the natural world increased enormously. If this uncomplicated idea is used, the following periods can be delineated:

Hunter-gatherers	Recent solar energy from plants and animals: fire	Per capita availability: *c.* 3,000 kcal/day
Agriculturalists	As above, plus concentrated solar energy of domesticated plants and animals	Per capita availability: 12,000–26,000 kcal/day
Industrialists	As above, plus energy from coal, oil and natural gas, hydro-power	Per capita availability: 77,000 kcal/day
Post-industrialists	As above, plus nuclear power and 'alternative' sources	Per capita availability: 230,000 kcal/day

The dating of these periods cannot be exact. Early agriculture started to overwhelm hunting and gathering as early as 8000 BC, but there were still non-agricultural people with little industrial technology as late as the 1920s, for example, in the high Arctic. But by *c.* 500 BC agriculture was a world-wide and expanding phenomenon. Likewise, industrialization based on fossil fuel had earlier roots than those of eighteenth- and nineteenth-century England, but were ineradicably established in what are now the developed countries by 1900. The civilian use of nuclear power dates from the 1950s, with the somewhat more recent, and currently more marginal, addition of passive solar collectors, photovoltaic cells and wind farms, to give a few examples of 'alternative' energy sources (Odum and Odum 1976). So in any one period there are always the early shoots of the next, just as there are places which, so to speak, 'lag' behind the rest of the world. The current designation of the less developed or technology-poor countries is an example of that type of labelling.

'TO CIVILITY AND MAN'S USE': THE PROGRESS OF HUMANIZATION

For each of these energy-related periods, it is possible to describe the essential characteristics of the material ecology in terms of resources gained and environments altered (Simmons 1993).

Hunter-gatherers

In 10000 BC, all the members of the human species were hunter-gatherers; now, perhaps 0.001 per cent or fewer live that way. Most hunter-gatherers ate as much plant material as they needed and as much meat as they could get, with the possible exception of those in regions like the High Arctic. Their success is attested to by the very wide range of environments in which they survived: literally from tundra to tropical forest. This was made possible by a low population density and, often, by a propensity for seasonal movement so that plant and animal resources were not overused. The low density was brought about by having to live off relatively dilute solar energy, and so the average hunter-gatherer needed access to *c.* 26 km² of terrain for food. Having to move encouraged a family size in which there was never more than one child who had to be carried.

The energy relations are usually marked by the control of fire in the landscape: few of the ecosystems in which they lived will not burn at some season or other, and it was often advantageous to burn the vegetation. At the very least it would flush out animals to be killed; at best it would encourage higher densities of food-bearing plants or a vegetation that would attract game.

Examples are well attested of the power of hunter-gatherer groups to change their environments permanently. Permanent reduction or extinction of plant and animal species may have followed heavy use, especially where climatic change put populations of species under stress. Permanent landscape changes were produced by repeated management practices to the point where fauna, flora and soils may all be said to be adapted to the management technique, for example, the repeated use of fire. Hunter-gatherers probably also developed early husbandry in such forms as the yearly gathering of seeds from certain stands of wild grasses, the taming of young animals, the diversion of water on to stands of plants and cutting of ditches to encourage eels, for instance.

Although they enjoyed an apparently robust and sustainable way of life, most such societies quickly adopted cultivation when it became available; most of our knowledge of these people comes from times when they had had prolonged contact with agricultural or indeed industrial economies.

Agriculturalists

The ecology of agriculture depends upon the concentration of food energy by bringing the plants and animals in, rather than going out for them. The field and the herd are high concentrations of energy compared with the wild systems that preceded them. To maximize energy surpluses, particular strains and characteristics of plants and animals were selected by humans to thrive under the new conditions, and this is called domestication. The earliest Old World domesticates, like wheat, barley, rice, cattle, sheep and the pig, are still key species in today's agriculture, supplemented by New World domesticates such as maize and the potato.

Agriculturalists produced the first totally humanized landscapes outside actual dwelling places, as land clearing, irrigation and the use of domesticated plants occupied intensely cultivated fields and gardens. The movement between cultivated and wild was not all one-way in the sense that irrigation systems failed and silted up, as their soils became salinified and unusable. The wild lost some of its ecologically pristine character where the river valley economies were surrounded by nomadic pastoralists. These groups grazed enough beasts to exert gradual changes on the vegetation in the directions of more xeric communities, for example, or produced areas dominated by plants resistant to grazing and browsing.

With the development of political empires, transmission of land-use patterns and of technology was facilitated, so that there were larger geopolitical units which transferred materials within them: grain, from North Africa to Rome, silver from Mexico to Spain, for example. The empires used both irrigation and rain-fed agriculture and understood the role of domestic animals in providing manure for crops. Most land uses ever known were implanted during this phase, including metal-based industry. So much of the world outside the truly marginal cold, high and dry zones was made over by communities practising agriculture, some of it terraced, and having parks, gardens, canals, reservoirs, managed forests for ship timber as well as implement handles, fish ponds, whaling and cod-fishing fleets in deep waters, mines and smelting works, and prosecuting wars. Quite large cities with complex social stratifications were made possible by agricultural surpluses.

It seems impossible to judge the sustainability of this way of life. In some places at some times, famines point to an apparent reaching of Malthusian limits, even in the absence of stochastic features such as climatic extremes or the breakdown of civil order. There was, however, always a likelihood that population growth would exceed agricultural production, especially when a degree of immunity to major trans-continental infectious diseases had been acquired; Gellner (1988) suggests that agrarian societies are always in conflict since they are in continual danger of experiencing the Malthusian limits to population but are ideologically pro-natalist since their societies need young men for the farms and the forces.

Industrialists

In the industrial era, the access to energy sources which had been dominated by solar sources is now subsidized by immense amounts of stored solar energy as fossil fuels. Of these, coal was the first to be developed on a large scale, especially in Europe after the discovery in the early 1700s of how to smelt iron with coke. Oil was added to the repertoire in the late nineteenth century (initially, it was sought as a replacement for whale oil used in lighting), and then natural gas (Table 1).

Mobility is greatly increased via many technologies: conceivably the only really novel experience of humanity between classical antiquity and today is that of rapid travel. On a global scale, there are core areas and peripheries where the impact has been much less. The North Atlantic is the type locality, but there are others, notably Japan, South Africa and other high-income economies. The environmental changes wrought derive in many instances from concentrations of the use of energy and materials, either as goods or as wastes. Technology has made possible the synthesis of substances not present in nature. When these are led off into the environment there may be no natural breakdown pathways, and so they are prone to accumulation with results that are toxic to life or detrimental to biogeochemical processes.

The application of energy through technology has made environmental alteration much more thorough and widespread. The getting of energy itself necessitates

Table 1 Growth in population and energy use, 1870–1986

Year	*Industrial energy use (TW)*	*Per capita (watts)*	*Cumulative use since 1850*	*World population (millions)*
1870	0.2	153	3	1,300
1910	1.1	647	25	1,700
1950	2.9	1,160	100	2,500
1970	7.1	1,972	200	3,600
1986	8.6	1,720	328	5,000

Notes: 1 TW (terawatt) = 1×10^{12} watts. The table refers only to *industrial* energy use: not therefore to biofuels like wood and dung.

local environmental change, as around a deep coal-mine or even more so at the site of open-cast mining. Steam power meant the transport of materials and ideas over larger distances much more quickly, and indeed consolidated empires whose purpose was to supply home countries with materials. Thus a periphery of less developed countries experienced the transformation of subsistence agriculture or pastoralism into commercial plantations.

For the first time, some of the consequences of human activity became truly global rather than simply world-wide at discrete points. The outstanding examples are those of toxic chemicals with very slow breakdown rates now found in the atmosphere (as aerosols), on land and in the seas, together with gases which have a long residence time in the atmosphere and enhance radiative forcing. These comprise the 'greenhouse gases', and of them carbon dioxide is the most important, with atmospheric concentration rising from 275 ppm in 1850 to 356 ppm in 1992. Methane is also important, and quantities are rising from rice paddy extension, the greater number of cattle in the world and positive feedback from peaty environments.

Many a writer has questioned the sustainability of any *genre de vie* which is so clearly based upon non-renewable resources. Given the economists' view of sustainability, the best that can be expected is that the knowledge gained by the use of the fossil fuels can be turned into the wisdom of how to do without them. The technological solutions seem to be nuclear power and/or 'alternative' energy sources, but the alternative of using a great deal less in the rich countries is also available, if there is the cultural and political will to pursue it.

Post-industrialists

Even more concentrated than the hydrocarbons is the energy in the atomic nucleus of elements like uranium, first released in controlled chain reactions in 1942, used militarily in 1945 and in civil power since the 1950s. In the latter application, it produces only electricity (and a great deal of waste heat not usually used since the installations are normally sited well away from dense settlements),

and so there are no discernibly new patterns or processes; it tends to reinforce existing configurations. In contrast, the environmental effects of fossil fuels and fears over their future supply have led to the development and small-scale introduction of 'alternative' or equilibrium energies based on direct but dilute solar energy (for example, passive collectors, photovoltaic cells), wind energy and the movement of the sea in tides and waves. Few of the latter have yet produced an energy surplus above their development and manufacturing energy inputs.

This phase is quite new, so differentiating its effects must necessarily be speculative. Steam has been replaced conceptually by electricity, and this force has made instant electronic communication available virtually everywhere via satellites. One consequence is the rise of the world city: a place where key decisions of the capitalist economy are made which then have the capacity to affect the ecology of any part of the earth. A major change may well come soon as result of changes of consciousness in low-income economies brought about by the ubiquity of electronic communications. In parallel there is a stronger awareness in the world of the web of effects of any given process and of the virtues of protection of some of the richness of species and ecosystems resulting from organic evolution. This awareness is made keener by the new-found ability to accomplish genetic manipulation of organisms with predictable biological if not ecological results.

It is nevertheless, a world of considerable unevenness of access to resources, as shown, for example, by the differences in per capita energy use during recent years or measures such as GNP per head. Whether these indices have anything to do with the real quality of life, or whether they are simply measures of the breakdown of complex molecules into simpler ones, has been the focus of investigations into alternative economic measures which use data not only on income but on, for example, literacy and health. But low income does not necessarily mean low environmental impact, as poor people are forced into marginal environments by the pressures of population growth or landlords' use of land for cash-crop production.

An overview

The outcome of 10,000 years of resource use has been a humanizing of the earth. Very little is now in the kind of pristine condition which maps of 'biomes' or 'world vegetation' in atlases might suggest. There is still a large area of dry land which shows only minimal human effects, most of which is desert, tundra or ice; the rest has been transformed by the human hand and its mechanical extensions. Table 2 shows the extent to which human-led appropriation of natural biological production has taken place: some 45 per cent of the land surface has undergone such change. The role of population growth is summarized in Table 3, where the millennia of agrarian economies are given their due; in environmental terms, these are put in the shade by the data of Table 4, where the access to energy of the industrial world provides for a giant leap upwards in the simple index of impact calculated there.

Table 2 Human appropriation of net primary productivity in the 1980s

World NPP	
Terrestrial	132.1
Freshwater	0.8
Marine	91.6
Total	224.5
NPP directly used by humans	
Plants eaten directly	0.8
Plants fed to domestic animals	2.2
Fish eaten by both	1.2
Wood use for paper and timber	1.2
Fuelwood	1.0
Total	7.2
NPP used or diverted by humans	
Cropland	15.0
Converted pastures	9.8
Others (cities, deforestation)	17.8
Total	42.6
NPP used, diverted or reduced	
NPP used or diverted	42.6
Reduced by conversion	17.5
Total	60.1

Source: J. M. Diamond, 'Human use of world resources', *Nature, Lond* 328 (1987): 479–80

Even some of the wilder parts have occasional concentrated reminders of human presence, as in the recent (1993) attempts to remove some of the debris of climbing expeditions from Mount Everest in the Himalayas. There are, in fact, subtler traces detectable by the right instruments: aerosol lead stratified into the Greenland ice sheet, for instance, and radioactive nuclides from pre-1963 atmospheric nuclear weapons testing in the slow-growing lichens of Arctic tundras. The seas are often omitted from such discussions. The continental shelves are without doubt altered considerably, since they receive the contents of the continental rivers as well as being the scene of hydrocarbon extraction and the most intensive fishing. The open oceans are more like a true wilderness, though spilled oil and pesticides are found in the water and some whale species have been brought to the brink of extinction. So Donne's 'western treasury, eastern spicery, / Europe, and Afric, and the unknown rest / were easily found' turns out to be true, and indeed these areas have been seen to be lands whose 'plenty and riches is / enough to make twenty such worlds as this'. Current concerns revolve around the future of the plenty and riches and the identity of those who will enjoy them. Is it a just world, for instance, in which the world's richest 20 per cent of nations absorbed 70 per cent of global income in 1960 but increased that share to 83 per cent by 1989, and in the same period diminished the share of the poorest 20 per

Table 3 Population and longevity: proportion of years lived

Date	*Population × longevity*	*Period covered*
10000 BC	8.6	From evolution of species
AD 1	34.2	10000 BC–AD 1
AD 1750	28.2	AD 1–AD 1750
AD 1950	16.8	AD 1750–AD 1950
AD 1990	12.2	AD 1950–AD 1990

Source: Livi-Bacci 1992

Notes: The second column shows a percentage of all the people who have ever lived, not an absolute number.

Table 4 Environmental impact as a function of longevity and energy use

Date	*Population × longevity*	*Per capita E use (W)*	*Index of impact*
10000 BC	8.6	50	430
AD 1	34.2	100	3,420
AD 1750	28.2	300	8,460
AD 1950	16.8	1,972	33,130
AD 1990	12.2	1,720	20,984

Notes: The index is obtained by multiplying the two previous columns and is obviously crude; it nevertheless puts into perspective the data in Table 1.

cent from 2.3 per cent to 1.4 per cent? Are systems which favour economic growth and consumption rather than equity and the alleviation of poverty just?

'NEW PHILOSOPHY': THE DEVELOPMENT OF IDEAS

Down the ages, each new philosophy has always had the potential to put 'all in doubt', and there is no denying that humans' ideation of their surroundings has been very varied from place to place and time to time (Simmons 1992). That these interpretations intertwine with some of the material changes is undeniable, yet it must always be remembered that what people say and write is not always what they do: Taoist philosophy of a quietist kind pervaded China just as the people were engaged in large-scale transformations of land use and terrain cover.

The metamorphoses of thought

For pre- and non-literate groups there is only a hazy notion of their conceptualization of their surroundings in the distant past. For more recent times and for the present, the work of anthropologists and ethnographers has shed much light,

though what chronological depth can be attributed to the notions expressed is usually unknown. When it comes to written sources of evidence, apart from the West since the classical period, there are materials from the Indian subcontinent, China and Japan, but nothing from aboriginal American foundations.

For instance, has the hunter-gatherer phase of human history (which must account for about 95 per cent of the species' evolutionary time) had any permanent psychological effects, comparable to the ecological ones? Traits of aggression amongst males useful when there were large mammals (and their predators) to be hunted will be of negative value in a more crowded and sedentary world if they have persisted. The cosmic world-view of such groups suggests eternal and recurring patterns and that there are many worlds of being and meaning (for example, religion is polytheistic) in which life can participate. This may lead to an acceptance of the diversity of human personality and ways.

In early irrigated agriculture, the contrast between the river valleys and the semi-arid surroundings must have been very great, and some locate the home of western thought in the desert/cultivated margins, with it becoming first codified in the Hebrews of Palestine. They occupied a niche between the pastoralists and the farmers: they accepted transience but not fatalism from the nomads. They also rejected much of the agriculturalists' ways since they appeared to lead to conscription, enslavement, famine and disease. The farmers of the valleys contrast, too, with hunters. Whereas the hunter moves through the land, the farmer is centred in it and can overview it as a whole. Nature can withhold: no matter how great the drudgery, failure at some point is inevitable (Shepard 1982). All important things are human-created and all else is *other*. History became linear and so might lead somewhere. An infusion of Zoroastrian duality transformed ambiguity into polar opposites.

The desert landscape of the previous phase sustained a vision of a split world in which images of opposition flourished: Christian Gnosticism plus Zoroastrianism provided a Manichaean expression of an unresolved tension and division of the world (Peters 1987). Mainstream Christianity kept up the idea of the Fall to explain undesirable places and events and then was implicated in the rise of Renaissance humanism and then of science, which promised the reclamation of a pre-lapsarian state and, eventually, the perfection of mankind. The second world created by humans would therefore also be perfect since man was the measure of all things. Monotheism and Utopianism led to authoritarian, imperialistic thinking informed by philosophies which were unambiguous, dichotomous and unmetaphorical. Historical events became unique and interpretable through envoys with control of the written word which could be used politically to control the 'true' version of events and of history. Gellner (1988) stresses the need for manpower of agrarian societies (for labour and defence) and thus their propensity to conflict as well as a Malthusian relationship with their productive environment.

The great change of the industrial phase is that humans exist within a technologized world rather than being in control of technology. In science and technology is sought the answer to problems, whether of resource shortages or

environmental pathologies. They were also the crucial factor in the success of European colonization during the nineteenth century. The city favours knowledge of mankind, of physics and perhaps chemistry, but not biology, and certainly sanctions a machine paradigm of the universe since nature to the city child is much less coherent than the constructions of humanity. Then to the adult, the city looks more organized than a wilderness. It seems as if those who are perplexed by the imperfections of society have a strong will to destroy what already exists as a first phase of reconstruction. As with pastoralists, transience is a feature, as is a detached sense of the value of things like work or soil. Indeed, single-shot activities and specialization are rational acts in a way which would not have been legitimized in hunter-gatherer societies and perhaps less so in agrarian times. Interestingly, the late nineteenth to mid-twentieth century seems to have been a period when less attention has been paid by major philosophers to the consideration of what their predecessors would have called the relationships of man and nature.

In the post-industrial world, the tendency to globalization, seen especially in the financial transactions of the world economy, is subject to countervailing forces which emphasize the virtue of the local and regional (witness the upsurge of nationalism in Europe in the early 1990s), so that small ethno-cultural groups assert their independence of the nation-states to which earlier mores bound them. There are some signs of a growth of a world consciousness that encompasses the non-human world at a level of intrinsic value rather than simply as an instrument for human use. This could equally bring the realization that humanity is not destined for a very long evolutionary tenure on earth: a short life but a merry one could be preferred. Sub-currents include the re-evaluation of holistic thinking (with some shifts within western religions) and the rise of feminist thought in environmental matters. There is also the opposite case of increased demand for production of all kinds, which results in the occurrence of unpredictable instabilities in major biogeochemical cycles and increased reliance on science and technology to produce solutions to any consequential problems at the same time as the realization that the findings of science are neither empirically nor epistemologically always reliable.

Meta-theories

In the last twenty years the notion of sustainability has come forward as the shibboleth to be included in all discussions of human–environment relations. In many discussions, it takes precedence over justice, since, it is argued, without a sustainable economy and environment, there is simply no chance of justice to either humanity or nature. Clearly, sustainability is a concept to be examined with a critical eye (Redclift 1993). In particular, it has to be analysed to see whether it is another avatar of the western world-view which currently holds sway over most of the globe's societies and their environmental relations. The foundations of the world-view are in a linear view of history, and in the beliefs that more is better and that science and technology hold the keys to more and better as well as

the solution of perceived problems (Kates 1988). To these ends, any philosophy of the non-human world is strictly instrumental. Within this framework, any notions of justice have been dominated until recently by those with a utilitarian base, though others (see Chapter 1 in this volume) are now entering the picture. Unlike many of the more restricted philosophies of environment, however, the western world-view is widely, if implicitly, held by millions of people.

'THE FIRMAMENT IN EIGHT AND FORTY SHARES': RESONANCES

In most commentators' views, nature does not communicate directly with the human species. The features of nature 'out there' do not report to *The Times* what they think of being made resources or receptacles for wastes or vehicles for human pleasures. But the social cognitions of the strands of environment and resources are the cause of much discussion within society about environmental concerns. This is not all directly pragmatic in its focus, since matters like the ontology of nature and the concept of justice (to take two rather different examples) are both part of the intellectual explorations. This discussion could be compared to a resonance within society being set up by humans talking to each other about their surroundings and their meanings.

A major consequence of the last 400-odd years which is relevant is that of specialization. Not only is the getting of resources and the study of environmental processes specialized, but the way in which they are discussed is split among specialists as well. Furthermore, the languages used are often different (Luhmann 1988). The predilection of the natural sciences for mathematics is very different, for instance, from that of a deconstructive post-modernist talking about Rousseau. It might be useful to compare the situation with that of a pipe-organ, with sounds of different frequencies and volumes in pipes of varying length and width. One result of all the resonance which seems always to have occurred and always to have created a set of harmonics which do not apparently make sense is the desire to simplify them. In place of a unitary knowledge of humanity as ecological agent interacting with nature and ideas flowing into and out of such minglings (Kates 1988), we have a series of separate channels for the resonances, in the manner of the pipe-organ. These have separate labels and are the province of specialists, with their own languages: ecology, climatology, the economy, religion, law and education form part of the list. Again, in attempts to simplify the complexities of the relationships, western culture at least has found comfort in binary opposites, one of which ought to be overcome (often 'conquered') in the cause of the greater good. The origins of this cultural trait seem to be located in Persian Zoroastrianism, and the most notable pair is that of good and evil. There are other pairs which are of direct relevance here, such as humanity ↔ nature; determinate ↔ creators; technocentric ↔ Green.

So it seems as if any discussion of a concept such as justice relating to the environment will have originated as a resonance arising as part of a strand of ideation weaving in and out of the discussion by humans of the interaction of humans and nature. That resonance is likely to occur in a number of channels; it

may well not be confined to the one marked 'law', for example. If it is, then it may well stay there, with all the drawbacks of intellectual isolation. A high probability (to be understood rather than eliminated, perhaps) is that attempts will be made to simplify the sounds into those heard as 'just' and those as 'unjust', which will make into black and white what presumably ought to display all shades of green as well.

'A NEW COMPASS': THE FUTURE

What meanings for today and tomorrow can be drawn out of a long-term historical-cum-sociological view of these complexities? A number seem evident. There is first the conviction that each human institution expresses at least an implicit philosophy of nature. This may arrogate to itself its own channel of resonance or may have to share with others: the evolving discipline of ecological economics would be a good example. As industrialization and urbanization have proceeded, most show an increasing detachment from natural processes, but this appears to be countered by a great deal of communication *about* the environment through various channels (Luhmann 1988). The electronic media, especially television, represent a new channel, with unforeseeable results.

Second, each new phase of human–environment relations appears holistically as possessing emergent qualities which are not easily, if at all, predictable from the features of the previous levels. What is there, for example, to predict that it would be Europe and not India or China that developed into industrialism? *Post hoc* explanations abound, but it would have been remarkable to find such a prediction (a) of the nature of the emerging economy and (b) of its location in, say, 1611. The same was doubtless true of the emergence of agriculture, and in fact it was in some places a reversible development.

Taking this further, the triple helix seems analogous to a *self-organizing system* in the sense of Jantsch (1980) and of Prigogine and Stengers (1984). These systems start with a set of interactions which are far from thermodynamic equilibrium and which dissipate concentrated energy in building up complexity. So while they cannot but create entropy, there are swirls and vortices, as it were, which allow the development of phenomena like life and human cultures. But such systems are essentially very complex, and their behaviour cannot be totally predicted from any set of initial states. The dynamics may well now include human purposes, but that is only one of the cybernetic loops which bind the system together and whose synergisms allow the creation of emergent properties which could not be predicted from hitherto existing states. This may serve as a reminder of the importance of contingency in any scheme of evolution, as brought out vividly by S. J. Gould (1989). He uses the word 'teleonomy' for changes which, while moving in a general direction, make use of contingency and chance and adapt in small increments.

These considerations may give us pause from blindly endorsing concepts with the label 'sustainable', desirable though they may sound. If at no stage in history could the future be accurately forecast, and the present is not a great deal better, what possible meaning can sustainability have? It seems founded on either

outdated concepts of biological equilibria no longer held by ecologists, or on the role of capital in neo-classical economics, and neither may survive either the realism of the next doubling of population or the new ideas about humanity and nature which are bound to evolve. In history, every time something could be identified as 'sustainable', it was replaced (hunter-gatherers, solar-based agriculture) by an innovation which spread rapidly. Humanity could decide now to immobilize nature, resources and ideas at the present stage, but the probability of so doing seems vastly remote.

There is need for caution here: if we define justice to include future generations, but cannot forecast the nature of that future at all accurately, then how do we know what to avoid now? A simple *laissez-faire* fatalism seems inadequate, but exploration of some guidance for the adoption of a teleonomy seems desirable even if teleological behaviour is abandoned.

Overall, this reading of history suggests firmly that there is no going back to some Golden Age, when all was an Arcadian and pastoral idyll with humans and nature coexisting under a sunny sky. But the lack of predictability also suggests that future Utopias are also mirages: the systems are too chaotic for any one *telos* ever to be possible. For relatively stable systems, Treumann (1991) posits,

> the percentage of the time up to which the behaviour of the system can be predicted with say better than about 66% amounts to somewhere between 5 and 10% of the length of time the system has been continuously observed in the near past up to the present time when the prediction is made.

If we add to this the trampling that occurs in the pursuit of Utopias, such New Jerusalems may not be very desirable either. A teleonomy in which the capacity to utilize unexpected novelty and to innovate replaces a far-off teleology seems preferable in human terms (Berlin 1990). The notions of contingency and radical openness to the future have their parallels in recent thought of a post-modern character: the environment and our relations to it surely come into Bauman's (1993) category of 'moral agonies which no reason-dictated recipes can soothe, let alone cure'. In the same mode of discourse, Schatzki (1993) quotes Lyotard's view that justice is in the realm of opinions and not of truth and therefore must take its character from diversity (what echoes of Rio!) and all parties must agree locally on the rules. In the case of the environment, this simply brings us back to many of the central arguments in environmental ethics about standing and about the extension of value beyond the instrumental to the intrinsic (Birch 1988). But it does point us to the notion that self-organizing systems may spin concepts of justice which are the result of continual renovation and adaptation.

> Nor are, (although the river keep the name)
> Yesterday's waters, and today's the same.

NOTE

1 *An Anatomy of the World*. Each heading in this chapter also quotes from the poem. All spellings have been modernized.