THE CONCEPT OF RESILIENCE

Understanding its Origins, Meaning and Utility

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Abstract: The concept of resilience is attractive to policy makers, practitioners and academics. It suggests an ability of something or someone to recover and return to normality after confronting an abnormal, alarming and often unexpected threat. It is used alongside security to understand how governments, local authorities and emergency services can best address the threats from terrorism, natural disasters, health pandemics and other disruptive challenges. This paper explains how the term is applied to: (1) the property of materials to accommodate shock and return to their previous form; (2) the ability of ecosystems to tolerate extreme climatic conditions and other external events; (3) the ability of adults and children to cope with abnormal and traumatic situations; and (4) the ability of communities and organisations to persevere in the face of adversity. The paper acknowledges the concept of resilience is imprecise but suggests that differences in its definition are not as wide as some literature may suggest. Indeed, regardless of its use the term *resilience* has a number of common characteristics which the paper discusses. The challenge facing us now is how best to promote evidence-based research so as to enable informed decisions to be taken on policy, and to assist the development of resilient systems, procedures and practice. [207 words]

Key words: Resilience, vulnerability, adaptable, recover, tenacity, capacity.

Introduction

In less than a decade the term *resilience* has evolved from the disciplines of materials science and environmental studies to become a concept used liberally and enthusiastically by policy makers, practitioners and academics. The UK Government has rewritten its civil contingencies law, doctrine and plans around the concept of resilience. Universities have established resilience centres, institutes, research programmes and offer resilience degrees. Business schools have embraced the concept to explain why and how organisations must adapt their strategies to meet the requirements of an ever-changing competitive business environment.

The term is attractive as it suggests the ability of something or someone to cope in the face of adversity - to recover and return to normality after confronting an abnormal, alarming, and often unexpected threat. Resilience embraces the concepts of awareness, detection, communication, reaction (and if possible avoidance) and recovery. These are essential features of the daily struggle for life and are founded in our basic instinct of survival. Resilience also suggests an ability and willingness to adapt over time to a changing and potentially threatening environment.

But defining resilience has proven elusive. Scholarly work often starts with its Latin root *(resilire)* then departs in a number of directions reflecting the many applications of the term. It is used to describe a property of materials, species, ecosystems, people, communities, organisations and even nations, and is often coupled with the concept of security. Resilience is a contested term and critics have argued that the concept is ambiguous, contradictory and raises unresolved questions.

This paper traces the origins of the term from its use in the early 19th Century in materials science through to its current use as an idea for understanding how society can respond more effectively to threats facing individuals, communities, organisations and nations. The paper identifies and describes a number of characteristics which are common to the concept of resilience in its many contexts and manifestations.

It is one of a series of foundation papers prepared for the Torrens Resilience Institute which aim to provide a frame of reference for the Institute's research, operational support, education and training.

Roots of the term 'resilience'

The term *resilience* was introduced into the English language in the early 17th Century from the Latin verb *resilire*, meaning to rebound or recoil (Concise Oxford Dictionary, Tenth Edition). There is no evidence of resilience being used in any scholarly work until Tredgold (1818) introduced the term to describe a property of timber, and to explain why some types of wood were able to accommodate sudden and severe loads without breaking.

Four decades later, Robert Mallet further developed this concept of resilience as a means of measuring and comparing the strength of materials used in the construction of the Royal Navy's fighting ships. Prior to Mallet's work, most vessels had been built of wood, but with the advent of the steam engine much interest was being shown in the suitability of iron for a warship's hull. Mallet's work is important in predicting with some confidence the suitability of using iron in different parts of "vessels in order to meet the force of the wind and sea; and how the material in the different parts should be proportioned and distributed so as to equalize their powers of resistance to the alternation of strains which the different parts undergo when the ship is afloat." (Fairbairn, 1865, preface).

Mallet developed a measure - the *modulus of resilience* - as a means of assessing the ability of materials to withstand severe conditions. He defined it as the energy required to rupture a material as a result of a force being applied. In a report to the Admiralty, Mallett (1856, p.44) used the concept to explain why "in bronze guns the expansion is so great and the resilience, or power of elastic recovery, so small that in extreme cases …. the gun becomes permanently lengthened."

The *modulus of resilience* was also used in assessing the suitability of materials in public buildings and homes. For example, the *Report to the Royal Society of London on the Great Neapolitan Earthquake of 1857* (Mallett, 1862) used this property to explain why so many churches and houses in Naples collapsed.

The UK's Institute of Civil Engineers accepted the measure and included Mallet's modulus in its *Manual of Civil Engineering of 1867*. Two decades later, Mansfield Merriman defined resilience in his *Textbook on the Mechanics of Materials and of Beams, Columns and Shafts* as "a measure of a material to withstand impact, for if a shock or sudden blow be produced by a falling body, its intensity depends upon the weight and the height through which it has fallen, that is, upon its kinetic energy or work. Hence the higher resilience of a material the greater its capacity to endure work that may be performed upon it. The modulus of resilience is a measure of this capacity within the elastic limits only." (Merriman, 1885, p.200).

The *modulus of resilience* still forms part of the design codes of civil and mechanical engineers, and naval architects. Today, the *Mechanics of Materials* defines it as "the ability of a material to absorb and release energy, within the elastic range" (Gere and Goodman, 2009, p.146). In the study and application of resilience as a property of materials, little has changed in over 140 years.

Resilience and the environment

There is agreement in the literature that Crawford (Buzz) Holling first introduced the concept of resilience to ecology and the environment. He promoted the use of systems theory and modelling, and is credited with the introduction of ecological economics, the adaptive cycle, panarchy (understanding transformations in human and natural systems) and resilience to ecology and evolution.

In his paper *Resilience and Stability of Ecological Systems*, Holling (1973) defined the resilience of an ecosystem as the measure of its ability to absorb changes and still exist. He compared and contrasted the concept of resilience with the notion of stability, which he defined as the ability of a system to return to its equilibrium state after a temporary disturbance; that is the more rapidly the system returns to its equilibrium, the more stable it is. He concluded that resilience and stability are two important properties of an ecological system.

Holling suggested there are two quite different ways of viewing the behaviour of systems, and the usefulness of each view depends on the properties of the system concerned. A building, bridge, ship or aircraft is designed to perform specific tasks under a range of predictable external conditions, and we are likely to be concerned with the ability of such systems to respond <u>immediately and constantly</u> to an external event. A quantitative view of the behaviour of a system is, therefore, essential. But if we are dealing with an ecosystem which may be profoundly affected by external changes, and continually confronted by the unexpected, the immediacy and constancy of its behaviour becomes less important than its <u>persistence and adaptability</u>.

Some ecologists, such as Richard Klein, question a core assumption that underpins Holling's original concept of resilience, namely that ecosystems exist in an equilibrium state to which they can return after experiencing a given level of disturbance. They argue that ecosystems are dynamic and evolve continuously in response to external influences taking place over a period of time.

In a conceptual study of the resilience of the Dutch coastline, Klein et al. (1998) discuss the interrelationship between ecological, biological and socio-economic processes in determining coastal resilience. These processes produce a coastal system that is continually changing, so no original or equilibrium state exists. Moreover, the changes are not isolated events from which the coastal systems may not recover, but are ever-present and occur at different times and in different ways. The authors defined coastal resilience as "the self organising capacity of the coast to preserve actual and potential functions under constantly changing circumstances". (Klein et al., 2004, 40)

In their book on sustaining ecosystems and people in a changing world, Brian Walker and David Salt define resilience as the capacity of a system to absorb disturbance and still retain its basic function and structure. They point out that the response of any system to shock and disturbance depends on its particular context, its connections across scales, and its current state. Every situation is different, and the world is ever changing. Sometimes changes are slow, like population growth and global warming, and sometimes changes are rapid, like exchange rates and the price of fuel. Walker and Salt note that humans are usually good at responding to rapid change, but are less willing to acknowledge or respond to things which change slowly. They point out that change, *per se,* is neither bad nor good; it can have desirable or undesirable outcomes, and it frequently produces surprises. "These broad statements, when applied to interacting systems of humans and nature (socio-ecological systems) take on special meanings with important consequences. Resilience thinking presents an approach to managing natural resources that embraces human and natural systems as complex systems continually adapting through cycles of change." (Walker et al., 2005, 10)

In spite of its lack of specificity, the concept of resilience is still considered useful in understanding the behaviour and improving the management of ecosystems. Academic networks and organisations such as the Resilience Alliance and the Stockholm Resilience Centre aim to advance our understanding of complex social-ecological systems and generate new insights and tools to improve the management practices and long-term sustainability of ecosystems. The Resilience Alliance (www.resalliance.org) is a global network of scientists and practitioners from a wide range of disciplines who collaborate to

explore the dynamics of social-ecological systems. The Stockholm Resilience Centre (www.stockholmresilience.org) is a joint initiative between Stockholm University, the Stockholm Environment Institute, and the Beijer International Institute of Ecological Economics at the Royal Swedish Academy of Sciences.

Since the early work of Holling (1973), many ecological definitions have emerged; see Table 1. The literature provides many perspectives and interpretations, indeed there appears to be little consensus on how the concept can be made operational or even how it can be defined.

Resilience of individuals

The term resilience has been used for over two decades in assessing how well individuals cope in traumatic situations. Early work (e.g. Garmezy, 1971 and Rutter, 1979) focused on the resilience of children, but it has broadened to encompass the ability of adults to manage abnormal situations, particularly their involvement in war, disasters and even 'routine' abnormal events such as major traffic accidents.

Author	Definition
Holling, 1973	Resilience of an ecosystem is the measure of the ability of an ecosystem to absorb changes and still exist.
Pimm, 1984	Resilience is the speed with which a system returns to its original shape
Holling et al., 1995	Resilience is the buffer capacity or ability to absorb perturbation, or the magnitude of the disturbance that can be absorbed before a system changes its structure by changing the variables and processes that control behaviour.
Alwang et al., 2001	Resilience is the ability to resist downward pressures and to recover from shock. From the ecological literature – property that allows a system to absorb and use and even benefit from change. Where resilience is high, it requires a major disturbance to overcome the limits to qualitative change in a system and allow it to be transformed rapidly into another condition.
Alkers et al., 2002	Resilience is the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions, and involves the ability of the system to reorganise following the disturbance driven change.
Cardona, 2003	The capacity of the damaged ecosystem or community to absorb negative impacts and recover from these.
Resilience Alliance, 2005	Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. Thus, a resilient ecosystem can withstand shocks and rebuild itself when necessary.
Stockholm Resilience Centre, 2009	Resilience refers to the capacity of a social-ecological system both to withstand perturbations from for instance climate or economic shocks and to rebuild and renew itself afterwards. Loss of resilience can cause loss of valuable ecosystem services, and may even lead to rapid transitions or shifts into qualitatively different situations and configurations, evident in, for instance people, ecosystems, knowledge systems, or whole cultures.

Table 1: Ecological definitions of resilience

Bonanno (2004, p.20) defines *adult resilience* as "the ability of adults in otherwise normal circumstances who are exposed to an isolated and potentially highly disruptive event such as a death of a close relation or a violent life-threatening situation to maintain relatively stable, health levels of psychosocial and physical functioning …. as well as the capacity for generative (i.e. capable of reproduction) experiences and positive emotions."

Recent studies of adult resilience following bereavement and exposure to terrorist attacks (Bonanno et al., 2005) and in response to natural disasters such as Hurricane Katrina (Mills et al., 2007) have provided substantial data to assess the different categories of reaction by adults to highly disruptive events.

Norris et al. (2009) suggest, as do others (Layne et al., 2007), that resilience represents just one of a number of categories of reaction by adults following exposure to trauma or severe stress. These categories of reaction include:

(1) *Resistance*, where an individual has no, or at least very little, negative reaction to a disruptive event;

(2) *Resilience,* where the individual may experience some negative reaction, then returns to the pre-event functioning;

(3) *Recovery* involves a period of dysfunction lasting several months or more, followed by a gradual return to pre-event functioning;

(4) *Relapsing/remitting,* in which symptoms display a cyclical course;

(5) *Delayed dysfunction*, in which post-traumatic stress disorder (PTSD) or some other trauma-related disorder emerges after considerable time has passed; and

(6) *Chronic dysfunction*, where PTSD or some other trauma-related disorder persists.

Norris et al. (2009) examined the presence of these six categories of reaction following mudslides in Mexico in 1999, where more than 400 people died and at least 200,000 people lost their homes, and the 11th September 2001 attack on the World Trade Centre. The results of their analysis showed the largest group of survivors demonstrated resistance, followed by those who demonstrated resilience, then recovery. Smaller numbers demonstrated chronic or delayed dysfunction response. Of particular importance is the need to distinguish between resilience and resistance; the latter being more evident in the above two examples.

This categorisation of the response of individuals post-trauma is not accepted by all, indeed there is still much debate on the usefulness of the concept of resilience in such circumstances. Norris et al. (2009) and others acknowledge this lack of consensus and suggest that more evidence-based research is required to enable informed decisions to be taken on policy, and to assist the development of improved systems, procedures and practice to assist people exposed to trauma or severe stress.

There are, however, two important areas of agreement in the literature regarding the resilience of individuals. The first is the issue of adaptability. Individuals who are able and willing to adapt are more likely to reduce their risk of being exposed to similar disruptive events, or at least to reduce the impact of such exposure; resilient individuals are likely to be able and willing to adapt. The second is the issue of transient dysfunction. Resilience does not preclude dysfunction or distress; indeed the absence of dysfunction or distress in an individual suggests resistance rather than resilience. It is now commonly accepted that some dysfunction or distress is a normal reaction to an abnormal event. However, dysfunction or distress is temporary, followed by a return to normal functioning.

Resilience of communities

Assessing the resilience of communities is a complex process as it involves the interaction of individuals, families, groups and the environment. There are many theoretical models which address this concept (e.g. Adger, 2003; Paton & Johnston, 2006; Pendal et al., 2007; Norris et.al, 2007; Mayunga, 2009). Most focus on the issues which reduce the vulnerability of communities, such as information and knowledge, supportive networks, shared community values, and the community's ability and willingness to adapt.

Vulnerability arises from the intersection of human systems, the natural environment and the built environment. The most obvious factor contributing to community vulnerability is its proximity to hazards such as coasts, floodplains, seismic zones, highly combustible forests, industrial contamination, or to explosive remnants of war such as minefields. Poorly constructed buildings, inadequately maintained public infrastructure and the density of the built environment also increase the vulnerability of communities. Equally important is the economic health of the community, which is closely tied to commercial and industrial

development (Chang and Falit-Baiamonte, 2002). Finally, there are demographic and social characteristics of residents that make some communities more vulnerable than others. The social vulnerability of communities is borne from inequalities which affect access to resources and information, the ability to absorb the impacts of hazards and disasters without government interventions, housing choice and location, and the political marginalisation of impoverished residents.

The resilience of communities is dependent on social interaction and collective action based on networks of relationships, reciprocity, trust, and social norms. Platteau (1994 and 2000) and Cantor and Rayner (1994) promote the concept of social capital as a means of assessing the potential of a community to demonstrate resilience to disruptive hazards. More recently, Adger (2003) and Morrow (2008) have stressed the relationship between social capital and resilience in explaining the responses of different communities to hurricanes and other natural disasters.

Social capital forms part of a broader asset framework (including economic, physical, human and natural capital), necessary for a sustainable livelihood. In the 1990s, the 'sustainable livelihoods approach' (SLA) emerged, as researchers attempted to understand how vulnerable people manage assets or capital (Moser, 2008). The approach is influenced by work on risk, vulnerability and rural development (e.g. Sen, 1981; Chambers and Conway, 1992). The SLA proposed a framework of five assets (human, social, natural, financial and physical capital), with the underlying assumption that people with more assets are more resilient as they have a range of livelihood options to withstand shocks, trends and seasonal changes. The UK Department for International Development operationalised the framework to understand how policies, institutions and processes can influence access to assets: how to create them, widen access and influence the rates of asset accumulation (DFID, 1999).

Mayunga suggests that the notion of capital aligns very well with the concept of sustainability which is often linked to the concept of resilience. The attraction of using a capital approach is the ability to measure the capital of a community, and hence its potential resilience to cope with future disruptive events. For example, the elements of social capital (trust, norms and networks), economic capital (income, savings and investment) and human capital (education, health, skills, knowledge and information) can be used as indicators of community resilience.

The capital-based approach is not accepted by all. Indeed, one of the problems in reaching a consensus is the different definitions of a community. As Norris et al. (2007) point out, communities are composed of built, natural, social and economic environments that influence one another in complex ways. The literature on community resilience includes everything from grass-roots groups and neighbourhoods to formal institutions and sectors, and so any useful research must define the levels of analysis as well as the composition and characteristics of the community.

Resilience of organisations

The concept of organisational resilience was first used to describe the need for companies to respond to a rapidly changing business environment. Hamel and Välikangas showed great foresight in their paper on *The Quest for Resilience* published in the Harvard Business Review in September 2003 by predicting a global economic crisis later in the decade that would lead to the collapse of a number of iconic US companies. They argued that successful organisations were those who understood the dynamic nature of their business environment (competitors, technology, the availability and cost of finance, taxation, government policy, and their customers' needs and expectations) and who were able and willing to adapt to sudden and large changes to the environment. In this regard, Hamel and Välikangas (2003) argued that successful organisations should evolve like resilient eco-systems, constantly adapting to reflect the changing external environment.

Resilient organisations should have: flexible staff and adaptable supply chains; a range of products which satisfy a range of customers; and agile organisational structures. Hamel and Välikangas and others argue that large companies which rely on legacy products and traditional customers are not resilient and will suffer most in an economic downturn. As with failing eco-systems, organisations which do not adapt will collapse, to be replaced later with new and more efficient organisations which are better suited to the new environment.

Over the past two years the concept of organisational resilience has changed its focus as organisations in the private and public sectors have redefined the extent and scope of the threats facing them. As our society becomes more complex and interdependent we are becoming more vulnerable to disruptive events from a broad range of threats and hazards. If not properly managed, a disruptive event can escalate into an emergency, crisis, or even a disaster. It can taint an organisation's image, reputation or brand in addition to resulting in significant physical or environmental damage, injury or loss of life.

The need for resilience is particularly important for organisations providing utilities and transportation and those operating in the financial sector. The availability of essential services during and following an emergency, crisis or disaster is dependent on the ability of organisations providing utilities and transportation to survive through a disruptive event. Therefore, enhancing organisational resilience is a critical step towards creating more resilient communities.

Seville et al. (2006, p.6) suggest that a resilient organisation is one "able to achieve its core objectives in the face of adversity. This means not only reducing the size and frequency of crises (vulnerability), but also improving the ability and speed of the organisation to manage crises effectively (adaptive capacity). To effectively manage crises, organisations also need to recognise and evolve in response to the complex system within which the organisation operates (situational awareness) and to seek out new opportunities even in times of crises."

Many organisations have strategic and operational plans and programs which address risk, business continuity, security, emergencies and crises. However, Oldfield (2008) suggests that most organisations manage these programmes in isolation from one another, resulting in gaps or wasted resources through overlaps. Risk managers maintain risk registers, security managers conduct threat and vulnerability assessments, and business continuity managers carry out business impact analyses. Organisational resilience aims to bring these tasks and activities together as a single process - one that sits at the very centre of an organisation's management ethos and way of operating.

Some countries have already started to develop national standards and guides for organisational resilience. In the US, the standard *Organizational Resilience: Security, Preparedness and Continuity Management Systems* (ASIS SPC.1-2009) was released in March 2009. Its stated aim is "to provide a comprehensive management framework to anticipate, prevent if possible, and prepare for and respond to a disruptive incident." It was prepared by ASIS International - an accredited standards development organisation – with a committee representing 68 different organisations from the private and public sectors in the US including the Department of Homeland Security. The US standard is now being used as the reference from which other national standards on organisational resilience are being developed. The aim is to reach sufficient international agreement that it will be possible to publish an international standard through the International Organisation for Standardisation (ISO). It is intended that the organisational standard be consistent with other international management standards such as Quality Management (ISO 9001: 2000), Environmental Management Systems (ISO 14001: 2004), Security Management Systems for the Supply Chain (ISO 28000: 2007) and Risk Management (ISO Guide 73). If such a standard is realised; it will demonstrate a major step forward in providing a common international view on one facet of resilience.

National security and resilience

The terms security and resilience are often used together, in particular at the national level. Both share common roots and requirements: the need to assess threats and vulnerabilities; the need to develop plans and procedures; and the need to have access to accurate and timely information. The Royal United Services Institute (RUSI) provides analysis on five areas of interest to both national security and resilience: critical national infrastructure; chemical and biological threats; transport security; intelligence and counter-terrorism; and the UK's Border Force and immigration.

In Australia there has been a convergence of national security and resilience. On 4 December 2008, in his first national security statement to Parliament, Prime Minister Kevin Rudd defined the security of Australia and its people in a broad sense to include threats to human security other than attacks from foreign states and terrorist acts. Such non-traditional threats include attacks on critical infrastructure and information systems, transnational crime including the trafficking of people, drugs and arms, and the impact of climate change which may bring unregulated population movements, declining food production, reductions in arable land, violent weather patterns and resulting catastrophic events. In response to these challenges, Prime Minister Rudd raised the issue of resilience three times in his speech. He stated that:

(1) "Effective mitigation of terrorist attacks involves the combination of an appropriate security response with broader strategies to enhance social cohesion and resilience and lessen the appeal of radical ideology."

(2) "One of the fundamental assets we have to promote our national security objectives is our underlying strength, resilience and cohesion as a nation. Through community engagement we can achieve important national security outcomes ranging from sustaining support for our forces deployed overseas, undermining the influence of violent ideologies and preserving the social cohesion of our diverse society. Just as neighbourhood watch programs promote security at a local level, so we recognise the contribution all Australians can make to promoting security at a national level."

(3) "In Australia we have a strong tradition of volunteering to support our communities, especially in times of emergency, demonstrating the innate resilience and collective responsibility we all share as Australians. This trait is a great strength within our community, a strength the Government will continue to encourage and nurture for the future."

There are advantages in bringing together national security and resilience in Australia. First, the large investment which is being made in national security, such as upgrading communications systems and IT, improving horizon scanning and national risk assessments, and the hardening of the country's critical infrastructure including utilities and transport, is making the country more resilient. Also by bringing together resilience and national security, the Federal Government in Canberra has more control over the instruments of resilience at the State level, and by doing so is better able to encourage a greater degree of standardisation and interoperability between the first responders such as the police, fire authorities, health bodies and the volunteer State emergency services.

There are, however, significant areas of difference and departure between national security and resilience. The threats to national security are usually inspired by the security forces or agents of other countries, terrorists or anarchists who aim to destabilise a government and its people, and national security aims to block or defeat such threats. In contrast, resilience involves an ongoing process of assessing a broad range of risks and threats, preparing to face such threats, accepting that some threats will become disruptive events, reducing the impact of events when they occur, and then recovering afterwards.

Resilience also requires an understanding of the needs and expectations of society, and how these needs and expectations are developing over time. Countries such as Australia have nurtured a strong and admirable tradition of their communities supporting one another in times of trouble. But such national resilience cannot be taken for granted and there are signs that society is becoming more brittle than in previous generations – requiring more investment and effort by the Federal and State Governments and local authorities in providing technical security measures to compensate for the diminishing resilience of families, groups and communities. David Templeman and Anthony Bergin suggest in their seminal paper *Taking a punch: building a more resilient Australia* that "too many in our community believe that calling 000 will generate an instant response: just-in-time shopping with instant access to banking, goods and services has encouraged a sense of public complacency. We've come to believe that our workforce of emergency volunteers will always be there to manage all hazards …. it's very difficult for individuals and some business organisations to comprehend that they might be affected." (Templeman and Bergin, 2008, p.3)

The characteristics of resilience

The term resilience has many critics. Kaplan (2005, p.39) states that "the deceptively simple construct of resilience is in fact rife with hidden complexities, contradictions and ambiguities ….. arguably, any consensus that exists regarding the nature of resilience rests upon the idea of achievement of positively (or the avoidance of negatively) valued outcomes in circumstances where adverse outcomes would normally be expected. A close examination of this idea, however, reveals a number of unresolved questions that at best render the concept less than useful, and at worse impede progress in understanding human adaptation."

Others are less critical. Holling (2006) who is considered by some to be the father of resilience theory, believes that the concept of resilience provides a new and useful framework of analysis and understanding on how individuals, communities, organisations and ecosystems cope in a changing world facing many uncertainties and challenges. Sometimes change is gradual and things move forward in continuous and predictable ways; but sometimes change is sudden, disorganising and turbulent. The resilience approach focuses on the interaction between periods of gradual and sudden change, and provides better understanding on how society should respond to disruptive events and accommodate change. Resilience is an area of research under rapid development with major policy implications for sustainable development.

Certainly, there is a broad range of definitions of resilience. In this paper, eight definitions of *environmental/ecological* resilience are provided, and many more could have been included. A similar spread of definitions could have been provided for the resilience of individuals, communities and organisations. But such a spread of definitions and divergence of opinion is not unique to resilience. The definitions of security and defence, for example, are equally contested yet the study of both is clearly useful and is encouraged.

Indeed, differences in the definition of resilience may not be as diverse as might appear at first sight. Resilience has a number of characteristics which are discussed at length in the literature and have been summarised in this paper.

(1) <u>Threats and events</u>. All definitions of resilience refer to threats and events which are abnormal in terms of their scale, form or timing. Resilience is seen as the ability to accommodate abnormal threats and events, be they enemy actions (Fairbairn, 1865), or perturbations from climate change (Stockholm Resilience Centre, 2009), or natural disasters such as earthquakes or floods (Bruneau et.al., 2003), or economic shocks (Hamel and Välikangas, 2003). Most definitions, particularly those involving individuals,

communities and organisations also refer to identifying, assessing and communicating the risk from such threats and events.

(2) <u>Positive outcomes</u>. All definitions refer to a positive outcome, be it the ability of a material to absorb and release energy and return to its original state (Gere and Goodman, 2009), or the ability of an individual, group or organisation to continue in existence in the face of some sort of surprise (Longstaff, 2005), or the ability to recover from or adjust easily to misfortune or sustained life stress, or the capacity of a system to absorb disturbance and still retain essentially the same function (Resilience Alliance, 2006). In some cases a positive outcome means returning to the state or condition that existed before the disturbance occurred; in other cases a positive outcome means returning to an improved state or condition.

(3) <u>Being prepared</u>. Resilience involves the ability or capacity to absorb, and then recover from an abnormal event. This capacity may be built formally and deliberately by developing plans, standards and operational procedures, or by developing physical, economic and/or human capital (Mayunga, 2007). It may also evolve informally through the development of social capital (Tierney, 2006), or it may exist naturally through the properties of the material being used (Mallet, 1856). Individuals, communities, organisations and, indeed, nations which are prepared and ready for an abnormal event, tend to be more resilient.

(4) <u>Desire/commitment to survive</u>. Survival is a basic human instinct, and individuals who demonstrate the strongest will to remain alive are able to accept extreme and abnormal conditions and recover from traumatic events. Similarly, groups, communities and organisations with a unity of purpose and a collective commitment to survive are more likely to succeed. This is achieved through strong leadership and by shared organisational values and beliefs.

(5) <u>Adaptability</u>. We live in a world which is constantly evolving, in some cases through natural processes and in other cases through the intervention of mankind. There is common agreement in the literature that systems, organisations and people who are able and willing to adapt tend to be more resilient.

(6) <u>Gaining experience</u>. The ability and willingness to learn is often linked to adaptability and being prepared. The learning may come from personal experience or by studying the lessons of others in a formal manner: by gathering and evaluating data, by conducting research in an objective, independent and balanced manner, and by communicating the findings, conclusions and recommendations.

(7) <u>Collective and coordinated response - interdependency</u>. As society becomes more complex and interconnected, and the impact of global factors become more immediate and apparent, we find ourselves more vulnerable to disruptive events. In facing such interconnected threats, resilient communities and organisations and indeed nations tend to be those which are well coordinated and share common values and beliefs. But researchers such as Durodie (2004) suggest that shared community values and beliefs in the modern world have been replaced by self interest and personal gain, resulting in vulnerable societies which are less able and willing to plan for, and react to, disruptive events.

Conclusions

The threat from terrorism, natural disasters, health pandemics, attacks on information systems and other disruptive challenges has increased in recent years, and changes to our society have made us feel more isolated and vulnerable. Resilience provides a positive response to these threats. It suggests an ability to cope in the face of adversity, and the

ability to recover and return to the status quo, or even to be stronger as a result of the experience.

Despite its popularity, there are widely differing views on the meaning and utility of resilience. The term is applied to materials, ecosystems, individuals, communities, organisations and nations, and there are wide differences in the way the concept is interpreted across the social science disciplines.

The paper acknowledges the concept of resilience to be imprecise but suggests that differences in its definition are not as wide as some literature may suggest. Regardless of its application, the term *resilience* has a number of common characteristics such as the ability to absorb and then recover from an abnormal event; being ready and prepared to face threats and events which are abnormal in terms of their scale, form or timing; an ability and willingness to adapt to a changing and sometimes threatening environment; a tenacity and commitment to survive; and a willingness of communities and organisations to rally round a common cause and a shared set of values.

There is also evidence that in some resilience applications there is a growing consensus on terminology and use. The development and publication of an American standard on organisational resilience, which will form the basis of an international standard, may provide an agreed point of departure for the development of common thinking, systems and procedures in organisational resilience. The establishment of resilience institutes, centres and research programmes in universities, and the development of resilience degrees at post graduate level may also help provide greater strategic direction and better coordination of work in resilience and its applications.

This paper has argued that resilience is a powerful and useful concept. The literature may contain a variety of definitions which reflect its many applications, contexts and manifestations, but each share a common set of characteristics. The challenge facing us now is how best to promote and coordinate evidence-based research so as to enable informed decisions to be taken on policy, and to assist the development of resilient systems, procedures and practice.

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