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NESTED SCALES OF LIFE SUPPORTING PROCESSES AND HUMAN JUSTICE

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Introduction

Present environmental models largely fail to explain system behaviour. This is attributed the hard stuck paradigm of simplified cause-effect behaviour of small number systems. At present notoriously applied to arbitrary discretised scales where it can be formulated as elaborate mathematical relations. Such relations are then analytically or numerically solved; uncertainties are introduced as random elements following the law of large numbers (which breaks down in the presence of living processes). The models thus lack a necessary transparency for improving decision making. This seduces managers, planners and policy makers into using reductionistic conclusions based on average conditions which do not, and can not, reflect the duality of the site specific, hierarchical and highly organised communication of the living system.

The role of science for policy and management of social and economic perspectives have been put on the agenda by Sokal, with his hoax article in the journal *Social Text*. This has also raised the question about natural science as a cultural construct. This clearly demonstrates that science is part of society, and that any science that formalises itself to a language (whether mathematical or linguistic) cut off from society is meaningless. Such formalistic language cannot ultimately achieve pure description and at the same time be rich enough to guide behaviour. The gaps between the complexity of for instance sustainability and models, represented as mathematical tools or legal systems, are approaching a level where they no longer communicate with society.

Time and complexity in natural science

In natural science complexity was introduced with thermodynamics - time was no longer irreversible (Prigogine and Stengers, 1984). Instead time lead to development. The increase in disorder over time is a necessity for life to exists as a structure far from thermodynamic equilibrium. Life nourishes from sucking order from its environment, enclosing a higher internal order at the cost of an outer increase in disorder. This is accomplished via a continuos hierarchy, ranging from a sub-cellular level to a global scale. Yet still arguments can be heard from leading scientists that LaPlace demon really could exist - everything can be forecasted by deterministic models. In water sciences this is reflected in the use of for instance Darcy's law for modelling ground water flow, and by the application of Navier-Stokes equation for solving turbulent flow problems in different media. Basic assumptions underlying these equations are seldom questioned. But it is now clear that for instance interactions between different phases (e.g. liquid-solid, liquid-gaseous) lead to chaotic behaviour at different scales. God is playing dice, at least at this scale.

Ideas of nature and societal organisation

Throughout Western history there has been a tendency to organise society according to mainstream ideas of what is a 'natural' system. Plato, in a Greek tradition of a decaying world, *mundus senescens*, wanted to organise society as a hierarchy led by enlightened philosophers. The aim being preventing the further decay. The forbidden seeking of knowledge should be privileged only for those capable of the correct interpretation. The prevailing thought was that of nature's being deducing moral constraints; rationality should rule the world. And nature was interpreted as a 'a great chain of being' (Lovejoy, 1936). That Christianity inherited these ideas is recognised by the resemblance of the myths of Prometheus and the garden of Eden - seeking knowledge is punished. The influence of these ideas reached all the way, at least, to T. More's Utopia (1516). With Romanticism comes a change - Kant formulates an alternative view on moral constraints as freed from the interpretations of nature. Another view on society, as organised after knowledge and science spread throughout, was advocated already by F. Bacon in his *New Atlantis* (posthumously published 1627). The scientific revolution led to the creation of the tools for technical support of a new 'industrial' development, mentally prepared by these changes. Instead of being the steward of a divine creation, man became the ruler of Earth and her lower beings. In the myth of Faust, the seeker of knowledge is forgiven by the divine.

New principles of justice and politics were constructed based on the Kantian ideal and the political philosophies of notably Bentham, Locke and Rousseau. Combined with the (Epicurean) idea of natural rights - leading to capitalism, and on the (platonic) idea of individual inequality and the paradox of freedom - leading to patriarchalism and communism. With the capitalistic system having evolved to a leading position, it is still clear that it can not constrain itself to live within ecological frameworks. Despite the efforts in Rio 1992, the environmental problems are still escalating, and are principally unsolved for a growing population. There is a need for new theories of social, economical and technical interactions under ecological constraints. With what has been said above, what are the potential routes to follow?

Nesting scales and justice - a solution?

In natural science many studies seek solutions either in nesting reductionistic models of different scales, or try to use holistic approaches based on first principles and heuristic pattern recognition for evaluation. The former is most commonly done nesting global circulation models (GCMs) with finer scaled models of for instance hydrology and ecology. The problem is that most GCMs are based on the same basic (cause-effect) assumptions of climate forcing; results are deterministic scenarios that still do not match climate observation data very well. Heuristic pattern recognition demands a very dense observation of the phenomena in time and space, where the observation must be adjusted to natural frequencies and architectures. The best example probably comes from medicine, where patterns of electrocardiograms (ECGs) now can reveal much about hart functions.

Justice and its distribution unquestionably influences sustainable development. In social science new theories on distributed justice have been formulated challenging the paradigm of utilitarianism set forth by Bentham, notably by Rawls (1972) and subsequent developers of his theory (see Viking, 1995). Rawls' theory rests on the idea of a social contract, in Rawls' case signed under a veil of ignorance - that is under conditions where individuals do not know their position in society. This holds a key for maximising the minimum. Strong advocates of animal rights have extended Rawls' ideas of a distributive justice to also include non-human beings (cf vegans). Both utilitarianism and Rawls' theory are based on a Kantian ideal, decoupled from any natural science foundation.

Norton (1996) proposes an approach for constraining human activity in harmony with natural 'quanta' as suggested by Holling (1992). An individual scale with locally developed values that express the preference of individuals, given the established limits and rules - physical laws, governmental laws, and market conditions. A community scale where society's dialogue with nature will be defined by policy and management on one hand and natural ecological and hydrological processes, *inter alia*, on the other. Norton (1996) recognises this as the most important scale for sustainable development at present. The discrepancy between the community and individual scale is manifold. Many of these problems have been investigated with game theoretical approaches, highlighting both the problem of scale like in the Hardin's (1968) tragedy in the commons, and in conflicting interests on the same scale, like in the prisoners dilemma. The importance of communicating systems between community and individuals for sustainable development, especially for securing the disadvantaged has been shown by Viking (1995). Norton (1996) also suggests a global scale. However, no organisation principle for accomplishing this has been shown to exist. It is interesting to note that Norton's suggestions in a sense is returning to the Greek idea of nature's being defining moral constraints.

Conclusion

Natural systems have a tendency to absorb small changes until they become brittle, reaching thresholds, where small changes can lead to bifurcations and chaotic fluctuations. Traditional cause-effect models of natural phenomena fail to forecast such events; societal organisation at different scales fail to constrain and distribute sustainable levels of environmental explorations. This advocates 'adaptive management' and medical approaches using robust pattern recognition as guiding principles. Using more transparent 'pattern' based models, including thematic maps, also promote the active participation of decision and policy makers. To secure sustainability, distributive aspects recognising scale dependency in both value and model formulation must be emphasised. Constraining society to ecological levels of total resource exploitations demands a natural science foundation; to justly distribute the resources is equally important for sustainable development, demanding a procedural justice decoupled from nature's being.

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