries. These assumptions may be less easy to defend in the future if impacts and coverage expand—for instance, through the continued integration of national economies and secondary contagion effects made more visible through improved data. Including the international scale is strategically important as it highlights the interdependence and co-responsibility of risk management. Finally, in the table below, we have resisted weighting or ranking vulnerability determinants.

The leftmost column of Table 2 begins with a list of dynamic cross-scale pressures. A dynamic pressure may be a subset of a particular vulnerability site but it is capable of acting on

vulnerability determinants in other sites as well. Population growth, for instance, may be a demographic issue but can influence the social site as well, affecting education level, for example, by putting strain on a system with limited capacity. The impacts that a dynamic pressure may exert within a particular site of vulnerability often differ greatly across scales. While at the national level, economic globalisation could lead to an inflow of foreign direct investment and the creation of jobs, at the local level domestic businesses might be crowded out and working conditions could become more precarious. Furthermore, dynamic pressures do not necessarily compound vulnerability. Depending on the contextual factors at different scales, their impact on vulnerability may be limited, negligible or even positive.

Building on the structure of Annex 1, the second column of Table 2 presents eight generic sites of vulnerability. These include the seven found in Annex 1 plus an additional site—Development Status and Integration with Disaster Risk Management—that recognises the influence of the development context on vulnerability. This site is reflected, for example, in approaches that have indicated vulnerability through application of the Human Development Index and its sub-indicators (e.g. Pelling and Uitto 2001). As has been noted in the Table, the five capitals used in the DFID Sustainable Livelihood Framework (1999) can be mapped onto these sites. It is important to acknowledge, however, that these capitals are most readily applicable at the local level and that their relevance is diminished at the sub-national, national and international scales. The generic sites of vulnerability are then acted upon by dynamic pressures, leading to distinct expressions of vulnerability at different scales. In the future, the scaled determinants of vulnerability will not change independently, but rather as a function of the interaction between dynamic pressures and generic sites of vulnerability.

Table 2. Scaled Determinants of Vulnerability

Dynamic Cross-Scale Pressures	**Sites of Vulnerability**	**Scale**			
		International	**National**	**Sub-National** (e.g., city level)	**Local** (individual, household and community levels. Note: not all indicators apply to each of these levels)
- Conflict - Demographic change (including ageing and migration) - Urbanisation - Technological innovations (including access to information) - Global environmental change (including	**Social** (including human and social capital)	- Transnational orientation to hazard and risk education - Quality of transnational social bonds and solidarity networks - Sensitivity of global scientific innovation to the needs of those at risk.	- Quality of hazard and risk education - Quality of health education - Quality of social support mechanisms - Quality of social safety nets	- Provision of hazard and risk education - Provision of health education	- Access to hazard and risk education - Access to health education - Access to social networks - Access to community based organisations - Individual psychological state
	Demogra	- Global and regional	- Gender balance and proportion of	- Gender balance and	- Gender and gender of household

Dynamic Cross-Scale Pressures	Sites of Vulnerability	Scale: International	National	Sub-National (e.g., city level)	Local (individual, household and community levels. Note: not all indicators apply to each of these levels)
climate change, biodiversity changes, etc.) - Globalisation (cultural and economic) - Economic shifts (including financial regulations, development aid funding and FDI patterns) - Political change (including democratisati	**phic**	demographic profiles and trends (including age, gender and health status) -Global population size - International mobility of populations	female headed households - Age distribution and proportion of age-dependents - Proportion of the population with long-term health issues or chronic illnesses (HIV-AIDS for instance) - Population size and density (hazard specific) - Proportion of minority/marginalized groups - Proportion of internally displaced	distribution of female headed households - Age distribution and distribution of age-dependents - Distribution of the population with long-term health issues or chronic illnesses (HIV-AIDS for instance) - Population density and distribution (hazard specific)	head - Age and age-dependency per household - Proportion of the household suffering from health issues, chronic illnesses or terminal illnesses (Malaria for instance) - Population density - Household size - Individual freedom of movement

Dynamic Cross-Scale Pressures	**Sites of Vulnerability**	**Scale**			
		International	**National**	**Sub-National** (e.g., city level)	**Local** (individual, household and community levels. Note: not all indicators apply to each of these levels)
on)			persons/refugees	- Household size distribution - Distribution of minority/marginalized groups - Distribution of internally displaced persons/refugees	
	Infrastructural (including physical/ manufactured capital)	- Cross-border and international influence of infrastructure on domestic resources and environment - Co-	- Quality and distribution of strategic national infrastructure - Integrated infrastructure systems (e.g. for riverine and coastal flood management)	- Quality of housing stock - Quality of critical infrastructure (formal/informal and quality of materials) - Existence of effective early	- Access to water and sanitation - Access to transport networks - Access to communication services (e.g., television, telephone, cell-

Dynamic Cross-Scale Pressures	Sites of Vulnerability	Scale: International	National	Sub-National (e.g., city level)	Local (individual, household and community levels. Note: not all indicators apply to each of these levels)
		dependence of integrated international infrastructure systems - International integration of early warning systems	- Existence of effective early warning systems - Health care infrastructure - Urban planning and housing with risk consideration	warning systems for sub-national hazards - Quality of disaster evacuation and response infrastructure	phone, internet) - Access to health services - Access to secure housing - Access to effective early warning systems - Access to emergency shelter and basic needs/services - Access to shelter and basic needs post-disaster
	Environmental (including natural	- Quality of the global environmental commons:	- Quality of soil or vegetation cover - Quality of water	- Quality of soil or vegetation cover.	- Quality of local natural capital (soil or vegetation) e.g. hillslope or

Dynamic Cross-Scale Pressures	**Sites of Vulnerability**	**Scale**			
		International	**National**	**Sub-National** (e.g., city level)	**Local** (individual, household and community levels. Note: not all indicators apply to each of these levels)
	capital)	air, water, soil, etc. - Interactions of natural systems extending beyond national boundaries (coastal, riverine, atmospheric and landscape)	reserves	- Quality of water reserves, watersheds and aquifers	mangrove quality - Predictability and precariousness of water resources (including the existence of shocks) - Access to natural resources
	Institutional - Governance (including social capital)	- International regime for technology transfer - Capacity of the international	- Existence of updated and enforced building, land use and zoning legislation (hazard specific) - Emergency organisation,	- Regulation of building codes, land use and zoning (hazard specific) - Emergency organisation, preparation	- Compliance with regulations on building, land use, zoning (including the influence of the shadow/informal sectors) - Participation of

Dynamic Cross-Scale Pressures	Sites of Vulnerability	Scale: International	National	Sub-National (e.g., city level)	Local (individual, household and community levels. Note: not all indicators apply to each of these levels)
		community to prevent contagion from national emergencies - Transnational agreements for risk management - Transnational research agendas into risk and loss - Legal rights afforded to	preparation and implementation - Legislative framework for risk management - Health care regime - Policies and regulations to protect ecosystem services, land and water resources - Decentralisation of organisation to diverse institutions and sectors - Culture of research/analysis	and implementation (early warning, preparedness, evacuation and reconstruction) - Access to disaster preparedness (rural vs. urban divide) - Policies guiding the transfer and redistribution of water resources - Enforcement of regulations to protect land	local population in local and national risk management institutions - Access to health care - Programmes to promote and enforce nature conservation - Access to/knowledge of hazard specific information (risk maps, etc…) and private protection measures - Locally available funds for DRR and reconstruction - Emergency

Dynamic Cross-Scale Pressures	**Sites of Vulnerability**	**Scale**			
		International	**National**	**Sub-National** (e.g., city level)	**Local** (individual, household and community levels. Note: not all indicators apply to each of these levels)
		forced migrants - Agreement and action on global environmental change - Frameworks for technology transfer	into risk and loss - Scope for critical reflection, supporting sub-national and local adaptive management approaches - National level restrictions on freedom of movement	areas - Scope for critical reflection, supporting local adaptive management approaches and influencing national frameworks - Restriction of free movement to specific regions (including national nature reserves and protected watersheds)	organisation, preparation and implementation (early warning, preparedness, evacuation, reconstruction planning) - Scope for critical reflection, supporting local adaptive management approaches and influencing higher-level investments
	Economic (including financial	- Proportion of global economy	- National levels of inequality and income poverty	- Sub-national distribution of inequality and	- Assets (monetary, non-monetary and constraints on

Dynamic Cross-Scale Pressures	**Sites of Vulnerability**	**Scale**			
		International	**National**	**Sub-National** (e.g., city level)	**Local** (individual, household and community levels. Note: not all indicators apply to each of these levels)
	and human capital)	invested in risk reduction - Existence of international re-insurance sector willing to cover hazard risks - Existence of effective regional risk pools - Balance between economic maximisation and resilience-based	(defined in terms of GDP per capita) and inequality - Proportion of GDP and of livelihoods reliant on agriculture and fisheries - Effectiveness/coverage of insurance sector	income poverty (defined in terms of GDP per capita and limited non-monetary assets e.g. house ownership) and inequality - Livelihood and employment type - Diversity or homogeneity of economic sector	saving) e.g. cash savings, seed stores, livestock - Employment strategies and livelihood diversification - Dependence on agriculture - Access to formal and informal risk-transfer and -sharing

Dynamic Cross-Scale Pressures	Sites of Vulnerability	Scale: International	National	Sub-National (e.g., city level)	Local (individual, household and community levels. Note: not all indicators apply to each of these levels)
		optimisation. - Transnational economic interdependence and susceptibility to contagion.			
	Culture	- Existence, exposure and susceptibility to harm of landscapes, and structures or artefacts of international significance - Risk tolerance and cultural	- Existence, exposure and susceptibility to harm of national scale landscapes, and structures or artefacts of national significance - Risk tolerance and cultural orientation to innovation	- Existence, exposure and susceptibility to harm of national scale landscapes, and structures or artefacts of regional significance - Risk tolerance and cultural orientation to	- Existence, exposure and susceptibility to harm of national scale landscapes, and structures or artefacts of local significance - Past experiences with hazards - Risk tolerance and cultural orientation

Dynamic Cross-Scale Pressures	Sites of Vulnerability	Scale: International	National	Sub-National (e.g., city level)	Local (individual, household and community levels. Note: not all indicators apply to each of these levels)
		orientation to innovation - Balance between internationalism, regionalism and nationalism.		innovation	to innovation - Identification with place - Identification with practices
	Development Status and Integration with Disaster Risk Management	- Overall quality and effectiveness of international institutions and governance (including diplomatic relations between states, accountability and	- Overall quality and effectiveness of institutions and governance (including voice and accountability, political rights, civil liberties, rule of law, level of corruption, political stability, freedom of movement and	- Provision of quality and effective sub-national institutions and governance structures (including voice and accountability, political rights, civil liberties, rule of law, level of corruption,	- Effective participation of local population in local and national level politics and governance (including formal/informal engagement, access and constraints)

Dynamic Cross-Scale Pressures	Sites of Vulnerability	Scale: International	National	Sub-National (e.g., city level)	Local (individual, household and community levels. Note: not all indicators apply to each of these levels)
		adherence to international normative regimes, rule of law and freedom of movement and association) - Overall health and stability of global economy (including accountability in global private sector, effectiveness of financial regulations and labour	association) - Overall health and stability of economy (national debt, inflation, capital stock, trade balance) - Unemployment level	political stability - Overall health and stability of economy (national debt, inflation, capital stock, trade balance) - Unemployment level	

Dynamic Cross-Scale Pressures	**Sites of Vulnerability**	**Scale**			
		International	**National**	**Sub-National** (e.g., city level)	**Local** (individual, household and community levels. Note: not all indicators apply to each of these levels)
		mobility/ precariousness) - Global distribution and disparities of wealth			

Conceptual Problems and Future Trends in Vulnerability Research

Looking at Table 2, we see that while there are some overlaps across scales there are also significant disparities related to interpretations of fundamental concepts. As highlighted in the economic site, for example, poverty is recognized across scales to be a key determinant of vulnerability. From the underlying indicators, however, we see that understandings of what this concept means vary greatly between scales. At the national scale, poverty is understood in terms of monetary assets while at the local level it is based on monetary as well as non-monetary assets and more focussed on the precariousness of those assets (Clark and Dercon 2009). Similarly, in the social site, hazard specific education is relevant across scales but what makes it relevant at these scales varies considerable. At the international scale, vulnerability is a function of transnational orientation to hazard and risk education, at the national scale, vulnerability is understood in terms of whether the hazard specific education is of good quality, at the sub-national scale, vulnerability asks if that hazard specific education envisioned at the national scale is actually provided and at the local level, vulnerability is focused on the capacities and constraints of households to accessing the hazard specific education.

Given these conceptual problems and current trends, it is likely that, going forward, there will be a shift in the scale and resolution of future vulnerability assessments. Research will transition from a predominant focus on the national to the sub-national scale and the integration of mixed-methodologies and different sectoral knowledge will allow for higher resolution at this scale (Birkmann 2006). While understandings of how to express multi-scale interactions remains limited (Fekete *et al*. 2008), in the future we may develop more sophisticated tools for dealing with this challenge. The quest for a universal vulnerability assessment will also likely be abandoned in favour of a) a common language to allow joined-up discussion of multiple (and disparate) vulnerabilities (i.e. Fussel 2007) and b) a proliferation of bespoke vulnerability assessments tailored to particular policy and funding communities (See Cardona in Birkmann 2006). These bespoke assessments will be of particular importance given the overwhelming complexities and contradictions of trying to tackle vulnerability in its entirety in the future. Finally, the future may see a turn towards a greater explicit integration of values into research tools and decision-making processes (for a discussion of the 'value-action-gap' and barriers to pro-environmental behaviour, see Kollmuss & Agyeman 2002).

Section 3: Resilience: Resistance, Persistence and Transformation

3.1 Introduction

Across scales and sectors, resilience is emerging as an important concept in development and disaster risk management research and policy (Brown 2011). Despite its messy intellectual heritage (as discussed in section 1) and a proliferation of its alternative, and at times contradictory, meanings, resilience has been widely embraced as a key idea going forward. Given that the term has not been fully thought through conceptually and that practical work remains quite limited (Miller *et al*. 2010), this prioritization is somewhat problematic. The challenge now is to develop a strong grasp of resilience despite its having already been used in policy and academic work for some time. Given what we now know about resilience, where does the concept add the most value? In this section, we unpack resilience into three component elements: resistance, persistence and transformation to provide some clarity and direction for targeted action

To begin, there are several key debates in the literature that have now come to a head and key resilience themes that can be advanced. Firstly, as discussed in section 1, resilience is not the opposite of vulnerability and, while there are clearly overlaps between them, they are best understood as discrete concepts. Besides the fact that perceiving them as 'two-sides of the same coin' leads to unproductive circular reasoning (Klein *et al*. 2003), there are characteristics or attributes that can simultaneously make us vulnerable and affect our capacity to adapt (Paton cited in Manyena 2006). For instance, experiencing multiple shocks can increase vulnerability by degrading resources, impacting health, etc… while simultaneously increasing resilience through social learning and reflexivity.

Next, we argue that resilience is more usefully understood as a process—derived from ongoing actions—than as an outcome, despite this common usage (Kaplan 1999 cited in Manyena 2006). While the latter entails a fixed state, the former can be understood as ongoing, dynamic and perpetually changing. This focuses attention for those who wish to track or inform resilience on decision-making systems rather than on their results – on process and intention rather than outcome. An outcome-oriented conception, for example, might present resilience as land-use. A process-oriented understanding, conversely, would present it as the capacity to consider altering land-use in the face of perceived emerging risks. The problem with solely

presenting resilience as outcome-oriented is that it tends to lead towards a reactive (rather than proactive, risk reducing) position and a reinforcement of traditional disaster management practice (McEntire *et al*. 2002 cited in Manyena 2006). An outcome-oriented approach does not offer a step change in dealing with risks, but is instead implicated in spreading more widely what is already done. While this is a useful exercise, and much needed in many contexts, it does not require the introduction of a new term or the implementation of a novel policy agenda.

While early definitions of resilience tended to be more outcome-oriented, there has been a shift in understandings over the years towards more process-oriented understandings (see Section 2 and Manyena 2006).

Finally, resilience is about more than just bouncing back (Folke 2006). Unlike ecosystems, individuals and societies have the capacity for anticipation and learning (Dovers and Handmer 1992; Folke 2006). Both socially and politically this means that, having learnt from an experience, it will never be actually possible to bounce back to the same position. Even if the structures are the same, the individuals and organizations within those structures are changed, thus highlighting the importance of reflexivity as a key theme in resilience. Furthermore, as will be discussed hereafter, social-ecological systems have multiple possible equilibria (Holling cited in Folke 2006), making it possible to 'bounce' or 're-organize to new equilibria and not just 'back' to the same state.

3.2 Resilience as a Governance Space: The RPT Framework for Disaster Risk Reduction

We argue in this section that resilience is found in the systems and processes of decision-making, and that it is constrained by worldview, capacity and procedure. This approach is captured succinctly by the Interagency Resilience Working Group (IRWG) of leading UK based humanitarian NGOs:

"Building resilience means changing how we programme not what we programme. It is about consciously recognising and addressing risk in analysis, decision-making and planning, and managing trade-offs with this in mind." (IRWG, 2012: 3).

The subsequent analysis will return to the characteristics of governance systems that can facilitate resilience pathways. An emphasis will be placed on reflexivity in decision-making and

social learning and self-organisation as primary components of resilience. First, however, we begin by unpacking resilience processes into three constituent pathways.

We start with the work of Handmer and Dovers (1996) who observed that across scales, choices made to confront risk and uncertainty can be understood as existing in a spectrum between incremental and transformational. They outline three states for risk management: resistance and maintenance, change at the margins, and openness and adaptability. The first type is resistant to changes of any sort, focusing instead on stability and the preservation of the status quo. The second type, dominant in most western industrialised countries, focuses on incremental change. While this state does not challenge power structures or address underlying causes, it does engage in critical reflection, acknowledging the existence of a problem and identifying specifically what that problem is. The third type is somewhat more radical, deliberately challenging the underlying causes of vulnerability and actively engaging in critical reflection on the values and power structures that underpin risk management.

These three states of risk management, and the associated spectrum of policy choices, correspond to resistance, persistence and transformation (RPT) as can be illustrated through the SES principle of multiple system equilibria. Fatalism may be yet another risk management state but offers little in the way of intervention and is not pursued in this account beyond a recognition that system collapse can be forced as well as chosen under transformational pathways. This RPT approach builds on Handmer and Dovers (1996), and also Pelling (2011, see below) but also Twigg (2009), who writing from a disaster risk management perspective presents resistance and adaptation as subsets of an overarching concept of resilience (2009). While we consider these three approaches separately, it is important to acknowledge that they could occur simultaneously within a system at different scales, as easily complementing as antagonizing one another. It is important to note that doing nothing can also be a key policy choice. With limited scope for reducing risk, however, this option is not a focus of this section.

Figure 2. Resilience Constituent Pathways: Resistance, Persistence and Transformation

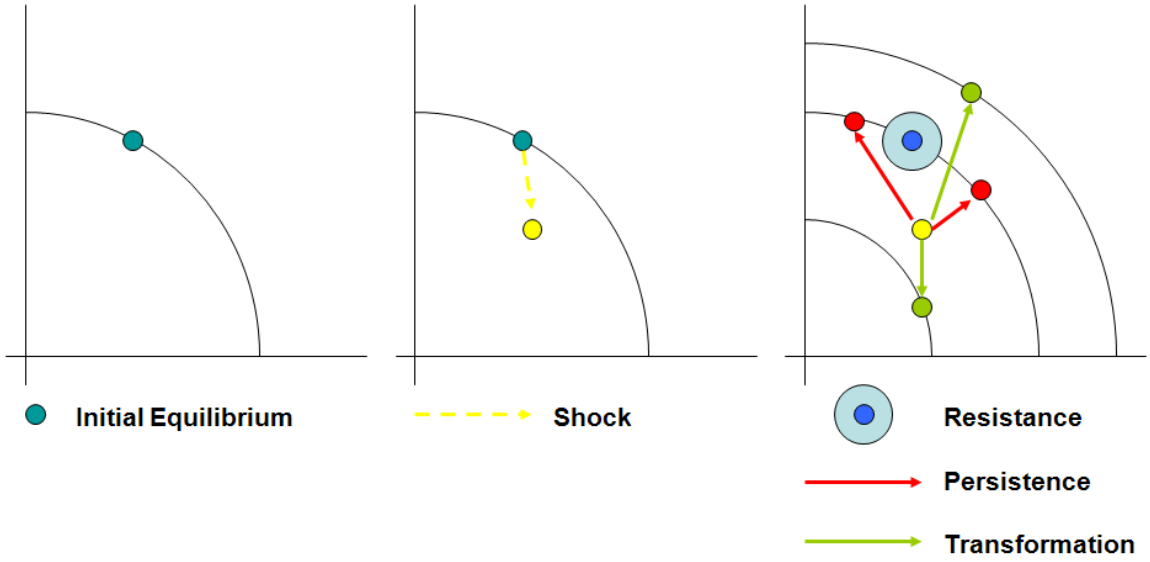


Figure 2 illustrates graphically the differences between resistance, persistence and transformation pathways, through an understanding of multiple system equilibria. With resistance, the system or component remains at the same point of equilibrium. There is no re-organisation of assets, capacities or capabilities. Policy effort focuses entirely on risk mitigation. With persistence, the system, having experienced disturbance, is able to re-organise its assets, capacities or capabilities, enabling a return to a similar equilibrium. Transformation, involves a more fundamental restructuring based on a questioning of established values and goals as well as associated practices. It pushes the system towards a different status quo. We argue that resilient risk management systems are able to consider each option and ideally would identify thresholds beyond which one or other approach is preferred. The positioning of such thresholds will be a function of risk tolerance in society set against competing resource demands. Deliberate positioning of these strategies requires reflexive modes of governance (Nelson el al. 2007).

Transformation is perhaps the most novel of the three pathways. Three contexts for transformational adaptation have been proposed by Kates *et al.* (2012): (1) enlarged scale or intensity—when existing technologies such as sea-walls may be deployed over far larger areas than before, with profound consequences for land-use and economic opportunities, (2) far-reaching and novel adaptation—where, for example, crop-insurance has been extended from richer to poorer agricultural communities greatly enhancing risk tolerance and livelihood stability, and (3) adaptations that change the nature of places and locations—for example through substantial planned, or autonomous migration that transforms both the rural source

and urban destination regions. All are expressions of transformation but we argue that a deliberate transformational process must intentionally confront dominant values. The above-cases could be transformations of the receiving culture or environment but not transformations of the locus of decision-making as described by Pelling (2011) and O'Brien (2012).

This intentional confrontation of values introduces reflexivity as one amongst a number of imperatives that drive current understandings of organisational performance, others including efficiency, equity, transparency and accountability. These imperatives may complement reflexivity or work to obstruct it. Equity and accountability, for instance, can help accommodate reflexivity, the former by democratising critical thinking and the later by fostering responsibility in the process. Efficiency and transparency, conversely, can impose constraints on innovation and experimentation, thus limiting the scope for reflexivity (Pelling, 2011). Distinctions between the practical application of resistance, persistence and transformation are exemplified in Box 2. The pathways and mechanisms presented are not exclusive to resistance, persistence or transformation. More important is their framing in relation to specific development practices. For example, while we present savings as illustrative of resistance, savings groups can also become the basis for collective action to reduce risk and for press for political change, thus potentially connecting more readily with transformation.

Box 2 Comparative Cases of Resistance, Persistence and Transformation

Case 1: A city in an earthquake prone region is concerned about its communication infrastructure in the event of a shock. Early warning messages are sent from a central hub via automated phone calls and the telephone lines all run beneath a single street in the city. If a shock severed this pathway, all communication would be lost. Resistance planning may strengthen the structures that house the phone lines to try and minimize the amount of damage that an earthquake could inflict on them. Persistence planning may involve a diversification of types of early warning communication to include radio broadcasts, bicycle riders with loudspeakers or messages sent to mobile phone. Transformation planning could involve a paradigm shift in control of early warning systems, consisting of political devolution/decentralisation and a radical shift in ownership of information. Observed locally, information could be communicated upwards in real-time through mobile technology and streamlined through online hubs like Ushahidi.

Case 2: A community living on a coastal floodplain faces inundation from storm surges and the prospects of a tsunami. It has a sea wall that has weakened since it was initially constructed and a mangrove that has been degraded from industrial effluents from a factory upstream that is a major source of employment for the community. The local government is looking to improve their capacity to deal with these shocks. Resistance planning may involve reinforcing the existing sea wall. Persistence planning could include a diversification of risk management from solely prevention to also include preparedness. In addition to an enhancement of the sea wall (and potentially superficial restrictions on the emissions of the factory to help revitalise the mangrove), there is also investment in education/ planning for contingencies in which the wall is breached. Transformation planning may involve a critical re-appraisal of the local economy, closing (or radically altering) the factory, and community employment structure, so as to preserve and re-grow the mangrove (potentially as a new source of income).

Case 3: A rural household whose primary source of income is agriculture and who saves through cattle and small remnants. The household faces the prospect of losing their crops through a negative rainfall shock and is contemplating financial modes of covering this risk and smoothing consumption. Resistance planning may involve building up savings as a buffer and selling those cattle or small remnants in the event of a shock. Persistence planning may involve building flexibility into the household economy by transferring risk through the purchase of a weather-based index insurance product. This product may be sold through an established risk-sharing network, thus complementing (or entrenching) existing structures. Transformation planning may mean a liquidation of all assets and the movement of the household to a nearby city under the auspices of accessing economic opportunities and services.

Table 3 draws out the core elements of resistance, persistence and transformation oriented strategies based on the narratives presented in Box 2. In practice such approaches may overlap and interact. Persistence in a social system, for instance, can constrain prospects for transformation and limit scope for longer-term systemic resilience. Path dependency from previous administrations and the persistence of patronage networks, for example, can lock a

system into a particular less desirable regime (Schlüter and Herrfahrdt-Pähle 2011). At the micro-level, high levels of trust between family or friends in conjunction with mistrust for others in the community may create closed circuits of power, constraining the prospects for organized opposition and limiting the communication of alternative values and discourses elsewhere in the system (Pelling and Manuel-Navarette 2011).

Table 3. Comparative Case Summaries for Resistance, Persistence and Transformation

	Resistance	Persistence	Transformation
Case 1: Earthquake Risk Communication in an Urban Context	Hazard mitigation through reinforcement of structures to protect existing communication infrastructure	A diversification of early warning communication systems to reach a broader network of actors	A paradigm shift in control of early warning systems, consisting of political devolution/decentralisation and a radical shift in ownership of information.
Case 2: Facing the Threat of Community Inundation in a Coastal Floodplain	Hazard mitigation through reinforcing of the existing sea wall	Diversification of risk management through risk transfer	A critical re-appraisal of the local economy, closing (or radically altering) the factory, and community employment structure, so as to preserve and re-grow the mangrove (potentially as a new source of income).
Case 3: Confronting Rainfall Shocks in an Agrarian Household	Strengthening coping capacity by drawing on savings	Building flexibility into the household economy through risk transfer	A reorganisation of assets and lifestyle through migration to an urban area

There is no inherent advantage to employing resistance, persistence or transformation pathways. Preferred options depend on the values and viewpoint of the decision-makers and on the development and risk context. Persistence, though often emphasised in policy and academic circles (See Brown 2011), may be detrimental. Resistance, conversely, though

somewhat marginalized in the literature (for instance Handmer and Dovers 1996; Schlüter and Herrfahrdt-Pähle 2011), may be the most effective approach in a given context. Ultimately, resistance, persistence and transformation are distinct approaches to risks and uncertainties with varying degrees of appropriateness depending on context and the actors involved different. This is illustrated in Box 2.

There are, however, limitations to resistance, persistence and transformation. Resistance may look like the best option for stability seeking decision-makers. Under the uncertainties of rapid social and dynamic environmental change, however, this 'all-or-nothing' strategy can be quite vulnerable to sudden collapse. Persistence (and resistance as well for that matter) is limited in being fundamentally committed to the continuance of prioritised systems functions. Committed to maintaining the system in its current state, there is no scope to challenge the underlying values that give rise to particularly vulnerability or ineffective forms of organisation. Implying significant structural changes, transformation has more potential to lead to maladaptation than resistance or resilience. Though transformation may be necessary to avoid the sudden collapses or crises that an incremental approach could engender, it may unintentionally damage necessary structures/processes or make changes less appropriate for possible contingencies (O'Brien 2011; Kates *et al*. 2012). Accordingly, it is important that steps are taken to minimize the scope for maladaptation from transformation. Furthermore, it is important to ensure that transformations do not occur perpetually. Continuously cycling from transformation to transformation can undermine the viability of a community or society.

While it is common for scholars to reference 'positive' or 'desirable' transformation (Folke 2006; Walker in press; O'Brien 2011), this is also true of resistance and persistence. Each has implications for the social, spatial and temporal distribution of risk and security. But each is also inherently political. Implicated in macro or micro level power struggles, we must ask 'to whom' these processes are 'desirable' and acknowledge that those at greatest risk are generally those who have the least say in these processes and least capacity to cope with uncertainty. This is the catch 22 of risk management – the most vulnerable are not only most liable to harm from risk but also least able to deliberately choose transformative risk reduction. Table 4 identifies some of the key advantages and disadvantages of resistance, persistence and transformation. These dimensions helps to explain why disaster risk management policy continues to remain dominated by resistance, especially in urban systems; with more recent advances in persistence oriented risk management, particularly in rural livelihoods and food security systems.

Table 4. The Advantages and Disadvantages of Resistance, Persistence and Transformation

	Advantages	Disadvantages
Resistance	-Allows for 'business-as-usual': established stakeholders and institutional regimes are already in place and are supported by capital throughput. Investments are externally visible examples of risk management with political advantage in this.	- In isolation this 'all-or-nothing' strategy can narrow down management options, often to an engineering paradigm, excluding social and economic tools for risk management and so generating vulnerability to sudden collapse.
Persistence	- Enables re-organization without causing major systemic disruption -Allows for system flexibility, diversity, supports redundancy and incrementally can open scope for experiments in decision-making enhancing broader objectives	- Committed to functional persistence, it does not allow for challenges to the underlying values that give rise to systemic vulnerability
Transformation	- Opens new areas of policy response by going beyond existing systemic forms. Allows deep-rooted causes of risk and vulnerability to be addressed	- Can cause significant secondary costs as systems reach new equilibria. Costs that may not all be expected. - If it is repeated perpetually, it can undermine the stability and viability of an economy, environment or society.

3.2 Constraints and Blockages to Resistance, Persistence and Transformation Pathways

While resistance, persistence or transformation may be the most appropriate approach in any given context, research is beginning to identify social factors that help explain preferences for specific resilience strategies. At the community level, while preferences for both persistence and transformation have been associated with strong ties of social capital, transformation is additionally observed in communities exhibiting a strong association with place and discontent with dominant development paths (Walker In Press). At the level of management, barriers to the implementation of transformation planning can include uncertainties over the scale of future risk and loss. In discussions of climate change, for instance, are anticipated future costs sufficiently high to justify the current costs and uncertainties associated with engaging in transformation now? This reluctance to act on uncertainty is combined with cultural constraints within organisations and regimes that tend to prefer the maintenance of existing resource management systems and structures over the additional uncertainty brought by change (Kates *et al*. 2012). These findings indicate both the local and structural constraints that limit the attractiveness of transformation, a significant problem given that social and environmental change is shifting the goalposts of risk management.

The emerging literature on transformation describes a variety of conditions under which it can take place. These include “acceptance of change and the need for it, the existence of trust and leadership, a cutback of incentives that maintain the current regime, the political capacity to implement structural change, and strategic investments in social and human capital, infrastructure and technology” (Gunderson *et al*. 2006, Olsson *et al*. 2006, Walker *et al*. 2009 cited in Schlüter and Herrfahrdt-Pähle 2011). More specifically, in adaptation planning, incorporating anticipatory transformation thinking into risk management frameworks, and initiating research to expand the menu of possible transformational adaptations (Kates *et al*, 2012), are necessary to provide decision-makers with the confidence to make informed decisions on the appropriateness of this option.

3.3 Towards Greater Reflexivity in Resilient Decision Making

This section has illustrated three distinct ways in which resilience can engage with/prepare for shocks. As previously stated, no one of these approaches is inherently superior to the others. Furthermore, no one is necessarily easier or harder to undertake. In a certain context with a particular constellation of interests, transformation may be chosen as the best and easiest way

forward while in another context resistance may be deemed the most appropriate and challenging path to undertake. Indeed alongside resistance, persistence and transformation pathways sits the possibility of choosing inaction, perhaps a result of risk denial, resignation or where there is short-term political or economic advantage. An important distinction, however, must be made between those choices that are based on deliberation – that is they involve critical reflexivity—and those that do not.

Reflexivity, we argue, is the essence of resilience. The following sections consider critical reflexivity in decision-making and point towards social learning and self-organisation as important attributes of systems, organisations, households, regimes, etc…These attributes will determine the degree to which a particular unit of analysis can explicitly or implicitly engage with resilience and make determined choices on resistance, persistence and transformation, in attempts to be, or become, resilient in a changing environment.

As early as 1969, the Brazilian educational sociologist Paulo Freire explored reflexivity at the individual level to distinguish between states of ‘adapted man’ and ‘critical consciousness.’ The former describes an individual who learns to better exist (or persist) within a particular status quo while the latter describes an individual with awareness of the social structures that constrain life changes and recognizes the possibility to challenge/make changes in those structures (Freire 1969). Adapted man may deliberately engage in resistance or the incremental changes involved in resilience. If transformation occurs for ‘adapted man’, however, he/she, by definition, cannot be active in that process. Transformation requires a re-ordering of the status quo and a reinvention of underlying values. The passiveness of this engagement can reflect marginality and may also be a factor that reinforces it. In developing a framework to deliberately choose between resistance, resilience and transformation, critical consciousness (reflexivity) becomes an integral dimension.

Reflexivity is a process that occurs at multiple scales and also across scales. Beck (1986), presents senior organisations (the state), governance regimes, and popular consciousness as possible loci of reflexivity or reflection. To this list, we could add the individual (Freire 1969) and social relations (manifest through dominant values, identity and technology (Szerszynski *et al*. 1996). Reflexivity at these different scales may provide an immanent critique—a government challenging its public policy process— a cross scale critique—individuals challenging power

structures of the senior organisations— or a transcendent critique—popular consciousness challenging the risk management regime at all levels.

It is important that reflexivity is understood dialogically, with attention to the ways that it is driven by power and contestation as well as often aiming, for consensual outcomes. At the national level, for instance, policy-making has been presented as a type of 'collective puzzlement on society's behalf' where governments and individuals try to figure out solutions to uncertain situations (Heclo 1974). Though small incremental (persistence) changes may be a product of civil servants and policy experts, larger transformative 'paradigm shifts' are a space in which politicians and the media may become central actors (Hall 1993). Here, competition for power between interest groups can actually be a driving-force behind the direction that social reflexivity takes (Hall 1993). While these actors can obstruct change, they can also be active in promoting it.

Social relations are also an important dimension of reflexivity, both in their ability to enable and their capacity to constrain. Effectively, mistrust will often weaken scope for reflexivity, but, in certain contexts, high levels of trust can have the same effect. As we will see in section 4, increased technological connectivity and changing access to information could change these trust dynamics with implications for the future of reflexivity.

3.4 Fostering Resilience: Social Learning and Self-Organisation

The mechanics of reflexivity remain, in many ways, opaque. Two processes that have been shown to help broaden the range of ideas and actors involved in deliberation and action, and that have accordingly helped to foster reflexivity, are social learning and self-organisation. While we consider these separately, it is important to note that they are often complementary, reinforcing one another in their collective contribution to reflexivity (Pelling 2011), and have been acknowledged as core attributes of the sustainability of social systems facing disaster risk (IPCC 2012). Both can be held by a range of organisations—within civil society, the state and private sector—and can observed acting across and between policy regimes.

Social learning

Across scales, social learning has been a major focus of systems thinking, featuring prominently in several definitions of resilience (for instance Wildavsky 1991; Carpenter *et al*. 2001; UNISDR 2005). By enabling a shift in behaviour following an experience, learning is

noted as being the major capacity that distinguishes social resilience from ecological resilience (Handmer and Dovers 1996). Coupled with effective communication, learning can also have positive effects on marginal societies (Osbahr *et al*. 2008 cited in Miller *et al*. 2010) and play a role in facilitating change (Heifetz *et al*. 2009; Tschakert and Dietrich 2010 cited in O'Brien 2011). The IPCC SREX (2012 p. 56), for instance, finds with high confidence that "robustness over time would increase if learning were a central pillar of adaptation efforts, including learning focussed on addressing current vulnerabilities and enhancing current risk management." Though learning is often about shifting behaviour or doing things differently, it can be about excising unwanted dimensions, processes or attributes. Reflecting critically on a past experience can enable actors or institutions to understand the importance of failure, and allow for loss to occur (Adger in Leach 2008). Additionally, though learning is predominantly viewed as a positive process, the possibility of 'learning the wrong thing' must also be taken into account: processes like groupthink (Janis 1972), partially addressing systemic failure (Redclift *et al*. 2011), and shifting epistemic (Arikha) and normative (Foucault 1964) regimes, can all be implicated in learning with negative consequences.

Argyris and Schön (1996) identify three modes of learning: first, second and third loop learning, which focus respectively on improving efficiency, changing goals and challenging underlying values. Constraints on learning must also be taken into account. In certain contexts, institutions shown elsewhere to enable learning, like social networks, can actually constrain learning opportunities (Schluter and Herrfahrdt-Pahle 2011). More reflective, 'triple loop' learning, in particular, may be easier to discuss in academic, media or even political discourses than to implement in practice (See references in O'Brien 2011). Finally, as in resistance, resilience and transformation more generally, politics and power are largely omitted from the analysis of social learning. Competitive politics, centralized power and rapid regime changes (with an associated lack of technocratic consistency) can limit if, and how, learning takes place (Pelling and Navarette 2011). Taking the idea of learning forward, it is important to recognize that while it is about puzzling it is also about powering; we can aspire to have equality for all actors involved, but must also appreciate how hierarchies play out in the learning process.

The literature that deals explicitly with social learning focuses firstly on learning within organisations and, more rarely, on learning in policy regimes. The social learning lens, however, could also be applied more broadly to consider the processes wherein civil society organisations hold government and the private sector to account. In this way, civil society advocacy and lobbying–or the regulatory functions of government—can be seen as conduits

for social learning. Effectively, advocacy and lobbying are vehicles through which values are spread through society and made tangible in decision outcomes. Analysis of urban regimes for resilience in Quintana Roo, Mexico, for instance, detail the potential for civil society to play this role. But, they also highlight barriers, including limited awareness of climate change science and, in the cases observed, a close association of many civil society groups with the state, thus restricting critical voice (Pelling and Manuel-Navarret (2011).

Self-Organisation

Self-organisation describes the capacity to form networks, institutions, organisation or other social collectives independently from the state or other central authority. It describes both formal (canonical) organisations such as registered co-operatives and trade unions and informal (shadow) organisations like networks of friends and faith groups (Pelling 2011). The emergence of new canonical or shadow self-organisation is indicative of reflexivity and provides an amenable context for it through the building of trust, and the creation of new pathways for information to flow and be validated. Shadow organisations, in particular, operating beyond the purview of formal administrations and administrators may be a locus of innovation by enabling experimentation and risk taking (Shaw 1997 cited in Pelling 2011). Within these networks, small groups of committed individuals can provide leadership and critical reflexivity (Olsson *et al*. 2006; Pelling *et al*. 2008 cited in O'Brien 2012).

3.5 Building a Tool-Set for Resilient Decision-Making

Given the importance of reflexivity in enabling a deliberate approach to disaster risk management, there is a need for tools that can be employed to encourage this process. A good starting point for this would be to recalibrate the existing tool-set towards a more reflexive process, and reorganize the existing methods which are, at present, a relatively ad-hoc assemblage of techniques drawn from disparate fields. While some methods—such as cost-benefit analysis (Harberger 1978; 1984)), participatory learning (Berkes 2009), scenario analysis (Moss *et al*. 2010), narrative storylines (Tschakert and Dietrich 2010), simulations (Nicholls *et al*. 2007), action research (List 2005), multi-criteria decision-making (Birkmann 2006) and adaptive co-management (Olssen *et al*. 2004) (amongst others)—show promise, they have yet to be systematically applied and reviewed for the distinct challenges of reflexivity in the context of disaster risk management. Furthermore, institutional structures rarely allow for learning (reflexivity) across institutional levels and timeframes (Keen *et al*. 2005 cited in Miller

et al. 2010). A more integrated reflexivity could potentially be facilitated through adjusted organisation structures, working routines and training. Going forward, new tools may be needed if critical reflexivity is to be encouraged in the DRM decision-making process (IPCC 2012). Tools to better consider tensions between existing imperatives (transparency and efficiency) and reflexive processes (social learning and self-organisation).

Section 4: Futures Prospects

This section explores two dimensions acting on vulnerability and sustainable futures: the influence of dynamic cross-scale pressures and the development of more robust policies for future scenarios. Some tentative findings are outlined.

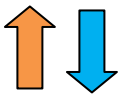
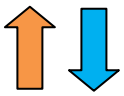
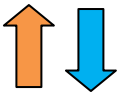
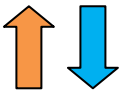
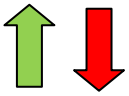
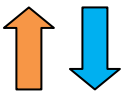
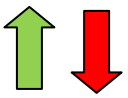
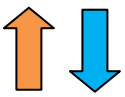
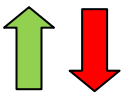
4.1 Changing Dynamics in Vulnerability and Resilience Pathways

It is impossible to determine categorically if vulnerability and resilience will increase or decrease in the future. What is certain, however, is that their texture will change considerably. Guided by the PAR framework (Blaikie *et al*. 1994; Wisner *et al*. 2004), and Table 2.2 on the scaled determinants of vulnerability, we can explore how changes in dynamic cross-scale pressures may interact with different sites to change how vulnerability manifests itself. Conflict, demographic change, urbanisation, technological innovations, global environmental change, globalisation, economic shifts and political change are all processes that are capable of altering the way vulnerability and resilience trajectories are expressed and how nations, communities, and individuals engage with risks and hazards. These changes have the potential to be good, bad, neutral, compounding, alleviating or all simultaneously depending on the nature of that interaction, the scale of analysis and the perspectives of the actors involved. In this section we assess how these different dynamics pressures could affect vulnerability in the future.

Conflict

In recent years, there has been a trend moving from full-scale conventional wars to lower intensity conflicts and a shift from interstate to internal warfare. Environmental degradation has also, in many cases, compounded or created tense situations, exacerbated the number and intensity of local level conflicts. Future vulnerability could be affected in multiple ways if these trends persist. Increasing numbers of internally displaced persons (IPDs) and declining numbers of international refugees may continue. Baring major changes to international regimes (both legal and organisational), this could lead to a decline in the proportion of displaced persons with access to international support. The overlap of disaster and conflict has been shown to worsen gender-related vulnerability and violence (UNDP 2011). This nature of this vulnerability could change if there was a shift from high intensity short duration, to low intensity high duration conflict.

Table 5. Future Impacts of Dynamic Pressures on Vulnerability and Resilience

	Vulnerability	Resilience
Conflict		
Demographic Change		
Urbanisation		
Technological Change		
Global Environmental Change		
Globalisation		
Economic Shifts		
Political Change		

Demographic Change

By 2050, world population is expected to exceed 9 billion people (UN DESA 2010). While significant in its own right, with implications for food security, access to resources, provision of services, etc…, the changing composition of this population will also influence vulnerability in different ways depending on context. A growing youth population, for instance, could lead to tension and social unrest. If accompanied by particularly accommodating conditions, however, (a proportionate rise in employment, for instance, or internal migration) a growing youth population could also present a 'demographic window of opportunity' wherein a shrinking age-dependency ratio enables greater productivity and income (Assad and Roudi-Fahimi 2007; Peng and Cheng 2007). The proportion of elderly people in the world is also expected to increase significantly. Caring for this population will put strain on public and private resources but, in a context of high communication and participatory learning, this group could also be a source of knowledge and experience related to hazards and hazard management, thus bolstering resilience.

Urbanisation

Over the next 40 years, the world population living in urban areas is projected to increase by 2.6 billion, growing from 3.6 billion in 2011 to 6.3 billion in 2050 (UN DESA 2011). A considerable amount of this growth is expected to be in less developed regions, most notably in Asia (with urban population increase of 1.4 billion) and Africa (with urban population increase of 0.9 billion) (UN DESA 2011). Moreover, an increasing number of these people will be situated on the coasts (Foresight 2011). How these trends will affect vulnerability and resilience, however, remain unclear. Cities offer great opportunity for risk reduction but are also made increasingly vulnerable by their interconnectivity and reliance on networks and systems that exist outside their physical footprint. This relationship means that cities will be progressively vulnerable to indirect shocks. Cities also project vulnerabilities outwards—the Fukashima reactor failure in Japan illustrates this well, with urban electricity demand generating vulnerability beyond the city.. Urbanisation, accordingly, could mean greater vulnerability for those living outside the city. More people on the coasts will also lead to higher exposure of individuals, infrastructure and assets, and a rise in associated vulnerabilities. Part of these growing vulnerabilities may be offset by increased expenditure on risk management and the increased participation of insurance and reisurance industries, but residual risks will remain requiring an increasingly urbanized humanitarian agenda.

Technological Change

Across scales, changing technology could have profound impacts on vulnerability and resilience. Significantly, there is scope for superficial as well as more comprehensive impacts. Mobile technology is a good example in that it has the potential to affect unsafe conditions as well as deeper-rooted determinants of vulnerability. At one level, it could improve the effectiveness of early-warning systems through a faster and more widespread dissemination of information. At another level, mobile technology could fundamentally affect access to information, reducing information asymmetries with implications for trust, accountability, market efficiency and reflexivity. The influence of technology, however, is not necessarily positive and indeed, also has the potential to increase vulnerability. Legibility regarding a population and its characteristics has proven to be a coercive instrument of state power (Scott 1998). If mobile transactions, for instance, made information about migrant populations more accessible, a repressive regime committed to limiting migration, could eliminate a key coping strategy of an already vulnerable community. Another dimension of note going forward is the difference between changes in big, expensive technology (which may remain inaccessible to developing countries or impoverished peoples) and cheaper more easily disseminated technologies (which could be used for disaster-risk reduction in ways completely unanticipated by technology developers).

Global Environmental Change

Global climate change is expected to lead to long-term shifts in weather conditions and an increased frequency and severity of extreme events. These changes will mean greater uncertainty and more complex risks for individuals and systems in a variety of areas (UNDP 2004). But beyond climate change, a number of other environmental changes are poised to influence future vulnerabilities. Environmental degradation, including deforestation and soil erosion, impacts local ecosystem but also has knock-on effects on national and global processes. Global biodiversity loss could be approaching thresholds of catastrophic change (Millennium Ecosystem Assessment 2005), destabilising environments and increasing risk. In the future, local environmental management will be increasingly important for mediating conditions of endangerment but global processes, implicated in the root causes of vulnerability, may limit the effectiveness of this type of intervention. Accordingly, choices made now regarding mitigation will have lasting effects on global, as well as local, vulnerability.

Globalisation

Economically and culturally, the future will be a more interconnected place. Inward investment could provide livelihood opportunities and improved life quality but, without effective government regulation, development may occur in hazardous places (UNDP 2004). Furthermore, disparities may increase between those countries and regions connected to global systems and those unconnected. Globalisation can also enhance resilience through connectivity but may simultaneously draw peoples and governments in places of security into the vulnerabilities of more exposed regions. From families and households to international corporations and reinsurance markets, understanding of how risk is spread and transparency in financial flows will be increasingly important in the future. Culturally, as connectively increases, globalisation will potentially be implicated in changing regimes of political accountability and alternative flows of knowledge and expertise. Box 3, for instance, illustrates how informal global networks like diasporas can be involved in this process.

Economic Shifts

Unlike many of the other dynamic pressures, where the trajectory of change facilitates reasonable projections, future economic trends are difficult to anticipate. A future economic crisis could radically alter the balance of contemporary economic powers or lead to fundamental changes in financial regulatory regimes. The growth of the Chinese economy could continue to draw labour intensive production away from western economies. This change is exacerbated by the Chinese move into high skill production and greater presence in global value chains. In Africa, continued natural resource extraction, in conjunction with political stability, could simultaneously mean improved economic conditions and degraded ecosystems. Regarding labour, unskilled labour intensive production will likely continue to grow in India and China, potentially increasing as well in highly populated parts of Africa and South America. Barring shifts in regulatory regimes, these developments could lead to increasingly precarious work environments and growing numbers of urban poor. Overall, economic shifts will have major impacts on vulnerability and resilience across scales. While some of these impacts will entrench current trends, others may undermine or transform how vulnerability and resilience manifest themselves.

Political Change

Trends in politics, like economics, are less certain but with equally large possible impacts on vulnerability and resilience. While, superficially, there has been an international movement towards democratisation of state governments, there is no certainty that this trend will continue and if it does, whether it will amount to increased access to, or participation in, government processes at the subnational and local levels. International aid and development regimes may also continue to change. Recent investment in Africa by China, for instance, has impacted development in recipient countries and affected how more established donor countries like the United Kingdom conduct operations and set priorities. In the future, the veneer of political inclusiveness may mask a variety of hidden vulnerabilities. Moreover, the imposition of particular regimes at the national level could weaken important local and informal forms of social organisation, increasing vulnerability.

Box 3 The Future of Diasporas in Disaster

In the future, globalization will likely facilitate the increased participation of diasporas in disasters. While they can engender many positive effects, their engagement has potentially negative and counter-intuitive outcomes as well, and so must not be viewed as a panacea (Skeldon 2008). Remittances, most obviously, have been noted as an important source of financial support following disasters (Wallsten 2004; Yang and Choi 2007). In Pakistan, for instance, remittances rose from $743 million per month to $874 million per month following the 2010 floods (House of Commons 2011). While these contributions might seem extremely positive, the benefits are often far more oblique. At the household level, financial flows are not necessarily evenly distributed and can exacerbate divisions between the rich and poor, powerful and marginalized (Van Hear 2004). At the national level, there are concerns about corruption and the channelling of relief money to political ends. In the future, the volume and speed of diasporic financial flows will likely increase. In the absence of effective institutions, regulations and governance structures, this could lead to an entrenchment of existing inequalities and a destabilization of political regimes.

Beyond their financial contribution, diasporas can provide expertise, lend institutional capacity and exert political influence in relation to disasters. But, while a diaspora may support the efforts of the government, it could just as easily

seek to undermine it (Kapur 2007). Moreover, given the heterogeneity of interests within a diaspora, constructive and destructive efforts could occur simultaneously. The willingness of governments to accept this non-financial engagement from diasporic communities has, accordingly, been reluctant at best, ebbing and flowing over time. In the future, the increased accessibility of information will lend itself to more informed diasporas. This heightened awareness could increase calls for greater accountability or transparency in the reconstruction process, leading towards a new paradigm of 'diasporic tied aid.' As a site or enabler of reflexivity, diasporas could help support a greater degree critical consciousness in decision-making.

Finally, it is important to acknowledge that in diasporas, flows of money, cultural norms, information and emotions are multi-directional. A shock in one country is not only a traumatic experience for the residents of that state but can have negative psychological and social effects on citizens of other countries as well (Simich *et al*. 2008). Multi-cultural developed states with diverse diasporic communities (the United Kingdom, Canada and the United States, for instance) must consider the mental health of these domestic populations. In the future, as technological innovations lead to increased social connectivity and access to information, these negative impacts may increase.

4.2 Competing Futures

In the domain of climate change planning, decisions on adaptation have to take place with constrained data operating at a spatial scale that lacks the required resolution for local planning (Kelly and Adger 2000). Disaster risk reduction, similarly, relies on models and forecasts, or on past experiences to help anticipate future conditions and situations (Demeritt and Nobert 2011). The uncertainties implicit in these projections, however, make for a challenging policy landscape. Currently, at least in the climate change domain, there has been an emphasis on direct sectoral impacts. In the interest of 'climate proofing,' policies may target specific pieces of infrastructure or industries. There are problems with such an approach, however. Climate proofing does not usually account for the indirect effects of hazards or the deep-rooted dimensions of vulnerability, addressing symptoms but not the underlying causes (O'Brien

2007). Furthermore, highly targeted plans may have a higher risk of leading to maladaptation than more hazard generic initiatives (IPCC 2012).

Recently, there has been a turn in the climate change tradition towards a 'no-regrets' approach to vulnerability reduction (Heltberg *et al*. 2009). This is an approach that is intentionally forward looking and opens scope for deliberative choices between transformation, resilience and resistance approaches. Instead of targeting specific sectoral impacts of a hazard, this approach supports social policies that simultaneously address climatic risk, issues of poverty including access to basic needs, and sustainable development. Microfinance, weather-based index-insurance and social funds are all examples of the multi-sectoral, multi-level policies typical of the 'no-regrets' approach (Heltberg *et al*. 2009). While the 'no-regrets' approach is not cost free, involving real and opportunity costs and trade-offs (Wilby 2008 cired in Heltberg 2009), it does offer distinct advantages. Unlike sector specific policies, this approach is not as susceptible to the uncertainty of climate projections or scenarios; policies will be beneficial regardless of whether a shock occurs or occurs differently than expected (Barnett 2001 cited in Heltberg 2009).

The space between adaptation, disaster risk management and sustainability is one of multiple (and oftentimes competing) goals, suggesting trade-offs with respect to actors, agendas, resource allocation and system rules (Wilibanks 1994 sited in IPCC 2012). As prospects for the development of 'no-regrets' policies that satisfy all actors are limited, decision-making must acknowledge and address these conflicts of interest across scales and sectors (Brock and Carpenter 2007 cited in IPCC 2012). Next, 'no-regrets' provides little scope for low frequency, high intensity events. Focussing on high frequency risks in which policies are more likely to lead to positive outcomes, 'no-regrets' may fail to address the uncertainties associated with less probable extreme events (Burby 2006 in IPCC 2012). To reduce vulnerability to these extreme events, decision-makers may be required to pursue risky policies on uncertain futures, a pathway unaccounted for in a no-regrets approach. Thirdly, 'no-regrets' has a tendency to privilege the viewpoints of local actors. While these perspectives are certainly significant, it is important not to romanticize them as local approaches may be unsustainable, more interested in short term than longer term risk, and ultimately lead to maladaptation (IPCC 2012). Finally, a no-regrets approach doesn't necessarily take into account the impact of formal processes on informal ones (how they are complementary, contradictory and in competition). Formal plans often fail, or are at least reprocessed by informal processes to create 'side effects' unanticipated by policymakers (Ferguson 1990 p.254). Going into the future, it is important to

recognize how these ‘side effects’ may create alternative conceptions of success; understandings of what regrets and ‘no-regrets’ entail could shift fundamentally when viewed as part of a different strategy (Ferguson 1990 p.19).

While ‘no-regrets’ is sensitive to potential issues of maladaptation, this approach may create significant limitations going forward by fostering change at the margins without tackling deeper-rooted causes of vulnerability (Handmer and Dovers 1996). Given the path dependency that decisions taken now will have on the future, critical consciousness about contemporary vulnerabilities and candidness about the potential impact of policies going forward is critical. Thinking through resistance, resilience and transformation with critical reflexivity could allow for difficult decisions to be made that a ‘no-regrets’ approach would fail to address.

Section 5: Conclusions

This paper has sought to provide an overview of the ways in which work on vulnerability and the management of disaster risk – including work on resilience – is framed, and also to contribute to this knowledge through an original exploration of resilience that positions it between do-nothing, resistance and transformation approaches to deliberate risk management. This analysis opens a more balanced discussion on the relationship between disaster risk management and sustainable development: one where the core variable is capacity for reflexivity in decision-making. For anticipatory disaster risk management, including forward looking risk and vulnerability reduction policy, early attempts to help decision-makers chose between competing policy options have emphasised the advantages of no-regrets policy approaches. While this emphasis is a good reflection of the trend in policy making, it also flags the challenge that lies ahead for thinking how best to influence disaster risk expected to be manifest 20-30 years in the future? At this time-scale, interactions between planned and unexpected outcomes of policy, even so-called no-regrets policy, will contain a degree of uncertainty. But this uncertainty should not be taken as an excuse to avoid thinking about and planning for the future. We offer below five key conclusions of this background paper that help to make more transparent the decision-making context for resolving vulnerability in the future, and in ways that can build the social equity and environmental integrity inherent in sustainable development.

1. Vulnerability is an expression of susceptibility to harm, and can also consider exposure to hazard. It asks us to consider the role of agency, social structures and environmental processes in determining those people and places most at risk.
2. While there are many ways of measuring and considering vulnerability, there is strong agreement that it is determined through the character of an objects social, demographic, infrastructural, environmental, institutional, economic and cultural characteristics and underlying development and risk management trajectory. These features can be observed at all scales from the individual to the global.
3. Resilience is a mode of governance and encompasses resistance, persistence and transformation.
4. Unpacking pathways for resilience in disaster risk management places emphasis on deliberation and reflexivity in decision-making.

5. Reflexivity can be expressed, or constrained at all social levels from the individual to the international community. Understanding of reflexivity and policy actions towards it can be leveraged with research on social-learning and self-organisation.
6. Global dynamic pressures can be identified (and include conflict, demographic change, urbanisation, technological innovations, global environmental change, globalisation, economic shifts and political change). It is likely that these will interact, potentially in compounding ways, to emphasise existing inequalities in the distribution of vulnerability and capacity to choose risk management approaches that can contribute to more sustainable futures.
7. Development is fast becoming a project of risk management, rather than one of economic growth. This shifting emphasis rebalances notions of optimality and trade-offs between efficiency and redundancy. It can present a significant opportunity to reinvigorate the sustainable development agenda through the introduction of well developed (but till now largely marginalised) concepts, tools and practices. Closer relationships between climate change adaptation and disaster risk reduction has already demonstrated this potential and the possibility of a paradigm shift in development practice.

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