Strengthening Climate Resilience

The resilience renaissance?

Unpacking of resilience for tackling climate change and disasters

Aditya V. Bahadur, Maggie Ibrahim and Thomas Tanner

Strengthening Climate Resilience Discussion Paper 1

Strengthening Climate Resilience (SCR) – through Climate Smart Disaster Risk Management' is a UK Department for International Development funded programme that aims to enhance the ability of developing country governments and civil society organisations to build the resilience of communities to disasters and climate change. It is co-ordinated by the Institute of Development Studies (UK), Plan International and Christian Aid, who are working with a variety of organisations across ten countries (Kenya, Tanzania and Sudan in East Africa; Nepal, India, Bangladesh and Sri Lanka in South Asia and Philippines, Indonesia and Cambodia in South East Asia). SCR has developed the Climate Smart Disaster Risk Management Approach (see Climate Smart Disaster Risk Management). If you would like to be involved in SCR meetings or work with the programme to trial the Climate Smart Disaster Risk Management Approach with your organisation, please either visit the SCR website: www.csdrm.org or send an e-mail to info@csdrm.org

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Abstract

The term 'resilience' is increasingly used in the context of discussion, policies and programming around climate change adaptation ('adaptation') and disaster risk reduction (DRR).

It has become particularly popular to describe the intersection between these two fields and those of poverty and development as 'climate resilient development', and 'climate resilient development' is rapidly becoming a catch-all for tackling climate change impacts in a development context'.

However, despite this growth in popularity, there has been little attempt to scrutinise the literature to examine how it might underpin an operational approach to resilience. This working paper reviews academic conceptualisation of the concept of 'resilience' in social, ecological and socio-ecological systems. It reviews 16 overlapping conceptualisations of resilience from the literature, outlining key characteristics and indicators of resilience. A meta-table captures the key findings of the paper, including detail on indicators.

Key findings

- The idea of resilience is employed in diverse fields including psychology, structural engineering and corporate strategy but in the social sciences it is primarily discussed in the context of society and ecology.
- The relationship between vulnerability and resilience is contested, but most commonly one is seen as the opposite of the other; i.e. high resilience in a community means that it is less vulnerable and vice versa.
- Similarly, there is a lack of consensus on the relationship between adaptive capacity and resilience. Adaptive capacity is sometimes seen as the 'ability to be resilient'; at other times it refers to 'learning' in response to disturbance in systems.
- In working towards an operational definition of resilience, we define the ten main characteristics of resilient systems. These are intended to provide a starting point for those working to operationalise the resilience concept in the context of climate change and disasters.

Ten main characteristics of resilient systems:

1. A high level of diversity in groups performing different functions in an ecosystem; in the availability of economic opportunities; in the voices included in a resilience-building policy process; in partnerships within a community; in the natural resources on which communities may rely; and in planning, response and recovery activities.

2. Effective governance and institutions which may enhance community cohesion. These should be decentralised, flexible and in touch with local realities; should facilitate system-wide learning; and perform other specialised functions such as translating scientific data on climate change into actionable guidance for policymakers.

3. The inevitable existence of uncertainty and change is accepted. The non-linearity or randomness of events in a system is acknowledged, which shifts policy from an attempt to control change and create stability to managing the capacity of systems to cope with,

adapt to, and shape change.

4. There is community involvement and the appropriation of local knowledge in any resilience-building projects; communities enjoy ownership of natural resources; communities have a voice in relevant policy processes.

5. Preparedness activities aim not at resisting change but preparing to live with it; this could be by building in redundancy within systems (when partial failure does not lead to the system collapsing) or by incorporating failure scenarios in Disaster Management (DM) plans.

6. A high degree of social and economic equity exists in systems; resilience programmes consider issues of justice and equity when distributing risks within communities.

7. The importance of social values and structures is acknowledged because association between individuals can have a positive impact on cooperation in a community which may lead to more equal access to natural resources and greater resilience; it may also bring down transaction costs as agreements between community members would be honoured.

8. The non-equilibrium dynamics of a system are acknowledged. Any approach to building resilience should not work with an idea of restoring equilibrium because systems do not have a stable state to which they should return after a disturbance.

9. Continual and effective learning is important. This may take the form of iterative policy/institutional processes, organisational learning, reflective practice, adaptive management and may merge with the concept of adaptive capacity.

10. Resilient systems take a cross-scalar perspective of events and occurrences. Resilience is built through social, political, economic and cultural networks that reach from the local to the global scale.

1. Introduction

1.1 The renaissance of resilience?

The term 'resilience' is becoming increasingly used within policies, programming and thinking around climate change adaptation ('adaptation') and disaster risk reduction (DRR). It has become particularly popular to describe the intersection between these two fields and those of poverty and development as 'climate resilient development', and 'climate resilient development' is rapidly becoming a catch-all for tackling climate change impacts in a development context. A meta-table captures the key findings of the paper, including detail on indicators

The climate change and disasters communities have created their own specialist lexicon, underpinned by the scientific synthesis efforts of the Intergovernnmental Panel on Climate Change (IPCC) and the Global Assessment Report, and international policy processes of the UN Framework Convention on Climate Change (UNFCCC) and Hyogo Framework for Action. Those involved in international development efforts in the context of climate change and extreme events have therefore been forced to adopt and absorb this language, creating ambiguity and overlap between and within fields.

The increased use of resilience within the development, climate change and disasters communities is possibly related to its semantic ability to represent a readily recognisable concept. 'Resilient' is a commonly used word, most popularly used to signify the ability to return quickly to a previous (and good) condition. In contrast, academic resilience thinking has multiple and diverse meanings, traversing a number of disciplines and communities of practice. However, there has been little attempt to scrutinise the literature to examine the variations in its definition and how it might underpin an operational approach to resilience. This working paper focuses on academic conceptualisation of the concept of 'resilience' in social, ecological and socio-ecological systems. It reviews 16 overlapping conceptualisations of resilience outlined to date from the literature. The paper does not attempt to critique the merits of resilience as a goal, instead analysing these existing conceptions to distil these diverse views into a set of key characteristics and indicators. A meta-table in Appendix 1 captures the key findings of the paper in a table, including detail on indicators.

1.2 The resilience concept across disciplines

The idea of resilience exists in a number of disciplines. In the field of Psychology, resilience is seen as the capacity to withstand the impact of stressors and fight stress. 'Resilience is the capacity to recover following a stress. From a genetic perspective, resilience is defined as the quality that prevents individuals who are at genetic risk for maladaptation and psychopathology from being affected by these problems' (Chicchetti et al. 2004: 17325). Humanistic psychology, the branch of the subject that stresses the importance of personal choice and responsibility takes a slightly wider perspective of resilience and understands it to be, '... an individual's capacity to thrive and fulfill potential despite or perhaps even because of such stressors... resilient individuals seem not only to cope well with unusual strains and stressors but actually to experience such challenges as learning and development opportunities' (Neil 2006). Structural and engineering science is another field to employ the idea of resilience, for example the concept of seismic resilience of buildings understands it to be the property of a system which has: '1. Reduced failure probabilities; 2. Reduced consequences from failures, in terms of lives lost, damage, and negative economic and social consequences; 3. Reduced time to recovery' (Bruneau and Reinhorn 2006: 1).

The concept of resilience has also found its way into the body of knowledge on corporate strategy where the idea of 'enterprise resilience' is being employed to make a case for mainstreaming 'risk management' into the everyday operations of a firm: '... enterprise resilience marries risk assessment, information reporting, and governance processes with strategic and business planning to create an enterprise-wide early warning capability' (Booz Allen Hamilton 2004).

In the social sciences, resilience is largely discussed in terms of society and ecology – in the context of social and ecological systems. There is widespread consensus amongst social and

natural scientists that studying resilience involves the adoption of cross-disciplinary and multidisciplinary methods, as natural and social systems are highly integrated. This acknowledges the need to employ instruments such as systems thinking and complexity theory.

While a high degree of interconnectedness between social and ecological systems is undisputed, theorists from different backgrounds understand resilience in different ways. This consequently affects their notions of the components, characteristics and indicators of resilient systems. Theories have emerged that are based variously on an understanding of resilience in social systems or social resilience, those that stress resilience in ecological systems, and those that see the two as highly interconnected. These provide the core focus of this paper's analysis of the anatomy of the concept.

Where theorists have stressed interconnectedness, some have created the Socio-ecological System (SES) as a specific conceptual entity in order to give the two the same weight in their analysis (Folke 2006). These are '... linked systems of people and nature. The term emphasizes that humans must be seen as a part of, not apart from, nature – that the delineation between social and ecological systems is artificial and arbitrary' (Simon 2009). A good example of this division is the 'Five Capitals' approach that acknowledges the interconnection of human and ecological systems by stating that both natural capital (air, soil, etc.) and social capital (trust, norms and networks) have a role in determining the resilience of a system (Mayunga 2007). This is in contrast to the 'Disturbance as Opportunity' approach which does not isolate human/social and natural/ecological factors, seeing them instead as a highly integrated, systemic 'whole' (Folke 2006). These concepts have been increasingly applied in the context of resilience to natural hazards (Manyena 2006; Mayunga 2007; Cutter et al. 2008) and climate change (Adger 2002; Rockefeller Foundation 2009; Osbahr 2007; Nelson et al. 2007).

1.3 Resilience, vulnerability, adaptive capacity and scale

Most understandings of resilience share a common interest in the concept of vulnerability, with a general tendency to regard vulnerability and resilience as opposing values. This idea is expressed in a number of different ways; some see an increase in vulnerability as a decrease in resilience, others regard these concepts as two sides of the same coin, still others see vulnerability as a property that needs to be countered by resilience.

The 'Resilience as Process' approach claims that certain definitions overlap vulnerability with resilience, whereas others lead to vulnerability being perceived as entirely separate from the concept of resilience. Resilience and vulnerability can therefore seem like the opposite ends of a continuum if vulnerability is understood to be the capacity of individuals to respond to hazards, but there is no interrelation between these terms if vulnerability is seen purely as the circumstances '... that put people at risk, including social, economic, political, technological, biophysical and demographic aspects' (Manyena 2006: 442).

Gallopin argues that vulnerability does not appear to be the opposite of resilience, because the latter is defined in terms of state shifts between domains of attraction, while vulnerability refers to structural changes in the system, implying changes in its stability landscape (2006). Robustness, according to Gallopin, may be thought of as the flip side of vulnerability. The fundamental distinction between vulnerability and resilience is that vulnerability refers to the capacity to preserve the structure of the system while resilience refers to its capacity to recover from non-structural changes in dynamics.

Adaptation and adaptive capacity, coined by the climate change community, also draw parallels with resilience, but without consensus on their conceptual overlap.. There remains a significant research gap in understanding the relationship between these terms. One strand of academic opinion argues that adaptation and adaptive capacity are terms that refer to the capability/ability/potential of systems or components within systems to be resilient to disturbances (Berkes 2007; Osbahr 2007). Another strand sees adaptive capacity as a reference to that component of resilience that relates to 'learning' by systems in response to disturbances (Resilience Alliance; Carpenter et al. 2001, Mayunga 2007).

The 'Resilience as Adaptation' approach treats adaptive capacity as a synonym of resilience,

stating '... it refers to improving the capacity (resilience), and thereby reducing the vulnerability of individuals or states, to respond to climate change impacts' (Osbahr 2007: 6). On the other hand, the 'Disturbance as Opportunity' approach sees resilience as a means of achieving adaptive capacity (Folke 2006).

A review of the literature on resilience in social, ecological and SESs reveals a few clear trends in academic opinion on its spatial dynamics and certain issues of scale. The first resonates with systems thinking in asserting that social and ecological systems '... are bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other' (Senge 1990: 43). This view underlines the importance of conceptualising resilience across governance scales and across various parts of a system.

Approaches highlight the need for a macro view that considers: matters in a local and regional context rather than only an individual or community context; the high degree of interconnectedness across scales of governance and institutions; and the fact that 'fixed scale' resilience can exist only under certain special circumstances (Folke 2006; Holling 1973; Foster 2006; Resilience Alliance; Carpenter et al. 2001; Cutter et al. 2008; Nelson et al. 2007; Berkes 2007). Second, any programme or project aiming to build resilience should engage locally or, possibly, use the community as an entry point. This acknowledges the importance of community participation in policy processes and decentralised institutions, and conceptualisation of resilience often uses the community as the unit of analysis (Manyena 2006; Mayunga 2007; Adger 2000; Cutter et al. 2008; Nelson et al. 2007; Adger 2002; Osbahr 2007).

2. Conceptualising resilience

This section reviews 16 overlapping understandings of resilience in social, ecological and socio-ecological systems, proposing a breakdown of their respective components, and the characteristics and indicators of these components. In doing so, this review aims to contribute to the operationalisation of the resilience concept in order to promote resilient development in a changing climate. Literature for the following review was gathered through a two staged process – first, the authors conferred with individuals engaged in research on relevant topics to source an initial bank of references, they then snowballed from these documents to gather more relevant documents till a certain degree of conceptual repetition entered the process.

A conscious attempt was made to focus on views on resilience that discussed the concept in the context of social, ecological and socio-ecological systems, enhancing the degree of overlap in the conceptualisations. Note also that the labels of each of the following paragraphs are not necessarily those that are used by the theorists who developed views of resilience contained in these sections but, instead are formulated by the authors of this review to best encapsulate the distinct quality of each of these views in comparison to others. The narrative summary below is summarised in Appendix 1.

2.1 Disturbance as opportunity (Folke 2006)

This conceptualisation of resilience treats disturbances in socio ecological systems as an opportunity. It equates resilience with the ability to use disturbances as occasions for doing 'new things, for innovation and for development' (Folke 2006: 253). This understanding encapsulates the idea that surprises in any system are inevitable and resilience will result from learning to live with uncertainty. This is in contrast to 'command and control' perspectives that seek to control the degree of variability and are successful only in the short term. A complex, interacting and dynamic system is therefore seen as a resilient system.

In this conception, a resilient system is also reliant on groups performing different functions and responding differently to the same environmental change. Resilient systems have 'far from equilibrium dynamics' meaning that the complexities of systems make it impossible to predict paths of recovery as socio-ecological systems can never be the same after a disturbance. Instead of conceptualising the system as one that has an equilibrium to which it must return after a disturbance, it is therefore more useful to look at it as having a 'domain of attraction', a dynamic state where different system elements have different equilibriums around which they are organised. A number of indicators can be conceptualised around these characteristics to deduce whether a particular system is resilient or not (see Appendix 1).

2.2 Resilience as Process (Manyena 2006)

Here, resilience is conceptualised as the ability of a system to adapt to environmental shocks and continue functioning without there being a change in its fundamental characteristics (Manyena 2006). This understanding underlines the importance of viewing resilience as a 'process' rather than only an outcome. Characteristics of a system resilient to natural disasters would therefore include a focus on recovery as opposed to a singular concentration on resisting shocks, effective adaptation to disturbances as opposed to attempts at only risk mitigation, and an attribution of importance to local knowledge and culture.

2.3 Persistence of systems (Holling 1973)

C.S. Holling understood resilience to be a measure of the ability of ecological systems to persist in the face of disturbance and maintain relationships between different elements of the system (Holling 1973). Holling's view of resilience springs from his understanding of natural systems as dynamic and being away from an 'equilibrium' or stable state at any point, instead being organised in a domain of attraction in which different elements of a system are organised around different, individual equilibriums.

Events in ecological systems are essentially non-linear and the 'randomness' of events within a system will be further exacerbated by human actions. Indeed, Holling argues that a certain degree of fluctuation in a system may actually improve the system's ability to persist in the face of change. Therefore while a disturbance might change the position of particular ele-

ments in this system, the system will persist if the nature of the relationships between these elements broadly remains the same.

Holling also stressed the importance of adopting a regional perspective on events in a system rather than a narrower, local one as relationships within a system might not be immediately clear at the micro level. He also argued that heterogeneity in systems contributes to enhanced resilience and spatially and temporally homogenous environments have a lower resilience. Holling substantiated this claim by talking of how the Great Lakes eco-system is fairly homogenous and hence has low resilience in comparison to spatially spread-out pest populations.

This conceptualisation has been used in particular in ecosystem management approaches, with resilience based on keeping options open, recognising that perfect knowledge can never be achieved, that future events can never be perfectly anticipated and drawing on complexity theory and systems thinking. Emphasis is also given to flexibility in management approaches, stressing adaptable generic guidelines instead of rigid steps.

2.4 Five capitals (Mayunga 2007)

This understanding of community resilience to disasters springs from the sustainable livelihoods approach where social, economic, human, physical and natural capital are seen as the determinants of resilience (Mayunga 2007). Each of these five capitals corresponds to a number of characteristics of resilient systems. For example, a strong base of social capital in the form of trust, norms and networks would lead to a high degree of coordination and cooperation in the community, evidenced by the presence of a large number of non profit organisations. Similarly, human capital in the form of education, health, skills, knowledge and information will lead to, for instance, a high capacity to develop and implement an effective risk reduction strategy. Indicators of this would include high levels of educational attainment and good health.

2.5 Social infrastructure (Adger 2000)

This conceptualisation of resilience is unique as it explores the notion of social resilience, defined as the ability of communities to withstand shocks to their social infrastructure. Social resilience is composed of components such as economic growth, stability and distribution of income, degree of dependency on natural resources, and diversity in the kind of activities/functions being performed within systems (see Appendix 1 for more detail) (Adger 2000). Broadly, a resilient system is one in which people are dependent on a variety of natural resources (so that a shock to one does not upset the entire system), has a low frequency of extreme weather events as these can lead communities to depend on particular natural resources, and where institutions in this systems are seen to be legitimate.
An important social factor that contributes to resilience is the nature of migration and mobility, so that migration caused by lucrative opportunities elsewhere may lead to increased resource flows that may enhance resilience but 'displacement migration may be caused by a deleterious state of affairs in the home locality (such as loss of assets) and often has negative impacts on social infrastructure in both sending and receiving areas' (ibid.: 355). Each of these characteristics has a number of possible indicators that can be used to gauge resilience (see Appendix 1).

2.6 Survival and recovery (Rockefeller Foundation 2009)

This understanding of resilience is in specific reference to climate change and here it is understood to be the capacity to respond to the impact of a changing climate while continuing to function regularly (Rockefeller Foundation 2009). Resilience results from:

- An individual, organisation or system having a high degree of flexibility in responding to climate change, when there is large variety in the skill sets contained within the system;
- A substantial degree of redundancy '... of processes, capacities, and response pathways within an institution, community, or system, to allow for partial failure within a system or institution without complete collapse' (ibid.: 2);
- Substantial planning in the preparation of identified impacts (it is acknowledged that accurately planning for future impacts of climate change is not useful but it nonetheless leads to learning and builds skills);

- A high degree of diversity of response and recovery options and a high level of decentralisation;
- Existence of plans for failure so that 'break-downs happen gracefully, not catastrophically' (ibid.: 2); and
- A number of different sectors come together to plan, execute and recover from climate-related impacts.

Each of these characteristics of resilience has a number of potential indicators that can be used to gauge the level of resilience (see Appendix 1).

2.7 Self-organisation (Ostrom 2009)

This conceptualisation defines resilience in terms of sustainability, itself determined by the ability of users (e.g. fishermen) within a system to self-organise and reorganise to sustainably manage resources (Ostrom 2009). The socio-ecological system is broken into four constituent elements – resource systems (e.g. a coastal fishery), resource units (e.g. lobsters), users (e.g. fishermen) and governance systems (e.g. organisations that regulate fishing). Each of these elements has a number of variables which impact the system's ability to self-organise which in turn determines system resilience.

Under this conception, resource systems should be of moderate size as very large territories are 'unlikely to be self-organized given the high costs of defining boundaries, monitoring use patterns, and gaining ecological knowledge. Very small territories do not generate substantial flows of valuable products' (ibid.: 420).

For self-organisation to take place there should be a certain amount of availability and scarcity in the resource system to provide the incentive for self-organisation for better management, enhanced when a high value is attached by users to the resource being offered by the system. It also relies on an ability to deduce how resource systems behave in order to gauge the impact of any regulation on supply and demand.

Self-organisation becomes easier when leadership structures at the local level are in place and some users have entrepreneurial skills and/or advanced educational degrees, where trust and respect amongst users reduces transaction costs of monitoring, and where users have the ability to develop their own rules to govern the resource system. Knowledge sharing is also key, as where '... users share common knowledge of relevant SES attributes, how their actions affect each other, and rules used in other SESs, they will perceive lower costs of organizing' (ibid.: 421).

2.8 Preparation and performance (Foster 2006)

This view of resilience is different from the others discussed up to this point in that it takes the metropolitan area as its unit of analysis (Foster 2006). It provides two complementary forms of resilience. Preparation resilience is formed of assessment and readiness and performance resilience is formed of response and recovery. Each of these four elements has a number of indicators that can be used to measure system resilience. For example, gauging the level of preparation resilience would be possible by looking at the capacity for trend analysis within a system and by analysing the flexibility of any policies and processes aimed at building readiness. Performance resilience, on the other hand, can be gauged by the cost-effectiveness, sustainability and viability of services delivered in the face of disturbances and the speed with which activity in a system returns to normal after a disturbance.

2.9 Stability, self-organisation and learning (Resilience Alliance 2009; Carpenter et al. 2001)

This understanding of resilience is developed by the Resilience Alliance, a research organisation comprised of scientists and practitioners who study socio-ecological systems. Very broadly, they see resilience as the amount of change a system can bear and '... still retain the same controls on structure and function', the capacity of a system to self-organise and the ability of a system to learn and adapt (Resilience Alliance, Carpenter et al. 2001: 766). Here resilience is seen to depend on four main components:

1. 'the magnitude of disturbance required to fundamentally disrupt the system causing a dramatic shift to another state of the system, controlled by a different set of processes'

(Resilience Alliance)
2. the policy, regulatory and governance structures which allow different parts of the system to reorganise;
3. the variety of groups performing different functions in an SES; and
4. the nature of learning processes that exist within a system (Carpenter et al. 2001).

Indicators within such an approach include fundamental variables which maintain a domain of attraction, such as the land tenure systems. Resilience is dependent the degree to which legal and regulatory environment gives control over natural resources to its users, and a number of different species that perform a variety of ecological functions. It also relies on local knowledge being used in any system of managing resources; the users (e.g. fishermen) within this system have a good understanding of how a socio-ecological system works, certain institutions test various methods of building resilience, monitor the results of these tests, update existing data on resilience building and have the capacity to modify policy as new knowledge is gained.

There is a certain degree of overlap between this concept and that which is discussed in section 2.7 but Ostrom's views on self-organisation are specifically in the context of resource management at the local level whereas ideas of self-organisation included here are more general and have a wider applicability.

2.10 The Drop Model (Cutter et al 2008)

In the Disaster Resilience of Place (DROP) model, existing concepts are analysed to form a dynamic and cyclical understanding of inherent resilience of a system to natural hazards (Cutter et al. 2008). Essentially, this model begins with an understanding that social systems, natural systems and the built environment determine the inherent vulnerability and inherent resilience of a system. This interacts with the nature of the hazard (i.e. frequency, duration, intensity, etc.) and the effects of the event are then amplified or reduced depending on the coping capacity of the system. If the absorptive capacity is exceeded the community will experience low recovery unless it can improvise and learn.
This model is cyclical, with the inherent resilience being determined by ecological, social, economic, infrastructural and institutional components as well as the level of community competence. Each of these components has indicators such that, for example, high biodiversity and low soil erosion are ecological factors that would lead to high inherent resilience in an ecosystem, while substantial presence of social networks and faith-based organisations are indicators of high inherent resilience in the social sphere. See Appendix 1 for more details.

2.11 Convergence (Nelson et al 2007)

This applies the resilience approach to climate adaptation. Adaptation to '... environmental change primarily takes an actor-centred view, focusing on the agency of social actors to respond to specific environmental stimuli', whereas the resilience framework is more systems-focused and takes a more dynamic view (Nelson et al. 2007: 395).
This thinking on adaptation benefits from thinking on resilience primarily through four concepts:
1. Multiple states: A resilience framework argues that systems are dynamic and can organise around a number of possible states and therefore makes a case for moving beyond adaptation that is reactionary (where action succeeds disturbance) to one that is more fundamental and can alter system dynamics to deal with shocks better in a more sustained manner. Resilience thinking also deals with the idea of 'thresholds' which are the boundary between one system state and another '... because thresholds are not fully predictable, system characteristics such as self-organisation and learning are critical to negotiate the changes' (ibid.: 402). Extending this point analytically, there are a number of indicators that can stem from resilience thinking and contribute to gauging the quality of adaptation, such as the degree to which official policies regarding use of resources in a system are decentralised and flexible. This is because if these policies are decentralised/devolved then those that are directly affected by changes in the SES can ensure that it stays in a state that is suitable for them.
2. Adaptive capacity: While much effort has gone into understanding how exposure to risk can be minimised, a system also needs to be ready for the unexpected. A system should

foster positive surprises that carry the potential to create opportunities and curtail negative surprises. Also, the resilience framework takes a systems perspective that informs adaptation by underlining the importance of working across governance and timescales. Indicators for this would include the existence of social networks that scale from local to the international level as well as processes of learning and reflection within systems.

3. Trade-offs: A resilience perspective also brings to the fore a dilemma regarding 'trade-offs'. Adaptation in a resilience framework... promotes managing the capacity of a system to cope with future change. It is premised on managing uncertainty and on having the right mix of system characteristics in place to deal with uncertain future events. These differences result in achieving high adaptedness and maintaining sufficient sources of resilience... A balance must be negotiated between what is an acceptable level of risk to current system stressors and the breadth of flexibility necessary to respond to future change (ibid.: 407).
   One way of ensuring this balance would be to include all stakeholders in a genuinely participatory process so that those most impacted by the environmental changes can themselves decide the level of flexibility that should be retained in order to best respond to the exigencies of change.
4. Governance and normative issues: 'A resilience perspective assumes that vulnerability is an inherent characteristic of any system. Reducing vulnerability in one area creates or increases vulnerability in another area or time' (ibid.: 408). Employing this perspective would then lead to stressing co-management of resources, local knowledge, flexibility of governance strategies and internal learning within governance systems. Indicators for this would include the presence of a large variety of interests in platforms for managing natural resources within a system, appropriation of local knowledge in policy and the explicit mention of justice and equity issues in any tools for measuring vulnerability.

2.12 Resilience spectrum (Dovers and Handmer 1992)

Here an element is added to resilience thinking as it is thought of as a continuum or spectrum broadly made up of three levels. Type 1 resilience is characterised by resistance to change; type 2 resilience is when marginal changes are made in order to make a system more resilient; and type 3 is when there is a high degree of openness, adaptability and flexibility (Dovers and Handmer 1992).

No one society would ever exhibit only one type of approach, although at an institutional level a clear preference may be discernible. The three approaches should be seen as a continuum of three levels, each with validity in different circumstances, and in which the next level subsumes the previous one (ibid.: 271).

The major difference between types 1 and 2 and type 3 seems to be that type 3 carries the potential for transformative action: '... its key characteristic is an ability to change basic operating assumptions, and thus institutional structures' (ibid.: 270). There are several indicators that can be analytically deduced to gauge the type of resilience being pursued in a system. Type 1 and 2 are characterised by policies that take a more reactive stance to disturbance, are more response-focused, have centralised institutional structures and '... seek to optimize available resources to maximize return in terms of desired production and consumption. Intentional spare capacity in the system, as a contingency in the face of change, is not favoured'; therefore, under an environment that favours this approach to resilience, manufacturing units will not follow sustainable business practices (ibid.: 271). Type 3, on the other hand, is characterised by readiness, organisational learning, decentralised organisational structures and the pursuit of sustainable business practices.

2.13 Migration and social resilience (Adger et al 2002)

Here, migration is discussed as a central pillar of social resilience (defined as the 'the ability to cope with and adapt to environmental and social change mediated through appropriate institutions') (Adger et al. 2002: 358). Migration carries the potential to exert a substantial influence on communities, 'altering economic well-being, changing the structure of the community, and affecting the natural resource base' (ibid.: 359). If remittances from migration are not controlled by effective institutions they can create severe inequity in society through reduced access to natural resources for some groups and reduced resilience. Similarly, effective

and responsive institutions would help in ensuring equitable social and economic trends and more equal access to natural resources; one possible indicator of institutional strength would be the effectiveness of mechanisms to collect taxes and employ this revenue usefully. Also, the manner in which remittance income is employed can increase or decrease social resilience. For example, if in an agricultural economy it is used for investing 'in human or physical capital to enhance household production' in a sustainable manner then the social resilience of individuals within the household is increased (ibid.: 359). On the other hand, if remittances are used to increase conspicuous consumption or for unsustainable agricultural production, this will have a negative effect on social resilience.

2.14 Four components of resilience (Berkes 2007)

Here, a review of literature is conducted to distil four components that are important in building the resilience of socioeconomic systems. First, resilience thinking requires an acknowledgement of the fact that systems must learn to live with uncertainty and that change is inevitable (Berkes 2007). '"Expecting the unexpected" is an oxymoron, but it means having the tools and the codes of conduct to fall back on when an unexpected event happens' (ibid.: 288); these tools and codes can spring from memories held by societies of similar events in the past.

Secondly, diversity is important to building resilience as it extends multiple options for dealing with perturbations, reducing risks by spreading them. This diversity can be nurtured ecologically through high biodiversity, both economically through livelihood diversification and through the inclusion of diverse points of view in policymaking processes.

Thirdly, to build resilience, different types of knowledge should be appropriated in any learning process. This can be done through the appropriation of local knowledge in policy processes; 'the creation of platforms for cross-scale dialogue, allowing each partner to bring their expertise to the table, is a particularly effective strategy for bridging scales to stimulate learning and innovation' (ibid.: 290).

Fourth, as renewal and reorganisation are essential parts of natural cycles, the ability of systems to reorganise is a critical determinant of their resilience. This is possible through strengthening community-based management and 'maintaining the local capacity for social and political organization in the face of disasters. Response by the community itself, through its own institutions, is key to effective response and adaptation' (ibid.: 291). Also, building linkages across scales of governance is another component of giving communities the ability to self-organise; community organisations need to work with regional and national organisations. 'The creation of governance systems with multilevel partnerships is a fundamental shift from the usual top-down approach to management' (ibid.: 291).

Lastly, ... a dynamic learning component is crucial for providing a rapid ability to innovate in terms of the capacity to create new responses or arrangements. Such learning can be improved by adaptive co-management, defined as a process by which institutional arrangements and environmental knowledge are tested and revised in a dynamic, ongoing, self-organized process of learning-by-doing (Folke et al. 2002). Learning organizations allow for errors and risk-taking behaviour as part of the learning process (ibid.: 291).

2.15 Resilience and adaptation (Oshbar 2007)

Here, a deeper understanding of resilience in the context of climate change is constructed through an analysis of climate change adaptation interventions/projects (Osbahr 2007). This is in order to identify '... specific elements of adaptation practice and intervention that might be important in enhancing longer-term resilience to climate change in developing countries' (ibid.: 4). Multiple characteristics of resilience are identified (see Appendix 1), including:

- The need for institutions that effectively translate scientific data into guidance for policymakers;
- Governments that are accountable for the distribution of risks in society;
- Donors engaged in climate change interventions over the long term (possibly through projects that last for more than five years);
- Formal training of communities using new thinking on adaptation;

- The employment of existing social and economic networks in spreading awareness on climate change adaptation and disaster risk reduction;
- Adaptation being thought of as a financially and commercially viable activity, possibly through the formulation of a business case for adaptation in the national budgets of countries.

2.16 Components and characteristics of resilience (Twigg 2007)

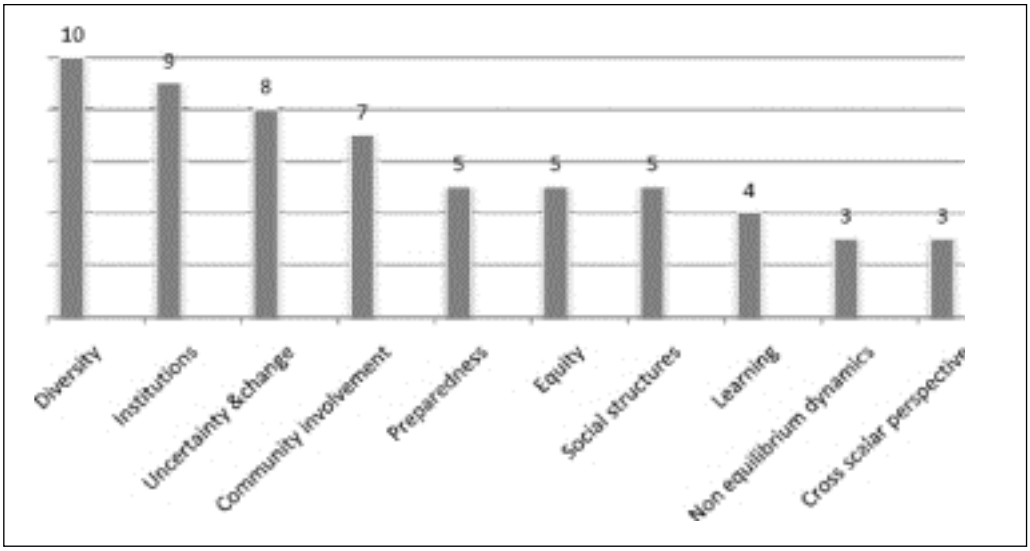
Twigg (2007) in his guidance note on 'Characteristics of a Disaster-resilient Community' defines resilience to be the ability of a community to absorb stress, capacity to manage, or maintain certain basic functions and structures, during disastrous events and the bounce backability of a community after a disaster. He takes building blocks provided by the Hyogo Framework for Action (the global framework to guide disaster risk reduction efforts) to define five thematic areas for action: governance, risk assessment, knowledge and education, risk management and vulnerability reduction, and disaster preparedness and response. He then devises three columns for each thematic area: components of resilience; characteristics of a disaster-resilient community; and characteristics of an enabling environment (dealing with wider institutional, policy and socioeconomic factors in supporting community-level resilience).

An illustrative example of this approach under the first thematic area, governance, argues that a component of resilience is 'accountability and community participation'; under this component a characteristic of a disaster-resilient community is 'access to information on local government plans, structures etc.', and one characteristic of an enabling environment is 'citizen demands for action to reduce disaster risk'. Taking another thematic area, hazard/risk data assessment, a characteristic of a disaster-resilient community is that hazard/risk assessment is a participatory process in which all sections of the community are represented, and one characteristic of an enabling environment is that 'hazard/risk assessments are mandated in public policy legislation, etc., with standards of preparation, publication and revision'.

3. Characteristics of resilient systems

After examining a range of 16 different approaches to conceptualising resilience in section 2, this section draws out major areas of convergence to distil ten characteristics of resilient systems. Figure 1 illustrates the number of times they are referred to in the approaches to resilience discussed in the previous section. While attempting to be scientifically precise, this methodology provides an indicative approach to characterising resilient systems based on a robust review of literature on the subject. Analysis of the literature in the previous section revealed that some concepts, for example the presence of 'high diversity', are stated to be characteristics of resilient systems in a number of different pieces of literature. Others such as 'community involvement' are discussed by comparatively few authors. To accurately judge the significance of each of the following ten concepts is beyond the scope of this review (and possibly something that would need extensive field testing); the aim here is to provide a more practical guide to the overlapping characteristics of resilience as discussed by a range of theorists who have come to define research in this field.

Figure 1: Characteristics of resilience by frequency of reference in reviewed literature



3.1 High diversity

The most important characteristic of resilient systems is diversity. High diversity in the range of functional groups within a system is seen to contribute greatly to the resilience of systems (Folke 2006; Holling 1973; Resilience Alliance 2009; Carpenter et al. 2001). This idea of ecological diversity is extended by a large number of theorists. The Four Components of Resilience approach underlines the importance of nurturing ecological diversity but also stresses the need for a range of available economic opportunities, a diversity of partnerships, and 'the significance of bringing additional constituencies into the policy arena' (Berkes 2007: 289). Different forms of diversity are interrelated. For instance, 'rural livelihoods and well-being are strongly dependent on the diversity and health of ecosystems and the services they provide' (ibid.: 289).

The Resilience and Adaptation approach uses a case study to demonstrate that variety in stakeholders is also important to the continued operation and success of a project (Osbahr 2007). This led to the involvement of individuals 'with external networks, education or history of migrant work' which made the processes associated with the project more robust (ibid.: 12). The Social Infrastructure approach emphasises the importance of communities relying on diverse natural resources as it insulates them from the 'boom and bust nature of markets', environmental variability and extreme weather events, which may adversely impact some resources (Adger 2000).

The Survival and Recovery approach sees a diversity of planning, response and recovery activities as an essential component of resilience to climate change because 'a diversity of options has greater potential to match the particular scenario of impacts that occur' (Rockefeller

Foundation 2009: 2). Each of these interpretations of diversity can have a number of analytically deduced indicators; for example, diversity in natural resource use could be measured by the degree of variety in livelihood activities being pursued within a system; and high economic diversity could be measured by the number of groups performing different economic functions.

3.2 Effective governance/institutions/control mechanisms

A number of different approaches stress the need to have effective institutions and institutional structures to build resilience in a system. The Five Capitals approach stresses the importance of 'trust, norms and networks' within a system, perhaps manifested through a large number of credible civil society institutions such as religious organisations and recreational clubs (Mayunga 2007). The Social Infrastructure approach examines how institutions must be seen as legitimate which in turn is a product of the level of 'inclusivity or exclusivity, and hence how effective they are in oiling the wheels of society' (Adger 2000: 351). A number of possible indicators that range from the turnout for local elections to the number of meetings of local councils can be employed to measure the legitimacy of institutions at the community level.

Closely associated with this notion of effective institutions is the idea of effective governance and a key theme running through thinking on resilience is the need for decentralised organisational structures and policies that are more flexible and in touch with the needs of communities and local realities (Folke 2006; Rockefeller Foundation 2009; Ostrom 2009; Dovers and Handmer 1992; Osbahr 2007). The Resilience and Adaptation approach notes that 'governance, the structures and processes by which societies share power, shapes individual and collective actions and can be formally institutionalised'. There is therefore a need for 'polycentric and multi-layered institutions to improve the fit between knowledge, action and the context in which societies can respond more adaptively at appropriate scales' (Osbahr 2007: 14).

Another domain of thinking on the importance of institutions deals not with their structure but the nature of the roles they can play in order to increase resilience. The Stability, Self-Organisation and Learning approach underlines the importance of institutions that can facilitate learning and 'experiment in safe ways, monitor results, update assessments, and modify policy as new knowledge is gained' (Carpenter et al. 2001: 778). Similarly, in the Resilience and Adaptation approach, institutions that can effectively translate scientific data on climate change into guidance for policymakers are seen as critical to building resilience in a system.

3.3 Acceptance of uncertainty and change

Another key theme is the ability of systems to accept uncertainty, change, the randomness of events. There seems to be a general consensus on how resilience results not from working towards resisting changes/perturbations but from setting up systems that work effectively with these. 'The resilience perspective shifts policies from those that aspire to control change in systems assumed to be stable, to managing the capacity of social-ecological systems to cope with, adapt to, and shape change' (Folke 2006: 254). This is closely associated with Holling's idea that due to the non-linear (random or 'change-ridden') functioning of ecological systems, it is more appropriate to think of the persistence of relationships between system components as a measure of resilience rather than working towards a state of stability or systemic equilibrium (Holling 1973).

This idea of working with change manifests itself in different ways across the range of reviewed approaches. The Survival and Recovery approach stresses the need for 'flexibility at an individual, organizational, and systemic level, with each level able to respond and contribute to each situation, and to respond to shifting and unpredictable circumstance" (Rockefeller Foundation 2009: 2). This can be manifested as decentralised decision-making systems within organisations that have a role in determining the resilience of systems (Rockefeller Foundation 2009). The Four Components of Resilience approach argues that remembering how societies have endured events in the past is critical to successfully dealing with unexpected events (Berkes 2007). This idea can be analytically extended to see that resilience of a community may be gauged by their memory of past disturbances and the existence of protocols that determine community action in the face of disturbance.

3.4 Community involvement and inclusion of local knowledge

Community engagement, ownership, participation and indigenous/local knowledge are commonly stressed in the reviewed literature (Manyena 2006; Mayunga 2007; Ostrom 2009; Nelson et al. 2007; Dovers and Handmer 1992; Berkes 2007; Osbahr 2007). Manyena critiques the United Kingdom's Resilience Programme and finds that while 'it will improve the coordinated response capabilities of emergency services and other government agencies', it does not involve the community, who will inevitably have to combat emergency situations if the scale of disturbance overwhelms the official response capacity (2006: 438). Ostrom advocates greater ownership of natural resources within the system by its users arguing that when users have 'full autonomy at the collective-choice level to craft and enforce some of their own rules, they face lower transaction costs as well as lower costs in defending a resource against invasion by others' (Ostrom 2009: 421).

This notion of co-management or greater ownership of resources by communities is dealt with directly in the Convergence approach where it is argued that 'the strong normative message from resilience research is that shared rights and responsibility for resource management (often known as co-management) and decentralisation are best suited to promoting resilience' (Nelson et al. 2007: 409). Berkes highlights the use of different forms of knowledge as one of four key areas of resilience in the context of climate change, 'Community-based monitoring and indigenous observations are significant in this regard because they fill in the gaps of global science and provide insights regarding local impacts and adaptations. Bringing different kinds of knowledge together helps increase the capacity to learn' (Berkes 2007: 409).

3.5 Preparedness, planning and readiness

Preparing and planning for disturbances also characterises resilient systems. This refers to accepting that change will occur and preparing to live with this change. This is incorporated into the Survival and Recovery approach, firstly through redundancy being seen as an attribute of resilient systems. This is when 'processes, capacities, and response pathways within an institution, community, or system allow for partial failure within a system or institution without complete collapse' (Rockefeller Foundation 2009: 2).

Secondly, this approach underlines the necessity of 'planning for failure', 'so that break-downs happen gracefully, not catastrophically – for example, when flood gates break, they do so in a way that channels floodwaters to uninhabited flood zones (ibid.: 2). Planning for failure can be operationalised by decentralised organisational structures, so that the failure of the central authority does not lead to system collapse, and through the explicit inclusion of system failure scenarios in any response plans. The Preparation and Performance approach adds 'assessment of a system to vulnerability' as a critical activity necessary for the adequate preparation of any system to a disturbance (Foster 2006).

3.6 High degree of equity

While a number of approaches engage with the idea that a high degree of equity in a system leads to its increased resilience, the Migration and Social Resilience approach adds a unique dimension to this view through a discussion of the impact of remittance income (Adger 2002). Here, it is argued that while remittances increase resilience to disturbances, they could lead to unequal access to resources and so enhance the vulnerability of some individuals within a community. There is therefore a need for institutions that would reduce the adverse impact of remittances and foster greater economic equity.

A different take on the notion of equity is that any programme of resilience building engages with the notion of gauging, sharing and distributing risk from disturbances and Nelson et al. (2007) argue that systems may become less resilient where issues of justice and equity are not taken into account. Adger also argues that stable livelihoods contribute to social resilience, that stable livelihoods are derived from sustained economic growth, and that economic growth over the long term is also promoted by the 'equitable distribution of assets within populations' (Adger 2000: 355). 'These linkages include the arguments made by Keynsian [sic] economists that equitable wealth enhances aggregate demand within the economy... and further evidence that the economic productivity of the workforce is jeopardized by the

consequences of large-scale inequality' (ibid.: 355). Twigg (2007) speaks of sustainable livelihoods as an essential component of resilience and specifies the equal distribution of wealth and assets as well as a strong and equitable economy as essential to building the resilience of a community.

3.7 Social values and structures

Social values and structures are also highlighted as having a significant role in resilience building. The Five Capitals approach sees social capital or trust norms and networks as one of five important elements needed for building resilient systems (Mayunga 2007). Here, it is argued that robust civil society institutions can foster cooperation and coordination in a community which can, in turn, lead to a greater amount of trust and respect amongst its members. This can result in more equitable access to resources and greater resilience. Ostrom (2009) discusses the capability of system users to organise for better ecosystem management, arguing that a high degree of trust and shared ethical standards makes it easier to reach agreements and also reduces the need to carefully monitor resource use by different users. Twigg (2007) also underlines this when he identifies cultures, attitudes and motivation to be a component of resilience and says that shared community values are a characteristic of disaster-resilient communities.

3.8 Non-equilibrium system dynamics

This notion is related with that noted in section 3.3 about uncertainty and change. Holling engaged with this idea most substantially in his analysis of the resilience of ecosystems, arguing that 'an equilibrium centred view is essentially static and provides little insight into the transient behaviour of systems that are not near the equilibrium. Natural, undisturbed systems are likely to be continually in a transient state'' (Holling 1973: 2).

Rather than stable states to which they should return after a disturbance, Holling argues that the sets of relationships amongst a number of different system elements are each organised around individual equilibriums. A disturbance may change the position of these components within a system, but the system will persist as long as the relationships between these components remain similar. This persistence of relationships then becomes a measure of the system's resilience.

Folke also discusses this when he writes: 'Old dominant perspectives have implicitly assumed a stable and infinitely resilient environment where resource flows could be controlled and nature would self-repair into equilibrium... The resilience perspective shifts policies from those that aspire to control change in systems assumed to be stable, to managing the capacity of social-ecological systems to cope with, adapt to, and shape change.' (Folke 2006: 253). Essentially, a non-equilibrium approach argues that restoring equilibrium may return a system to a state where it is vulnerable to the impact of the same perturbation again.

3.9 Learning

Learning from experience is another characteristic of resilient systems highlighted by the reviewed literature. A number of approaches reviewed highlight the need for iterative processes and organisational learning in initiatives to promote resilience. Learning is one of three core components of resilience for the Stability, Self-organisation and Learning approach, which merges learning with the idea of adaptive capacity; 'a component of resilience that reflects the learning aspect of system behaviour in response to disturbance' (Carpenter et al. 2001: 766).

Learning is also central to the notion of adaptive management (Gunderson and Holling 2001). This considers a range of plausible hypotheses about future changes in the system, weighs a range of possible strategies against this wide set of potential futures, and then favours actions that are robust to uncertainties. Others have highlighted the high degree of uncertainty that exists in socio-ecological systems and argued that effective and continual learning is a way of dealing with this (Folke 2006). Indicators for learning are complex, but certain steps like flexibility in guidelines issued by authorities, employment of accepted organisational learning techniques and undertaking exercises of reflective practice within organisations may contribute to effective learning.

3.10 Adoption of a cross-scalar perspective

At the heart of the resilience concept seems to be an acknowledgement of the high level of interconnectedness between the various components of a system. This in turn means that resilient systems have perspectives that transcend the specificities of the local and take a regional view of events. It also means that resilience can be derived from high spatial and temporal variability.

Holling (1973) compares the resilience of fish stocks in a closed, local ecosystem like that of a lake to that of pest populations which are highly dispersed in space and time to find that the latter are far more resilient. The Convergence approach looks at the issue of transcending scales of governance but in the context of networks and systems and finds that networks that transcend scales are found to have greater resilience (Nelson et al. 2007). The importance of cross-scalar networks is acknowledged in a number of places and is possibly evidenced through societal or kinship networks that connect the local to the global, or simply through the existence of strong social, political, cultural, economic and natural links of one system with other systems/groups/communities. Twigg (2007) does not acknowledge this directly but this characteristic is implied in a number of points that he outlines, but especially when he discusses early warning systems and outlines the importance of the local being integrated with the regional.

4. Conclusion

The operationalisation of resilience thinking is founded upon the understanding that ecological and social systems are highly integrated. This implies the need to work with the high degree of complexity and connectedness that exists in and between these systems. The notion of 'complexity' manifests itself in particular through understanding processes and events in a system as non-linear. All of the points discussed above have a critical link to tackling a changing climate as most of the material discussed in the preceding sections seeks to make SESs more resilient to 'disturbances' and, be it hydro-meteorological disasters, change in rainfall patterns/quantity or temperature variability, it is projected that climate change is likely to change the nature, and increase the intensity and frequency, of disturbances that SESs will face across the globe.

While reviewing literature on the resilience concept has yielded insight into the essential components, characteristics and possible indicators of resilient systems, a number of gaps in understanding remain. Firstly, there remains a lack of conceptual clarity on the relationship between adaptation, adaptive capacity and resilience. This results in a lack of understanding of the additional benefit that taking a resilience approach brings to adaptation, whether resilience pertains to an idealised form of adaptation or whether the terms can be used interchangeably. This problem is compounded by the paucity of robust, documented case studies on the operationalisation of the resilience concept.

Secondly, most theorists refer to resilience in the context of a 'system' but no part of the reviewed literature provides a substantial explanation of how this entity and its boundaries are defined. The use of 'system' in the context of resilience stems largely from ecological theory where theorists such as Holling discussed the resilience of 'ecosystems'. However, this review highlights how theorists have taken many of the original ideas developed in the context of ecosystems research and applied them to understanding socio-ecological systems. While this has yielded a range of insights outlined in the previous sections, insufficient thought has been given to understanding the limits and contents of a system in the context of interpretations outside ecology. It has variously been understood to be a sum of resource systems, resource units, governance systems and resource users. It has also been understood to be a community or even a contained ecological space such as a lake (Ostrom 2009; Mayunga 2007; Holling 1973).

Thirdly, it is clear that there is major gap in understanding how 'resilience' should be measured. This problem is inherently linked to the two issues discussed above. If there is a lack of clarity on the spatial dynamics of resilience building through a confusion about the limits of system and a lack of clarity on how resilience and adaptation are separated, then measuring the concepts naturally becomes difficult. While some theorists propose tentative indicators and formulas (see, for example, Twigg 2007), there is little guidance on how indicators should be developed and tailored for specific situations or direction on the kind of data that needs to be collected. Appendix 1 provides an initial set of analytically deduced indicators from the basic findings of this literature review.

Lastly, the vast majority of the available literature on the resilience concept still tends to be largely conceptual and, while some empirical examples are discussed, there remains a lack of robust case studies that prove or test the theories put forward. The development of this paper and the work within the Strengthening Climate Resilience Programme has stimulated communication with a range of experts engaged in research on relevant topics and concluded that few case studies exist on operationalising resilience concepts. We hope that this paper goes some way to advancing the discussion and practice of operationalising resilience, both through understanding the overlapping conceptualisations and the initial plotting of potential indicators for its key characteristics.

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No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
1	**Disturbance as Opportunity** In a resilient social-ecological system disturbance has the potential to create opportunity for doing new things, for innovation and for development. **(Folke 2006)**	• Diversity and individuality of components. • Nature of control mechanism. • Number of functional groups and variability of responses to environmental change.	1. Learns to manage by change. 2. Accepts uncertainty. 3. Interaction between system components is dispersed. 4. Has far from equilibrium dynamics; non-linear. 5. Large number of functional groups which have variable responses to environmental change (in reference to ecosystems).	1. Change in operations occurs based on learning; governance policies are continuously changing to reflect learning; components are changing and not static. 2. Policies reflect understanding of uncertainty. 3. Evidence of each component interacting with each other with no centralisation; policies and procedures do not follow a staged process but are iterative. 4. There is no central governance structure but a networked governance system. 5. Diverse actors with varied social/economic/political/ecological functions.	N/A
2	**Resilience as Process** Disaster resilience	Resilience thought of not as an outcome but as a sum of processes which include: • broad-scale community involvement in resilience;	1. Focused on recovery and 'bounce backability'. 2. Proactive adaptation to risk (rather than only risk mitigation).	1. Communities demonstrate awareness of actions to be undertaken when disasters strike. 2. High human development index (where	Two views: a) vulnerability is a factor of resilience b) they are separate

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	could be viewed as the intrinsic capacity of a system, community or society predisposed to shock or stress to adapt and survive by changing its non-essential attributes and rebuilding itself. **(Manyena 2006)**	programmes; • recognising human role in disasters; • having disaster plans; • building capabilities; • purchasing insurance; • sharing information.	3. Acknowledges local knowledge and culture.	data are available). 2. Effective platforms/structures for information sharing exist. 2. Social/economic/political factors are considered in any action to increase resilience. 3. Participatory tools are employed in the formulation, implementation and evaluation of resilience programmes.	entities.
3	**Persistence of Systems**[+] Measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables.	• Relationships of different elements and their impact on system stability. • Understanding of event dynamics within an ecological system (random vs linear). • Degree of fluctuations within a system. • The nature of the domains of attraction. • Design of management (open vs closed options).	1. Flexible. 2. Dynamic. 3. Able to absorb change and disturbance. 4. Intra-system relationships persist. 5. Variable over space and time. 6. Contains diverse functional groups. 7. Open and dispersed. 8. Regional rather than local. 9. Heterogeneous.	1&2. Complexity theory and/or post-modern approaches are employed in a management approach based on resilience. 1&10. Policies aimed at building resilience contain general guidelines instead of rigid steps. 3&4. Levels of wellbeing do not change dramatically after disturbances. 5,7,8. Existence of strong social, political, cultural, economic and natural links with other systems/groups/communities. 6&9. High diversity amongst actors performing social, political, cultural,	N/A

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	(Holling 1973)	• The spatial view of events (regional vs local context). • Degree of diversity (heterogeneous vs homogeneous). • Capacity to absorb and accommodate unexpected events.	10. Recognises limits of know-ability.	economic and natural roles.	
4	**Five Capitals** Resilience is the capacity or ability of a community to anticipate, prepare for, respond to, and recover quickly from impacts of disaster. This means that it is not only the measure of how quickly the community can recover from the disaster impacts, but also the ability to learn, cope with or adapt to hazards.	Five types of capital can determine levels of resilience: • social capital; • economic capital; • human capital; • physical capital; • natural capital.	1. Trust, norms and networks lead to: • high degree of coordination and cooperation in the community; • community members accessing resources. 2. Income, savings and investment lead to: • high capacity, e.g. insurance; • fast recovery processes; • high wellbeing and low poverty. 3. Education, health, skills, knowledge and information lead to: • high levels of knowledge and skill to	1. Large number of non-profit organisations, voluntary organisations, religious organisations, high level of voter participation and registration and newspaper readership, and sport and recreational clubs operating in the community. 2. Growing household income, property value and investment; stable and well-paying employment opportunities. 3. High levels of educational attainment (e.g. years of schooling); good health; low population density; sustainable levels of population growth; good access to transportation services; good quality	Believes that conceptualisation of resilience as the opposite of vulnerability is not helpful as it does not add to its understanding.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	(Mayunga 2007)		understand community risks; • high ability to develop and implement risk reduction strategy. 4. Housing, public facilities, business/industry lead to: • effective communication and transportation, evacuation; • increased safety. 5. Resource stocks, land water and ecosystems lead to: • sustenance of all forms of life, increased protection , protection of environment.	housing; and low dependency ratio. 4. Good quality and dispersed housing units, business/industry, shelters, lifelines and critical infrastructures. 5. High-quality air, water and soil; adequate degree of wetland and forest cover.	
5	**Social Infrastructure** Social resilience is the ability of human communities to withstand external shocks to their social infrastructure. **(Adger 2000)**	Here the resilience of social systems is linked to the resilience of ecological systems but components of social resilience include economic, demographic and institutional variables such as: • economic growth; • stability and distribution of income; • degree of dependency on	1. Dependent on diverse natural resources. 2. Has low frequency and intensity of extreme weather events. 3. Has stable livelihoods. 4. Has equitable distribution of assets. 5. Has positive forms of migration/movement. 6. Institutions within this system are seen	1&3. Number of different livelihood activities exist in the community. 1. Dispersed settlement patterns. 3. Stable income levels. 3. Low number of extreme weather events. 3. High level of formal sector employment. 4. Low recorded crime rate. 4. Low income variance.	Resilience is the opposite of vulnerability.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
		natural resources; • degree of environmental variability; • stability of livelihoods; • mobility and migration; • level of functional diversity; • degree of legitimacy of institutions; • resource dependency.	to have legitimacy.	5. Low level of displacement migration. 5. High levels of circular and seasonal migration. 6. High turnout for local elections. 6. Adequate number of meetings of local councils with community participation. 6. Land rights are underpinned by an understanding of the notion of sustainability.	
6	**Survival and Recovery** Climate change resilience is the capacity of an individual, community, or institution to dynamically and effectively respond to shifting climate impact circumstances while continuing to function at an acceptable level.	• System dynamics. • Nature of skill sets contained within the system. • System structure. • Nature of approach to planning. • Nature of response and recovery planning. • Level of planning and foresight.	1. Flexible. 2. Includes multi-faceted skill sets. 3. Has redundancy (so that partial failure does not lead to total collapse). 4. Incorporates multi-sectoral approaches to planning, execution and recovery. 5. Has high level of planning and foresight. 6. Is diverse and decentralised.	1,6&3. Decentralised systems of decision-making within organisations. 4. Availability of financial services that insure against new kinds of risk. 4&5. Existence of sustainability and/or resilience plans for various sectors of the economy. 4&5. Existence of climate change risk mainstreaming in infrastructure projects. 4&5. High degree of knowledge of CC impacts on health amongst community-level health workers.	No detailed explication but building resilience conceptualised as method of reducing vulnerability.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	(Rockefeller Foundation 2009)	• System organisation. • Approach to failure. Resilience can also include a number of different activities, for example: • building codes for homes; • evacuation plans; • insurance; • reducing stressors unrelated to climate change.	7. Plans for failure.	4&5. Mainstreaming of CC into existing DM plans. 5. Existing and developing DRR/CC response plans; enforceable building codes are in existence; communities are aware of localised evacuation plans in existence. 6. Disaster response plans take into account local realities. 7. Inclusion of system failure scenarios in any resilience management approaches.	
7	**Self-organisation** This concept deals with the notion of resilience implicitly through a multilevel, nested framework for analysing outcomes achieved in social-ecological systems. This is explained	The SES is broken into 4 constituent elements: 1. resource units; 2. resource systems; 3. governance systems; 4. users. Each of these units has a	Rather than characteristics of a resilient system, the following are characteristics which positively affect the likelihood of users self-organising to manage a resource: 1. Moderate territorial size; 2. Certain amount of scarcity in a resource system; 3. System dynamics need to be sufficiently predictable;	Rather than indicators of a resilient system, these are indicators of conditions that will lead to system users reorganising: 1. Diminishing yield of produce from system; 1&4. Low cost of managing and monitoring a system; 3. Effective knowledge amongst users of how the ecological environment will	N/A

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	through the use of an example identifying ten subsystem variables that affect the likelihood of self-organisation in efforts to achieve a sustainable social-ecological system. **(Ostrom 2009)**	number of variables which positively or negatively affects the likelihood of users' self-organising to manage a resource which in the context of writing on SES will contribute to an SES's resilience. They include: • size of resource system; • productivity of a system; • predictability of system dynamics; • resource unit mobility; • number of users; • leadership; • norms/social capital; • knowledge of the SES; • importance of resource to users; • collective choice rules.	4. Moderate amount of mobility in resource unit; 5. Some users have entrepreneurial skills and command respect; 6. Shared moral or ethical standards; 7. Common knowledge; 8. High dependency on resource system for livelihood; 9. Autonomy of users to craft and enforce some of their own rules at the collective choice level.	respond to activities within the system; 5. Presence of college graduates, users returned from the city or other opinion leaders; 6. Presence of functioning formal and informal groups amongst users (e.g. religious groups, credit societies, etc.); 7. Users have high degree of knowledge about the carrying capacity of the system; 8. Large proportion of livelihoods directly or indirectly dependent on products from the system; 9. Effective, devolved and decentralised policies that control/grant access to system resources.	
8	**Preparation and Performance**	Regional resilience conceptualised as sum of two forms of resilience –	1. The system (region) assesses its vulnerabilities to disturbance well.	1. Actors, policies and processes display knowledge of trend analysis and assess	• Assessing vulnerability thought of as a step in

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	Resilience as the ability of a region to anticipate, prepare for, respond to and recover from a disturbance. **(Foster 2006)**	preparation resilience and performance resilience. Components of preparation resilience: • assessment; • readiness. Components of performance resilience: • response; • recovery.	2. The system readies itself to respond to assessments and potential disturbances well. 3. The system responds well to disturbances. 4. The region recovers from the disturbance effectively and learns from lessons and insights.	probability of risks and disturbances. 1. Policies, processes and resources in place for distilling lessons from prior experience of disturbance. 1. Lessons from previous disturbances have been used in the establishment of 'trigger points' for activating response and information, and organisations/bodies charged with responding are made aware of these. 1. Timely, accurate, reliable, relevant, usable, actionable risk assessment products exist at the regional level. 2. Policies, actors and processes have capacity to mandate response actions and coordinate readiness actions. 2. Policies and processes aimed at ensuring readiness of system have built in measures to ensure flexibility. 2. Drills to cope with disturbances to system are carried out. 2. Leadership structures for managing response during disasters are established and individuals adequately trained. 3. Low damage to physical, economic and social infrastructure in comparison to	building resilience. • Acknowledges that vulnerability is seen as opposite of resilience.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
				other systems facing similar disasters. 3. Response mechanisms are cost-effective, sustainable and viable. 3. Leadership structures put in place for responding to disasters execute their brief effectively. 3. Effective engagement takes place with the media and communications outlets after a disturbance. 4. Systems damaged during disturbance are repaired effectively and in a timely manner. 4. Commercial and social activity returns to normal rapidly after disturbance. 4. Exercises in organisational learning/reflective practice are undertaken after a disturbance and a framework is in use to integrate lessons learned into future readiness actions.	
9.	**Stability, Self-organisation and Learning** Resilience is:	• Change in variables within domains of attraction. • Ability to self-organise. • Diversity within an SES.	1. Has variables which maintain domains of attraction 2. Has economic and institutional arrangements which allow system components to self-organise.	1. Existence of land tenure systems that promote equity and sustainable land use. 2. Economic and institutional arrangements give users (e.g. fishermen, agriculturists, pastoralists) the ability to determine quality of resource units (e.g. soil and	No explicit mention but implicitly seems to understand vulnerability to be something that diminishes as resilience increases.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	(a) the amount of change the system can undergo and still remain within the same domain of attraction; (b) the degree to which the system is capable of self-organisation; and (c) the degree to which the system can build the capacity to learn and adapt. **(Resilience Alliance 2009; Carpenter *et al.* 2001)**	• Quality and nature of learning.	3. Has ecological functional diversity. 4. Has networks that create flexibility in problem solving. 5. Has an understanding of its own dynamics. 6. Has institutions that support genuine learning.	water quality) through greater control. 3. Existence of diverse groups of species performing different functions in an ecological system. 4. Local knowledge is appropriated in systems of managing resources. 5. Users of a system display a high degree of knowledge of the roles and functioning of various elements within an SES. 6. Institutions effectively conduct experiments in building resilience, monitor results, update assessments and modify policy as new knowledge is gained.	
10.	**The DROP Model** To ameliorate the shortcomings in existing vulnerability and resilience models and to provide a conceptual basis for establishing baselines for measuring resilience, the authors	• Antecedent conditions. • Inherent vulnerability. • Inherent resilience (composed of ecological, social, economic, institutional, infrastructural and community competence factors).	Characteristics of inherent resilience: 1. Diverse ecological factors combine to strengthen community resilience. 2. Supportive social structures create an environment which makes a system more resilient. 3. Economic conditions/climate lead to enhanced resilience in a system. 4. Institutions undertake actions that lead	1. High biodiversity; low rates of soil erosion; high amount of wetlands acreage; adequate number of coastal defence structures. 2. Large number of social networks; community possesses cohesive values and opinions; presence of effective faith-based organisations. 3. High rate of employment; consistent and equitable processes of wealth generation;	See vulnerability and resilience as overlapping concepts, so that they are not totally mutually exclusive, nor totally mutually inclusive. Some characteristics influence either vulnerability or resilience, others influence both.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	have developed a disaster resilience of place (DROP) model. The disaster of place model is designed to present the relationship between vulnerability and resilience. **(Cutter 2008)**	• Hazard events. • Coping responses at the community level. • Impact of hazard (cumulative effect of the antecedent condition, the characteristics of the hazard event and coping responses). • Capacity of the community to absorb the impacts. • Adaptive resilience (improvisation and learning).	to increased resilience. 5. Infrastructure is able to withstand natural hazards and still operate. 6. The community is able to function well and understands risk.	high municipal revenues. 4. High participation by communities in hazard reduction programmes and hazard mitigation plans; existence of building standards which reduce risk from natural hazards; existence of emergency response plans; high degree of continuity in operation plans. 5. High level of functioning of critical infrastructure in the face of natural hazards; diverse and extensive transportation networks; diverse commercial and manufacturing establishments. 6. High degree of understanding of risk amongst community; availability of counselling services; low psychopathologies; high degree of health and wellness; high quality of life.	
11	**Convergence** The authors argue that adaptation is a process of deliberate change in anticipation of or in reaction to external stimuli and	Rather than describing the components of a resilient system, the authors discuss four elements of what they call a 'resilience framework' (essentially a systems view) and what this adds to thinking on climate change adaptation (essentially actor-oriented).	The resilience framework adds to understanding on climate change by: 1. Acknowledging that social-ecological systems can organise around a number of possible states; self-organisation and learning are important when boundaries of a system state are crossed.	1. Official policies regarding use of resources from ecosystem are devolved and flexible. 1,2&5. Procedures and practices for learning (in some cases organisational learning) and reflective practice within a system are in place. 2. Large social networks that scale from	• Vulnerability is an inherent characteristic of any system, reducing vulnerability in one area creates or increases vulnerability in another area or time. • Integrating principles of equity with the

'Overall it is argued that a resilience framework provides a dynamic perspective on adaptation processes and the effects of these processes at different spatial and temporal scales. Actor-based analyses look at the process of negotiation, decision-making, and action. Systems-based analyses complement this approach by examining the implications of these processes for the rest of the system (Nelson et al. 2007).

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	stress. It primarily takes an actor-centred view. The resilience approach is systems-oriented and takes a more dynamic view. The two approaches converge in identifying the necessary components of adaptation. **(Nelson *et al.* 2007)**	• Multiple States. • Adaptive capacity. • Trade-offs. • Governance and normative issues.[1]	2. Acknowledging that proactive, long-term adaption results from deep and broad sources of resilience (such as extensive and cross-scalar learning and development of networks). 3. Understanding that two kinds of surprises exist – positive and negative. A resilient system should foster the former and curtail the latter. 4. Understanding how high adaptedness (the degree to which a community is adapted) can lead to low resilience. 'A balance must be reached between what is an acceptable level of risk to current stressors and breadth of flexibility needed to respond to future change.' 5. Looking at how co-management of resources is best suited for promoting resilience; governance systems should themselves be adaptable through internal learning; local knowledge should be considered; strategies should be altered to meet	local to international communities exist. 3. Policies, actors, processes in the system are sensitised to the nature of opportunities that a disturbance may bring. 4. There are avenues for genuine citizen participation in the formulation of policies aiming to increase resilience. 5&6. Presence and participation of divergent interests in platforms for managing natural resources within a system; local knowledge in governance policy is appropriated. 6. Issues of justice and equity are integrated in any tools for measuring vulnerability.	identification of vulnerability is an important element of adaptational decision-making.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
			changing parameters. 6. Measures to enhance resilience should entail equitable processes and equitable outcomes.		
12	**Resilience Spectrum** Here an ideal type of resilience is conceptualised and "is based on abandoning the generally fruitless search for stable systems" and is a move "towards evolving resilient systems capable of adaptation". **(Dovers and Handmer 1992)**	The concept of resilience is conceived of as a continuum composed of three broad parts. A) Type 1 resilience: characterised by resistance to change. Here resources will be put to maintaining the status quo. This type of resilience would lead to societies being poorly equipped to deal with unexpected shocks. B) Type 2 resilience: characterised by incremental change. If substantial change occurs it usually serves the interests of the powerful. C) Type 3 resilience: reduces vulnerability through a high degree of flexibility. It is able to change basic operating assumptions and institutional	1. Systems that subscribe more to Type 1 and Type 2 are characterised by their adoption of policies that deal with only symptoms of disturbances. These systems are also characterised by rigid institutional structures; they seek to optimise available resources to maximise return in terms of desired production and consumption. 2. Systems that emphasise a Type 3 approach are likely to have policies that address the root cause of a problem. These systems assume that potential risks are great enough to demand profound changes in our societies and their patterns of production and consumption; this could be proactive or reactive depending on the circumstance.	Indicators of systems subscribing to Type 1 and 2 resilience: 1. Policies are more reactive in approach; more focus on response than preparedness; institutions have centralised organisational structures; manufacturing units are not aware of sustainable business practices. Indicators of systems subscribing to Type 3 resilience: 2. Values such as readiness, preparedness and institutional/organisational learning underpin policies in this system; institutions have decentralised organisational structures; manufacturing units follow sustainable business practices.	• Resilience perceived as method of vulnerability reduction. • Vulnerability seen as reflection of the global social structure and is seen to determine impacts of disasters. • It will be expressed in the amount and type of damage, and, perhaps more importantly, in the ability to recover from the damage.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
		structures.			
13	**Migration and Social Resilience** Resilience is the ability of communities to absorb external changes and stresses while maintaining the sustainability of their livelihoods. **(Adger 2002)**	• Structures of livelihoods. • Access to resources. • Social institutions. • Social trends. • Patterns of migration. • Nature of remittances. This conceptualisation of resilience places migration as an important determinant of the social resilience of communities.	1. Dynamic range of livelihoods. 2. Accessible resource base. 3. Responsive institutions. 4. Social and economic trends that lead to equity. 5. Investment of remittances in human and physical capital and in sustainable environmental practices.	1. Utilisation of remittance income for the establishment of new businesses or strengthening of existing livelihoods. 2&3. Effective mechanism to collect and spend taxes exists at the local level. 2&4. Low Gini co-efficient. 5. Increasing primary school enrolment rates.	Vulnerability seen as opposite of resilience. Vulnerability is seen to be possibly caused by unequal distribution of remittance income.
14	**Four Components of Resilience** Resilience is defined as the capacity of a system to absorb disturbance and reorganise while undergoing change yet still retain essentially the same function, structure,	• Attitude to change and uncertainty. • Degree of diversity. • Variety of knowledge employed in learning processes. • Ability of self-organisation and cross-scalar linkages.	1. System should learn to live with change and uncertainty. There should be high social and ecological memory. 2. System should nurture diversity. 3. Different types of knowledge should be combined for learning. 4. Opportunities for self-organisation should be created within the system.	1. Community displays good knowledge of past ecological disturbances; tools and codes of conduct that determine a community's behaviour in the face of ecological disturbances should exist. 2. Large number of species exist within ecosystem; large variety of economic opportunities are available to communities within system; high diversity of constituencies in the policy arena. 3. Local and indigenous knowledge is utilised in the formulation of any policy	Resilience thought of as way of reducing vulnerability.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	identity and feedbacks. **(Berkes 2007)**			aiming at increasing systemic resilience. 4. Community should have control over use of natural resources within system; institutions owned and managed by communities should have capacity to respond adequately to disasters; linkages across governance scales should exist.	
15	**Resilience and Adaptation** Resilience is a measure of the amount of change a system can undergo, while retaining the same controls on structure and function. **(Osbahr 2007)**	• Nature of social networks. • Use of new knowledge. • Nature of communication pathways. • Degree of heterogeneity of individuals in a system. • Nature of formal structures and associations • Nature of participatory processes. • Degree of accountability of authorities. • Institutions that translate scientific knowledge into practical guidance for	1. Social networks transfer information and financial support and facilitate collective action. 2. New types knowledge are employed in the formulation of sustainable adaptation strategies. 3. Formal communication pathways such as structured learning forums, training and skills exchange visits help transfer innovative new practice and knowledge. 4. There is a high degree of heterogeneity of stakeholders involved in any project of climate change adaptation. 5. Structures and associations support responses to seasonal variability, continuity in poverty reduction	1. Substantial remittance income in community. 2. Adaptation actions based on autonomous efforts and indigenous knowledge exists. 3. Training sessions being organised on various facets of adaptation for communities. 4. Individuals with history of migrant work or links with external networks are stakeholders in adaptation project. 5. Existence of effective labour exchanges and agricultural associations. 6&9. Communities display knowledge of adaptation project being undertaken and there is evidence of their views being included in the project planning and implementation process.	• Vulnerabity to climate change is seen as something that the building of resilience can counter. • Increase in vulnerability seen to lead to a decline in resilience.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
		policymakers. • Quantum of investment in improving climate models and vulnerability. • Nature of networks that improve awareness of disaster risk and climate change. • Clarity on leadership on disaster and climate risk management efforts with influence on budgeting and planning processes. • Local-level capacity to implement adaptive measures. • Level of engagement by donor advisory staff. • Degree of flexibility in the approaches of governments and donors in climate change adaptation. • Nature of tools for climate change data analysis.	strategies and food security. 6. Robust participatory processes are employed in an adaptation project. 7. Polycentric and multi-layered institutions exist to improve the fit between knowledge, action and the context in which societies can respond more adaptively at appropriate scales. 8. Institutions effectively translate science into guidance for policymakers. 9. Authorities are accountable and pursue just distribution of benefits and involuntary risks. 10. High degree of investment in improving climate models. 11. Networks in existence improve awareness of disaster risk and climate change. 12. A national-level leader on climate change and disaster risk is identified. 13. There is a high capacity at the local level to initiate and implement adaptive measures. 14. Donors stay engaged over the long	7. Decision-making in relevant institutions is decentralised. 8. Existence of materials that communicate climate science to policymakers simply. 10. Sophisticated climate models prepared in collaboration with renowned local and international institutions exist. 11. Existing social and economic networks are employed in spreading awareness of CC and DRR. 12. The communities and all relevant authorities display knowledge of the individual/organisation with whom responsibility for CC and DRR projects resides. 13. Community displays high degree of knowledge on CC adaptation and measures to reduce risk from disasters 14. Funding and institutional support for CC and DRR projects for donors lasts for over five years. 15. An iterative project implementation approach is employed. 16. Role of informal institutions is formally recognised in any new CC and DRR	

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
		• Importance attributed to local support networks in new climate change adaptation initiatives. • Nature of institutional involvement in adaptation initiatives. • Degree of innovation in developing financing mechanisms for climate change adaptation. • Variety in the availability of alternative livelihoods.	term in adaptation projects. 15. Governments and donors display high degree of flexibility in the implementation of climate change adaptation projects. 16. New initiatives do not replace previously existing informal institutions. 17. A financial/business case for adaptation is included in national budgets. 18. Multi-level institutional involvement in adaptation initiatives. 19. High degree of innovation in the development of financing options for development.	project. 17. National budget documents carry discussion on financial/economic benefits of CC adaptation. 18. Capacity building initiatives are undertaken with district and local authorities in order for them to effectively engage with CC and DRR issues. 19. Varied and unique financial instruments are in use for leveraging funds.	
16.	**Components and Characteristics of Resilience** Resilience is the ability of a community to absorb stress, capacity to manage, or maintain certain basic functions and	Twigg structures his work around five thematic areas (derived from the HFA for DRR) which have components of resilience, each of these components have characteristics of resilience:	*It is not possible to list all characteristics here, therefore one characteristic per component is being listed.* 1a) Community DRR (and DP) plans, developed through participatory processes, put into operation, and updated periodically. 1b) Community understands relevant	As Twigg develops extremely detailed characteristics of resilience and characteristics of an enabling environment, analytically deducing indicators here would be reductive. Twigg notes 'some characteristics are equivalent to the "outcome" indicators used in project evaluation because they represent an end state resulting from DRR interventions. Others are closer to "output" indicators because they represent DRR	The terms 'resilience' and 'vulnerability' are opposite sides of the same coin, but both are relative terms. One has to ask what individuals, communities and systems are vulnerable or resilient to, and to

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
	structures during disastrous events and the bounce backability of a community after a disaster. **(Twigg 2007)**	1. Governance • Policy, planning, priorities and political commitment. • Legal and regulatory systems. • Integration with development policies and planning. • Integration with emergency response and recovery. • Institutional mechanisms, capacities and structures. • Responsibilities. • Partnerships. • Accountability and community participation. 2. Risk Assessment • Hazards/risk data and assessment. • Vulnerability and impact data and assessment.	legislation, regulations and procedures, and their importance. 1c) Community DRR seen by all local stakeholders as integral part of plans and actions to achieve wider community goals. 1d) Community and other local-level actors in sustainable development and DRR engage in joint planning with community- and local-level emergency teams and structures. 1e) Representative community organisations dedicated to DRR/DRM. 1f) Access to government and other funding and resources for DRR and recovery. 1g) Local capacity and enthusiasm to promote DRR and scale up activities (through community-external actor partnerships). 1h) Devolved DRR structures facilitate community participation. 2a) Skills and capacity to carry out community hazard and risk assessments maintained through support and training.	activities that must be carried out or measures that must be put in place if resilience outcomes are to be achieved' (Twigg 2007: 10).	what extent.

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
		• Scientific and technical capacities and innovation. 3. Knowledge and Education • Public awareness, knowledge and skills Information management and sharing. • Education and training. • Cultures, attitudes, motivation. • Learning and research 4. Risk Management and Vulnerability • Environmental and natural resource management. • Health and wellbeing. • Sustainable livelihoods. • Social protection. • Financial instruments. • Physical protection;	2b) Community vulnerability and capacity assessments (VCAs) carried out which provide comprehensive picture of vulnerabilities and capacities. 2c) Community members and organisations trained in hazards, risk and VCA techniques and supported to carry out assessments. 3a) Open debate within community resulting in agreements about problems, solutions, priorities, etc. 3b) Impact of information materials and communication strategies evaluated. 3c) Community experience of coping in previous events/crises, or knowledge of how this was done, used in education and training. 3d) Shared community values, aspirations and goals (and positive sense of the future, commitment to community as a whole, agreement of community goals). 3e) Documentation, use and adaptation of indigenous technical knowledge and coping strategies. 4a) Access to community-managed common property resources that can		

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
		structural and technical measures. • Planning regimes. 5. Disaster Preparedness and Response • Organisational capacities and coordination and response. • Early warning systems. • Preparedness and contingency planning. • Emergency resources and infrastructure. • Emergency response and recovery. • Participation, voluntarism, accountability.	support coping and livelihood strategies in normal times and during crises. 4b) Community healthcare facilities and health workers, equipped and trained to respond to physical and mental health consequences of disasters and lesser hazard events, and supported by access to emergency health services, medicines, etc. 4c) High level of local economic activity and employment (including among vulnerable groups); stability in economic activity and employment levels. 4d) Established social information and communication channels; vulnerable people not isolated. 4e) Community access to affordable insurance (covering lives, homes and other property) through insurance market or micro-finance institutions. 4f) Adoption of physical measures to protect items of domestic property (e.g. raised internal platforms and storage as flood mitigation measures, portable stoves) and productive assets (e.g. livestock shelters).		

No.	Conceptualisation/ Definition	Components	Characteristics	Potential indicators *(numbers correspond to Characteristics)*	Interplay with vulnerability
			4g) Local (community) disaster plans feed into local government development and land use planning. 5a) Defined and agreed coordination and decision-making mechanisms with neighbouring communities/localities and their organisations. 5b) Technical resources (monitoring and communications equipment) in place, with systems and trained personnel for maintenance and operation. 5c) Plans reviewed and updated regularly by all relevant stakeholders. 5d) Community-managed emergency/ contingency funds. 5e) Agreed roles, responsibilities and coordination of recovery activities (involving local and external stakeholders). 5f) Self-help and support groups for most vulnerable (e.g. elderly, disabled).		

The Climate Smart Disaster Risk Management Approach

Strengthening Climate Resilience

The questions in the approach are suggestions only and there may well be others

1. Tackle changing disaster risks and uncertainties

1a

Strengthen collaboration and integration between diverse stakeholders working on disasters, climate and development

To what extent are climate change adaptation, disaster risk management and development integrated across sectors and scales? How are organisations working on disasters, climate change and development collaborating?

1b

Periodically assess the effects of climate change on current and future disaster risks and uncertainties

How is knowledge from meteorology, climatology, social science, and communities about hazards, vulnerabilities and uncertainties being collected, integrated and used at different scales?

1c

Integrate knowledge of changing risks and uncertainties into planning, policy and programme design to reduce the vulnerability and exposure of people's lives and livelihoods

How is knowledge about changing disaster risks being incorporated into and acted upon within interventions? How are measures to tackle uncertainty being considered in these processes? How are these processes strengthening partnerships between communities, governments and other stakeholders?

1d

Increase access of all stakeholders to information and support services concerning changing disaster risks, uncertainties and broader climate impacts

How are varied educational approaches, early warning systems, media and community-led public awareness programmes supporting increased access to information and related support services?

2. Enhance adaptive capacity

2a

Strengthen the ability of people, organisations and networks to experiment and innovate

How are the institutions, organisations and communities involved in tackling changing disaster risks and uncertainties creating and strengthening opportunities to innovate and experiment?

2b

Promote regular learning and reflection to improve the implementation of policies and practices

Have disaster risk management policies and practices been changed as a result of reflection and learning-by-doing? Is there a process in place for information and learning to flow from communities to organisations and vice versa?

2c

Ensure policies and practices to tackle changing disaster risk are flexible, integrated across sectors and scale and have regular feedback loops

What are the links between people and organisations working to reduce changing disaster risks and uncertainties at community, sub-national, national and international levels? How flexible, accountable and transparent are these people and organisations?

2d

Use tools and methods to plan for uncertainty and unexpected events

What processes are in place to support governments, communities and other stakeholders to effectively manage the uncertainties related to climate change? How are findings from scenario planning exercises and climate-sensitive vulnerability assessments being integrated into existing strategies?

3. Address poverty & vulnerability and their structural causes

3a

Promote more socially just and equitable economic systems

How are interventions challenging injustice and exclusion and providing equitable access to sustainable livelihood opportunities? Have climate change impacts been considered and integrated into these interventions?

3b

Forge partnerships to ensure the rights and entitlements of people to access basic services, productive assets and common property resources

What networks and alliance are in place to advocate for the rights and entitlements of people to access basic services, productive assets and common property resources?

3c

Empower communities and local authorities to influence the decisions of national governments, NGOs, international and private sector organisations and to promote accountability and transparency

To what extent are decision-making structures de-centralised, participatory and inclusive? How do communities, including women, children and other marginalised groups, influence decisions? How do they hold government and other organisations to account?

3d

Promote environmentally sensitive and climate smart development

How are environmental impact assessments including climate change? How are development interventions, including ecosystem-based approaches, protecting and restoring the environment and addressing poverty and vulnerability? To what extent are the mitigation of greenhouse gases and low emissions strategies being integrated within development plans?

This publication is part of the Strengthening Climate Resilience Discussion Series, which aims to elaborate concepts and application of the Climate Smart Disaster Risk Management approach. All papers are available free to download through the Strengthening Climate Resilience (SCR) website: www.csdrm.org

The Resilience Renaissance? Unpacking of Resilience for Tackling Climate Change and Disasters. Bahadur, A.; Ibrahim, M. and Tanner, T. (2010) Strengthening Climate Resilience Discussion Paper 1, Brighton: IDS

Assessing Progress on Integrating Disaster Risk Reduction and Climate Change Adaptation in Development Processes. Mitchell, T., Van Aalst, M. and Silva Villanueva, P. (2010) Strengthening Climate Resilience Discussion Paper 2, Brighton: IDS

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Other publications from SCR on the Climate Smart Disaster Risk Management Approach:

Climate Smart Disaster Risk Management in Brief. Mitchell, T. and Ibrahim, M. (2010) Strengthening Climate Resilience, Brighton: IDS

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