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Seen from a satellite, the way in which our planet functions paradoxically looks a lot simpler than, say, the operation of world financial markets, the running of a large metropolis or the working of a nuclear plant. Perhaps it is this apparent simplicity which has sparked the proliferation of works on the future of our natural habitat ever since the Club of Rome published its report *Limits to Growth* in 1972 – a report which to this day heads the best-seller lists in the realm of futurology, with over three million copies sold.

Since those days, dire warnings about the future of the biosphere have alternated with rosy confidence, and prophecies of the imminence of apocalypse have taken turns with deliberately optimistic professions of faith in the future. The net result has been a blurring of environmental assessment to cover the next 20 to 50 years and to cast doubt on the credibility of forecasts in this field. But none of the confusion and suspicion is justified in fact, whether it refers to the extent of scientific controversy about ecological phenomena, or to the complexity of the forces which interact to produce the 'environment'. For although there is considerable uncertainty about the long-term changes in technology, knowledge, values and even institutions, the broad sweep of evolution of the biosphere in the course of the next century can largely be 'foreseen' – provided we operate on a sufficiently global scale.

Gradual transition: stable trends

The environment, together with demography, is by now one of the few areas in which futurologists will still venture predictions beyond the next 25 years.[1] This is because the characteristically slow rate of ecological change renders futurological forecasting both feasible and necessary:

- The time scale involved in measuring climatic change and the changes in forest cover, soil, inland seas, genetic diversity or biochemical cycles runs into a century at least.
- It takes a very long time to set up regulatory mechanisms or implement effective policies: a century to reconstitute irrigation systems, 50 years

21ST CENTURY

ONMENT AND RESOURCES

by Jacques Theys

to come to grips with smog in California, only marginally less for a satisfactory solution to France's problems with water pollution.

But coupled with the considerable inertia of ecological systems, which is linked to the predominance of cumulative (or stock) phenomena as opposed to flux phenomena, the stability of 'heavy' trends, which it appears will determine the development of the key environmental problems in coming decades, is every bit as remarkable.

A typical example of such a 'robust' environmental determinant is, of course, demography. We all know that the past 20 years have seen a decline in fertility not only in the industrialized countries but in a large majority of developing countries as well, thus checking the steady annual rise in the rate of world population growth which has characterized the past two centuries. Some journalists, historians and politicians have pounced on this fact to invalidate the United Nations' 1963 population forecasts prophesying a world population of some 6 billion by the year 2000, rising to 8 billion by 2025 (Pierre Chaunu even went so far as to call their projections 'absurd' and 'not devoid of humour').

Not so, however. There is ample evidence that these forecasts will turn out to have been astonishingly correct. the decline in fertility is merely a new, but nevertheless eminently foreseeable stage in the long-term demographic change initiated in Europe 200 years ago and which, most experts concur, will gradually cause the world population to level off at around 10–11 billion by the end of the 21st century. By that time, six out of every seven people will live in what is now the Third World; Europe will represent only 5 per cent of the world population whereas Africa, which with 10 per cent is on a par with Europe today, will account for 25 per cent of the total. Far from the exponential explosion envisaged by the Club of Rome, the most likely prospect is one of slow stabilization at a level of some 10 times higher than that prevailing at the onset of the demographic revolution – with a global population spread that is radically different from today's.

Demographic trends – characterized by this slow progress to distant stabilization – provide a handy yard-

stick by which to 'measure' the pace of future change in four other major determinants of environmental quality: growth, technology, energy and urbanization. There is reason to believe that whatever the force and magnitude of the changes that occur, pressure on resources and ecosystems will nevertheless continue to mount – more slowly no doubt but still too fast for comfort – well into the first half of the next century at the very least:

- By itself, the mere process of the Third World catching up with its industrialized counterpart will continue to push **economic growth** rates up and, except in Africa, these will everywhere exceed the rate of population growth. Most experts agree that globally speaking, per capita growth will not fall below an average 2 per cent in the next few decades.[2]

- There is no reason to expect the present technological revolution to affect, in any startling fashion, the structure and impact of activities as compared to the present day. This is, first of all (see Chart 2), because the switch from one technical system to another takes far longer than is generally supposed (Marchetti introduces the concept of 'semi-secular thrusts').[3] Then again, the relative costs of access to new technology may well prove way beyond the means of many Third World countries for many years to come. It is likely, therefore, that by the year 2050 the system will feature a **juxtaposition of technical strata** representing all three of the great industrial revolutions rather than a world plunged wholesale into a 'post-industrial' structure dominated by services, informatics and biotechnology.

- The 21st century is likely gradually to achieve a **more uniform level of urbanization** which will probably, by and large, reflect levels currently prevalent in the industrialized countries (75 per cent). As this implies a virtual reversal of the ratio of urban to rural population in the developing countries – where 70 per cent of people still live in rural communities – we may safely assume that the vertiginous spread of Third World cities is not about to stop.[4]

- The imperatives of climbing the development ladder, the slow rate of technical replacement and fast urban growth all help to explain why despite

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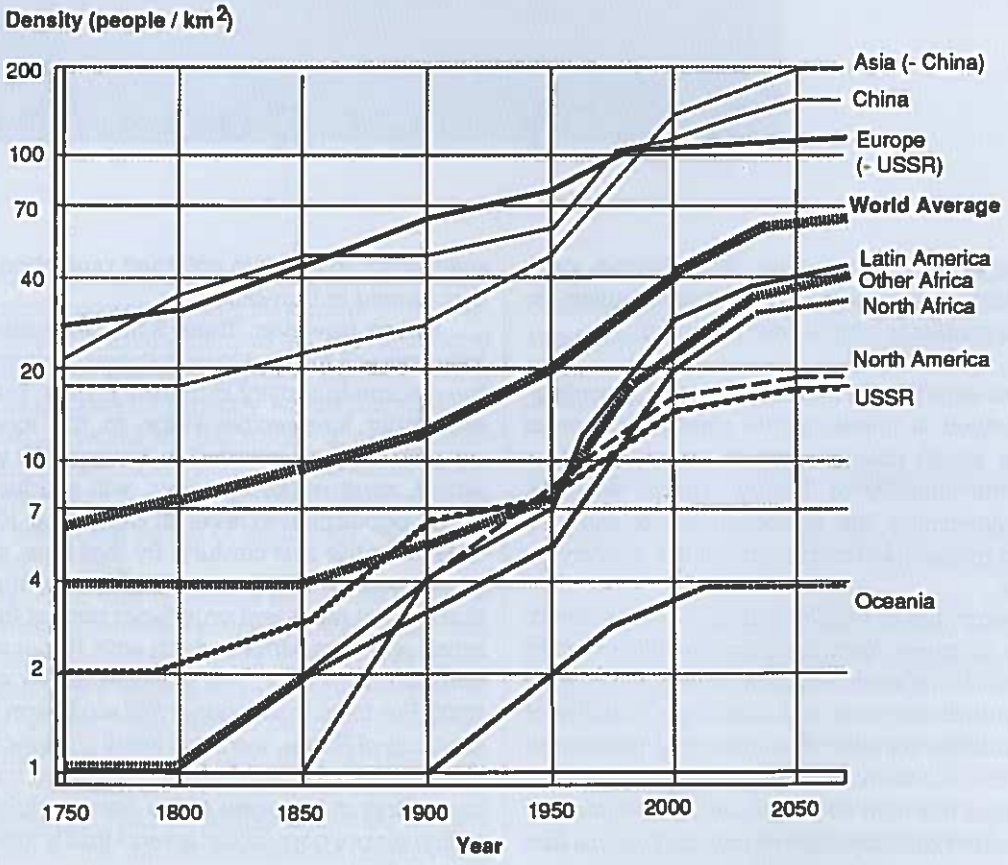
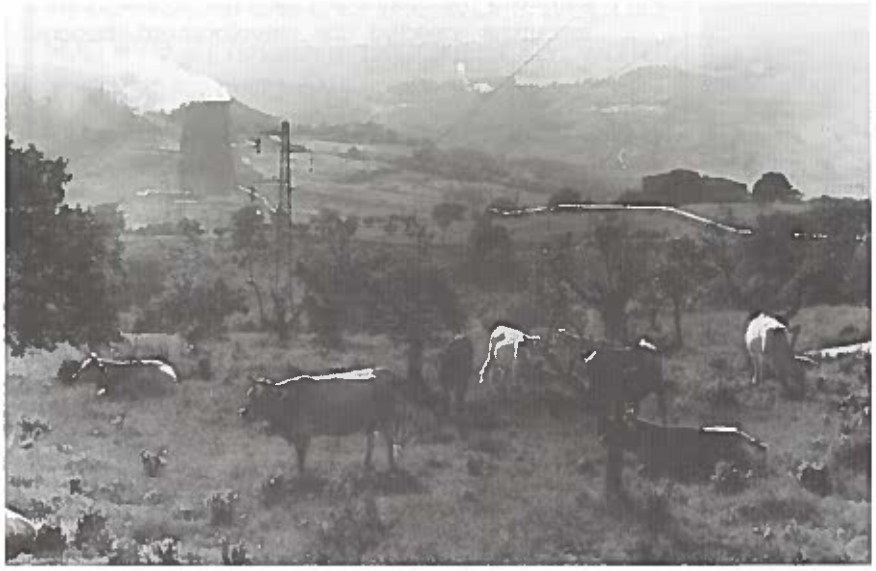
History and projections of population densities for the world as a whole and for continental regions



Source: *Sustainable Development of the Biosphere*, William C. Clark and R.E. Munn (eds.), CUP, IIASA, New York, 1986, p. 27.



'energy demand will continue to increase sharply at world level: a doubling of consumption by 2025 and a quadrupling or even quintupling by 2075, with ... a sweeping redistribution of current energy sources ... with oil dropping from 40 to 20 per cent of the total and nuclear energy surging from 3 to 15–25 per cent'.

substantial improvements in energy productivity (+25 per cent in the USA between 1973 and 1982), **energy demand** will continue to increase sharply at world level: the most cautious experts foresee a doubling of consumption by 2025 and a quadrupling or even quintupling by 2075, with considerable variations on the average depending on the locale (virtual stabilization in Europe and a tenfold increase in India).[5] Significantly, no one seriously envisages a massive breakthrough of new forms of energy (solar, methanol, fusion) in the next 50 years, but all expect a sweeping redistribution of current energy sources by that time, with oil dropping from 40 to 20 per cent of the total and nuclear energy surging from 3 to 15–25 per cent.[6]

- Finally, a comparable growth scenario is envisaged for **agriculture** (a 250 per cent increase in production between 1975 and 2025).

All these trends represent global averages and, needless to say, different countries may present vastly different scenarios. Still, these differences will be in part wiped out by the general growth of awareness of interdependence and globalization which first came to be recognized in the late 1960s when traces of mercury and lead were found in Antarctica, for instance, and when people began to worry about the effects of supersonic aircraft on the ozone layer. W. Clark and C.S. Holling hold the emergence of these global issues to be the great futurological event of the next decades, echoing the concern expressed by Kenneth Boulding that the 'most worrying thing about the world is that there seems no way of preventing it becoming one world.'

If one then considers that the 21st century will at least in part be called upon to cope with the accumulated inheritance of past decades, it takes little imagination to visualize even at this stage how past trends may affect the future environment:

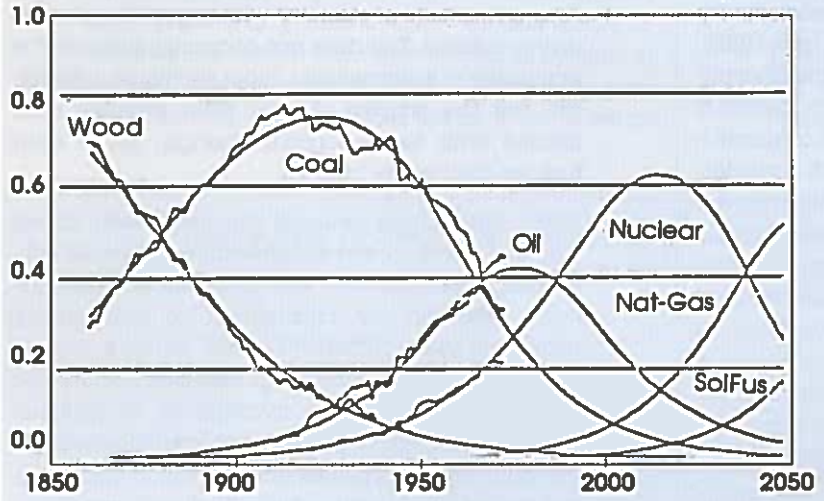
- First, a measure of stability with regard to present-day problems. This does not, of course, exclude the possibility of interruptions, local shocks or upheavals, nor the advent of new risks, possibly connected with technological change, but it does reduce their likely impact.
- Next, the crucial issue of the continued strong upward trend in environmental pressure which, although perceptibly less pronounced than initially foreseen by champions of exponential growth is yet sufficient to spark, in time, a new debate on the relationship between economic development and the availability of physical resources, a debate currently at low ebb owing to the build-up of surpluses and the fall in commodities prices worldwide.[7] Quantitatively speaking, the changes lying in wait may not differ greatly from those which the biosphere has had to accommodate over the past hundred years – in the course of which the area under cultivation has more than doubled and industrial production increased fiftyfold. But they will affect far more ecologically fragile and economically vulnerable countries at unprecedented speed.[8]
- Finally, the 21st century more likely than not will be called upon to cope with the enormous stresses brought about by the difference between local conditions (themselves highly varied) and global problems, which will in most cases be completely out of phase with the former. How indeed does one alert the dwindling population of Europe, staggering under vast farm surpluses to the dangers of global food shortages? How indeed will people come to terms with the inevitable redistribution and migration of populations and activities in the world?[9] The forging of new forms of solidarity between peoples will constitute one of the most uncertain challenges for the environment in the next few decades.

A hierarchy of problems and risks: first things first

In order to arrange past developments into a credible hierarchy of future problems for the environment, at least four major categories of countries facing highly divergent problems must first be defined:

- ***ONE*** – countries such as Japan or the United States, already well into the third industrial revolution and sufficiently wealthy to devote 2–3 per cent of their GNP to the protection of the environment: their number one problem will be to hold galloping innovation (biotechnology, flexible industrial plants) in check and to stay one step ahead of ever-increasing vulnerability to ever greater risks.

Chart 2 ***Substitution of different primary energy sources, 1850 – 2050***



Source: C. Marchetti, *The Dynamics of Energy Systems and the Logistic Substitution Model*, IIASA, Dec. 1979.

SOLFUS = Solar+ Nuclear fusion

- ***TWO*** – countries like France or the United Kingdom, with low demographic and economic growth rates, which will face serious local problems connected with de-industrialization and depopulation, hence 'ecological inequality'. For these countries, maintaining a high level of environmental quality will mean juggling financial imperatives and cultural options.
- ***THREE*** – a large majority of developing countries like Brazil, India or China which, if they can keep population growth under control, will probably achieve high rates of economic growth and a correspondingly high increase in pollution-related problems and industrial risks (with Asia becoming by far the foremost 'producer' of waste and net pollution in the world).
- ***FOUR*** – the poorest Third World countries, mostly in Africa, which if, as seems likely, they fail to curb the birth rate and increase per capita growth, will probably face serious problems as the natural resources needed for development become scarcer and scarcer.

The following section focuses on two major groups of future problems: the imbalance of common resources and the vulnerability to risk of complex industrial systems.

1. The imbalance of common resources

Most common resources now need to be managed as if they were constant or even declining stocks under far from optimal conditions. The lack of an effective pricing system either causes excessive stock depletion or an investment lag (to re-build stocks). The situation varies widely from country to country and from continent to continent, so there is not much point in attempting a global assessment; nevertheless, the overall 'heavy' trend is one of imbalance.

Water

One of the great eye-openers of the next quarter century may well prove to be the return of serious water shortages in the industrialized world. However, in talking about the growing scarcity of water it must by understood that it is the cheap, plentiful supply which will gradually become a thing of the past; the sustained upward trend in water prices[1] will probably continue and lead to far stricter husbanding of water resources and uses.[10]

Things are a lot bleaker in many Third World countries, even when, globally speaking, the 'stable' water supply will remain well above demand until the middle of the next century. Cases in point are the Sahel countries, North Africa and Middle East – there, the combined burdens of climate and demographic pressures may prove too much, despite the increased use of solar energy for pumps, desalinization of seawater, systematic recycling of waste water, freshwater production from brackish supplies or the use of sparing irrigation schemes (of which Israel provides an example).

But the water 'crisis' is not confined to arid regions: by now 30–40 per cent of the world population live in regions plagued by water shortages and this is expected to rise to over 50 per cent by the beginning of the 21st century. Three Third World citizens in five have no access to any clean drinking water whatsoever, and four in five have no proper plumbing. Allowing for world population growth, over 2.5 billion people will need to be connected to clean water supplies over the next 25 years if the deficit is to be made up.

'... 30–40 per cent of the world population live in regions plagued by water shortages and this is expected to rise to over 50 per cent by the beginning of the 21st century. ...

... in 25 years over one billion people will be affected by firewood shortages, i.e. 10 times the number ... today.'

Soil

Desertification is a problem in almost 100 countries. With the desert advancing at the rate of 6 million hectares per year annual losses are already estimated at US $25 billion. 20 per cent of farmed areas and some 100 million people will eventually be directly affected. But desertification is only the most visible part of a general trend – that of the overall deterioration of arable soil. 25 billion tonnes of soil are lost to excessive erosion each year, a phenomenon which might explain up to a quarter of the decline in agricultural productivity in Africa. Finally, at the world level, there will be virtually no increase in the area under cultivation between now and the turn of the century, and for a third of the world population it is actually in decline.

Living species and their ecosystems

Living species face three major problems at the world level: the reduction of forest cover in tropical regions, over-fishing and the decline in genetic diversity. Quoting FAO figures, 15-20 per cent of the planet's tropical forests are fated to disappear over the next 20 years, rising to 40 per cent in 50 years' time, with none left at all at the end of a century. For every 11 million hectares of forest felled each year, a bare two million are replanted. The most pressing problem has now become the dramatic rise in firewood shortages – firewood still supplying the sole source of energy for one third of the world's population. Estimates say that in 25 years over one billion people will be affected by firewood shortages, that is, 10 times the number involved today (demand will outstrip supply by 25–40 per cent !).

Where the fish catch is concerned, fish stocks may be reduced by as much as 20 per cent compared to demand by the end of the century, in spite of the rapid development of aquaculture.

Finally, it would be a mistake to underestimate the likely repercussions of the disappearance of part of the tropical forests on genetic stock. Half of all living species are native to the tropical rain forest. Genetic diversity has already fallen by 10 per cent in a quarter of a century.

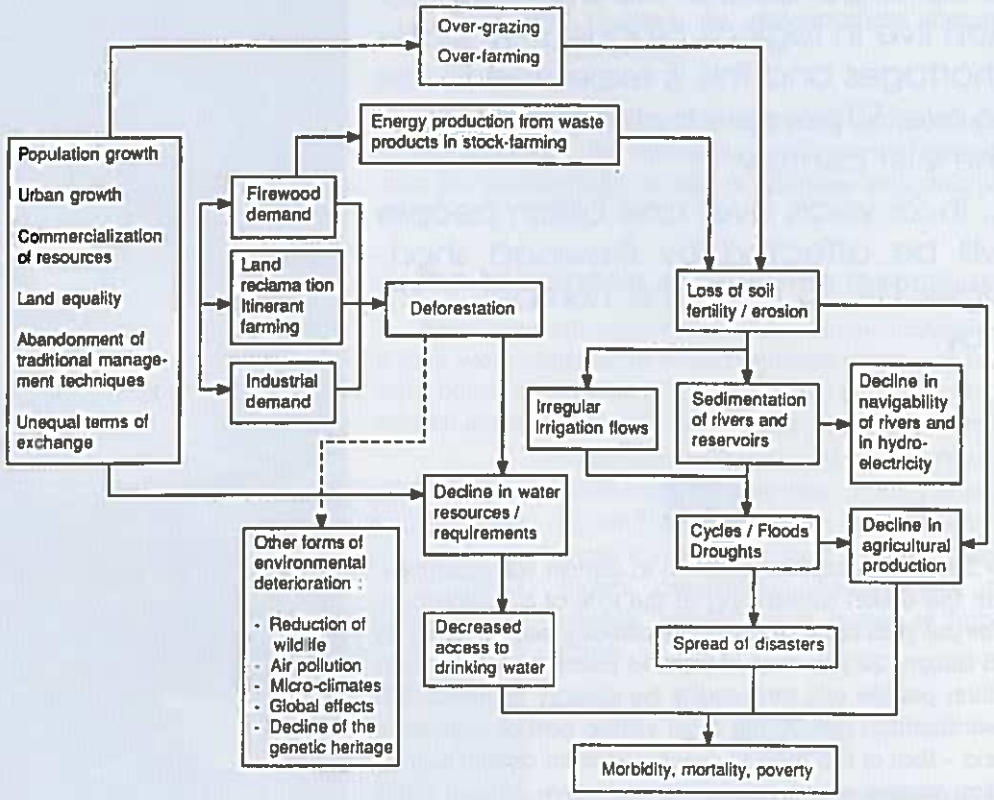
All these partial imbalances, themselves aggravated by the demographic overload (See Chart 1), overlap to produce a chain of cause and effect. It is no exaggeration to say that some regions have absolute growth limits: one half of the African continent will fail, in the long term, to feed its people unless radical changes intervene. The developed countries are fortunate in comparison. The problem there will be to halt the far more subtle deterioration of the natural habitat, which could be an important factor in the development of leisure activities and the maintenance of multi-purpose farming.

Air and climate

The problem of the long-term effects of air pollution on eco-systems (e.g. acid rain) and on climate (build-up of CO_2, the greenhouse effect, and the destruction of the ozone layer) is likely to prove one of the major resource-related issues as the 21st century approaches.[11] A large majority of scientists claim even now that given the current energy and industrial outlook, the CO_2 content of the atmosphere must double sometime between 2040 and 2075 and that, coupled with the rise in methane concentrations, the doubling of the CO_2 level will bring about an average temperature increase of 2–3 °C, with wide variations according to latitude. The increase will

Chart 3

The interplay between economy and environment in Third World countries



Source: David Pearce, *Futures* (Oct. 1985), according to Repetto and Holmes.

be virtually nil at the Equator but could rise to as much as ten degrees in the polar regions. The outlook for the ozone layer is somewhat less fraught, yet the objectives set by the Montreal Conference last September are not, unfortunately, likely to suffice to permanently solve a problem which must remain at the forefront of concern.

2. The vulnerability of complex systems

The growing vulnerability to risk is the second major environmental problem which will need to be addressed not only by most developed economies but by a very large majority of Third World countries as well. Vulnerability, indeed, is linked not only to the degree of concentration of activities, to urbanization and to the use of increasingly dangerous technologies but, paradoxically, also springs from the very improvement in the performance of technical systems and from the way in which people become accustomed to a high level of security still objectively on the rise.

Over the last 30 years, the tenfold increase in chemical production and in the size of industrial plants, and the quadrupling of energy consumption have led to a rize in the number of serious industrial accidents from 3 to 4 a year between 1940 and 1970, to 15 between 1970 and 1975 and to around 30 since then – another tenfold increase. Security has in fact improved tremendously and this has been instrumental in keeping the consequences of two industrial revolutions since 1950 within manageable bonds, in the richest countries at least.

Yet zero risk is not really a feasible objective in the 21st century or even beyond: expenditure on security is not infinitely elastic and its yield does decrease beyond a certain threshold; automatic processes are not infallible; the reduction of risk in one quarter often engenders new risks in another; and there are obvious limits to the awareness of risk (even today nobody knows exactly how harmful up to 70 per cent of chemicals on the market really are). Above all, there are social limits to how far people will accept the constraints of a hypersafe society. Hence there will always be risks which will slip through the even most efficient safety net. In this sense the major challenge in decades to come will be to adjust to the unexpected (this might, for example, apply to risks connected with biotechnology or in the nuclear field).

This brings us to the outer confines of futurological insight, even though, ultimately, most environmental problems of the future (and these should include the traditional risk of pollution) can, as we have seen, be anticipated to an amazing degree (see Table 1).

Although the forces of inertia lend plausibility to the developments outlined above, it would of course be wrong to portray them as inescapable by passing over the fundamental impact of technical, institutional, scientific and cultural regulation.

Back in 1972, the Club of Rome managed, by ignoring these levers of adjustment, to predict the exhaustion of natural resources and the collapse of the world economy in the 21st century, while the American authors of *Global 2000*, the most exhaustive work of futurology ever written, felt confident that by the year 2000 the world would be 'more populated, more polluted, less ecologi-

cally stable and more prone to disruption than at present'. At the other end of the scale, Simon, in *The Resourceful Earth*, more recently arrived at a diametrically opposed view by overestimating and mythifying 'human ingenuity'. These divergences certainly highlight the full importance of properly assessing the regulatory mechanisms used.

The technical argument

The use of new technology may well bring about a complete change in the way the environment is managed in the future. Biotechnology is poised to open new vistas of, for example, an integrated biological approach, the fixation of atmospheric nitrogen, the reprocessing of agri-food waste and ways of repairing environmental damage. Great strides may be made in respect of the storage, transport and processing of industrial waste – for example, bacteria capable of metabolysing toxic molecules, tele-monitoring techniques, etc. Finally, the expected development of hydroponic cultures, in vitro breeding, gene banks, and extremely fast-growing varieties of trees foreshadow radical changes in the manner of agricultural production early in the next century and open perspectives for an entirely people-made natural environment.[13]

The scientific argument

The notion that a politician must at all times defer to well-established and proven scientific fact before taking environmental decisions seems about to be exploded by the very complexity of ecological phenomena – and this despite a notable improvement in the accuracy of monitoring and measuring equipment. Jerome Ravetz, for example, suggests a reversal of the traditional relationship between objective ('hard') fact and subjective ('soft') opinion on the part of politicians. He claims that 'henceforth we shall increasingly demand "hard" decisions from our politicians for which there is no "soft" scientific evidence or which are the subject of controversy'.

While this may be something of a caricature, it nevertheless opens an issue which will prove crucial to efforts at forecasting problems for the next century. It also raises the more nitty-gritty issue of the autonomy of monitoring bodies.

An array of new institutions

A decisive step forward was taken in the 1970s with the creation of national and international institutional structures with the express purpose of managing the

'... growing vulnerability to risk ... will need to be addressed not only by most developed economies but by ... Third World countries as well. ... Vulnerability is linked ... to the degree of concentration of activities, to urbanization and to the use of increasingly dangerous technologies.'

Fifty years ago, Lewis Mumford came up with the idea that the second industrial revolution, – the revolution of petrol, electricity, automobiles and organic chemistry – would bring about much positive environmental change – the development of clean working methods, recycling and renewable energy, the abolition of the town/country divide, soil conservation, production in decentralized mini-units. Unfortunately, exactly the reverse has happened and we are now saddled with the consequences. In one way, today, environmental policy is at a comparable historical crossroads: will we be able to seize these technological opportunities which also pose a formidable economic challenge? Some countries have already come to recognize this.

environment, a concrete acknowledgement of the avowed need for public intervention. The future development of the natural habitat will of course depend to no small extent on the efficiency, political clout and financial scope of these institutions (1, 2 or 3 per cent of GNP). But a glance at the deeper underlying causes of environmental deterioration in the Third World (unequal access to land, commercialization of natural resources, disruption of traditional management systems, population growth, deterioration of the terms of trade, ill-controlled industrialization, poverty) is enough to make us realize that neither the establishment of specific agencies nor blind confidence in 'human ingenuity' will go very far in solving the dilemma. One of the key challenges to the

Table 1

25 major environmental problems for the next century *

1. Biotechnology-related risks (invasion of genetically modified species, release of viruses or bacteria, 'artificialization' of nature)
2. New compounds or electronic materials (polymers, ceramics, memory alloys, carbon fibres, selenium, berrylium, phosgene...)
3. Non-ionizing radiation (microwaves, computer screens, electric and electromagnetic fields, television ..)
4. Repercussions on the marine environment of marine exploitation-soil and off-shore constructions, polymetallic nodules, intensive aquaculture, waste storage....
5. Nuclear energy – chemical and radio-active pollution, accidents, problems of waste storage, de-commissioning....
6. New energy sources (synthetic coal-based fuel, bituminous shale, hydrogen storage, the methane chain, biomass fuel, nuclear fusion, solar energy.....)
7. Climatic changes from increase in CO_2 levels, methane and nitrogen oxides (greenhouse effect)
8. Risks of reduction of the ozone layer.
9. Decline in the genetic diversity of species.
10. Erosion and increasing desertification.
11. Massive disappearance of tropical forests and the firewood crisis.
12. Increased salinity of soil and water.
13. Microbe contamination of water; sudden disruptions in the supply of drinking water.
14. Generalized pollution of soil, water and ground-water from fertilizers (nitrates) and pesticides.
15. Risk of sudden dumping of accumulated poisons or heavy metals in rivers, estuaries or groundwater.
16. Unexpected interruptions in the natural absorption and neutralizing mechanisms for pollutants.
17. The relationship between chemical pollutants (in the natural environment and in the organism) and the growing controversy about their effects.
18. Sudden invasions of harmful species.
19. Secondary effects and the vulnerability of environmental protection systems (pollution caused by filtering equipment, chlorination, concentration of wastes, exposure of environmental workers to harmful substances, over-use of natural habitats, proliferation of protected species.....)
20. Transport and storage of toxic waste.
21. The growing vulnerability of complex industrial systems and networks to breakdowns, attack, accident or natural disasters.
22. Pollution within enclosed premises or environments.
23. Pollution from motor vehicles (air, congestion, noise....)
24. The expansion of industrial, agricultural and urban land clearance and the growing difficulty of maintaining the landscape.
25. The growing artificiality of habitats, use of the natural environment and the shift in values about nature.

* Excluding war-related risks

21st century will be the need to invent new instruments of solidarity, institutional or informal, which should, in particular, aim at:

- involving (either by contract or treaty) as wide a range of operators (public, private, local, national and international) as possible in the communal management of natural resources in the major eco-regions (rivers, seas, etc.);

- preventing, through direct mobilization of private interests, the defence of the environment from gradually becoming the sole prerogative of experts, however capable.

Current thinking on management of the patrimony runs along these lines, but there is still a great need for creative innovation.

Choosing a value system

'Since we may expect future generations to be richer than ourselves, what we do with our resources does not really matter: to ask us to cut down consumption today in order to leave something to those who come after would be like asking the poor to give presents to the rich'. Simon does not mince his words and his statement puts us squarely into the picture: increasingly, the issue of environmental protection in the developed world will be one of values – of 'passion' rather than or 'interest'.[14]

The people of the 21st century, highly urbanized individuals ensconced in a world of increasingly non-material values, utterly cut off from their rural roots, may well come to terms with living a life divorced from nature, in a sort of peaceful indifference. They will be capable both of creating a perfectly artificial 'natural' habitat and of throwing off the shackles of the environment. In such a scenario, environment as an issue would likely become the concern of a rarefied circle of experts.

Nobody can really visualize the way in which nature will claim its dues nor how people will co-exist with nature 50 years from now. What is abundantly clear, however, is that there is little point in pinning our hopes on the present situation somehow stabilizing, rather than taking a good hard look at the role of nature in a society dominated by informatics, services and biotechnology. One only has to think that the Camargue, in France, was a cereal-growing region as little as a century ago to realize how vain is the hope of preserving our natural heritage in its present state. It would be far more relevant to maintain fora where the values connected with the future of our environment and our planet's natural resources can be expressed and discussed in the full light of reason.

For, finally, the issue of environment must not become a further source of misunderstanding and tension among the peoples of the world.

References

1. The International Institute of Applied Systems Analysis (IIASA) is currently studying the future of the European environment until 2075. UNEP, under the Mediterranean Action Plan, is setting up scenarios to 2030, and Bruce E. Tonn, a researcher at Oak Ridge National Laboratory, USA, has gone so far as to propose resource planning for the next 500 years.
2. This effectively corresponds to a total growth rate of 2–3 per cent for Europe and of 4–5 per cent for countries in Asia and Latin America.
3. Even since the start of the economic crisis, growth rates in the developing countries have exceeded 4 per cent (although they have been only 0.8 per cent for the very poorest among them) and the World Bank suggests an average rate of 4–6 per cent annually for the period 1985-2000 (4.5–6.5 per cent in Asia).
4. The dynamics of energy systems and the logistic substitution model, International Institute of Applied Systems Analysis, Vienna, 1979. By the year 2000, 21 out of every 25 urban centres of +10 millionh inhabitants will be located in developing countries.
5. IIASA suggests three development scenarios for 2075 with a respective increase in energy consumption from index 100 in 1975 to indices 130, 460 and 300 in Europe, and to 1,000, 1,600 and 1,200 in India. Globally speaking, the most likely scenario foresees a tripling of energy consumption between 1975 and 2025. We have used the lowest increases in order to emphasize the contrast.
6. By this time, oil prices ought to be around US$40 a barrel and oil consumption roughly equivalent to today's (4 Terawatts (TW) out of 20). In France, nuclear energy will make up more than 40 per cent of total energy output in the year 2000, production having increased a hundredfold between 1973–1986).
7. No study today seriously assesses the extent to which usable natural resources will suffice in a world in which 10 billion people will produce four times as much per capita as we do at present. The 'economic' risks of shortage are, however, much more likely to occur than the 'physical' risks. For example, there is some reason to expect a recurrence of energy crises given the contrast between the high costs of investment and the low marginal costs of exploitation.
8. It is worth remembering that even at the peak of the population explosion in the industrialized countries in the 19th century, maximum growth rates never exceeded 0.8 per cent compared with the 2 per cent current in the Third World (and 2.4 per cent only ten years ago).
9. Cf. Jacques Lesourne, *L'immigration, une dimension majeure du XXIi me si cle europ en (Le débat sur le débat)*, Jacques Lesourne, Jan. 1984. Countries such as Indonesia, for example, are already trying to organize mass migrations from more to less densely populated regions in the country.
10. The price of water rose by 100–200 per cent in the OECD countries between 1970 and 1980. This trend is likely to persist as attempts to improve water quality for the consumer continue.
11. Recent assessments indicate an average reduction of approximately 10–15 per cent of the ozone layer within 50 years if CFC emissions stabilize at current levels. *The Sky is the Limit*, Research Report No. 3, World Resources Institute, Nov. 1986.
12. Conversely, the Third World countries will accumulate pre-18th century epidemics, 19th century industrial insecurity, 20th century chemical accidents (Bhopal!), and the repercussions of hard-to-master technical progress will also probably be transferred to these countries.
13. It would be a mistake however, to suppose that the problem of rare 'collective' resources can be resolved in the short run by massive recourse to the products of biotechnology – and hence of capital and energy – to replace natural factors, if only for economic reasons (particularly in the Third World).
14. See *Les Passions et les Intérêts: Justifications politiques du capitalisme avant son apogée*, Albert O. Hirschmann, P.U.F., Paris, 1980. In the developing countries, environmental management is very much a matter of economic survival.

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Photos: Michael Agee.