4

Beliefs about Resources

Food and energy

The anthropologist Mary Douglas has described two neighbouring communities in Africa which live in the same climate but experience it in different ways.[1] What to one group seems the hot season is cool to the other. Beliefs about the environment are like that, she says; they relate to social systems and values, not only to facts, and in the western world, as in Africa, one can confront people with the same facts about the environment and find them coming to diametrically opposed conclusions. Economists and scientists, especially, are often found to interpret the same information about resources or pollution in different ways. Similarly, it was noted in the previous chapter that engineers and public health officials interpret river pollution differently, and that divergent views are held by informed people about the causes of cancer. Experts from different backgrounds are notoriously in disagreement about many other technical questions also – the nutritional requirements of the human body, for example, or the economics and safety of nuclear reactors.

Mary Douglas explains these differences by pointing out that we all need to find coherence and regularity in experience; we need a frame of reference or world view by which to order our perceptions. To achieve this, we must inevitably allow 'the destruction of some information for the sake of the more regular processing of the rest'. This destruction of information or backgrounding of matters we do not wish to think about may be done in several ways, for example, by rejecting ideas that do not fit into a linear view of progress, or by discussing the safety aspects of VDU screens rather than more serious worries about their social impact.

Sometimes this process can lead to a form of double-think. We are mostly well aware of the advertising, the marketing techniques, and the planned obsolescence by which manufacturers of domestic consumer goods, clothes and automobiles seek to promote sales. Yet we do most of our shopping in precisely the way that the manufacturers want, pushing our doubts into the background. Through similar backgrounding habits, professionals of unimpeachable integrity produce biased projections or preside over organized waste in the electricity and water industries without noticing it. All of us habitually do this, because otherwise the world would seem too complex to deal with. We accept a distorted world view in order to make the more immediate parts of our experience manageable.

One distortion which has become part of the conventional western world view is a caricature of the Third World and its myriad 'starving people'. Some organizations estimate that 1,200 million people are undernourished; others say 400 million; a few experts say less than 100 million. The figures are almost meaningless because of confusion about what they are meant to measure. Do they measure hunger, or rather poverty? Do they measure manifest symptoms of malnutrition or perhaps chiefly a risk of under-nutrition? And what criteria define under-nutrition anyway? Ambiguities about all these things give ample scope for the distressing but unmeasurable reality of poverty to be manipulated by cynics who would rather do nothing about it – or by powerful interests with fertilizer or farm machinery to sell, or surplus American wheat to dispose of. Some of the latter may want to believe in food shortages where none exist in order to justify their export drives, and their 'aid'.

Many people have become poorer precisely because of such exports – because the green revolution promoted by the West as a technical fix for a misperceived problem has deprived people of land and employment, and made many of them *more* hungry than before. Chronic malnutrition is certainly widespread, but it is not caused by single physical factors such as a specific scarcity of food. Rather it is a problem 'having multiple causes, many of which are closely linked to . . . conditions of inequality of resources, of poverty, and of social discrimination'.[2]

As to famine, studies in India, Nigeria and elsewhere have shown that its frequency and intensity have varied historically according to changes in the economic regime – not with the frequency of poor harvests alone. Under some economic conditions, for example, food prices are pushed up beyond what the poor can afford by speculative buying on the part of traders; and where farm output is depressed, this may be because prices paid to farmers are too low to encourage them to produce. 'The connections that do exist between . . . food scarcity and the environment are mediated by the political and economic relations of a society.'[3] Famine, like recession, is largely man-made.

Such facts are known, and in recent years some countries have made appropriate reforms in food marketing. Yet we persist in thinking about hunger as if there were an absolute shortage of food, and as if the problem of matching food supplies to a growing population were a purely technical one, to be solved by the new crops and fertilizers of a green revolution, supplemented in times of difficulty by food aid from Europe and North America.

The way in which westerners are willing to destroy information in order to maintain this belief is illustrated by the way in which food aid is sometimes dispatched even in the face of clear evidence that it is not needed. A striking instance described by Tony Jackson[4] followed the major earthquake which occurred in Guatemala in 1976. Some 23,000 people were killed and over a million were left homeless. Relief agencies responded on a big scale, not only with medical aid and help with rebuilding, but also with food. Yet the earthquake had not damaged growing crops, and a record harvest was completed in its aftermath. But food aid to the stricken region still arrived. American field workers cabled their headquarters to stop them sending food, but it still came. The Guatemala government placed a ban on food imports, but ways were found of evading it. The result was that the bottom fell out of the local market for grain, and local farmers sowed less in the next season.

Some people in Guatemala were certainly destitute and needed help in obtaining food. But at least one relief agency met this need by buying food grown locally. This could be done in many other countries where people are hungry, thereby supporting local agriculture rather than undermining it.

Part of the problem here is that the West has adopted a set of beliefs – or world view – in which, as Tony Jackson says, 'the Third World is portrayed as a vast refugee camp, with hungry people lining up for food from the global food-aid soup kitchen. This view is false. Some disasters aside . . . the basic problem is not one of food, but poverty. Free hand-outs of food do not address this problem, they aggravate it.'

That does not mean that we should immediately switch to a tough-minded approach in which food aid is never given. Some countries now depend on it; some can use it intelligently, and there are emergencies where it is essential. But the mode of giving needs radical reassessment so that it complements rather than disrupts local agriculture. And before that can be achieved, western planners and all of us need to be aware of the bias in our conventional beliefs about the world. Part of this is a reluctance to think seriously about poverty and how it might be reduced. Another factor, though, is that the West's own major food problem is over-production, and just as the over-production of weapons is justified by phoney intelligence, so also we maintain a phoney world view about requirements for food. This not only includes the 'soup kitchen' image of the Third World, but also the acceptance of a good deal of organized waste, amongst which the inefficiencies of feeding grain to livestock are the most often quoted.

Food, one might think, ought to be central to the arguments that go on about the earth's physical resources, for although there is over-production at present, this may be rather fragile. In 1973–74, after two successive bad harvests in the northern hemisphere, world wheat prices temporarily doubled and food stocks fell to a level which caused some alarm.[5] Moreover, the resources on which farm output depends are regarded in some quarters as very vulnerable. The West's high grain yields and food surpluses are heavily dependent on fertilizers and pesticides produced by the petrochemical industry. It is sometimes said of western diets that we are 'eating oil'. But much less is said about two resources that are disappearing even faster than oil – agricultural land and trees.

Thus it is salutary to find one lone voice asking, 'should we conserve food like energy?'[6] Logically, 'conservation applies . . . to renewable resources', including land, food and trees, as much as it applies to energy. All these things interlock. Modern meat production is not only wasteful in grain and in energy, but beef is now being produced in Brazil by cutting the rain forest to make grazing land for cattle. This exposes a very unstable soil, and once the trees have gone, it is capable of supporting livestock for only two or three years. The resource costs of Brazil's beef exports are thus very high.

Africa presents an equally worrying spectacle. This is the one major region where, if statistics can be believed, food production has consistently failed to keep up with population growth. During the 1970s, per capita food production fell at an average annual rate of 1.1 per cent.[7] There are some states, notably in West Africa, where farm output may be depressed by the effects of food aid. More widespread, however, is the deterioration of soil and the extension of deserts arising from deforestation.

Food and timber are, of course, both forms of energy, and it is the need for firewood for cooking that is the cause of much of the African deforestation. In many respects, this is the most serious energy crisis of all. Yet in the West we tend to see energy shortages very narrowly in terms of oil. Government research in Britain has looked at farm, food, forestry and paper wastes to see how much motor fuel could be produced if these were all hydrolysed, concluding that 27 per cent of all surface transport requirements could be provided this way.[8] But economic recession has abruptly altered perspectives on such issues. During the 1970s, it was widely predicted that oil consumption could go on rising into the 1990s before a crisis of high prices and scarcity forced the adoption of alternative fuels. Now it is noted that a peak in world oil consumption was passed in 1980, and some commentators think that this may prove to be the all-time maximum.

The recession also offers other reminders that the real energy crisis is not just a matter of oil or even firewood, but of poverty as well. Every winter, some old people in Britain die of hypothermia because they cannot afford adequate heating. And in Tanzania, to take one example among many, there is a hospital that cannot use its kitchens and hot water system, because the equipment, given by German donors, is oil-fired. The effect of recession on Tanzania is that oil can no longer be imported on a sufficient scale. So washing, bathing and laundry in the hospital are done in cold water, and 500 meals a day are cooked outside, on open fires, using wood which has to be brought an ever-increasing distance as trees disappear.

Minerals and energy

So many of the world's problems, it seems, turn out to be problems of poverty, but the habitual preoccupations of many of us are solely with technical matters; that must also be our concern in the next few paragraphs, and the reader with a non-technical interest may prefer to move ahead to page 69. Even adopting this narrower focus, we find strangely different views among the experts. Some say that a major resources crisis is looming, but many economists assert that there is no real problem. Tunnel vision is, of course, a factor. Economists want to get back into the business of managing economic growth, while scientists imagine different kinds of crisis according to what their expertise can cope with. Space technologists envisage an energy regime favourable to building solar power devices on satellites. Nuclear scientists envisage an energy crisis for which nuclear fission, and ultimately fusion, is the only possible answer. Biotechnologists claim that their new techniques are the key. Environmentalists hope that energy shortages will force us to take renewable resources seriously.

The economists can defend their case by referring to the way in which prices affect perceptions of resources. For example, it is sometimes said that aluminium reserves could be exhausted within thirty to fifty years. Yet aluminium is one of the commonest elements in the earth's crust. It is a constituent of clay, and so of most soil. However, extraction from clay would not be economically worthwhile, so this source of the metal is not counted in estimates of reserves. But eventually prices will rise and other methods of extracting the metal will develop. Many ores which are not now counted as part of the reserve will then be exploited.

How far can this argument be extended? Wilfred Beckerman says that for most key metals, the amount available within a one-mile depth of the earth's surface is 'about a million times as great as present known reserves'. Even though we do not have the capability to extract this enormous endowment now, he argues, by the time we need it, 'I am sure we will think up something.'

That last comment tells us a good deal about the fundamental beliefs of those who argue that the earth's physical resources will last indefinitely. They have a remarkable faith in technology, and accuse the scientists who foresee a crisis of scarcity of not understanding society, and in particular, of under-estimating the way human inventiveness can respond to market forces.

Another economic argument[9] is put forward by Julian Simon, who notes that the values and world views which people build into their analyses of resources are illustrated particularly clearly by the way graphs are drawn, and by assumptions about interest rates and prices. Simon presents graphs of his own that represent a longer historical period than is usual, and he plots the price of each major resource relative to average incomes. For both food and energy – that is, for grain, oil and coal – the long term trend up to 1980 is for this price criterion to fall. Yet if there were any constraints on supply, and if shortages were looming, we would expect prices relative to incomes to be rising. Thus again, economic argument seems to show that there is no problem.

Such arguments certainly have a point, and we may agree with the economists that scientists do sometimes misunderstand society. But economists do not always seem to appreciate the laws of nature as scientists formulate them, especially the laws that set limits to what technologists can achieve. An example which illustrates this concerns uranium. As with aluminium, the quantity that exists is far larger than the stated reserves. But it is rather too easily assumed that we can get at it all. There are uranium salts in sea water, for example, but to extract them, one would need a plant capable of dealing with enormous volumes of water, which would itself consume a great deal of energy. When used as a fuel in a nuclear reactor, the uranium obtained would, of course, constitute a new supply of energy – but perhaps less energy than was used in the extraction process. To claim that we can add to the world's energy supplies this way is therefore like saying that we can create energy out of nothing, contrary to the laws of nature.

An alternative world view relating to this is provided by the new discipline of energy analysis. The idea is that apart from doing our accounts in terms of money, as the economists do, we also need to account for energy consumed. Peter Chapman,[10] one of the pioneers of this approach, has used energy accounting to emphasize the difficulty of obtaining uranium from sea water. Others have used energy analysis to study the proposal for a satellite-mounted solar power plant. They show that this would barely succeed in paying back the enormous amount of energy needed to manufacture its components and lift them into orbit.[11]

More conventional, earthbound solar energy devices can potentially do much better (though the performance of some existing ones is certainly poor). They can pay back the energy used in their construction several times over.[12] This contrasts sharply with conventional energy systems, whether for electricity generation or domestic heating, which consume gas, coal or uranium and pay nothing back. It will be evident, then, that energy analysis presents a view of resources which coincides fairly closely with what environmentalists have been saying for a long time: that the only way to develop a sustainable lifestyle is by depending mainly on the sun for our energy.

This idea allows us to get the economists off the hook regarding the extraction of uranium from sea water. Suppose that some way were found of using the sun's energy for this, would we then be able to go on obtaining uranium for reactors indefinitely? One method is to grow plants in sunlight and exploit their ability to extract mineral salts from water in their surroundings. Thus, in 1980, Japanese scientists obtained a 4,000-fold concentration of the uranium from sea water by growing algae.

Other ways of extracting minerals from low-grade ores using biotechnology are already under development. They will certainly alter our perspective on resources, and will ease some of the constraints which resource scarcity could impose. But do they provide the ultimate technical fix for the problems associated with resources, pollution, and limits to growth?

A realistic answer must be grounded in understanding of the accessibility or availability of resources. The real problem is not that any key raw material is likely to run out, but that most resources will become less accessible. For example, clay is a much leaner ore of aluminium than the ores that are currently worked. In that sense, the metal would be much less available if we had to extract it from clay. But if, in the future, the richer ores are insufficient to meet demand, means might be found to exploit some clays economically. But there would still be a need to process large amounts of material, perhaps digging up vast areas of land, so there would be a cost in terms of food production. However, it is rarely made clear how big such costs may be, and it is often argued that damaged landscapes can be restored and noxious wastes disposed of, provided only that sufficient money is spent. Nathan Rosenberg is one economist who believes that ecological pessimism is exaggerated because it underestimates our capacity for 'corrective action by using the tools of science and technology'.[13] He suggests that if there are limits to this corrective action in the United States, this is because too much is spent on armaments, space ventures and nuclear energy, and too little on the environment. That is an economic limit, but in his view there is no technical limit on what could be done to correct environmental damage.

Such argument is not entirely convincing, however, and the clearest account of its defects has been put forward by Nicholas Georgescu-Roegen, a Roumanian mathematician-turned-economist who has lived in the United States since 1948. He comments that most of his colleagues in the economics profession fail to recognize limits to what can be achieved by technology partly because they use a linear mode of analysis, but partly also because they assume that damage due to pollution and mining is always reversible. The latter is consistent with a scientific world view based on classical mechanics; it is inconsistent, however, with more recent thinking based on thermodynamics.[14]

To illustrate this point, Georgescu-Roegen discusses several kinds of technical fix which economists regard as being capable of contributing to a solution of the problem of scarce resources. One is the recycling of metal and other wastes. While this is most emphatically to be encouraged, there are two ways in which it is limited. Firstly, there is an energy cost in transporting scrap metal back to a smelter and melting it down. Secondly, many ways of using materials involve spreading them around, in painting or spraying and in general wear, and this makes them unavailable for recycling. It would seem, then, that for a full analysis of questions relating to resources, we need a way of measuring availability, or rather 'unavailability' – and such is provided by the idea of entropy.

Thus the second law of thermodynamics uses the entropy concept to tell us that as energy is used, it becomes less available. Georgescu-Roegen complements this by proposing a fourth law of thermodynamics which states that as material resources are used, they also become less available; machines cannot run indefinitely because their material frames wear out.[15]

These generalizations clarify a point about solar energy applications. The sun continually replenishes available energy on the earth, but there is no equivalent replenishment of materials. Thus solar energy does not provide a complete answer to the question of resources, and Georgescu-Roegen concludes that there is indeed no complete answer – there is no totally sustainable lifestyle.

The fourth law of thermodynamics also clarifies several issues regarding pollution and environmental degradation. It leads to the observation that although most applications of technology appear to make materials more available and more usable, for example, by irrigating deserts or refining metals, there must always be a cost, not only in money and energy, but also in entropy. The evidence of this cost will be some form of waste, either visible as slag or spoil heaps, or less visible as fumes in the atmosphere or reject heat from an engine. All these things represent resources that have been made less available. And the laws of thermodynamics make it clear that every process in the real world must lead to such effects. A solar energy device may run without any pollution whatsoever, but there is no way of constructing it without producing wastes of some kind, and making some resource less available. All processes, of man or of nature, must add to the global deficit.

This leads directly to the conclusion that there can never be a real fix for pollution. For example, the energy we might use in cleaning up a polluted lake will be dissipated in the atmosphere as a small extra burden of exhaust gases and thermal pollution; and the chemicals we use in the same operation will have been produced at the cost of some extra waste at a distant factory. Solving a local problem merely adds slightly to the global one.

Thus Britain's clean air campaign in the 1950s had a dramatic, almost miraculous effect in cities such as Manchester and London. Pea-soup fogs all but disappeared and the incidence and severity of lung diseases declined. This was achieved by controls on burning coal and by greater use of electricity supplied from coal-fired generating stations outside the cities, with very tall chimneys to disperse fumes. That dealt with the local problem, but we now find that it transferred some of the pollution damage from towns in England to forests and lakes in northern Europe, where sulphur dioxide from British electricity production, carried to the ground as acid ran, has killed fish and is now thought to be destroying many hectares of trees.[16] A better solution now feasible is to burn coal at generating stations on a fluidized bed onto which crushed limestone is also fed; this retains the sulphur content of the coal in the ash. Fixes for pollution are like this; they may contain the pollution (as ash in this case), or they may alter its location, but they cannot prevent the production of waste in some form. The only way to do that is to use less resources, because use of materials of any kind is inescapably linked to the production of waste.

Every nation with aspirations for industrial growth has a problem. To meet the requirement for a clean and pleasant environment for its people, selected lakes and rivers may be cleaned up, and limited areas of good environment protected, but that implies a parallel decision that elsewhere, the environment will be allowed to deteriorate. This may even be planned. One idea is that the United States and other industrial nations should designate national sacrifice areas where mineral extraction, nuclear power plants, heavily polluting industries and waste disposal would be concentrated. Every English county planning officer knows that he must designate some parts of the county for waste disposal, and perhaps for a polluting industry. He can often choose where these areas should be and insist on high standards of management, but he cannot choose not to have them.

Differing world views

Mary Douglas, drawing on her work in anthropology, suggests that all human societies have fears about the environment and pollution. In pre-industrial societies, these fears are rooted in harsh experience of drought and harvest failure, dirt and disease, and they are always expressed in ways which link environmental fact with social values. Where there is illness, that may be because of moral transgression associated with impurity or pollution.

Similar connections are made in the modern world. Some people think about cancer in puritanical terms: they argue that prevention depends on abstinence from smoking, sex and fatty food. An equally puritancal note is struck by the conclusion we have just observed that the only way to prevent pollution is to stop burning fuel and mining metal. But the values of people who worry about environmental problems are concerned with more than puritan morals; they also include a concept of nature in which living things have intrinsic worth and the goal of material development is regarded as, ideally, to find ways of living in harmony with nature. By contrast, the confidence of many economists and engineers in human ability to overcome every problem may often reflect a moral judgement that the proper role of man is mastery over nature.

In other words, although the different beliefs about resources and the environment outlined in the previous section are related to scientific theories about energy and thermodynamics, they are also linked to moral attitudes and values. Thus the three (or four) different world views summarized in table 3 are based on different conceptual frameworks within which the same facts may have different meanings. Although scientists may discover objective facts about the environment, they can never construct an objective view of society's interaction with it, because moral values and the social ethos must always be part of that. Thus Julian Simon ends his analysis of population and resources with a chapter-heading which asks: 'Ultimately – what are your values?'. He points out that there is no scientific truth about whether oil resources are being used up too fast, and similarly 'it is scientifically wrong – outrageously wrong – to say that "science shows" there is overpopulation (or underpopulation)' in any particular region or in the world. To seek authority for value judgments such as these by claiming that they have been established by science is no better than to claim that

TABLE 3 An interpretation of three 'world views' regarding natural resources

Technologists tend to be divided between a majority who take a technical-fix approach and a minority interested in energy analysis or other environmental aspects. The technical-fix approach coincides closely with the views of the 'economists' and is not discussed separately.

	Economics (e.g. Beckerman)[1]	Technology-based		Bio-economics (e.g. Georgescu-Roegen)[3]
		Technical fix	Energy analysis (e.g. Chapman)[2]	
World views as defined by:				
(a) science	classical mechanics	thermo-dynamics[4]	thermo-dynamics[4]	amplified thermo-dynamics[5]
(b) concept of nature	nature as machine	nature as machine	nature as system	nature as process
(c) proper role of man	mastery of nature		acceptance of nature	harmony with nature; restraint
(d) currency of account	money		energy	entropy
(e) time perspectives	20–50 years, and growth open-ended		20–50 years; equilibrium; limits to growth	100–1000 years? with limits to sustainability
(f) concept of technology	production	construction, innovation	construction, innovation	management of process
Policy implications	nuclear energy, solar satellites, improved mineral extraction		solar energy, biological technologies, modified lifestyle	

[1] Wilfred Beckerman, *In Defence of Economic Growth*, London, Cape, 1974.
[2] Peter Chapman, *Fuel's Paradise*, Harmondsworth, Penguin, 1975.
[3] Nicholas Georgescu-Roegen, *Energy and Economic Myths*, New York, Pergamon Press, 1976.
[4] This is founded on four laws of thermodynamics, as follows: *Zeroth law*, about thermal equilibrium; *First law*, that energy cannot be created or destroyed; *Second law*, about entropy and the availability of energy; *Third law*, about the absolute zero of temperature.
[5] Georgescu-Roegen adds a new law of thermodynamics: *Fourth law*, 'unavailable matter cannot be recycled'.

racial discrimination is scientifically justified by research in genetics.[17] In today's world, ecology is a science which has been abused particularly badly in this way.

Yet it is clear that ecology, like thermodynamics, can provide extremely valuable ways of analysing some of our current problems. Thus while we use the insights of these sciences, we ought to be very clear about why they cannot lead to firm conclusions about future resources that everybody can agree on. Once again, the same facts have different meanings according to the conceptual framework we use; and especially crucial to any such framework is its time dimension. This applies particularly to thermodynamics, where the conclusion about a steady deterioration in the availability of resources seems inescapable, but the rate of deterioration and the time over which problems will arise is undefined. Man's industrial activity has tended to accelerate the process, but we may still believe that the deterioration is so slow as not to matter.

There is also no agreement about what time-scale in the future we ought to be considering. Varying but often vague assumptions about this can make all the difference between optimism and pessimism. Thinking twenty years ahead, many people would agree that there is perhaps no problem about energy resources (except firewood), but that forests, soils and farmland ought to cause us concern. But to think ten thousand years ahead, by which time there may be a new ice age, is for most purposes absurd. On that time-scale, we may even contemplate the possible end of human civilization with philosophical equanimity. Most people want to feel that the future is assured for much more than twenty years, but are not worried for so far ahead as ten thousand. One study group has argued that we have an obligation to future generations to think fifty years ahead, and criticizes most commercial and political planning for its 'horizon blindness' beyond about ten years.[18]

Economists argue that growth is sustainable, but on what time-scale? Environmentalists and energy analysts deny that much further economic expansion is feasible, but argue for a lifestyle that is kept in equilibrium with the environment by attention to recycling and the use of solar energy (table 3). Georgescu-Roegen, though favouring the latter proposals, argues that even this way of living is not sustainable in the long term. Thermodynamics, he reminds us, portrays a universe which must gradually run down, like an unwound clock. Social scientists who have reviewed these issues conclude that, as Stephen Cotgrove puts it, 'views of the future are rooted in systems of meaning that are social constructs and lack any firm objective certainty. They are faiths and doctrines'.[19]

But action and policy need a firmer footing. The lesson can only be that all these beliefs need to be examined with the greatest circumspection. The dominant world view in modern society is that of the economists and the technical-fix brigade. But that does not mean that they have the best evidence on their side – only that they exert most influence over decisions. So Cotgrove warns that this dominant 'faith' has 'no superior claim to truth'. Indeed, simply because it determines most policy within industrial societies, it may be 'in the most urgent need of sceptical reappraisal'. It would seem prudent, then, to take careful account of the arguments of those who talk about ecology and thermodynamics. One sees opposition to their attitudes: 'their view of reality must struggle against considerable odds. But they could be right. And if their vision of the future is closer to reality, and if we ignore it, then the results could well be disastrous . . .'

Georgescu-Roegen carries his analysis of these issues to the point where he formulates specific 'bioeconomic' policy proposals. Recommendations range from population policy to wider use of solar energy. The suggestions are similar to those of other environmentalists except that they are related to thermodynamic concepts concerning the processes of nature. Indeed, they can be taken to imply a concept of technology as the management of process. There are two particular points of significance here.

Firstly, this perspective offers a philosophical basis for the emphasis on maintenance and disease prevention stressed in the previous chapter, for these can both be regarded as means of husbanding the products of artificial or natural processes. Maintenance and prevention are both conservation activities; they both seek to slow the inevitable, cosmic processes of decay.

Secondly, this concept of the management of process calls for some reassessment of the conventional view of technology as being primarily concerned with the engineering of inorganic matter. As one engineer has observed, his profession 'has been going through a phase of rejecting natural materials. Metals are considered more "important" than wood.'[20] The same is true of fuels and chemicals.

But thinking about technology in terms of process involves recognizing that most of the processes which take place in the world are actually biological ones. For example, the plant material produced by photosynthesis each year amounts to ten times as much fuel as the world's population annually consumes. That is not to say that plant material – any more than engineered solar energy devices – can provide all our fuel. Such simple answers are always suspect. But in a broader sense, living plant materials – especially trees – contain many of the processes that need to be managed, and constitute one of our biggest resources. We ought to worry much more about how that resource is being destroyed, whether by cattle ranching in Brazil or by acid rain in Europe and North America. The *Global 2000 Report*, commissioned by President Carter, estimated that the world's stock of growing trees would fall from 327 billion cubic metres of timber in 1978 to 253 billion by the year 2000.

Yet it is a mistake to think of trees and plants as merely material or fuel, for they also contain information in genetic form. It is estimated that something approaching half of the world's genetic heritage is to be found in the tropical rain forests. It is claimed that here are all the resources for a natural biotechnology which, running on solar energy, could provide 'great cornucopias' of substances with 'potential in medicine' as well as timber and food.[21] But trees are being felled and forest lands cleared at a rate of around ten million hectares per year, and the rain forests may be largely destroyed before an adequate scientific assessment has been made of the resources being lost.

Yet even as the importance of biological resources is recognized, we still think in engineering terms about how they should be exploited, with the result that in some places, trees are being destroyed even more rapidly and soil resources are misused with the cultivation of alchohol fuel crops.[22] There is a parallel irony in much solar energy development, where the emphasis is on solar-powered water heaters, solar-electric devices, satellite-mounted power stations and wind turbines. All these depend heavily on conventional engineering and inorganic materials (steel, glass and aluminium), and so on established coal-fired and nuclear-powered industries.

The human potential

One drawback with all the three world views as they have so far been presented is that they do not take account of the end-use of the resources they consider. To complete the picture, we need to ask: what human purposes and goals are served by expanding economies, and what limitations on living are there in more sustainable conditions? How is poverty to be overcome if not by economic growth? It is mainly by answering these questions that we can begin to recognize what choices are available and avoid the impression that some kind of thermodynamic determinism is at work. For even if we accept that the laws of nature set limits on the material aspects of life, there is no absolute, fixed connection between material and social development. As Georgescu-Roegen puts it, what matters most is not the material flow from resources through the economy, but the immaterial flow to human well-being. And one knows that there have been communities living in material poverty where well-being was high. For more than a century and a half, western visitors to Botswana in southern Africa have noted something of this.[23] One described communities there by talking about the 'abiding city' of 'human civilization and enlightenment', and speaking of a 'welfare society', though on the level of 'grinding poverty'.[24]

But romanticized accounts of poor communities abound, and it is only if the part of the description that mentions 'grinding poverty' is tackled realistically that we can begin to make gains in understanding. Grinding poverty usually means insufficient food, ill-health, poor housing, and poor educational opportunity; the conventional wisdom is that only economic growth can raise standards in these areas.

Yet there are places where health and education do seem to advance, even in the absence of much economic development. One such is Sri Lanka. Another is the nearby state of Kerala in south India. Statistics indicate that in both, education at primary level is good (table 4). Life expectancy at birth exceeds 65 years, which is closer to the 73 years that Americans can look forward to than the 55 years more typical of India as a whole. It would appear, then, that high incomes are 'not necessarily a prerequisite for low mortality, a message of obvious significance to other low-income countries'.[25] Equally, it seems that good health and social progress do not always depend on a high consumption of material resources. And this conclusion seems so important that the remainder of this chapter is devoted to a case study, focusing on Kerala.

One of the most sensitive indicators of a community's level of health is the death rate among infants during the first year of life. This reflects the health of both mothers and children, and shows what kind of start in life the new generation is getting. In Kerala, infant mortality fell sharply from the 1950s and into the 1970s. This is illustrated by figure 7, and is an achievement which deserves to be recognized as 'technical progress' just as such as any of the developments plotted as graphs in chapter 2. Indeed, the conventional wisdom is that reductions in infant

TABLE 4 Some indicators of health and economic conditions in Kerala and Sri Lanka compared with the whole of India

	Year	Sri Lanka	Kerala	All-India
Quality of life				
Life expectancy at birth (years)	1981	*67*	*66*	*55*
Infant mortality within one year of birth, estimated per 1,000 live births	1958–9		90	150
	1968–9		66	132
	1978	42[a]	40–50	120–30
Adult literacy rate	1981	70%[a]	69%	36%
Children enrolled at primary school	1977	94%	95%	78%
Demography				
Crude birth rate per 1,000 population	1977	28.5	27.9	32.9
Crude death rate per 1,000 population	1977	7.4	8.3	15.4
Average annual population growth	1971–81	1.8%[a]	1.74%[b]	2.21%
Couples using family planning	1981		29%	22%
Food supplies				
Estimated average energy (calories per person per day)	1972–5	*1950–2250*	*1600–2300*	*1950*
Protein (grams per person per day)	1972–5	*45*	*47*	*55*
Economy				
GNP per capita (equivalent US dollars)	1975	*200*	*135*	*145*
Growth in GNP per capita per year	1960–76	2%	1.3%	
Electricity use per capita (kWh per year)	1972–3		*81*	*97*
Growth in per capita electricity use per year	1972–3		11%	8%

[a] Sri Lanka figures calculated at slightly different dates from those stated
[b] trend markedly to lower growth rate

Sources: United Nations and UNESCO Statistical Yearbooks; also T. P. Dyson, 'Preliminary demography of 1981 census', *Political and Economic Weekly* (Bombay), 16, no. 33 (15 August 1981), pp. 1349–54; R. H. Casson, *India: Population, Economy, Society*, London, Macmillan, 1978; D. R. Gwatkin, in *Food Policy*, 4 (1979), pp. 245–58; P. D. Henderson, *India: the Energy Sector*, Delhi, Oxford University Press, 1975.

mortality in England, also shown on figure 7, were primarily due to such applications of technology as the improvement of water supply and sanitation and the hygienic bottling of milk. One factor that tends to be forgotten is that when infant mortality in England began to fall in the late 1890s, the mothers concerned were the first complete generation to have benefited from universal primary education.[26]

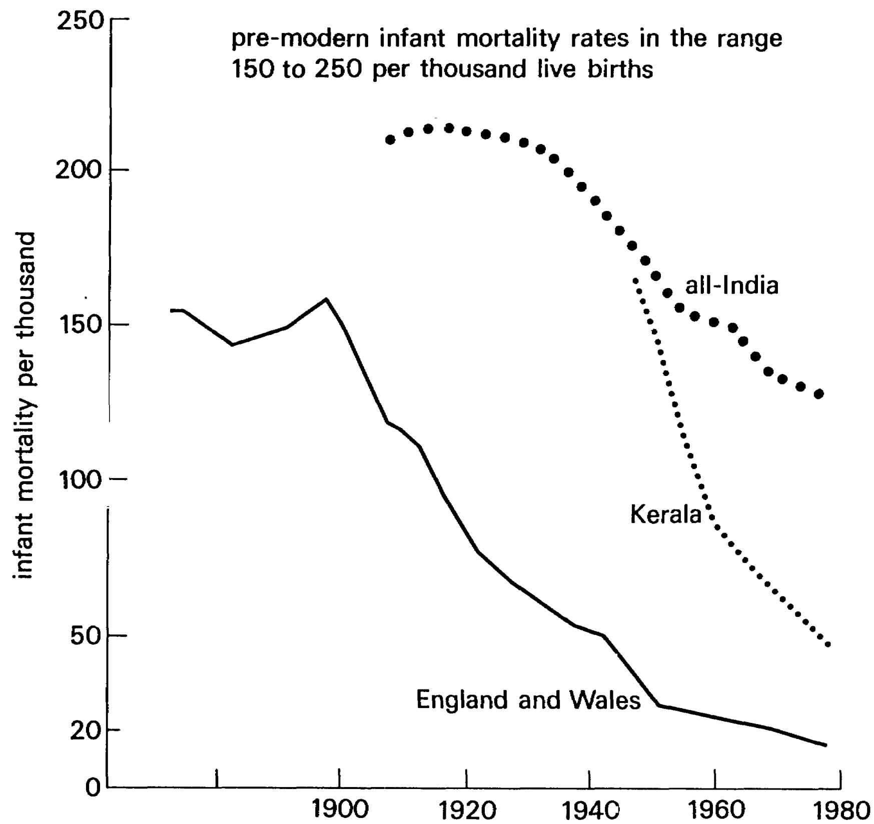

FIGURE 7 *Mortality of infants during the first year of life, in India and in England (Data for India are very approximate)*
Source: Arnold Pacey, 'Hygiene and Literacy', *Waterlines*, 1 (1), July 1982, p. 26.

In both Kerala and Sri Lanka, improvements in water and sanitation have come slowly, and cannot account for the recorded changes in mortality; malaria control, despite its limitations, has had a bigger impact. But primary education and adult literacy have developed rapidly. In 1981, some 69 per cent of the adult population of Kerala were literate compared with an average literacy rate throughout India of 36 per cent. The difference is striking, but how might it affect child health and mortality?

Two factors may be involved, one of an immediately practical nature, and one more intangible. The practical point is that where most mothers are literate, they make better use of the well-staffed network of primary health clinics which is one of Kerala's most notable features. The mother can read her baby's health record when it is filled in at the clinic; she can read family planning posters and the instructions on medicine bottles.

Many experienced people 'view literacy instruction as the best possible means . . . to break the vicious circle of low incomes, high birth rates, and slow development'.[27] But more important than its immediate utility, reading offers a less tangible benefit; it gives the individual ability to control the 'message input' – to stop, think, and reread difficult sentences – and this may allow unused mental abilities to be unlocked. Acquring literacy sometimes makes people more innovative and more self-aware. Sociologists in South America have found a close connection between functional literacy and innovations in the home such as the installation of latrines and medicine cupboards.[28]

In some places where this influence of literacy on levels of awareness and social development has been noticed, it has been spoken of as an awakening or a consciousness-raising effect. In Kerala, it seems, there has been an awakening which has led people to grasp new possibilities in health and social change. One account of a rural latrine-building programme there traced its origins to a women's literacy class.[29] More generally, it is said of Kerala that 'sanitation is good because people are educated'. There may be no modern sewerage in most places, but good standards of public hygiene are maintained because of the care taken over removal and disposal of night soil.

Kerala's achievements in education and health during the 1970s were made against a background of considerable poverty. Most economic indicators were below the average for India (table 4) and Kerala was one of the poorer states in the country. What this may mean to the individual has been vividly described by the economist Leela Gulati,[30] through a detailed record of the lives of five poor women in Kerala. Their employment opportunities are limited, and tasks are segregated by gender. Women may do heavy work carrying bricks, but get paid half the wages of men in the brick-making industry. Work available in the coir industry and in agriculture may be equally badly paid. Yet often women feel that they have no choice but to work if they are to buy food for their children.

Where people are living so near to the limit of subsistence, economic growth as well as redistribution of wealth must be desirable, and fortunately there is evidence of such growth occurring. Rice production has been rising by around 3 per cent annually, and tapioca production much faster. Fisheries do well, and engineering workshops capable of repairing diesel engines for fishing boats have blossomed into small industries. One now manufactures engine components, including valves and crankshafts. Other engineering works have benefited from the rapid expansion of electricity supplies (table 4), helped by investment from the Kerala government, and have gained contracts to make equipment for the Electricity Board. The improvement of health services may have helped also; on the edge of the Cochin-Ernakulam conurbation, a small industrial estate is devoted mainly to enterprises making drugs and medicines. One local entrepreneur began his career as an apprentice to a traditional or ayurvedic physician, and now has modern equipment manufacturing nine different pharmaceutical products.

An industrial survey which reports these instances also mentions a factor which has certainly held back the local economy: almost half the factories covered had suffered through strikes. 'One plastics manufacturer, who had just experienced a 2½ month strike, said that his major aim now was to save for more automatic machinery.'[31] In the rural areas, there has also been a long history of labour unrest. This slowed down the introduction of the new rice varieties associated with the green revolution, and in the early 1970s, deprived Kerala of some of the economic expansion which other states experienced. So bad was the trouble that farmers sometimes left fields uncultivated rather than face the problems of employing labour.[32]

At the root of this unrest were not just the usual campaigns for better wages and for land reform. In addition, from 1964, there was a split in the large local Communist Party. A strongly Marxist faction broke away to form cells in the villages and to promote a continuous mass campaign against employers. Other sectors of society shared the feeling that led to all this, and a parallel campaign within the Catholic Church in Kerala argued that true religion should involve the 'struggle for bread, human dignity and social justice'. Members of the Mahatma Gandhi movement also talked about a 'struggle' aimed at 'organizing the poor to overthrow the bonds . . . of vested interest'.[33] These Catholic and Gandhian groups have complemented the militant labour movement by organizing 'social welfare societies' working mainly with women and seeking to improve women's employment opportunities. They have sponsored literacy classes, handicraft workshops, and an impressive waste-paper recycling project in Cochin-Ernakulam.

All this ferment is reflected by the many flourishing local newspapers representing several points of view – Communist, Muslim and Congress Party. The circulation of papers in the local language exceeds two million, and they are read aloud in village teashops and vigorously discussed.[34] Political turmoil seems thus to have stimulated the growth of literacy. At the same time, a long history of trade unionism, and of political parties representative of the poor, has helped keep governments interested in providing education and health services at the most basic level.

In evaluating Kerala's development, we are faced with some of the same problems as in assessing the Cultural Revolution in China. In both instances, economic growth was badly impeded by mass movements, but political experience and literacy, plus the awareness these brought, may have paved the way for other kinds of development. The parallel with Sri Lanka also needs to be remembered. In one of the most convincing of recent assessments, Davidson Gwatkin notes cultural similarities between Kerala and Sri Lanka which differentiate them from the rest of the Indian subcontinent. He observes that in both states, the 'cultural setting' has fostered 'political systems unusually conducive to popular will. Open elections are prominent features of each society.'[35]

Popular participation is not without its drawbacks, however. Governments in Kerala and Sri Lanka often look ineffective and are frequently overturned by ballot. They are prisoners of popular feeling, and that 'prevents adoption of the tough development measures necessary for growth'. The contrast with the newly industrialized countries of south-east Asia, with average economic growth rates of around 8 per cent during the 1970s – but with governments that are rarely democratic – could hardly be more striking.

Gwatkin suggests that in Kerala and Sri Lanka, the 'tyranny of public opinion' may have led to two specific features of policy: an emphasis on production of food for local consumption rather than cash crops for export, and a welfare system centred on primary health clinics, primary education, and provision of heavily subsidized food on ration. Sri Lankan agriculture has enjoyed considerable success with an average annual 6 per cent increase in rice output during the 1970s – a record which outstrips all other South Asian countries apart from Thailand.[36]

Although food supplies have grown faster than population, statistics suggest a rather low average consumption, especially of protein (table

4). But there is little evidence of malnutrition in either Sri Lanka or Kerala, possibly because diets contain a good variety of foods, and possibly also because, as Gwatkin says, the stress 'on education (especially for women) . . . seems likely to exert influences on diet composition, by helping heighten nutrition awareness'. Above all, there is an equitable distribution of food based on the subsidized ration and fair-price shops.

Government policies in Kerala and Sri Lanka were once 'scorned' by economists of the international community because of the very limited economic growth they produced; attention was focused further east, on fast-growing Taiwan and Korea, Singapore and Hong Kong. But in 1979, Gwatkin reported a change of mood. Policies in Kerala and its neighbour 'are now praised because of the remarkable social achievements for which they are said to be responsible'. Since then, however, there has been a further change. Sri Lanka's policies have moved markedly away from 'basic needs' and towards the encouragement of economic growth. There have been cuts in food subsidies, the establishment of free trade zones, and a massive hydro-electric scheme that has meant the loss of a large proportion of the country's remaining natural forest cover.

The contrast between basic-needs development in south Asia and rapid growth along the East Asian Pacific rim is blurred in another way also. In the latter region, one or two countries have not only achieved economic success, but have also made impressive advances in meeting basic needs, with a considerable reduction in income differentials between rich and poor. Taiwan, in particular, has become known as an instance of 'growth with equity'[37] with its land reforms and rural co-operatives as well as electronics factories and steelworks. Moreover, it is widely observed – in Kerala as well as Taiwan – that with increasing literacy and greater equity, birth rates fall, population growth slows, and there are qualitative improvements in living standards. Mainland China seems to have achieved similar results by yet another route, so again it seems clear that there are no totally unique right answers.

There are no unique formulae for raising living standards, that is, if we consider political systems, or growth rates, or the technical fixes associated with western aid. But one thing common to most countries where equity has increased alongside economic development is that, in one way or another, the interests of low-income groups have been effectively represented in the political process. Sometimes this has come about through peasants' movements, trades unions and organized protest, sometimes through open elections, and sometimes through revolutionary change. Circumstances differ greatly, but nearly always, demands have had to be expressed from below before there is a more equitable allocation of resources – including food, welfare provision, and in agricultural communities, access to land.

In some respects, perhaps, these southern and eastern parts of Asia present us with the most striking image available of the kinds of *choice* which may confront us in the future. Neither the rapid-growth societies of the Pacific rim, nor the basic-needs approach of Kerala may seem ideal. But if we in the West were less preoccupied with the narrowly technical aspects of resources, we might find constructive potential in what these examples demonstrate.

Firstly, we might become more aware that many of the problems of food and energy arise from inequitable distribution, and are not primarily due to material limits. Figures about the current extent of malnutrition throughout the world, or about likely future shortfalls in minerals, food and energy, draw attention to the supply of these commodities, and are often intended to gain support for policies (and technologies) that will increase production. We saw many examples of this in chapter 3. But what matters to people is their consumption, and it is often poverty, inequality, and costly or wasteful technologies which restrict consumption, not fundamental scarcity.

But scarcities there will sometimes be, and a second and more hopeful point of which Kerala should remind us is that a great deal can be achieved by human endeavour even where material resources are limited. As beliefs differ, so many will evaluate these issues differently. But perhaps we should consider that it is our own resources as people that may ultimately matter most.

5
Imperatives and Creative Culture

Imperatives and choice

The prospect of choice with which the last chapter ended implies criteria for choosing. It therefore implies values. In the choices between broad socio-economic options, the values involved are clear enough: wealth on the one hand and welfare on the other. Even the more narrowly technical ideas discussed concerning resources were seen to depend on values, such as the idea that it is good and right for mankind to seek mastery over nature (table 3). But on the more mundane level, 'values which are incorporated in technological products and which guide and inform the actions of technologists and those who direct their work, are either unrecognized, or simply taken for granted'.[1]

Hence the idea has come to be accepted that technology is value-free. People have come to feel that technological development proceeds independently of human purpose. They see it as the working out of a rational pattern based on impersonal logic. Yet in discussing the beliefs which contribute to the culture of expertise and to conventional world views, the three preceding chapters have inevitably implied a good deal about the values that underpin those beliefs. If people use the steadily-rising efficiencies of steam engines as evidence for a linear pattern in technical progress, that is not only because they believe that this provides a realistic insight into the nature of such progress, but also because they value increasing efficiency as something desirable in itself, they value the rationalism and logic which the linear pattern seems to show, and above all, they value technical progress. Yet if people were to assess technical progress in terms of different values,