Graham Harris

Seeking sustainability in an age of complexity

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Seeking Sustainability in an Age of Complexity

Seeking Sustainability in an Age of Complexity explains why sustainability is hard and why 'collapse' can occur. In the last 20 years the theory of complexity has been developed – complex systems science (CSS) speaks to natural systems and particularly to ecological, social and economic systems and their interaction. Due to the growing concern over the huge changes occurring in the global environment, such as climate change, deforestation, habitat fragmentation and loss of biodiversity, Graham Harris sets out what has been learned in an attempt to understand the implications of these changes, and suggests ways to move forward. This book discusses a number of emerging tools for the management of 'unruly' complexity, that facilitate stronger regional dialogues about knowledge and values, that will be of interest to ecologists, sociologists, economists, natural resource managers and scientists in state and local governments, as well as to those involved in water and landscape management.

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To Chris, my wife and best mate, for her forbearance, support and love

Epigraph

I can think of no better way to put it.

> This book does not run a straight course from beginning to end. It hunts; and in the hunting, it sometimes worries the same raccoon in different trees, or different raccoons in the same tree, or even what turns out to be no raccoon in any tree. It finds itself balking more than once at the same barrier and taking off on other trails. It drinks often from the same streams, and stumbles over some cruel country. And it counts not the kill but what is learned of the territory explored.
>
> From the Foreword to *Ways of Worldmaking* by Nelson Goodman.
> Published by Hackett Publishing, Indianapolis and Cambridge, 1978

In his review of John Horgan's book *The End of Science*[1] in 1996 John Casti argued strongly that we have by no means run out of 'big questions' that remain to be answered. He concluded his review thus:

> All that is needed is a 'big question' requiring new concepts and new methods. For example, many systems constituting the warp and weft of everyday life – say a stock market or a traffic network – involve a collection of agents (traders or drivers) interacting on the basis of limited, local information. Moreover, these agents are intelligent and adaptive: their behaviour and interactions are determined by rules, just like those governing the behaviour of planets or molecules. But unlike these lifeless objects, adaptive agents are ready to change their rules in accordance with new information that comes their way, continually adjusting to their environment to prolong their own survival. So far, there is nothing remotely close to a formalism, or set of scientific rules, for even stating, let alone understanding, questions surrounding the weird and wondrous ways of such processes.[2]

NOTES

1. John Horgan. *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age.* (New York: Helix (Addison-Wesley), 1996).
2. J. L. Casti. Lighter than air. *Nature*, **382** (1996), 769.

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Finally Alan Crowden, my editor, kept on nagging me and believing in me for nigh on ten years. Thank you, Alan; I just hope that the result was worth the wait!

1 Preamble: the world we are in

From the first members of the human species wandering the African savannahs down to the present day we have witnessed ice ages, extreme events of various kinds and a plethora of cultural, political, historical and other changes. We live in a changing world and it was ever thus. But things are different now. At the beginning of the third millennium we have a nexus of social, economic, technological and environmental trends the like of which has not been seen before.[1] Population growth has brought us to the point where we are the dominant species on this planet, and there is growing evidence of our power to modify the global climate. Human activity is affecting the global biosphere in ever more complex ways as a result of technological development, resource use and industrialisation.[2] We are approaching global constraints on our activities, particularly through our modification of global cycles of energy, water and nutrients.[3] We have unprecedented global connectivity through advanced transportation and telecommunications systems. Our social organisation and our economic activity have grown to the point where we have reached and exploited just about every corner of the globe; so we are now the dominant planetary engineers.[4] In the past thirty years there has therefore been a sea change in our relationship with the planet on which we live. We now have a much more complex and recursive relationship with ourselves and with nature.[5] This is why I am going to argue in this book that there is something different this time, something that is a challenge we have not faced before. I am going to argue that there is something qualitatively and quantitatively different this time around in terms of the nature of the constraints, the speed of change, and the magnitude and complexity of the tasks we face if we are to achieve sustainability.

The process of growth and development has not been linear or constant. There are both long-term trends in the human condition – population growth, cultural development, global exploration, resource use – and cyclical patterns of political and economic activity and technological development. Human societies have grown and collapsed many times in human history. The causes of growth and collapse are many and varied, arising from a mix of intrinsic and extrinsic factors.[6] Certainly some of the past collapses have been associated with regional environmental degradation, such as deforestation and soil erosion; in other cases social and economic factors have dominated. The one long-term trend that is focusing minds at the present time is population growth, resource use and the possibility of global change. For the first time in human history we have the potential to make irreparable changes to the entire global fabric, including atmospheric chemistry, global nutrient cycles, climate, water distributions, land use and biodiversity. The constraints are now global as well as regional. These are the long-term drivers on our present thinking about the human condition, which may lead to the predicted 'singularity': when technology and environmental change reach a new convergence point.[7]

Technology development, innovation and resource use has also led to a number of quasi-cyclical changes in economic activity during the past two centuries in particular. Each cycle has been characterised by upswings and downswings in economic activity and intensity of energy and resource use.[8] Although their existence is debated, some claim to have identified approximately fifty-year cycles of economic activity over the past two centuries (known after their first proponent as Kondratiev cycles). Technology development has characterised each cyclical period of economic growth and resource use in the modern era: steam engines, canals, iron production from coke and spinning machines in the (so-called) first Kondratiev cycle beginning around 1789; coal, railways, steamships and the telegraph in the second cycle beginning around 1846; oil, automobiles, electricity, wireless and telephones in the third cycle beginning around 1897; jet aircraft, television, nuclear power and computers in the fourth cycle beginning around 1950. At the turn of the new millennium, it is said, we are about to enter a new cycle – the fifth Kondratiev cycle – which is likely to be dominated by such technologies as wireless communications, multi-media, nanotechnology, genetic engineering, superconductors and what has been called 'friction-free' capitalism.[9] We are progressively 'dematerialising' the global economy.

Whatever the precise timing and nature of these cyclical patterns in economic and sociocultural activity, when taken together with the longer term drivers of human population growth, resource use and ever greater global mobility and connectivity, we are brought to a particularly significant turning point in the present 'fifth' cycle. Table 1.1 summarises some of the current global driving forces.

A more sustainable future for all inhabitants of the global biosphere requires some reconciliation and consilience between these various time varying drivers and responses. The key products of technological advances in the late modern era – loss of biodiversity, resource depletion, impacts on global elemental cycles (including climate change), rising energy prices, global flows of financial capital and global markets for products and services (including culture, sport and the arts) – are affecting all our lives. Convergence between many of these driving forces means that we live in a time of rapidly increasing complexity and of changing relationships, both between ourselves as individuals and as global communities and between ourselves and the natural world.[10]

Before we go any further there is an important point that must be made. Despite the evident problems at the turning of the millennium, and although there is need for concern over the speed and magnitude of change and for some urgency, we should not lose sight of the successes of the modern era. Life really was 'nasty, brutish and short' for all before the advent of Western humanist

Table 1.1 *Major global trends and key issues at the beginning of the twenty-first century*

Population growth
De-ruralisation and urbanisation
Poverty, inequality, terrorism
AIDS, avian influenza
Water supply, sanitation
Changes to global biogeochemical cycles[11]
Climate change, greenhouse effect
Environmental degradation, loss of ecosystem structure
Habitat destruction, land use change
Loss of biodiversity
ICT revolution
Computers, digital communications, World Wide Web, Internet
Mobile telephony
Multi-media convergence
Biotechnology, biosensors
Nanotechnology
Advanced materials
Globalisation of finance
Commoditisation
Growth of China and India
Growth of externalities
Increasing cost of some resources (oil)
Complex systems
Postmodernism (or Radical Modernism)
Feminism

ideals. Even those who believe that it has all gone wrong and that we now live in the wreck of Western culture accept that progress has been made.[12] Now this, of course, is very much a Western view. There are far too many people in this world for whom the evident successes of the modern era do not apply, and the very fact that we have a set of United Nations Millennium Development Goals[13] is an indication that there is still much to be done. There are still too many for whom clean water, sanitation and sewers, health care and reliable supplies of varied foodstuffs are but a dream. Poverty and inequality remain and must be addressed, and progress in the West has been bought at a price. Sustainability and development are therefore closely interconnected and, because of the close link between global sustainability, development, health and freedom, following Amartya Sen I would definitely add public health and freedom to the list of achievements and issues to be worried over.[14]

A global network society is emerging, shrinking time and space through information and communications technologies (ICT), mobile telephony and the World Wide Web.[15] The ICT revolution is daily bringing us added information about the ever-increasing human impact on the planetary biosphere, the dramatic reductions in biodiversity and the threat of global climate change. In his book *The Condition of Postmodernity* David Harvey argued that the West experienced a sea change in its experience of time and space after about 1972, into a condition of postmodernity.[16] (Looking back on it we can now see that the 1970s were a time of change in many aspects of the human experience. As well as the many social changes during that decade – including changing attitudes to Nature and the environment – Tim Flannery has shown that the global climate went through a 'magic gate' in 1976 as global warming suddenly became more evident.[17] Certainly, as I shall show later, the climate over parts of Australia changed suddenly in that year.) Without including the climate changes, Mark Taylor[18] insists that this present period of change is as far reaching as that at the end of the eighteenth century: the industrial revolution. The ICT revolution brings us information and builds knowledge with unprecedented speed and scope, and widens the reach of our intellect. Web search engines and television news bring us access to global databases and snapshots of global events; time and space are telescoped and fragmented.[19] Some have argued that an 'extended mind' is emerging.[20] Certainly there is now a need to pay heed to the social construction of mind and the possibilities for creative collaboration that the new technologies bring.

As knowledge is being made more accessible there is a trend throughout the Western world towards subsidiarity: the pushing down of decision making to local and regional communities and the shrinking of central governments.[21] In his book *The Third Way* Anthony Giddens[22] discussed the challenges and ethical issues of governing in this new and fragmented world and identified the trend towards 'double democratisation' – of managing both globalisation and subsidiarity simultaneously – as a major issue to be dealt with. Subsidiarity empowers local and regional decision making; as I shall argue, this is both a good and a bad thing, but in the end sustainability will depend on the decisions that individuals take in the context of signals received and incentives provided by markets, government policies and global interactions. In 1988 Joseph Tainter wrote about the historical and archaeological evidence for relationships between growing complexity and the collapse of past attempts at constructing sustainable human societies. The present experiment has global implications. One of the major themes of this book will be the importance of regional, local and individual actions and the ways in which, when played out in the context of global and national information sources, signals and incentives of various kinds, they determine larger-scale outcomes. In ecological, social and economic systems and their interactions, the microscopic really does determine the macroscopic outcome. Globalisation and subsidiarity place huge demands on individuals and communities for increased capacity and improved decision making under conditions of complexity and uncertainty.[23] The 'extended mind' is both a boon and a challenge. This increased complexity of information flows and relationships from the individual to the global is a feature of the modern world which adds to the level of personal challenge. So the present ICT revolution has also led to conceptual and philosophical advances in the area of complexity and complex systems that in many ways bring greater realism to our world view. In this respect the idea of the 'extended mind' has real merit.

Relationships, collaboration, trust and social capital[24] are the keys to success in this more complex technological, social, environmental and economic context in which we all live. The social science literature has much to offer us in this regard. This book could in many ways be seen to be an extended commentary on Anthony Giddens' *The Consequences of Modernity* in the context of the management of natural resources and the environment at the turn of the new millennium.[25] Perhaps nowhere else has the effect of these changes struck so hard. The influences of new scientific knowledge revealing complex interactions and fundamental limitations on human actions, and the setting of that knowledge in new economic, technological, institutional and social contexts, have totally changed the way we view, value and manage our biosphere and natural resources. Science is being dragged into the world of Realpolitik, an uncomfortable position in which it finds itself ill suited to exist. This is a world of uncertainty and risk, quite different from the controlled world of disciplinary science.[26] Nevertheless this is inevitable and things are changing. The position I take here is one of attempting to understand and explain complexity and systems behaviour; one in which I lean towards John Ralston Saul's view on the importance of the apprehension of context and of shared responsibility.[27] Anyone who studies systems in all their complexity can do no other.

Ideas are changing rapidly, long-standing theories and practices are being overturned and new concepts are being developed. The rising concern over sustainability merely adds to the complexity of our daily decision making, so we can add environmental factors to the social and economic challenges of the 'third way'. Above all we must now accept and cope with greatly increased complexity at all levels in our lives: individually, at the level of the community, nationally and even internationally. Do we as individuals and institutions have the capacity to adapt and grow under these circumstances? For that to happen there must be a strong dialogue between institutions and individuals in a changing world. This isn't rocket science – it is much harder. If it was easy we would have figured it out by now.

The importance of context

So to understand how we got here requires an appreciation of social, economic and intellectual history because the present situation has deep historical and contingent roots. The landscape in which we live in the West (and in other parts of the world) very much reflects a period of faith in progress and expansionism: the Modern Era. Safety, security, wealth and improved public health were the drivers of behaviour and values. Acts of enclosure changed medieval landscapes to 'modern' ones and brought with them the beginnings of pollution and urban blight. 'Where there's muck there's brass' was a common saying in Northern England during the heyday of its industrial period of mills and densely populated cities. What the industrial revolution created was a modern (Western) semiotics of place, a set of signs and symbols that were used to define and describe our sense of place in the landscape. These semiotics were different depending on class, social standing and place of birth, but taken together there was a defined set of values and sensibilities that described the modern world. The modern era similarly produced a set of urban semiotics. Modern cities are now almost the same everywhere in terms of architectural design and scale, and the expansion of modern techniques of water storage and supply, power generation and distribution, manufacturing and transport, have led to an urban modernist sameness all across the globe.

Each new technological advance and each new cycle of development brought periods of change; the early cycles of the industrial revolution were no exception. It was also a period of great social and economic change.[28] There are parallels with the present time. Not only was the relation between science, nature and society then changing rapidly (as it is now), but basic concepts and understanding were undergoing major revisions also. The cultural and philosophical context – what we (think) we know, how we know it and what we do with the knowledge we have – has changed over time in quite fundamental ways. Whereas the limitation during the industrial revolution was social capital (natural resources were thought to be unlimited) there is now a dawning recognition of both a need for a dramatic increase in social capital and capacity to deal with complexity as well as an urgent need to live within a limited stock of natural capital and resources.

There are huge sunk costs which limit our present options and determine our course of action.[29] Even if we determined to change our ways and become sustainable overnight (even assuming we knew how to do this) it would take generations to achieve the result. We are hedged about by many words that begin with the letter C: culture, community, capitals, constraints, complexity, connectivity and context. Cultural persistence is an important aspect of the *longue durée*, which determines many aspects of human life.[30] So, first: culture, community values and semiotics do not change rapidly. Ideas, concepts and values are slow to change; we are much more dependent on the past than many realise.[31] Second, there are many forms of capital that must be considered in addition to the more familiar financial capital. To be sustainable we must balance the growth of financial capital with various other forms of infrastructure development (physical capital) and the critical forms of human, social and knowledge capital. All this is set in the context of the use, conservation and restoration of environmental or natural capital. Third, there are biophysical limitations and **constraints**. Changes in global and regional stocks and flows of key elements and materials are now evident, and response times may be long. Drastic cuts in global carbon dioxide emissions do not lead to immediate reductions in the concentration of carbon dioxide in the atmosphere because of the long residence times involved. Water supply is limited by climate and rainfall; building new dams does increase the total water supply for human use, but only by the amount harvested from catchments and diverted from their component ecosystems. The huge investments required and the lifetimes of our built infrastructure (from home appliances such as toilets and washing machines, to major power, water and transport infrastructure) mean that we cannot re-engineer our built environments overnight. Fourth, the interactions between the biosphere and the human-dominated world (sometimes called the anthroposphere) are highly complex and variable in space and time and form a set of complex interacting and adaptive systems. Complex adaptive systems are those in which the nature of the networks of interactions (the connectivity) between components changes with time and is influenced by the context so that novel properties emerge, which are not predictable from the behaviour of individual components. Some of our 'limits to growth' arise from these recursive interactions.

The concepts of place and human dominion

A series of concepts and values that were centred on progress, domination and exploitation of the natural world and a requirement for certainty and security were appropriate when the world seemed limitless. In a time when nature seemed boundless and threatening the plan was to have dominion over the natural world, to subdue it and exploit it for human benefit. We made particular efforts to provide safety and security for the human race in the face of risk and variability. We were highly successful in this aim.

Since the earliest times *Homo sapiens* has been a curious animal; curious firstly in the sense of our constant search for knowledge about the world and for explanation and security[32] and secondly in the sense of quirky or peculiar. Our success as a species is a direct result of the success of the first strategy, but we have never succeeded in freeing ourselves from our evolutionary history. The evolutionary context is crucial. As bipedal primates of a particular longevity and stature we see the world in particular ways and have a predilection for some types of explanation over others. What we know, how we know it and what we do with the knowledge gained is always set in a biological, cultural and historical context, which changes slowly with time.[33] We always were very good at particular time and space scales, particularly those that suited a two-metre-high primate that lives for decades, but very bad at perceiving others, particularly the very small and the very fast and the very large and slow. We have numerous curious (peculiarly human) perceptions of cause and effect, some of which we shall have cause to (re-)consider as this book unfolds.

Now that we have come to dominate the planet it is high time to understand what is going on at those inconveniently large and small scales and to lift the level of the debate around critical issues such as the need for security and the impact of our actions around the globe. Throughout the world there is land clearing, habitat fragmentation, loss of biodiversity, degradation of water quality and increasing dryland salinity.[34] Make no mistake, there is urgent need for action on all fronts: more than 40% of the original planetary biomes have now been destroyed and the figure will reach more than 60% by 2050.[35] Over half of the world's major river systems are seriously affected by fragmentation and flow regulation resulting from the construction of dams.[36]

It would be disingenuous of me to deny that there is debate about the so-called 'litany' of environmental degradation. There are many who deny that the world is going to hell in a hand basket, and many who insist that statements such as those I have made above about climate change and biodiversity loss are merely the usual 'litany' and just more 'green' scaremongering.[37] There is a debate about whether 'business as usual' is not just as good a strategy as wholesale sackcloth and ashes. There should be such a debate. Part of the basis of the debate comes from political, religious and social attitudes to the natural environment: we do not all share the same values or land ethics, and no-one is free from bias. Part of the debate also comes from some fundamental issues around the nature of the evidence and varying interpretations and appreciations of uncertainty, risk and even outright indeterminism. Nothing is as simple as it might seem and the world is indeed very complex. We hold vigorous debates and take firm positions in opposition while standing on quicksand. This endangers all involved. There is, however, in my view, a growing sense of realism abroad.

The human population is now about 6 billion; even so there is no question that the lot of the average global inhabitant has improved dramatically in the past hundred years, even the past fifty. Wealth and longevity are increasing, major diseases have been defeated and the average calorific intake per capita is increasing. This is, however, being bought at a cost to the natural environment and limitations are now beginning to be seen in the depletion of natural capital.[38] This is the direct result of the 'Davy Crockett syndrome': once the world was large enough that it was always possible to find another forest to cut down, or another fish population to exploit in even deeper water. If we could not live off the interest from the local natural capital we could always live off the capital itself and then move somewhere else and repeat the trick. Now we have explored and altered the far corners of the Earth and over-fished the ocean depths,[39] dominion must give way to negotiation and constraint. Debates rage about how much has been lost, the nature of the evidence for loss and ways of knowing. The stories we tell ourselves are changing. Science, which once meant power and wealth for the few and human domination of the biosphere by many, has become a matter of contention. The nuclear bomb, Chernobyl, radioactivity, genetically modified organisms (GMOs), bovine spongiform encephalopathy (BSE) and 'foot and mouth' disease have all called into question the relationships between knowing things, and using and distributing the information.

There is a growing consensus that the next fifty years or so are going to be critical. If we can manage the transition we have a chance to set a new course to a more ethical and sustainable future. E. O. Wilson has written of a potential 'bottleneck' in the next fifty years[40] and raises the important issue of how much progress we can make in areas such as climate change and biodiversity conservation before we irreversibly damage the fabric of the planet. Certainly there is growing evidence that we are reaching the physical limits of the globe in terms of population growth, our use of available land for agriculture[41] and impacts on global elemental cycles.[42] We face the problems of maintaining food production through intensive production practices.[43]

The importance of ethics and systems thinking

I am not going to address the global 'litany' at length here. The arguments have been well made by others, especially and most elegantly by E. O. Wilson. What I wish to address here is the question: 'Can we grasp the complexity of it all and, if so, what do we do about it?' Given the fundamental nature of the problem – the destruction of the biosphere and its ecosystem services together with the huge changes going on in human societies and cultures driven by globalisation and technological change – the precautionary principle would suggest that even if the epistemology is flawed, the data are partial and the evidence is shaky, we should pay attention to the little we know and do whatever is possible to mitigate the situation even if we fundamentally disagree about the means and the ends. The only ethical course of action is, as John Ralston Saul writes,[44] based on 'a sense of the other and of inclusive responsibility'. We know enough to act. Ethics is about uncertainty, doubt, system thinking and balancing difficult choices. It is about confronting the evidence.

Over the past two or three decades, as there has been an increasing appreciation of the importance of good environmental management, and as western societies have become more open and the ICT revolution has made information much more widely available there has been a growing debate between the worlds of science, industry, government and the community around environmental ethics and environmental issues and their management. During this period new knowledge has been gained, ideas have changed (sometimes quite fundamentally) and there have been huge changes in government and social institutions and policies. We are all on a recursive journey together: we are literally 'making it up as we go along'. This is not easy and there are no optimal solutions. This is an adaptive process requiring feedback from all parts of the system. Yes, there will be surprises. This is why it is so important that when we act we constantly reflect on what we know and what we are doing about it and where it is all going.

As we reach the physical limits of the global biosphere the values we place on things are changing and must change further. A new environmental ethic is required, one that is less instrumental and more embracing. Traditionally there has tended to be a schism between those who take an anthropocentric view (that the world is there for us to use) and those who take the non-anthropocentric view (those who value nature in its own right). Orthodox anthropocentrism dictates that non-human value is instrumental to human needs and interests. In contrast, non-anthropocentrics take an objectivist view and value nature intrinsically; some may consider the source of value in non-human nature to be independent of human consciousness.[45] What is required is a more complex and systems view of ethics which finds a middle ground between the instrumentalist and objectivist views. Norton,[46] for example, proposes an alternative and more complex theory of value – a universal Earth ethic – which values processes and dynamics as well as entities and takes an adaptive management view of changing system properties. For sustainable development to occur, choices about values will remain within the human sphere but we should no longer regard human preferences as the only criterion of moral significance. 'Humans and the planet have entwined destinies'[47] and this will be increasingly true in many and complex ways as we move forward. There are calls for an Earth ethic beyond the land ethic of Aldo Leopold.[48] The science of ecology is being drawn into the web.[49] Ecologists are becoming more socially and culturally aware and engaged[50] and the 'very doing' of ecology is becoming more ethical.[51] Some scientists are beginning to see themselves more as agents in relationships with society and less as observers.

One important consequence of this is that conservation biology is becoming less of a movement that is concerned with the setting aside of the world's 'last great places' and more one that is concerned about the 'rest of nature': the place in which we all live.[52] What we have attempted to do in the past is the geographical separation of the instrumentalist and the objectivist views – setting areas of natural capital aside from our focus on physical and financial capital growth on the rest of the planet – but this policy, the conservation of biodiversity through the establishment of special reserves, simply is not working.

For example, reserves in West Africa are being plundered for bush meat when other sources of protein are lacking.[53] We have suddenly realised that protection of the fabric of the biosphere, conservation of biodiversity and restoration of ecosystem function are all going to require us to value the 'ordinary' and find ways of living more sustainably with nature.[54] This is going to require nothing less than a fundamental rethink of many conservation policies and a focus not just on physical and economic capital as separate from natural capital but more on the intertwining of the various forms of capital that make up sustainable development. We must find ways of balancing, protecting and valuing all six forms of capital; natural, physical, financial, human, social and knowledge.[55] This is a major challenge to conservationists and is a way to end the usual conflict between proponents of 'business as usual' and environmentalists.[56] It does, however, raise all kinds of issues about managing the complexity of these interactions and the development of the necessary capacity in human societies. We are moving from a belief in certainty into complexity, uncertainty and doubt.

So these chapters are about ecology, the way it is done and the way it is used. They are also about landscapes and waterscapes, what we know about them, how they work and how they can be managed. Inevitably they are also about society, culture, place, values and other ways of knowing. I will assert that the world is much more complex and precarious than we have hitherto assumed and that this realisation, together with the increasingly complex relationships within and between society and the environment, will have major implications for the way we conserve, manage and restore landscapes, catchments and aquatic ecosystems.

The importance of water

I have chosen to focus on water because water is *the* issue for the twenty-first century. Water is essential for life and for quality of life (not just for human species). The global stock of water is finite. Rising population means pressure on water resources, so water is a model for all issues: culture, values, knowledge, management, complexity, policy, governance and society. Water is also an excellent model for understanding and managing what are called common pool resources – such as the atmosphere, water, fisheries, forestry – resources that are held in common and suffer from particular kinds of natural resource management problems which arise from issues around ownership, regulation and institutional difficulties as well as deep cultural, philosophical and ethical considerations.

Water is fundamental to almost all common pool resource management issues around the world. It is also inextricably tied up with numerous social and economic issues. The problem with water supplies for people in both the West and developing countries is not just the quantity of supply. (The ready availability of potable water is something we all take for granted in developed countries but it is a major issue in many parts of the world.) The water supply must be fit for purpose and that means, in most cases, breaking the link between faecal and oral contamination. To provide water supplies for human consumption, for agriculture and for industry most of the world's accessible rivers are now dammed (and as many as 250 new dams are being built each year, even now[57]). Many rivers are dammed more than once on their way from the mountains to the sea. Agriculture is usually the biggest water user and irrigation areas continue to expand across the globe. As a result river flows are regulated and diverted, salinity is increasing and inland lakes and seas, like the Aral Sea, are drying up. What freshwaters remain are being degraded, aquatic biodiversity is declining more rapidly than that on land,[58] wetlands and swamps are being drained, overfishing is rife and nutrient pollution from cities, industry and agricultural runoff is widespread.

So water embodies all the complexity and conflict which lies at the nexus between rational use and conservation, extraction for consumptive and productive use versus protection of natural flow regimes and water quality, recycling and reuse, protection of biodiversity and ecosystem function, sustainability and the concern for the 'triple bottom line': balancing environmental, social and economic sustainability. Science has a key role to play but so do social and cultural values, politics and economic interests. By flowing through, under and across the landscape water connects together and integrates much of what we do, both on the land and in the water. The connection between human society, land use change, ecosystem function and water quantity and quality is a complex and intimate one, which makes water a model subject for this study.

Water is not just the freshwater we see in streams, rivers and lakes. There are a series of complex interactions between evaporation (largely from the oceans), rainfall, infiltration, groundwater and surface runoff. The water in rivers, soils and lakes is only about 0.014% of the total global water[59] so that the water we use (the so-called 'blue' water) is only a small fraction of the total global water flux which maintains the biosphere, its ecosystems and functions (the 'green' water).[60] We are totally dependent on the proper functioning of the biosphere and its ecosystem services and hence on the 'green' water fluxes. Ecosystem services are all those (apparently) free services that the biosphere provides for us; services such as the provision of food, fuel, fibre, pollination, pest control, fertile soils, clean water, balancing the atmospheric gas composition and so on.[61] Without the 'green' water fluxes there would be no natural capital, no ecosystem services and no conservation of biodiversity. By focusing on the security of supply of 'blue' water at the expense of the biosphere we have, as I shall show, knocked the much larger 'green' water flows out of balance and this is causing widespread landscape-scale damage. We have focused on turning natural capital ('green') into financial capital ('blue') through the construction of physical infrastructure; 'blue' water is often bought and sold through market mechanisms. Wealth and human wellbeing are clearly growing year by year but the global environment is suffering a loss of water and biodiversity.

Externalities

There is clear evidence of human domination of the biosphere, especially in the changes to the global cycles of the major elements, carbon, nitrogen, sulphur and phosphorus. Carbon is building up in the air through energy generation and industrial activity and causing global warming. The present concentration of carbon dioxide in the atmosphere is at unprecedented levels, at least as far back as the present records go, which is about 650 000 years. We are in uncharted waters and the past is no guide to the future. In a world of unprecedented technological, environmental and social change and rapidly increasing connectivity and complexity we are in for surprises. Now, it is true (and this is where we can have an argument about the evidence for the 'litany') that there have been some spectacular local and regional successes: forests have regrown, species have recovered and been conserved, pollution levels in our major cities have decreased, human health and water quality have been improved. There are some spectacular examples of conservation and innovation in action which we should celebrate, but the evidence coming in daily from our new range of sensors in space, from cameras on the ground and under water, and from remote monitors coupled to computer models and huge data banks (our new and extended mind) is that human activity is changing the face of the planet at an ever-quickening pace. So, somehow, we must find ways to link the local successes with the less encouraging global picture – to link the micro- and the macro- more effectively across scales.

In economic terms we are beginning to face an exponential increase in 'externalities': impacts on, and costs associated with, all those goods and services that are outside the traditional sphere of economic activity.[62] The stocks and flows of non-market goods and services are being modified, often in ignorance and by mistake. In particular we face a growing loss of ecosystem services as landscapes and waterscapes are degraded and biodiversity declines.[63] By focusing on security, wealth generation and profit and not including the 'externalities' in our cost–benefit calculations we have managed to improve the lot of most, if not all, people on this planet, but the biosphere is paying the price for a narrow view of growth. We are not balancing the various forms of capital. Some take the 'business as usual' and highly instrumental view that democratic reform, market forces and economic globalisation will solve all our problems. Furthermore, adherents to this view would probably discount most of the environmental 'litany'.[64] In short, physical and financial capital growth outweighs other considerations and if we are doing some environmental damage in the process, well, there will be time to fix that up later. At the other extreme we have many environmental groups and non-governmental organisations (NGOs) who oppose globalisation and all that it stands for, and who tend to take an objectivist view and value natural capital above all else. Interestingly, most of the managerial and economic literature about globalisation and its discontents[65] focuses more on the social and economic capital impacts and less on the environmental capital aspects of the problem. This is also true of much of the development literature,[66] although in recent times this has been changing.[67] Similarly, 'green' groups tend to focus more on the changing patterns of (charismatic) biodiversity rather than on the more complex changes to ecosystem function and process. Others take a less instrumental and more patient and broadly ethical middle-ground view, favouring a more 'social democratic' stance in which human, social, financial and physical capitals are balanced through regional differentiation and selective market engagement. This is consistent with a complex systems view of the problem of development and sustainability.[68]

A more broadly sustainable framework is now required as we seek a more ethical and system-based view of the global economy and society. This involves walking into a very complex and contested middle ground. 'Here be monsters.' Traditional economic management has led to a demonstrable degradation of many renewable and non-renewable resources. The global supplies of both oil and water are finite. Both are, or once were, controlled by the activities of the biosphere. In the end every economy is a wholly owned subsidiary of the environment and will remain so as long as we are carbon- and water-based life forms with primate origins. There is an urgent requirement for a 'great transition' to a more sustainable future – and soon. Maybe the next fifty years – the years of the next economic and resource use cycle and the years of technological, social and environmental convergence – really are going to be critical. About the only viable solution is going to be an economy of nature in which we take a more inclusive and ethical view. Of necessity it will include more of the complex and adaptive interactions between the 'systems of systems' that make up the world in which we live. This is a major challenge of comprehension, capacity and managing complexity. This also requires a very new and different form of leadership: one in which context, community, constraints and complexity are the watchwords of a more nuanced style.

So, until now, we have done an excellent job of dominion, and of providing ever-increasing levels of safety and security for our species. We have used up a lot of our stocks of natural and other capital. We still have a very long way to go to address all the issues of poverty, deprivation and inequality on this planet. We do have much to do, but life is better for more people in many areas. We now need to lift the level of the debate and comprehend the changing nature and scale of the challenges we face. There have been massive changes in the past thirty years as the postmodern revolution has hit home. And revolution it truly is.

NOTES

1. Some argue that we are heading for a very special time in human history – a 'singularity' – when all kinds of social, technological and environmental trends all come together in ways which will forever change human civilisation. Around 2050 computing power might well exceed the power of the human brain. We are also seeing exponential increases in complexity, connectivity in the World Wide Web, genetic sequence data and the speed of uptake of new inventions such as mobile phones and the internet. See R. Kurzweil. Human 2.0. *New Scientist*, 24 September 2005, pp. 32–7; also R. Kurzweil. *The Singularity is Near: When Humans Transcend Biology*. (New York: Viking, 2005).
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2 Complexity and complex systems

The characteristics of complex adaptive systems and networks, and an introduction to emergence and emergent properties

What is emerging from the shadows is a new future, one which, instead of having dominion over nature, works with and mimics many natural functions and processes. We are beginning to focus on water recycling and reuse, just as the biosphere has been doing since time began. We are beginning to find ways of lifting water, nutrient and energy use efficiency to levels comparable to those found in natural systems; and we are beginning to recycle more raw materials and find more and more renewable energy resources. The question is: instead of security and domination, can we find a new resilience in the face of global constraints, and of complexity, change and variability? To do so will require a new approach to complexity and change and a new view of the interactions and relationships between individuals, communities and institutions that allows of greater flexibility, adaptiveness and collaboration.[1] Epistemology and science are changing also; what we know, how we know it and what we do with the knowledge we have already changed irreversibly. Not all the experiments have been, or will be, successful, but the trends are clear.

We are hedged about by sunk costs and by semiotics: the cultural baggage we carry and the signs and symbols we use to conceptualise, describe, model and manage things. Yes, even science must be concerned with semiotics – it too carries a lot of baggage and it is not as culturally and value-free as scientists would have us believe.[2] Right across the board the semiotics of culture, values, science and natural resource management are changing rapidly and we need tools to understand complexity. So it is hardly surprising that complexity theory is a field of inquiry undergoing rapid development. There is no doubt that complexity theory is very popular, but it comes in many guises. In a review in 2001, Manson attempted to define a typology of complexity theory differentiating between algorithmic complexity, deterministic complexity and, finally, aggregate complexity, in which the complexity arises from the synergies arising from the interaction of system components.[3] It is the systems that show aggregate complexity and emergence with which we shall be primarily concerned here.

One of the themes of this book will be the rising awareness of the significance of small-scale, individual actions undertaken by agents (individuals, communities, institutions) acting largely on local information (context). Actions and interactions of agents rely on information mediated by culture and connectivity. They may or may not appreciate the global context of their actions. The significance of these actions lies in the ways in which interactions between agents lead to the emergence of meso- and macro-scale system-level properties, which are not predictable from the properties of the individual agents. The recursive nature of the world in which we live is demonstrated by the fact that the emergent system-level properties of these complex systems themselves become contexts for lower-level action.

Complex adaptive systems (CAS)

The systems that have received most attention in recent times are those systems in which complex behaviour emerges from the interactions of agents, individuals or components acting on the basis of local rules and local information. In many physical and chemical systems

> complexity is associated with system-wide, self organisation to a critical point (self-organised criticality, SOC) or a bifurcation point near the 'edge of chaos'. In both cases, even the generic, random states exhibit long-range correlations.[4]

Whereas the ideal SOC systems consist of identical agents (e.g. sand grains in piles), most natural and anthropogenic systems consist of interacting sets of highly specialised and highly evolved agents (e.g. individuals and species) which show evidence of complex design and contingent (historically dependent) histories. Biological systems can evolve to an optimised state through trial and error and by swapping constituents (e.g. species)[5] over time – a mechanism very different from the thermodynamic approach to 'the edge of chaos' in physical and chemical systems. There is more to life than SOC; thus, although SOC is widely discussed in the ecological and other literatures, I lean more towards the more parsimonious explanations of Carlson and Doyle, who have been able to replicate many of the apparent statistical properties of SOC with systems that they have called Highly Optimised Tolerance (HOT) systems.[6] HOT systems have many types of interacting component and are designed for high performance in an uncertain environment. They are 'robust-yet-fragile'; that is, they are robust to designed-for perturbations and hypersensitive to unanticipated disturbances.

There is much evidence that ecosystems and other CAS are much sloppier and more loosely connected than SOC would imply, with 'kludges'[7] (see below) and other contingent structures, which show design features that are hangovers of past contexts. So although we must understand the properties and complex dynamics of the interactions of natural and man-made CAS it is not necessary to use some of the restrictive physical analogies to explain their properties. Henceforth I am going to use the more general term 'self-generated complexity' or SGC to include the observed self-organised properties of HOT and other aggregate complex systems.[8]

Physical systems may frequently be regarded as complex and may display emergent properties, but biological systems, including artefacts of human biology, psychology and sociology (financial, human, social and knowledge capitals), are indeed different. The fundamental difference lies in the non-linear and adaptive nature of the basic interactions between the differing evolved agents. For this reason biologically based CAS are sometimes referred to as Agent-based Complex Systems or ACS.[9] Biological (species; natural capital), psychological, social and cultural entities (agents, individuals; social, human and knowledge capital) interact and change their behaviour as a result, thereby leading to CAS where the system behaviour unfolds over time in a recursive manner. In CAS, context is crucial[10] and actions develop a higher-level meaning in that context. So complex is quite different from merely complicated. Relationships are important and must be seen in context. The unfolding properties of CAS are extremely difficult to predict from the behaviour of the individual isolated agents. Differing interactions and relationships in differing contexts give differing (or similar) outcomes. CAS show strong path dependence. There is an important point to be made here. The complete behaviour of the CAS arises from the pandemonium of local interactions. There is no need to invoke higher-level, structuralist rules. As Dennett[11] pointed out, there may be emergent 'cranes' to lift up system-level properties but there is no need for 'sky hooks'.

CAS have a number of important properties

First, CAS feed on variability. In a world of CAS, variability is not noise, it is signal. The pandemonium of interactions adapts both to internal, context-sensitive outcomes and to external drivers. Ecosystems respond to both biodiversity and climate change, and the interactions between them over a range of time scales; species evolve over millennia, motorists respond to traffic conditions and world fuel prices, farmers respond to local climate and world commodity prices. The resulting systems show variability at a wide range of scales and often show a spectrum of responses without displaying any single characteristic, easily identifiable periodicity. (This is precisely why there is a debate about whether Kondratiev cycles are real; technological, financial and human developments show all kinds of periodicities.) Without variability CAS would not exist.

Second, CAS are not optimal, equilibrium systems. Change is the only constant and it is not states we are interested in so much as trajectories. As they evolve over time there is much 'make do and mend'. As Dennett termed them, there are many 'kludges': entities or agents that arose in response to past demands, now being pressed into service in new contexts.[12] In many contexts we see a constrained walk through evolutionary, ecological, social and cultural space;[13] the walk is constrained by biophysical and physiological factors, by the constraints of biology and evolution, and by history and institutions.

Third, CAS are highly non-linear, as well as being adaptive and recursive. Pathways, networks and flow patterns change over time and control becomes problematic. Simple, linear systems respond to interventions in predictable and proportional ways. CAS, on the other hand, often appear arbitrary and all over the place. The same intervention in different contexts produces totally different and unexpected results, or different interventions at different times may produce the same result. This is the problem of equifinality. CAS characteristically show unpredictable fluctuations and catastrophic changes. Landslides, stock market crashes and major evolutionary extinctions have been well documented.[14] All seem to follow statistical power law distributions, with few large events and many small ones. In trying to control or manage CAS, a small nudge at a critical time may be better than a large intervention. None the less there are repeatable patterns that we can observe.

Fourth, CAS are frequently self-organised in remarkable ways. CAS show properties much like 'self-organised criticality' (SOC). Many 'SOC-like' patterns are apparently fractal – that is, they are self-similar across a range of scales – and they follow power law statistical distributions. This has two important consequences. First, in a fractal world it is very difficult to pick or define a particular scale of study, prediction or management; the systems are self-similar across scales from seconds and centimetres to decades and continents. Second, in a non-equilibrium fractal world we are not dealing with the laws of large numbers; averaging in space and time is dangerous because small-scale events can have large and long-term consequences. This means that there is a high degree of indeterminacy in all this: it is simply not possible to know all the small-scale contingent histories of individual events or to predict the outcomes that may arise from seemingly trivial happenings.

Finally, the indeterminacy and complexity of interactions in CAS, coupled with the high degree of non-linearity, mean that there always will be surprises, points of no return and hysteresis ('you can't get back by the path you came on') effects in the responses and dynamics of these systems.

Overall, the understanding and management of CAS requires a high degree of adaptability and risk management, and an acceptance that the past is no guide to the future. This is a major challenge to individuals, institutions and societies.

The view of societies, landscapes and waterscapes and ecosystems as CAS changes an entire world view. The science of ecology and natural resource management is changing away from an equilibrium view concerned with being and with the states of systems, to a much more dynamic, non-equilibrium view concerned with becoming and unfolding trajectories in complex interactions between various kinds of capital. Again, it is not system states but pathways over time with which we must be concerned. Natural systems are not homogeneous;

they are very patchy, and patch dynamics are a critical part of their form and function.[15] Much of the damage we have done to ecosystems occurred because of the imposition of human requirements for security and stability onto naturally variable systems. Because they are complex adaptive systems, ecosystems feed on and generate variability. Some of the variability is imposed through changes in climate and weather whereas some is internally generated through SGC. This world view values not averages but variability, because variability is part and parcel of ecosystem biodiversity and function. Averaging over space and time actually destroys both information and ecosystems. As might be expected from CAS, ecosystems show strong links between system structure, species identity and distribution, and may display resilience or fragility in the face of human-induced perturbations. The ecological systems that make up the critical natural capital on which we depend are robust, yet fragile, and particularly sensitive to unanticipated (anthropogenic) perturbations.

Networks

With the rise of the Internet, the World Wide Web and mobile phones, the globalisation of financial and commodity markets and intercontinental air travel, the interconnectedness of ecosystems, societies and economies is growing rapidly.[16] Information, knowledge, money and influence flow rapidly from place to place – as do people, diseases and organisms – creating unexpected change and mayhem not infrequently.[17] The changing networks of interaction and influence also show CAS properties: unpredictable fluctuations, infrequent crashes and periods of quiescence. These human networks are very similar to biological systems in that they are characteristically made up of modular architectures that are interconnected in elaborate hierarchies and layers of feedbacks. This structure appears to derive from a 'deep and necessary interplay between complexity and robustness, modularity, feedback and fragility'.[18] Network architecture and interaction patterns matter.[19]

Network architecture is an important determinant of behaviour. Networks of randomly interconnected nodes show massive phase transitions as the number of interconnecting links increases.[20] The network behaviour may suddenly jump from linear and predictable to non-linear and chaotic as the number of links is slowly increased. Detailed scrutiny of network architecture in human and biological networks is revealing that patterns of interconnection are never random. Instead of random connection patterns, many natural networks are what have been called 'small-world' nets, with many local links and fewer long-range links.[21] This is the basis of the famous 'six degrees of separation' discovered by Milgram[22] wherein it is possible to reach almost anyone in the world through about six personal links. The World Wide Web is also a good example of this kind of connectivity. Other examples include the patterns of connectedness in enzyme systems in cellular physiology and metabolism[23] and collaboration networks in science.[24] Many networks show 'scale-free' power law patterns of interconnectedness (few long links, frequent local links) quite like the power laws that describe the properties of CAS. Indeed, this appears to be a fundamental property of many natural network systems.[25] It turns out that these 'small-world' networks have remarkable properties of resilience and may have evolved to cope with the vagaries of the real world of CAS dynamics. 'Small-world' networks are highly resistant to random attack but vulnerable to targeted attack on highly connected hubs. Resilience and resistance to attack and degradation are desirable properties in a contingent world.[26]

Parallels have been drawn between SOC states, 'power law' statistical properties of networked systems and 'small-world' network architectures, but we should be careful because various types of 'power law' distribution seem to be universally observed in the dynamics of complex interacting systems: some strictly SOC, some not.[27] As Andreas Wagner has argued, the widespread presence of these statistical distributions may not necessarily be used to infer the mechanisms that generated them – and there is good evidence to assume that biological systems, with their ability to evolve and change components over time, are different from physical and chemical systems.

What we have done as the human population has grown and society has developed over the centuries, in effect, is to superimpose networks of ecological, social and economic activity – all of which have different patterns of modularity and connectedness and which operate at different scales – and we have no idea what the interconnections or overall properties of this very complex CAS are. The entire 'system of systems' has been cobbled together as we have gone along, and history has been the judge of each experiment. Some have been more successful than others and some 'kludges' have made successful transitions into new roles. Through our activities we have knocked out hubs and spokes, changed modules and altered connectivity in the natural world.

So it comes as no surprise to realise that as the human population rises and we become the most dominant and highly interconnected species the nature of the problems we face is changing rapidly. Yes, we are making progress on environmental and natural resource management issues, but as progress is made on some issues others arise in a recursive and context-sensitive way. Interactions between societies, polities and cultures are changing – a global network culture is emerging[28] – globalisation is driving the competitiveness of nations,[29] and the distribution of 'haves' and 'have-nots' is changing rapidly. Many observations have shown that the distribution of nations and enterprises in terms of wealth also follows a power law, with few very wealthy nations and many poor ones. In terms of sustainability this means we shall have to manage the growth of inequality of wealth and opportunity[30] and the growing ingenuity gap.[31] Human population growth, urbanisation and resource depletion will continue until a more sustainable future is achieved.

Emergence

The basic tenets of emergence are: first, that emergent entities arise from the coming together of lower-level modules or entities in context-sensitive interactive configurations. So CAS show emergent properties. Second, all properties of higher-level, emergent entities arise from the properties and interactions of their constituent parts. Third, emergent properties are not predictable from even exhaustive information about the properties of the lower-level entities. Fourth, emergent properties are not reducible to lower-level conditions.[32]

Emergence is something that has been the subject of debate for many years; it has given the philosophers plenty of opportunity for analysis and discussion.[33] The debate is all about the very existence of emergent entities and their predictability from the properties of their basal agents or conditions. The key conditions, which Holland identified, are non-linearity and context-sensitivity. We are concerned here with what has been called 'strong' emergence in biological and social systems.[34] With strongly non-linear and adaptive interactions between entities or agents then the emergent features of these complex interactions will not be simply predictable from the properties of the constituent agents or modules in isolation. So CAS with emergent properties show both 'upward' and 'downward' causation: the interacting modules or agents together generate the higher-level emergent entities and the emergent entities provide a context for richer forms of behaviour than would be expected from the agents alone. This is something that has given the philosophers problems. It is the non-linearity and context-sensitivity that provide the key. Context-sensitive, non-linear interactions in CAS provide rich opportunities for emergent behaviour, but only recently have attempts been made to quantify the phenomenon.[35]

If we take a view that there are many CAS in the interactions between society, the economy and the environment (between the various forms of capital) and that non-linearity is both characteristic and important in institutional and community interactions, in global market dynamics and in biology and ecology, then there are a number of things that need to be explained.

Interestingly, although they are highly dynamic and contingent systems, ecosystems do seem to generate functional constraints and repeated emergent patterns; in the process of evolutionary development under regional and global constraints, ecological systems have developed some broad similarities in growth and life forms. These are the so-called homoplasies[36] – generic similarities developed in quite different systems and situations. The existence of homoplasies would tend to indicate that there are some constraints on the way ecological systems are configured. If this is the case then it has important implications for the ways in which we might restore and redesign landscapes and waterscapes to be more sustainable. Equally, the potential existence of homoplastic structures in other types of CAS – social and economic systems, for example – would also inform our attempts to structure our affairs.

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3 New science, new tools, new challenges

The implications of complexity for science and socio-economics; personal and institutional challenges

Viewing the world as a CAS puts an emphasis on the contingent history of the present. There are deep historical roots to all present enterprises and institutions. The enterprise of science is no different. It has a long history, which began in the sixteenth century with a change in philosophy from an Aristotelian view, seeking the underlying essences of things, towards a more practical way of knowing.[1] Concepts of nature have a similarly long history, being based around concepts of balance, unity, equilibrium and human dominion. Science is one of the cornerstones of the modern, humanist enterprise. So science is inextricably connected to an instrumentalist ethical view and has developed to its fullest extent in the context of the culture and religion of the West. In the modern era science has developed what Salthe[2] would call a Baconian, Cartesian, Newtonian, Darwinian and Comptean bias (which Salthe abbreviates as BDNDC from the first initials of Bacon, Descartes, Newton, Darwin and Compte) – being essentially realist, materialist and mechanistic, also value-free and logical – the perfect hand-maiden to the industrial revolution.

As opposed to a science of balance and equilibrium, a new science of complexity and resilience sees the world through new eyes. Instead of concentrating on linear responses to change around the equilibrium, on central tendencies, and on the average properties of data, the new science focuses instead on nonlinearities, on dynamic interactions, on contexts, and on network structures and the emergent properties of the interactions of agents.[3] If we are to study the interactions of humans with the natural world we need to rethink our basic assumptions and semiotics as well as our basic philosophies and values, particularly ones in which the choices we make are constrained by global constraints.

It has been said that there is a 'new science' emerging – or a 'postmodern science' – changing from a narrow disciplinary and instrumentalist base to focus instead on larger-scale problems and engaging the community in a debate about values, purposes and outcomes.[4] Certainly there have been major changes in the enterprise of science since the early 1970s. Science is now more 'postmodern' and occupies a world in which more emphasis is placed on values, ethics and transparency. Society at large is more interested in, and concerned with, developments in science that are likely to affect the lives of the general population.[5] I do not agree with the full 'postmodern' position of ontological and epistemological relativism. Like Giddens, I prefer the term 'radicalised modernity' to the more common 'postmodernity' because I do not subscribe to the position of