From sustainability to resilience: a paradigm shift

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Background and introduction

Despite inherent definitional and interpretational difficulties the term 'sustainability' is widely used in contemporary economic, social and environmental discourse to describe a desirable endgame. Although the term was popularized in the 1987 report *Our Common Future* published by the World Commission on Environment and Development (also known as the Brundtland report), its origins can be traced back to the United Nations Conference on the Human Environment held in Stockholm in June 1972 (UNEP). This declaration, although the title refers to the human environment, acknowledged the importance of the environment in achieving human well-being. More importantly, it drew attention to the "growing evidence of man-made harm in many regions of the earth: dangerous levels of pollution in water, air, earth and living beings; major and undesirable disturbances to the ecological balance of the biosphere; destruction and depletion of irreplaceable resources; and gross-deficiencies, harmful to the physical and mental and social health of man, in the man-made environment…" (UNEP 1972:1).

The Brundtland report penned the now classic definition of sustainable development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs." This report was followed by a set of 27 sustainable development principles adopted at the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil in 1992. The conference also adopted Agenda 21, a global plan of action for sustainable development, described in 40 separate chapters with a set of actions. The conference was notable for establishing three seminal instruments of environmental governance: the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), and the non-legally binding Statement of Forest Principles. A further consequence was the creation of the Commission on Sustainable Development (CSD).

A number of similar conferences have been held subsequent to 1992, including Earth Summit+5 in 1997; World Summit on Sustainable Development (WSSD) in 2002; and most recently the 2012 Rio+20 conference in Brazil. However, it could be argued that the more recent recognition given to climate change and the work of the Intergovernmental Panel on Climate Change (IPCC) has provided a new impetus to sustainable development, or as Drexhage & Murphy argue, "sustainable development has found a de facto home in climate change" (2010:9).

Resilience, on the other hand, is a term that first appeared in literature with regard to material science: it was used as a term to describe the behaviour of timber in warships, and later the behaviour of steel in warships in the 1800s. Its use was connected to the ability of the material to withstand the impact of cannons. It did not appear in ecological literature until Holling applied it in the 1970s "as a measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (1973:14).

The term has also gained popularity in political discourse and policy, perhaps because of its suggestion of strength, and perhaps because of the more recent actual experience of climate change and its impacts.

The ‘environment’ is a broad term and can be described in natural and built (man-made) terms. This essay relies on the National Environmental Management Act (Act 107 of 1998) definition:

“Environment means the surroundings within which humans exist and that are made up of –

i) The land, water and atmosphere of the earth;

ii) Micro-organisms, plant and animal life;

iii) Any part or combination of (i) and (ii) and the inter-relationships among and between them; and

The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.”

This essay examines the relationship between sustainability and resilience.

Sustainability concept and theory

The 1972 declaration (UNEP) contains 26 principles to guide efforts for the preservation and improvement of the human environment. The principles refer to key concepts that have become *de facto* terms in conservation-based human development policy. The principles contain notions such as ‘protect and improve the environment for present and future generations’; ‘the natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded’; ‘the capacity of the earth to produce vital renewable resources must be maintained’; ‘management of non-renewable resources’; ‘halting the discharge of toxic substances and the release of heat’; ‘the adoption of an integrated and coordinated approach to development planning’; and the ‘application of science and technology to the identification, avoidance and control of environmental risks’. More critically the principles focused attention on single biological resources such as fishery, the interdependencies of multi-resource ecosystems, and the complexity of economic-social-physical settings.

It also raised a number of challenging issues, such as the right to a healthy and productive environment, intergenerational implications of resource use, contemporaneous socio-economic equity, time horizons, and the dependence of humanity on Nature.

Essentially, sustainable development is predicated on a convergence between economic development, social equity, and environmental protection – also known as the three pillars of sustainable development. In its content it is fundamentally growth focused where growth is understood to be economic – but argues that growth must be fair (equitable) and not cause harm to the environment (Drexhage and Murphy 2010). While in application it has been compartmentalized as an environmental issue, the guiding principle is interpreted as “do least harm” otherwise euphemistically known as ‘the precautionary principle’. As noted by Drexhage and Murphy (2010:2) the “problem with such an approach is that natural resources are in imminent peril of being exhausted or their quality being compromised to an extent that threatens current biodiversity and natural environments.”

Perhaps sustainability theory’s most spectacular failure is its inability to change patterns of consumption and production – despite its efforts in this regard. In developed countries gross domestic product (GDP) remains the yardstick for measuring economic performance and is reliant on consumerism, while in developing countries high levels of unemployment and poverty make millions of people dependent on accessing natural resources, legally and illegally. Both actions depend on access to resources with the difference being that developed economies are essentially depleting non-renewable resources (mining, fossil fuels) while in developing economies communities are depleting renewable resources (forestry, fishery). Again, both actions share a common outcome: undermining of biodiversity and natural environments.

While there have been some sustainable development successes – most notably the results of the Montreal Protocol – unsustainable trends continue. Drexhage and Murphy (2010:16) ascribe this to the following issues:

i) The concept remains too amorphous to be clearly defined, and hence implemented.
ii) Sustainable development remains fundamentally an environmental issue.
iii) Sustainable development has been subject to competing agendas.
iv) Development as economic growth continues to be the dominant paradigm.
v) Developed countries have not met commitments to developing countries, generating an atmosphere of distrust.
vi) Sustainable development has not been able to find political entry points to make real progress.

Resilience concept and theory

Resilience was historically used to describe the ability of a material to withstand shocks. It was not until 1973 when its definition broadened from its engineering and material background to encompass ecology, and to include the ability to adapt as well as withstand shocks. As Fiksel (2006:16) notes, “resilient systems, including biological and socioeconomic entities, are able to survive, adapt, and grow in the face of uncertainty and unforeseen disruptions”.

Central to resilience theory is the acknowledgement that “a perturbation can bring the system over a threshold that marks the limit of the basin of attraction or stability domain of the original state, causing the system to be attracted to a contrasting state” (Folke et al. 2010). Folke et al (2010) stresses that this is qualitatively different from returning to the original state, an observation that Holling recognized in the 1996 definition. Holling (1973:1) noted that “individuals die, populations disappear, and species become extinct.”

So it may be that some species do not survive: a disturbance of significant impact may well result in the extinction of a dominant species which allows a new species to enter that domain. Change is an integral part of growth and development and can have either positive or negative outcomes. It can be argued that extreme environmental changes can push an ecosystem beyond its capacity to cope, yet even in instances where changes have resulted in extinction, extraordinary ecosystem growth has occurred afterwards. There is an argument that mass extinctions have sometimes accelerated the evolution of life on earth (van Valkenburgh 1999). Figure 1 below indicates the growth in the number of specie types over the past 545 million years despite (or perhaps because of) the five major extinction types (shown in red triangles).

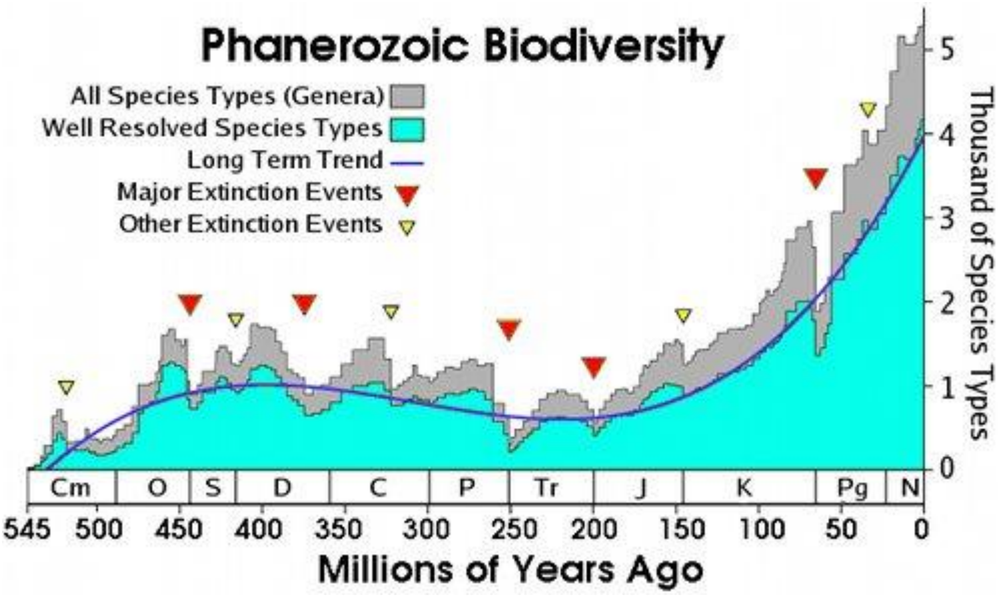

Figure 1: Specie types and major extinction events (Source: Wikipedia 2014)

Fiksel (2006:16) argues that "the sustainability of living systems – including humans – within the changing earth system will depend on their resilience". However, it may be that the current rate of species loss will make it difficult for species to recover, or for new species to access previously dominated areas. Estimates of current species loss range from 4,000 to 6,000/annum, making it the largest species loss since that of the dinosaurs 65 million years ago at almost 1,000 times the background rate of extinction (Quammen 1998). Again, as Gunderson et al. note, ecological resilience is different from engineering resilience. In the latter, resilience is the time it takes to return to a global equilibrium after a disturbance while in the former it is "the amount of disturbance that a system can absorb before it changes state" (2002:3). The latter view implies only one stable state, whereas the former view is based on "the demonstrated property of alternative stable states in ecological systems" (2002:3).

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Folke et al. (2010) argue that there are three aspects central to resilience thinking: resilience, adaptability, and transformability. Resilience is the tendency of change to remain within a stability domain, continually changing and adapting yet remaining within critical thresholds. Folke et al. (2010) refers to Berkes et al. (2003:393) argument that adaptability "captures the capacity of a system to learn, combine experience and knowledge, adjust its responses to changing external drivers and internal processes, and continue developing within the current stability domain or basin of attraction." Folke et al. goes on to describe transformability as "the capacity to transform the stability landscape itself in order to become a different kind of system, to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable" (2010:16).

The sustainability/resilience nexus

Sustainability theory and resilience theory are both fundamentally concerned with the environment where 'environment' is understood in the context of the National Environmental

Management Act (Act 107 of 1998). Both theories acknowledge the importance of the environment in achieving human well-being. Both draw attention to the "growing evidence of man-made harm in many regions of the earth: dangerous levels of pollution in water, air, earth and living beings; major and undesirable disturbances to the ecological balance of the biosphere; destruction and depletion of irreplaceable resources; and gross-deficiencies, harmful to the physical and mental and social health of man, in the man-made environment…" (UNEP 1972:1).

Sustainability theory and resilience theory both embody integration, and "understanding and acting on the complex interconnections that exist between the environment, economy, and society" (Drexhage and Murphy 2010:6).

The sustainability/resilience disconnect

Unlike resilience theory, sustainability theory attempts to distil an amorphous concept into three neat pillars, i.e. economic, social and environmental sustainability.

Unlike resilience theory sustainability theory is fundamentally growth focused where growth is understood to be economic. Sustainability theory foresees endless (economic) growth, and posits that this is achievable if a certain behaviour is maintained (do least harm).

Unlike resilience theory sustainability theory introduces the concept of ethics into environmental preservation through its intergenerational commitment and its desire for social fairness. It also introduces the concept of human rights through its acknowledgement of the right to a healthy and productive environment.

Unlike resilience theory, sustainability theory has, as a guiding principle, the 'do least harm' approach otherwise euphemistically known as 'the precautionary principle'.

Perhaps sustainability theory's most spectacular failure is its inability to change patterns of consumption and production – despite its efforts in this regard.

However, the biggest flaw in sustainability thinking is the assumption that steady state equilibrium can be achieved. Sustainability assumes that, providing certain measures are put in place particularly consumption and production processes, growth will be continuous into the future. In theory, steady state systems have numerous properties that are unchanging in time. Sustainability thinking discounts uncertainty and unforeseen disruptions. However past experience indicates that the earth is not in a steady state although there may be times when it is in an apparent state of equilibrium. The earth is subject to dynamic spatial and temporal changes on an ongoing basis, with a wide range in the rate and frequency of these changes. Some of the changes are of sufficient magnitude to significantly alter the state. As Fiksel argues, "force of change, such as technological, geopolitical, or climatic shifts will inevitably disrupt the cycles of material and energy flows" (2006:16). Gunderson et al. (2002) argues that the difference between engineering resilience and ecological resilience is the first focuses on maintaining efficiency of function while the second focuses on maintaining existence of function. They argue that the two are so fundamentally different that they become alternative paradigms.

Resilience theory, in contrast, is predicated on disruption and the possibility of a new development trajectory. Resilient systems, including biological and socioeconomic entities, are able to survive, adapt, and grow in the face of uncertainty and unforeseen disruptions and it is this adaptive capacity which may lead to new equilibria, a precondition for sustainability.

Discussion

Arising out of the above, a number of difficulties arise.

The first difficulty has to do with the temporal and spatial lens with which sustainability is viewed. Contemporarily, sustainability is viewed as the potential for the human species to live and thrive forever i.e., the intergenerational commitment. This essay has argued that species have come and gone, and – in the absence of a religious view – there is no ecological reason why *homo sapiens* too could not become extinct, just as their predecessor hominids did. Using the argument that the emergence of *homo sapiens* occurred during a time of dramatic climate change 200,000 years ago (Smithsonian Institute 2014), a case could be made for a similar evolutionary step to occur sometime in the future, especially if the earth is heading for (or is already in the process of) a sixth extinction. The notion that sustainability is the key to be able to proceed indefinitely into the future becomes even more problematic given the projected lifespan of the sun. It is thought that the sun formed about 4.567 billion years ago and is roughly halfway through the most stable part of its life (Williams 2013). However, long before that occurs, earth's water "will evaporate making it inhospitable to all known terrestrial life" (Schroder and Smith2008). Thus the notion of what is sustainable changes pending the spatial and temporal scales employed. Perhaps sustainability only exists at the scale of cosmic inflation.

The second difficulty arises from the way that sustainability efforts generally focus on a single entity or industry: a business will report about its annual sustainability performance, or an industry sector, transport for example, will speak about the goal of sustainable transport, but it is unrealistic to perform an analysis of sustainability in the absence of the broader supporting environment. Setting boundaries for analysis is and remains a formidable challenge.

More critically, the third difficulty arises in the manner that sustainability theory discounts uncertainty and unforeseen disruptions. Global environmental change includes both systemic changes that operate globally through the major systems of the geosphere-biosphere, and cumulative changes that represent the global accumulation of localized changes (Turner et al. 1990). As Fiksel argues, to better understand sustainable systems, the field of biocomplexity is being pursued: this is concerned with "characterizing the interdependence of human and bio-physical systems. It is necessary to study the links among industrial systems (energy, transportation, manufacturing, food production), societal systems (urbanization, mobility, communication), and natural systems (soil, atmospheric, aquatic, biotic), including the flows of information, wealth, materials, energy, labour, and waste" (2006:16). He notes that it is the "complexity, dynamics, and nonlinear nature of these interdependent systems" (2006:16) that makes the notion of sustainability unrealistic. Fiksel suggests that systems must be designed to be inherently resilient by "taking advantage of fundamental properties such as diversity, efficiency, adaptability, and cohesion" (2006:17).

The United States Environmental Protection Agency (EPA) proposes a new scientific framework that adopts a more systematic and holistic approach to environmental conservation and preservation that takes the complex nature of environmental issues into account. Its *Sustainability Research Strategy* (2007:40) encompasses several important challenges:

- Addressing multiple scales over time and space.
- Capturing system dynamics and points of leverage or control.
- Representing an appropriate level of complexity.
- Managing variability and uncertainty.
- Capturing stakeholder perspectives in various domains.
- Understanding system resilience relative to foreseen and unforeseen stressors.

The fourth difficulty arises with the emerging notion that the development of resilient, adaptive systems is required for achieving sustainability. Given the likely future of this planet, sustainability within the context of this essay is only applicable at a specific spatial and temporal scale.

Conclusion

Anthropological activities, which include land use changes and greenhouse gas emissions, have changed and continue to change the surroundings in which humans and other species live. Global environmental activities, which include climate change and extreme weather events, also change the surroundings in which humans and other species live. Global environmental change includes both systemic changes that operate globally through the major systems of the geosphere-biosphere, and cumulative changes that represent the global accumulation of localized changes. The natural and built environments will, in turn, react to and influence these changes in different ways: however, both systems are sensitive to variability and while some of these changes may be beneficial, others may represent a serious threat to species survival.

As Fiksel (2006:17) argues “it is necessary to move beyond a simplistic ‘steady-state’ model of sustainability.” In its place must be developed policies rooted in the dynamic interdependencies of species including the recognition of the dependency of *homo sapiens* on his surroundings, aimed at adaptation and mitigation, and derived from and supportive of ecosystem functions.

Folke et al. (2010:16) make a powerful case when they argue that:

> transformations do not take place in a vacuum, but draw on resilience from multiple scales, making use of crises as windows of opportunity, and recombining sources of experience and knowledge to navigate social–ecological transitions from a regime in one stability landscape to another. Transformation involves novelty and innovation. Transformational change at smaller scales enables resilience at larger scales, while the capacity to transform at smaller scales draws on resilience at other scales. Thus, deliberate transformation involves breaking down the resilience of the old and building the resilience of the new. As the Earth System approaches or exceeds thresholds that might precipitate a forced transformation to some state outside its Holocene stability domain, society must seriously consider ways to foster more flexible systems that contribute to Earth System resilience and to explore options for the deliberate transformation of systems that threaten Earth System resilience

At its most fundamental level the human species must shed itself of its perceived privileged species status, and acknowledge that as a species we are equally vulnerable to disruption and shock. Only once *homo sapiens* realise that their resilience is inseparable from ecosystems’ resilience, will policy focus on enabling society to cope with unexpected challenges and to adapt to changing circumstances, recognizing that those changed circumstances may be significantly different from what came before.

To paraphrase Robin Williams in the movie Dead Poet Society, “That the powerful play ‘goes on’ and you may contribute a verse”: only in the context of this essay the stage and the actors may well be different.

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