A role for diversity in achieving sustainability through ecological, social and economic domains

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Modern conceptions of progress, based on the dominant Cartesian reductionist paradigm, are associated with a linear drive towards ever greater ascendancy, order, organisation, homogeneity, hegemony, performance, efficiency, and control. Similarly modern conceptions of progress are associated with positivist approaches to overcoming and extinguishing disorder, inchoateness, uncertainty, redundancy and risk. In this framework, diversity is conceived as a threat to system organisation, efficiency and control. Many contemporary conceptions of sustainability and sustainable development, framed within this paradigm, envisage sustainability as aligning with such ideas of progress. By this narrative, sustainable systems are achievable through ever greater efficiency, through for example, technological prowess, improved organisational structure/control, taming of 'big data' and through risk reduction/extinction. Similarly, corporate sustainability would be advanced through growth, mergers and acquisitions, rationalisation, pruning of smaller operations/sites within firms, layoffs, increased corporate control, accountability and managerialism. 'Bigger is better' is the apposite maxim.

From a complex systems perspective however, a very different picture is evident. In the ecological domain, sustainable ecosystems have been quantitatively shown to be those which maintain an appropriate (context, time and space dependent) dynamic *balance* between opposing tendencies of ascendancy and efficiency on one hand and diversity and redundancy on the other (Ulanowicz, 2009; Goerner et al., 2009) (Fig. 1).

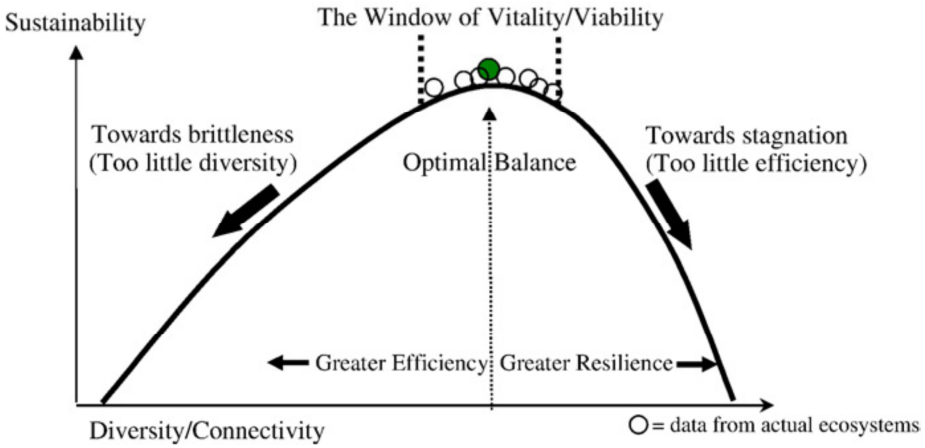

Fig. 1 Sustainability as a function of diversity and efficiency (Goerner et al., 2009).

Ecological biodiversity is an absolute requirement for ecosystem endurance since it facilitates system resilience in the event of significant perturbation (whether sudden shock or longer term stress). For example, a species which can feed on a selection of available prey species is more

resilient against partial ecosystem destruction/prey extinction than one which relies on a single species for food. While the latter scenario represents a situation of greater efficiency, it is also more rigid and less resilient. Moreover, while the tendencies of complex systems towards ascendancy (organisation, efficiency) and disorder (redundancy, diversity) are antagonistic at local levels, they are in fact mutually dependent at higher levels (Ulanowicz et al, 2009):

"A requisite for the increase in effective orderly performance (ascendency) is the existence of flexibility (reserve) within the system. Conversely, systems that are highly constrained and at peak performance (in the second law sense of the word) dissipate external gradients at ever higher gross rates."

This model has been mirrored across techno-economic and social domains wherein similar sustainability models have been proposed (e.g. Stirling, 2011). This framework has manifested itself in research outputs across virtually every discipline, where in different guises sustainable and persistent systems have been shown to require a balance between tendencies of control, structure and organisation and those of diversity and disorder. Some examples follow.

In agriculture, reductionist scientific approaches lead to homogenous monocrop plantations, the displacement of smallholder/family unit farms in flourishing local communities with commercial scale farming and the promotion of energy demanding intensive farming practices over labour intensive organic farming practices. Each of these outcomes have disastrous ecological and social consequences, such as for example, soil degradation and erosion, reduced resilience (e.g. the 1840's Irish potato famine) and increased unemployment.

In engineering, dependence on a vast grid supplied by a small number of very large power generation sources is less resilient and more prone to widespread power outages than when supplemented by diffuse micro-generation and distribution (microgrids) of electricity locally. Moreover a diverse range of generation sources has energy security implications.

In biology, populations of species which maintain a diverse gene pool are more resilient against threats such as disease, ailments and environmental changes.

In politics and governance, states and political units which have strong regional and local devolution and citizen empowerment are far more resilient than large centralised autocratic entities that maintain power and seek to control from the centre. Moreover, a reductionist prioritisation of competitive forces between individuals ahead of interconnectedness and social cohesion promotes individualism, rising economic inequality and hegemonic globalisation characterised by corporate control and economic centralisation and concentration of wealth. The same forces of hegemonic globalisation also threaten diversity through reducing local jobs, businesses, customs, cultures, languages and overall social cohesion, thus also increasing social fragility. The global economic crisis from 2007 has borne testament to the inherent unsustainability of this approach.

In business organisation, Japanese car manufacturers found in the wake of the 2011 Tsunami that their relatively small number of globally centralised lean production manufacturing sites led to significant manufacturing supply chain problems.

Diversity and trust also facilitates creativity and (business and social) innovation and entrepreneurship. Conversely these are stymied by an approach which seeks system

optimisation through ever increasing organisational control, strategic planning and process efficiency. A vision of progress which seeks to extinguish uncertainty to gain ultimate control is as delusional as it is potentially dangerous however, since it is directly analogous to seeking to violate the second law of thermodynamics through creating an isentropic universe, a 100% efficient machine or a trip back in time. Essentially it is an impossible and unsustainable mirage!

Ulanowicz, R.E. (2009a) The dual nature of ecosystem dynamics, Ecological Modelling. 220, 1886–1892

Ulanowicz, R.E., Goerner, S.J., Lietaer, B, and Gomez, R. (2009) Quantifying sustainability: Resilience, efficiency and the return of information theory. Ecological complexity 6, 27–36.

Goerner, S.J., Lietaer, B. and Ulanowicz, R.E. (2009) Quantifying economic sustainability: Implications for free-enterprise theory, policy and practice, Ecological Economics 69, 76–81.

Stirling, A. (2011) From Sustainability, through Diversity to Transformation: Towards More Reflexive Governance of Vulnerability, In: A. Hommels, J. Mesman, and W. Bijker , eds., Vulnerability in Technological Cultures: New Directions in Research and Governance Cambridge MA: MIT Press, forthcoming

http://www.exeter.ac.uk/energysecurity/documents/publications/Stirling_chapter_on_resilience_to_transformation.pdf