

THE ENVIRONMENTAL CONSEQUENCES FOR THE EUROPEAN COMMUNITY OF
POPULATION FACTORS WORLDWIDE AND WITHIN THE COMMUNITY

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"If current predictions of population growth prove accurate and patterns of human activity on the planet remain unchanged, science and technology may not be able to prevent either irreversible degradation of the environment or continued poverty for much of the world. ... Unrestrained resource consumption for energy production and other uses...could lead to catastrophic outcomes for the global environment. Some of the environmental changes may produce irreversible damage to the Earth's capacity to sustain life. The overall pace of environmental changes has unquestionably been accelerated by the recent expansion of the human population. ... Global policies are urgently needed to promote more rapid economic development throughout the world, more environmentally benign patterns of human activity, and a more rapid stabilization of world population. The future of our planet is in the balance."

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EXECUTIVE SUMMARY

The world's population is undergoing an increase in numbers that is unprecedented in scale and speed. The present total of 5.5 billion is projected to more than double before it stabilizes at zero growth. A high projection indicates it may well grow three or even four times, while a low projection shows it could, through greatly expanded planning efforts, be held below 8 billion. Roughly nine-tenths of future growth will occur in developing nations, precisely the nations least able to accomodate such a large increase in numbers in short order.

These demographic projections are merely projections. They are not predictions, still less are they forecasts. Demography is not destiny. Projections are entirely divorced from constraining factors such as environmental resources--soils, water, vegetation, climate, etc.--that ultimately support all economies and constitute a crucial basis for sustainable development. There is much evidence that environmental resources are being ever-more rapidly depleted in developing nations (in developed nations too), to an extent that will critically curtail economic advancement. Much environmental depletion is due to population pressures--and this is all the more significant in that economic advancement is a key contribution to the processes that lead to

reductions in fertility. Equally to the point, it may well be that environmental degradation will prove so severe and pervasive in certain developing nations that it will undercut the capacity for many human communities to maintain themselves even at their present inadequate levels, resulting in a rise in morbidity and mortality, and thus further postponing declines in fertility. So probable is this prospect that, without immediate and far-reaching changes in policy, the population/environment travails of developing nations today could likely turn out to be minor compared with what lies ahead.

But population/environment linkages are not so simple and deterministic as is sometimes asserted. A host of other variables are at work, notably the economic, social and political systems and the policy strategies in developing nations concerned, plus exogenous factors such as aid, trade and debt relationships with developed nations. The scope for corrective policy is by no means confined to the population and environment sectors. There is abundant opportunity for policy interventions on many fronts. To date, however, policy responses have been far too limited to make much difference, due ostensibly to lack of appreciation of the multiple dynamic linkages between population and environment in conjunction with associated sectors of development. This lack of appreciation is often due to the multiplicity and complexity of interactions at work within the environment/population nexus. It is difficult to demonstrate specific cause-and-effect linkages of both exclusive and conclusive sort. As a result, absence of evidence about the problem tends to be taken as evidence of absence of the problem. The case goes by default.

Developed nations too feature much environmental decline, especially with respect to ozone-layer depletion and global warming--two superscale problems that will affect nations throughout the world. Developed nations likewise feature some population growth, which, while not nearly so great as in developing nations, is nonetheless a significant variable to be addressed.

All this has profound implications for the European Community. Because of its manifold relationships with developing nations, notably environmental and economic relationships, the future of the Community is intimately tied in with the future of developing nations. These interdependency relationships will surely become more numerous and significant in the decades ahead. The Community can play a major role in confronting the challenges of environment and population. It will thereby go far to safeguarding its own long-term interests--provided it comprehends the challenges in their full scope and scale. Certain of the changes required will be difficult indeed. But they will not be nearly so difficult as the changes imposed by gross population overload and grandscale environmental ruin.

Fortunately the outlook is not entirely negative. There is still time, though only just time, for imaginative policy and incisive action to turn profound problems into exceptional opportunities. A number of success stories demonstrate that with sufficient creative leadership--which the European Community is well placed to supply--we can still get on top of many of our problems before they get on top of us. These success stories reveal that in the main we know what to do,

the science and technology are available, and the required measures need not always be expensive in light of the multiple benefits generated. Indeed a radical reorientation of policy will generally prove to be a super-productive investment for both the European Community and developing nations alike.

What is mainly lacking is the political foresight and the policy initiatives to reflect not only the costs of action but the concealed costs of inaction. Or, to put it more constructively, an approach of "business as usual, only more so and better so" will entrain profound penalties, whereas a seismic shift in policy responses will engender highly positive payoffs. On both the population and environment fronts, with all they mean for sustainable development for the international community as a whole, we face a time of breakdown or breakthrough. The resources in shortest supply are time and vision. The decades ahead surely present the most daunting and the most creative challenges confronting world leaders during the whole course of the human enterprise.

Chapter I

INTRODUCTION

"The environmental problems of the poor will affect the rich as well, in a not too distant future, transmitted through political instability and turmoil."

Gro Harlem Brundtland, 1986

The world is in the middle of an unprecedented expansion of human numbers. It took 10,000 lifetimes for the world's population to reach two billion people. Now in the course of a single lifetime, it is increasing from two billion to three times as many, and within another lifetime it could well double again.

The great bulk of this population upsurge is in the developing nations. There is strong evidence that population pressures generate adverse repercussions for the environmental resource base that ultimately underpins much economic activity in developing nations. Hence too the conclusion that population growth harms the prospects for economic advancement in these nations.

This will carry profound implications for the European Community:

--First and foremost is what might be termed the "moral imperative". The Community has many connections with the developing nations by virtue of historical relationships reaching back for centuries. For this reason alone, the Community bears a responsibility for helping to reverse the widening divide between the developed and developing worlds. In 1900 the ratio of per-capita income between Western Europe and India was 2:1, but the gap has widened to 40:1 in 1965 and 70:1 today. Since 1980 the developed nations as a whole have

increased their average per-capita GDP by almost \$8000, whereas most developing nations have increased their's by only a few hundred dollars at most--and many, notably those of the Indian sub-continent, sub-Saharan Africa and the Andean region, have experienced zero or even negative growth. When Community nations achieve an annual economic growth rate of 2 percent, they expand their per-capita GDP by \$300; the same growth rate for leading developing-world nations such as Nigeria results in a per-capita increase of \$5. Similarly, an already-affluent Community citizen grows richer each year by an amount that is twice as large as the entire annual income of a least-developed nation citizen.

Moreover, the Community nations, in common with other developed-world nations, engage in international economic relationships that are often disadvantageous to the South. Were the Community to persist with these relationships, would it not deny certain responsibilities of its global role? This is all the more pertinent insofar as the Community should soon be able to offer greater leadership in the international arena.

--Second, the Community has a marked interest in political stability around the world. This applies specially with respect to regional conflicts such as the recent Gulf War. If developing nations fail to advance economically, there will be increasing scope for outbreaks of violence.

--Third, a number of exceptional-value resources are at stake in developing nations. While many of these resources fall entirely within

the sovereign jurisdiction of nations concerned, they rank as resources of "global heritage" through their significance for all humankind--and hence outsider nations can express a legitimate interest in their status. These resources include, for instance, tropical forests, containing the bulk of the Earth's species and chief site of the mass extinction underway; and, still more importantly, sectors of the Earth's atmosphere and climate systems.

--Fourth is the factor of migratory pressures. We are starting to witness a phenomenon of economically disadvantaged migrants from the South, many of whom can be regarded as environmental refugees. This phenomenon is growing so fast that it may soon become a prominent feature of the international arena. Europe is already perceived as an "escape valve" for multitudes of migrants from North Africa who can readily make the short passage across the Mediterranean.

--Finally there are trading and other commercial relationships between the Community and developing nations. The South receives 30 percent of the Community's exports and it supplies 21 percent of its imports. Unless the South can maintain economic progress, the hope of expanded trade will diminish. Community exports to developing nations declined during 1982-88, at a cost of \$171 billion and with a loss of at least half a million jobs (George, 1992). Moreover, developing nations owe much foreign debt to the Community (around \$85 billion in 1988) and there will be reduced scope for this debt to be paid off if economic growth in the South does not expand.

For all these reasons, the Community has a distinct stake in the economic advancement of developing nations, and hence in the environmental resource base that sustains their economies. In certain respects, this environmental resource base is more important to developing-nation economies than is the case for developed nations (for details, see Appendix 1). Yet environmental resources in developing nations tend to be more susceptible to severe and often irreversible injury, as witness tropical deforestation, desertification, soil erosion and water deficits. Moreover, if a developing nation finds its environmental-resource base is declining, it will generally have difficulty switching to other economic activities if only because of shortages of capital investment and trained manpower.

As noted, environmental resources in developing nations are undergoing depletion through population pressures--and thus the European Community has an interest also in population factors in developing nations. But the argument is by no means straightforward. In many instances, population/environment linkages are far from clear and explicit, let alone deterministic and predictable. It is not necessarily the case that more people must always mean more environmental problems (and in turn more economic problems). Many other variables are at work. They include present population stocks, differentiated rates and patterns of population growth, the distribution of additional human numbers, the share-out of resource endowments, the types of resource exploitation, and the technologies utilized for exploitation. Further, they embrace social and cultural factors, economic systems, political structures, and policy strategies of nations

concerned. They also extend to exogenous factors such as aid, trade and investment relationships with the wider world. Each of these variables features linkages to many if not most (sometimes all) the other variables, making for a multiplicity of dynamic interactions.

So there is no single linkage between population and environment. Still less are there directly and exclusively causative linkages for the most part. Linkages can be both proximate and ultimate. Interactions can be modulated by a host of additional factors such as socioeconomic advancement, technological innovation and policy reform (also by subsidiary factors such as migration). Nor are the interactions always two-way. The situation is much more complex than is sometimes represented (Harrison, 1992; Kessler, 1992; Keyfitz, 1991; Myers, 1991a).

Note, moreover, that the phenomenon of population growth is by no means a characteristic of developing nations alone. There is still some growth underway in most developed nations, including most of the European Community. While this growth is small as compared with that of developing nations, it is nonetheless significant in light of the levels of resource consumption, together with the technologies employed to support consumption, that characterize the European Community. While developed nations are often forthright in urging that developing nations institute vigorous and urgent policies to reduce population growth to zero as soon as possible, they have been noticeably reluctant to institute parallel policies of their own. This policy lacuna deserves to be addressed in explicit, comprehensive and systematic fashion. Not a single Community nation has done that.

Chapter II

CONCEPTUAL FRAMEWORK:

AN OVERVIEW OF POPULATION/ENVIRONMENT LINKAGES

1. Background Perspectives

"Can these (population) projections ever materialize, knowing that more than 90 percent of the population growth would take place in poor countries with limited natural resources as mass poverty, ignorance and complacency might well lead to rising death rates. If we do not get population growth under control, habitat on Earth will be destroyed by ecological disaster and/or violent migration processes."

Willy Brandt, 1989

Global Population Factors

Global population in mid-1992 amounts to almost 5.5 billion people. Of these, 4.3 billion or 78 percent are in developing nations, and 1.2 billion or 22 percent are in developed nations (United Nations Population Division, 1991) (Table 1). Some 345 million, being 6.3 percent of the global total and almost 29 percent of the developed nations' total, are in the twelve nations of the European Community (Table 2).* The Community is far and away the most populous entity in the developed world: compare the United States with 253 million people, the Commonwealth of Independent States with 262 million, and Japan with 124 million.

* Today there are twelve nations in the European Community. If the five additional nations that have made application for membership are admitted within the next few years, they will increase the EC's population to 377 million, and raise the EC's share of the world's population to 7 percent (of developed nations, 31 percent).

Moreover, global population is growing at a rate of 1.7 percent per year, or 93 million people (the equivalent of Germany and Netherlands combined, or four times the whole of Scandinavia) (Table 1). The rate of annual increase will peak in 1998 with 98 million people. As we shall see below, it is this factor, viz. the annual increase in absolute numbers, that is also critical to nations' prospects for sustainable development (meaning, broadly, development based upon a safeguarded environmental-resource base; see box). Of the annual increase, more than 90 percent is in developing nations, and over half in Africa and Southern Asia which feature the majority of the 1.2 billion "poorest of the poor". By definition, developing nations have limited capacity to cope with the environmental and economic consequences of ultra-rapid growth in human numbers, due to their low per-capita incomes, unproductive agriculture, poor infrastructure, meagre technology and inadequate investment (Tables 3 and 4).

The latest projections (United Nations Population Division, 1991; World Bank, 1992) indicate that the global total will reach 6.3 billion people by the year 2000 and 8.6 billion by 2025, before levelling out at a total of 11.6 billion by 2100 or shortly thereafter. Of the projected increase from 1991 till 2025, 3.2 billion, 94 percent will occur in developing nations.

Note, moreover, that the 11.6 billion figure for the 2100 global total is the medium-level projection. The high projection indicates the total could attain 14.2 billion (and even 20.7 billion by 2150), while the low projection indicates it could be held as low as 7.9

Box

DEFINITIONS OF SUSTAINABLE DEVELOPMENT

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs...Living standards that go beyond the basic minimum are sustainable only if consumption standards everywhere have regard for long-term sustainability."

World Commission on Environment and Development, 1987,
Our Common Future, Oxford University Press, Oxford,
U.K.

"Sustainable development...involves providing a bequest to the next generation which is at least equal to that inherited by the current generation."

D.W. Pearce et al., 1989, Blueprint for A Green Economy,
Earthscan Publications Ltd., London, U.K.

"Sustainable development distributes the benefits of economic progress more equitably, protects both local and global environments for future generations, and truly improves the quality of life."

Inter-American Development Bank, 1990, Our Own Agenda,
Inter-American Development Bank, Washington D.C., U.S.A.

"Sustainable development means improving the quality of human life while living within the carrying capacity of supporting ecosystems. A "sustainable economy" maintains its natural resource base. It can continue to develop by adapting, and through improvements in knowledge, organization, technical efficiency, and wisdom."

IUCN, UNEP and WWF, 1991, Caring for the Earth: A Strategy for Sustainable Living, Earthscan Publications Ltd., London, U.K.

"A sustainable society is not necessarily the same as a zero growth society. That concept is as primitive as that of perpetual growth. Rather a sustainable society will discriminate among kinds of growth, and purposes of growth. It will ask what growth is for, who will benefit, what it will cost, how long it will last, and whether it can be accommodated by the sources and sinks of the Earth. That is to say, a sustainable society will be less interested in growth than in development. ...To grow means to increase in size by the assimilation or accretion of materials. To develop means to expand or realize the potentialities of; to bring to a fuller, greater, or better state. When something grows it gets quantitatively bigger; when it develops it gets qualitatively better."

D.H. Meadows et al., 1992, Beyond the Limits, Earthscan Publications, London, U.K.

billion (and even 5.6 billion by 2150). The difference between the high and low projections for 2100, 6.3 billion, is to be compared with today's total of 5.5 billion--and it serves as a graphic measure of the manouvering room still available.

Specially significant is the situation of 1.2 billion absolutely impoverished people in developing nations, these being the people who (a) most need the benefits of development, (b) often cause a disproportionate amount of environmental degradation, and (c) feature the highest fertility rates (World Bank, 1991). While their percentage share of total numbers, now 22 percent, is likely to decline, their absolute numbers are projected to keep on increasing (in the absence of vigorous remedial measures) for several decades of the next century (World Bank, 1991).

We should note, moreover, that all these demographic projections are no more than extrapolations of recent trends, together with some assumptions about the role of economic advancement and family planning in stemming the rate of population growth. Projections are not predictions, still less are they forecasts. By their nature, they take no account of other variables such as policy changes and technological breakthroughs. Nor do they reflect environmental factors: they assume there will be no Malthusian constraints. But as we shall see below, the fast-growing degradation of the environmental-resource base that ultimately supports all communities may soon start to exert a markedly constraining effect on population growth. Given the record of the last two decades, it becomes increasingly hard to see how sub-Saharan Africa,

for example, will experience a projected quadrupling of human numbers within another century as long as gross environmental impoverishment continues to spread with the impact of the recent past: per-capita incomes are generally no higher than in 1960, and per-capita food supply is 20 percent less. Those who consider that population growth may soon be pressing against or even exceed "carrying capacity" (an important concept to be considered shortly) are inclined to be increasingly sceptical about demographic projections made in an "environmental vacuum".

A further dimension to this demographic background impinges significantly on environmental questions. It is the distribution of population, especially the fast-growing shift from rural to urban areas in developing nations where the urban population is projected to increase from 1.3 billion to 2.3 billion, a 77-percent expansion, during just the next 15 years (United Nations Population Division, 1991). This urban increase--stemming in major measure from population growth--engenders acute shortages of many basic requirements for acceptable living standards, including supplies of water, sanitation, food, energy, housing and sheer space. Huge congregations of urban communities are obliged to subsist in shantytowns and other slum-type settlements that are characterized by extreme squalor and deprivation. It is projected that by the year 2025, three-fifths of humankind will be living in urban areas; and of these, between one third and one half will be in developing-nation shantytowns.

Population in the European Community

As noted, there is little population growth in the European Community (Table 2). While it comprises the most populous political entity in the developed world with 345 million people, the population growth rates of its member nations range from a mere 0.6 percent per year in Ireland to -0.1 percent in Germany, with an average of 0.2 percent. Its annual rate of natural increase (not counting immigration) is around 700,000 people. Natural growth rates appear to be slowing still further in most nations, though a few nations such as France, Germany and Italy are seeking to increase fertility.

But the Community's citizens enjoy advanced levels of affluence. Per-capita GNP averages more than \$14,000, or 19 times greater than the developing nations' average. Moreover the technology deployed to generate this affluence often has harmful effects on the environment. So even a small amount of population growth can exert a powerful impact. Consider energy consumption in the case of Britain. British people consume energy, mostly in the form of fossil fuels, equivalent on average to 35 barrels of oil per year. While Britain's population of 58 million has a natural growth rate of only 0.2 percent per year, this still means an additional 116,000 people per year, worth energy consumption equivalent to 4 million barrels of oil. An average Bangladeshi consumes energy, mostly in forms other than fossil fuels, equivalent to 3 barrels of oil per year. Bangladesh's population of 120 million people features an annual growth rate of 2.4 percent, meaning an additional 2.9 million people per year--worth energy consumption equivalent to 8.7 million barrels of oil. So Britain, with only half as

many people as Bangladesh and a population growth rate a mere one twelfth as large, produces almost half as much extra carbon dioxide for the global atmosphere each year as does Bangladesh through population growth alone. Britain's population growth rate plays a far more significant role, by proportion, in global warming processes than does Bangladesh's--yet Bangladesh is likely to suffer far more severely from global warming than Britain.

Population Growth and Economic Growth

Population growth can be detrimental to economic growth in direct fashion as well as through its indirect impact via environmental degradation (Daly and Cobb, 1989; Keyfitz, 1989; McNamara, 1991). But as yet there is no strong consensus of expert opinion on all the precise linkages at work. A nation with an annual economic growth rate of 5 percent and a population growth rate of 2.5 percent loses half of its per-capita economic advance to population growth. But there is more to the situation (Repetto, 1987). Provided population growth is not too large and not too fast, it can sometimes contribute to the expansion of domestic markets and other economies of scale (Demeny, 1989; Kelley, 1988). Similarly, population pressures can, in certain circumstances, engender institutional change and technological innovation that might not otherwise occur, through e.g. intensification of agricultural systems (Boserup, 1981). But in many parts of the Indian sub-continent and sub-Saharan Africa, population growth has led to such fragmentation of agricultural smallholdings, with inadequate product surplus for farmers to invest in improved agriculture, that intensification has not

advanced nearly fast enough to keep up with population growth. Still, multiple variables in agriculture remain significant (Dreze and Sen, 1989). China has only half as much cropland per person as India, yet India suffers widespread and persistent hunger while China does not.

A number of related questions arise. Can we suppose that under given sets of circumstances, slower population growth would necessarily increase per-capita income through greater per-capita availability of resources, both renewable and exhaustible? Would it relieve pollution and other forms of environmental degradation? Would it enhance levels of schooling and health, worker productivity, and labour absorption into the modern sector? How far is there a causative connection between population growth and poverty--and is it comprehensive or only partial? Does it work in both directions--if, in some cases at least, population growth leads to or exacerbates poverty (in conjunction with other contributory factors), does it mean that a slowing of population growth will necessarily go some way to relieving poverty? If that is true, can we achieve more by slowing population growth than by other measures such as policy change, institutional initiatives, and improved technologies?

The issue has been summarized by the World Bank (1984): "Policies to reduce population growth can make an important contribution to development (especially in the long run), but their beneficial effects will be greatly diminished if they are not supported by the right macroeconomic and sectoral policies. At the same time, failure to address the population problem will itself reduce the macroeconomic and sectoral policies that are possible, and permanently foreclose some

long-run development options." Regrettably this statement, like most conventional economic analysis, takes no account of the crucial dimension of environmental factors.

Carrying Capacity

Certain observers, often ecologists, assert that carrying capacity is not only a key constraint to population growth, but that it can readily become an absolute factor. Other observers, often economists, assert that it is such a flexible affair, subject to endless expansion through technology and policy interventions, that it soon ceases to have much operational value at all.

Carrying capacity can be defined as "the number of people that the planet can support without irreversibly reducing its capacity to support people in the future" (Ehrlich et al., 1989; see also Daly and Cobb, 1989; Keyfitz, 1990; Pimentel and Pimentel, 1989). While this is a global-level definition, it applies at national level too, albeit with many qualifications as concerns international relationships of trade, investment, etc. It is a highly complex affair, being a function of factors that reflect food and energy supplies, ecosystem services (such as provision of freshwater and recycling of nutrients), human capital, people's lifestyles, social institutions, political structures and cultural constraints among many other factors, all of which interact with each other. Particularly important are two points: carrying capacity is ultimately determined by the component that yields the lowest capacity; and human communities must live off the "interest" of environmental resources rather than off their "principle" (Ehrlich et

al., 1989).

Thus the concept of carrying capacity is closely tied in with the concept of sustainable development (see below). There is much evidence that human numbers with their consumption of resources, plus the technologies deployed to supply that consumption, are often exceeding carrying capacity already. Consider a specific example, food production. The World Hunger Project (Chen et al., 1990), has calculated that the planetary ecosystem could, with present agrotechnologies and with equal distribution of food supplies, sustainably support no more than 5.5 billion people even if they all lived off a vegetarian diet--and the 1992 global population is already 5.5 billion. If humans derived 15 percent of their calories from animal products, as do many people in South America, the total would decline to 3.7 billion. If they gained 25 percent of their calories from animal protein, as is the case with most people in North America, the Earth could support only 2.8 billion people.

True, these calculations reflect no more than today's food-production technologies. Some observers protest that such an analysis under-estimates the scope for technological expertise to keep on expanding the Earth's carrying capacity. We can surely hope that many advances in agrotechnologies are still available to come on stream. But consider the population/food record over the past four decades. From 1950 to 1984, and thanks largely to remarkable breakthroughs in Green Revolution agriculture, there was a 2.6-fold increase in world grain output. This achievement, representing an average increase of almost 3

percent per year, raised per-capita production by more than one third. But from 1985 to 1992 there has been far less annual increase, even though the period has seen the world's farmers investing billions of dollars to increase output, supported by the incentive of rising grain prices and the restoration to production of idled U.S. cropland. Crop yields have "plateaued"; it appears that plant breeders and agronomists have (temporarily?) exhausted the scope for technological innovation. So the 1991 harvest has been little higher than that of 1984. Meantime there are an extra 600 million people to feed. While world population has increased by almost 13 percent, grain output per person has declined by nearly 7 percent (for elaboration of the analytic methodology, see Brown et al., 1990; and for a brief review of carrying capacity with respect to food-production potential in the case of Kenya, see Appendix 2).

Environment and Sustainable Development

As is now widely recognized (Daly and Cobb, 1989; Goodland et al., 1991; Pearce et al., 1989 and 1991; World Commission on Environment and Development, 1987), economic growth is by no means to be equated with sustainable development (see box for definitions of sustainable development). Apart from the fact that development connotes many processes that are non-economic in nature (social and cultural development, for example), much economic growth of the recent past is clearly not sustainable for environmental reasons alone. This, in conjunction with the linkages between environmental degradation and population growth, alters the development outlook profoundly. It may well turn out that we have achieved economic advancement in the past at

a cost to the future's capacity to supply still more advancement--and even at the more serious cost of an actual decline in human welfare.

Consider again the case of Green Revolution agriculture, which enabled growth in grain production to keep ahead of growth in human numbers throughout the period 1950 to 1984. There appear to have been certain covert costs, in the form of overloading of croplands leading to e.g. soil erosion, depletion of natural nutrients, and salinization of irrigation systems. These costs, while unnoticed or disregarded for decades, are now levying a price in terms of cropland productivity. In Pakistan, at least 32,000 square kilometers of irrigated lands (20 percent), and in India 200,000 square kilometers (36 percent), are so salinized that they have lost much of their productivity. Yet these two countries have often been proclaimed as prime exponents of Green Revolution agriculture.

In fact, environmental constraints of several sorts are now causing significant cutbacks in food production at a time when population growth continues with insufficient restraint. Soil erosion leads to an annual loss in grain output estimated at 9 million tonnes; salinization and water logging of irrigated lands, 1 million tonnes; and a combination of soil compaction, loss of organic matter, and a number of other factors, 2 million tonnes. The total from these forms of land degradation is 12 million tonnes. In addition there are various types of damage to crops: air pollution is estimated to be worth 1 million tonnes of grain output foregone each year, and flooding, acid rain and increased ultraviolet radiation, another 1 million tonnes (Brown et al., 1990).

So the total from all forms of environmental degradation comes to 14 million tonnes of grain output per year. This total is to be compared with gains from increased investments in irrigation, fertilizer and other inputs, worth 29 million tonnes per year. Thus environmental factors are now causing the loss of almost half of all gains from technology-based and other advances in agriculture. This is a loss we can all the less afford insofar as we need an additional 28 million tonnes of grain output each year just to cater for the needs of population growth (let alone the demands of economic advancement and enhanced diets). While the net gain in grain output is now about 1.0 percent each year, population growth is 1.7 percent (Brown et al., 1992).

It is apparent, then, that there are multiple sets of dynamic interactions between population growth and environmental deterioration (Ehrlich and Ehrlich, 1990; Harrison, 1992; Keyfitz, 1989 and 1991; Myers, 1991a; Tabah, 1992). Both are central to the cause of sustainable development. That much is generally accepted. But in terms of critical linkages, the picture is less clear cut.

2. Critical Linkages

"The stage is being set for one of the greatest human tragedies of all times. The destruction of renewable resources in the developing world poses a threat as great to the human future as the prospect of nuclear war."

Maurice F. Strong, 1987

A Basic Equation

Consider first some central factors of population growth and its impacts. We can identify four principal components: P, being population itself, I being environmental impact, C being per-capita consumption (determined by income and lifestyle), and T being environmentally harmful technology that supplies C (amended from Ehrlich and Ehrlich, 1990; see also Davis et al., 1989). The three factors P, C and T interact in multiplicative fashion, i.e. they compound each other's impacts. So whatever the size of C and T, the role of P is bound to be significant even when a population, its growth rate too, are relatively small. According to this analysis, we can conclude that for any type of technology, for any given level of consumption or waste, for any given level of poverty or inequality, the more people there are, the greater is the overall impact on the environment. We can represent the processes involved in the form of a basic equation, $I = PCT$ (Ehrlich and Ehrlich, 1990).

This equation demonstrates why developing nations, with large populations but limited economic advancement, can generate a vast impact on the environment if only because the P multiplier on the C and T factors is so large. For an indication of how this applies to China, see Appendix 3. Likewise the equation makes clear that developed

nations also generate population impacts insofar as the A and T multipliers for each person are exceptionally large. For an indication of how this applies to the European Community nations, see Appendix 4.

A number of other factors are at work besides the three elements of the equation. They include socioeconomic inequities, cultural constraints, government policies, and the international economic order, to cite but a few (Tables 3 and 4). Moreover these additional factors vary greatly throughout the global community of almost 200 nations, disparate as they are in agroclimatic zones, natural resource endowments, historical traditions and the like. But sooner or later all these additional factors operate through one or another of the equation's three variables.

To illustrate how the equation's interactions work, suppose that, by dint of exceptional effort, humankind managed to reduce the average per-capita consumption of environmental resources (C in the equation) by 5 percent; and to improve its technologies (T) so that they caused 5 percent less environmental injury on average. This would reduce the total impact (I) of humanity by roughly 10 percent. But unless global population growth (P) were restrained at the same time, it would bring the total impact back to the previous level within less than 6 years (Ehrlich and Ehrlich, 1990).

All this applies notably to population growth on the part of a particular sector of humankind, the one billion people who live in absolute poverty. Their impoverished status and their large numbers

serve to aggravate their environmental impact, and again the linkages operate in multiplicative fashion, each one reinforcing the other. Moreover, these people tend to feature the highest population growth rates. Of the poorest one fifth of developing-nation households, between 55 and 80 percent have eight or more members, whereas at national level the proportion is only 15 to 30 percent (Lipton, 1985; see also Sadik, 1992). In addition, these people are unusually dependent for their survival upon the environmental-resource base of soil, water, forests, fisheries and biotas that make up their main stocks of economic capital. At the same time, they see scant alternative to exploiting their environmental-resource base at a rate they recognize is unsustainable: they experience unusually short "time preference" rates, meaning they feel obliged to mis-use and over-use their resource stocks today even at cost to their prospects tomorrow. They thereby undercut their principal means of livelihood--thus entrenching their poverty (Kates and Haarmann, 1991; Little and Horowitz, 1987; Mink, 1991). In turn, this appears to reinforce their motivation to have large families (Keyfitz, 1990). As upshot, they face the prospect of ever-tightening constraints.

These people's plight also reflects the failure of development in general. They have been bypassed by the usual forms of development, notably Green Revolution agriculture: they cannot afford costly inputs such as high-yielding seeds, fertilizer, irrigation and farm machinery. So they become "marginalized". They are marginalized too in that they generally lack economic, political, legal or social status, meaning they can do little to remedy their plight. All too often this drives them to seek their livelihood in environments that are unsuitable for

sustainable agriculture, being too wet, too dry or too steep. Hence there is the phenomenon of the impoverished peasant who causes deforestation, desertification and soil erosion on a wide scale: the marginal person in marginal environments. In developing countries as a whole, these "bottom billion" people may sometimes cause environmental injury as great as that of the other three billion people (Kates and Haarmann, 1991).

In short, far from enjoying the development benefits that would ostensibly push them through a demographic transition to smaller families, these people are caught in a demographic trap. Given their severely constrained circumstances, population growth denies them the very inducements that could serve to reduce population growth (Keyfitz, 1990).

Socioeconomic Infrastructure

A further linkage is relevant. It is the capacity of governments to cope with the processes involved (population growth, increased consumerism and technology expansion), i.e. to plan for them and otherwise accommodate them. This reflects a host of government activities: political responses, policy interventions, institutional initiatives, promotion of technology advances, and a host of measures to establish socioeconomic infrastructure.

It is a planning challenge unprecedented in its character and extent. No societies in the past have had to cater for population growth at annual rates of 2 percent or more for decades on end, let

alone the rates of 3 to 4 percent that have recently characterized a sizeable number of nations in sub-Saharan Africa and the Muslim world. Indeed it would tax the planning capacities of the most sophisticated and established societies. Yet it is a challenge confronting nations that often have experience of only a few decades of nationhood and the modern state organization. Moreover many developing nations are further constrained by exogenous factors such as adverse trade relations, inadequate and often inequitable aid flows, and foreign debt. In these circumstances it is remarkable that so many developing nations have achieved so much in such a short period.

North-South Relationships

Certain North/South relationships, and notably the Community's relationships with developing nations, serve to exacerbate problems of population and environment (Ramphal, 1992). They thus act as ultimate, by contrast with proximate, factors--a somewhat covert dimension that is often overlooked (Shaw, 1989). Consider two such relationships, external debt and international trade.

Developing nations owe \$1.2 trillion of outstanding loans from developed nations. This debt burden weighs heavily on developing-nation prospects for development generally (George, 1992; O'Neill, 1990), and on environment and population concerns in particular. It has induced governments to over-exploit resource stocks such as tropical forests in order to generate immediate, albeit unsustainable, revenues (Weaver, 1991). It has obliged many poorer nations to cut back on their government spending on health and family planning activities, and has

thus contributed to the slowing in fertility-rate declines in Philippines, India, Tunisia, Morocco, Colombia and Costa Rica (United Nations Population Fund, 1990). It can even be demonstrated to be causing the deaths of half a million children each year through general slowing or even reversal of development processes in developing countries generally (UNICEF, 1990), with all that implies for population planning prospects.

Next, international trade and its adverse impact on environmental concerns. Agricultural trade protectionism on the part of developed nations in Western Europe, North America and the Pacific entails the outlay of \$200 billion a year to protect domestic agriculture. The policy militates against agricultural exports from developing nations, depriving them of trade revenues worth \$30 billion a year (Winglee, 1989; Zietz and Valdes, 1986). In turn, these direct losses reduce developing-country farmers' profits, leaving them less money to invest in upgraded agriculture and thus perpetuating poverty. In turn again, they ultimately induce poor farmers to overload their croplands and to cultivate marginal lands.

Environmental Discontinuities

Growth in human numbers, in conjunction with growth in human consumption and growth in environmentally adverse technology (the I = PCT equation), serves to build up a situation that can eventually generate an "overshoot" outcome. In turn, this outcome can precipitate a downturn in the capacity of environmental resources to sustain human communities at their erstwhile level--a phenomenon known as an

environmental discontinuity. Technically speaking, the phenomenon occurs when ecosystems have absorbed stresses over long periods without much outward sign of damage, then eventually reach a disruption level at which the cumulative consequences of stress reveal themselves in critical proportions (an example is acid rain). We should anticipate that as human communities continue to expand in numbers, they will exert increasing pressures on already over-burdened ecosystems and natural-resource stocks, whereupon environmental discontinuities will surely become more common (Myers, 1992a).

An instance has arisen in the Philippines where the agricultural frontier closed in the lowlands during the 1970s. As a result, multitudes of landless people started to migrate into the uplands, leading to a buildup of human numbers at a rate far greater than that of national population growth. The uplands contain the country's main remaining stocks of forests, and they feature much sloping land. The result has been a marked increase in deforestation and a rapid spread of soil erosion (Myers, 1988). In other words, there occurred a "breakpoint" in patterns of human settlement and environmental degradation. As long as the lowlands were less than fully occupied, it made little difference to the uplands whether there was 50 percent or 10 percent space left. It was only when hardly any space at all was left that the situation altered radically. What had seemed acceptable became critical--and the profound shift occurred in a very short space of time.

This problem of land shortages is becoming widespread in many if not most developing countries, where land provides the livelihood for almost 60 percent of populations and where most of the most fertile and most accessible land has already been taken. During the 1960s, arable areas were expanding at roughly 0.5 percent per year. But during the 1980s the rate dropped to only half as much; and primarily because of population growth, the amount of per-capita arable land declined by 1.9 percent per year (United Nations Population Fund, 1990). Similarly, the annual expansion of irrigated lands, which supply one third of our food from one sixth of croplands, fell by half during the same period.

For details of other environmental discontinuities in the offing, relating to e.g. deforestation, fuelwood deficits and fisheries decline, see Appendix 5.

All the environment/population issues examined so far relate primarily to developing nations. Hence they are of only indirect interest to developed nations. But much environmental degradation, notably global warming and ozone-layer depletion, affects the entire global community, and it does so directly--these being problems that are principally the responsibility of the developed nations, though developing nations are playing an increasing role.

3. Problems of the Global Environment

"The biosphere recognizes no division into blocs, alliances or systems. All share the same climatic system and no one is in a position to build his own isolated and independent line of environmental defense."

Eduard Shevardnadze, 1988

Even though developed nations comprise only a small proportion (22 percent) of humankind and feature low rates of population growth (average of 0.5 percent per year), their consumption of natural resources and their environmentally harmful technologies cause their population factor to count prominently as concerns the environment--especially the global environment which supports all nations. To this extent, the imperative of sustainable development is just as significant for developed nations as for developing nations.

Global Warming

Buildup of so-called greenhouse gases in the atmosphere appear set to bring on a phenomenon of global warming (Houghton et al., 1990 and 1992; see also Leggett, 1990; Oppenheimer and Boyle, 1990; Schneider, 1989). What is the role of population growth?

Western Europe and North America, while comprising only 13 percent of global population, are responsible for roughly 65 percent of the fossil-fuel carbon dioxide emissions that account for half of global-warming processes. The European Community, with only 6.3 percent of global population, accounts for 13 percent (Table 5); on a per-capita basis, the Community's share is 2.3 tonnes per year, a level surpassed only by North America with 5 tonnes, as against a global average of less

than 1 tonne. Developing nations, with 77 percent of the world's population, contribute only a small (albeit fast growing) share of fossil-fuel emissions of carbon dioxide. But they contribute 30 percent of total carbon dioxide emissions taking into account tropical deforestation as well as fossil fuels.

According to a pioneering analysis by Harrison (1992; see also Holdren, 1990), population growth in developing nations has accounted for 46 percent of increased carbon dioxide emissions during the period 1960-88 (and in developed nations, 35 percent). In the future, the role of population growth in conjunction with economic advancement in developing nations will become more pronounced, generating by 2025 a projected additional 5.8 billion tonnes of carbon dioxide--a total to be compared with the present worldwide annual total of 8.0 billion tonnes. (If India were to use the same meagre amount of energy in 2010 as today, its carbon dioxide emissions would jump by 70 percent simply due to population growth (Sadik, 1992).) Whereas developed nations now account for roughly 70 percent of total carbon dioxide emissions and developing nations 30 percent, these proportions under a "business as usual" scenario are likely to be reversed by 2025 or shortly thereafter.

Several other greenhouse gases apart from carbon dioxide account for the other half of global warming processes. For details of the European Community's emissions, see Table 5.

So far as we can discern--there is much uncertainty--global warming would exert profoundly harmful impacts on the world's, and especially developing nations', capacity to grow food. Preliminary analysis

suggests it could well reduce present croplands by as much one third (within a range of 10-50 percent) (Schneider, 1989); and droughts could cause a 10-percent drop in grain harvests on average three times a decade (Daily and Ehrlich, 1990). The latest and much the most extensive assessment proposes a 10-15 percent decline in grain harvests, with substantial shortfalls for many other crops, in large parts of the tropics, plus perhaps reduced yields in North America; and the consequences could include a rapid rise of 400 million in the number of people at risk from hunger, soaring to a total of more than 1 billion within 50 years (Rosenzweig and Parry, 1992). Alternatively calculated, there could ensue the malnutrition deaths of as many as 800 million people over 20 years (Daily and Ehrlich, 1990). Note, moreover, that all these analyses conclude the best mode of adaptation to the greenhouse threat is to reduce population growth.

For further analysis of global warming, including consideration of the potent greenhouse gas methane, together with additional details of global warming's potential impact on food production, see Appendix 6.

Ozone-Layer Depletion

Ozone-layer depletion will have many human-health repercussions such as increased cancers and eye cataracts, together with a host of adverse effects for crop plants on land and phytoplankton-based food chains in the seas (Benedick, 1990; Mintzer et al., 1990).

In 1987 when the production of CFCs and three halons was at its height, global output totalled 1,180,000 tonnes. Of this, the seven leading European Community producer nations amounted to 634,000 tonnes, or almost 54 percent (Table 6). As for consumption, the European Community accounted for around 320,000 tonnes or 27 percent of the global total, out of 88 percent for the developed nations as a whole. Developing nations produced slightly over 200,000 tonnes or 17 percent of the global total, and they consumed less than 120,000 tonnes or 10 percent. Thus the Community produced CFCs at a rate 37 times the developing nations' per-capita average, and consumed them at a rate 30 times the developing nations' per-capita average.

But if recent trends of population growth and CFC production were to continue, the developing nations' output of CFCs would reach roughly 30 percent of the global total as early as the year 2000 (Phillips, 1990; Rosencrantz and Milligan, 1990; and for some clarificatory details, see Appendix 3.). Fortunately the international community has taken steps to phase out CFC production by the year 2000 (the European Community and the United States have decided to end it by 1995). This initiative has won support from most leading CFC producers, both actual and potential. But there is emergent evidence that even these cuts will not be enough to safeguard the ozone layer. Over northern Europe the layer is disappearing twice as fast as previously assumed--and the rate could well double again by the end of the 1990s, and even double yet again during the first half of next century. All the more reason for CFC production to be halted forthwith.

Chapter III

POPULATION AND ENVIRONMENT LINKAGES: ILLUSTRATIVE SECTORS

"The "triad" of excessive population growth, environmental degradation and poverty threaten us and our planet as never before."

International Forum on Population in the 21st Century, Amsterdam, November 6-9, 1989

In this chapter we shall look at a short selection of population/environment linkages to illustrate the conceptual analysis of Chapter II.

Illustrative Sectors*

a) Soil Erosion

Agricultural lands are losing topsoil at a rate of 24 billion tonnes per year (Brown et al., 1990; see also Pimentel, 1992). The cost to soil fertility and agricultural production is high: unchecked erosion could well cause a decline of almost 30 percent in food output from rainfed croplands during the period 1985-2010 (Sfeir-Younis, 1986). A good part, though only a part, of this problem is due to population growth, especially among impoverished peasantry--precisely those people inclined to feature the highest fertility rates. Population pressures result in subdivision of smallholdings into ever-smaller plots, sometimes as little as one hectare or less, whereupon croplands are subject to over-intensive cultivation and accelerating soil erosion. Of course a number of other factors are at work, such as faulty

*There is not space here to set out all the documentary evidence and detailed analyses. For further assessment, see Appendix 8.

agricultural practices, lack of extension services, and inadequate policy emphasis on subsistence agriculture. But population growth often plays a prominent part, and a pre-eminent part in many high-density areas.

b) Desertification

Desertification causes at least 60,000 square kilometres of agricultural land to be eliminated each year (an area almost the size of Ireland), and another 200,000 square kilometres (equivalent to the United Kingdom) to be so impoverished that crop yields fall off sharply (Dregne and Tucker, 1988). It undermines the livelihoods of 850 million people, with costs in the form of agricultural output foregone totalling \$30 billion per year (Mabbutt, 1984). Population growth is generally higher (3 percent or more per year) in semi-arid and arid lands than elsewhere. As in the case of soil erosion, population pressure is far from the only factor. But it is frequently a reinforcing if not a triggering variable.

c) Water Deficits

Water consumption has doubled twice this century, and demand is projected to double again during the next two decades, primarily because of population growth. At least 2 billion people already suffer chronic water shortages (Falkenmark, 1990 and 1991; la Riviere, 1989). Within another decade at most, virtually all nations of North Africa (a region of special interest to the European Community if only because of the migration factor), also of East Africa, are expected to experience critical water deficits. Much the same applies to Syria, Jordan,

Lebanon and Israel, nations that share the waters of the River Jordan system and face potential conflict in view of acute water shortages in the river basin (Starr and Stoll, 1988). In the developing world as a whole, the number of water-short people totals more than 300 million today, and is projected to reach 3 billion by 2025. Of the latter total, well over 1 billion people are expected to be in Africa, or two-thirds of the continent's entire population (Falkenmark and Suprato, 1992; Sadik, 1992).

d) Tropical Deforestation

Tropical forests have already lost roughly half their expanse, and are currently declining by about 2 percent per year. The rate almost doubled during the 1980s, and there is good reason to suppose it could double again during the 1990s if only because of the phenomenon of the displaced peasant who now accounts for at least 60 percent of all deforestation--a proportion that is increasing (Myers, 1991b). This "shifted" cultivator is expanding in numbers far faster than national population growth rates, meaning there are other factors besides simple population increase that are pushing him into the forests. But population growth can be roughly reckoned to cause almost four-fifths of present deforestation (Harrison, 1992; Myers, 1990a).

e) Mass Extinction of Species

The great majority of Earth's species, estimated at 30 million, occur in tropical forests. Due to deforestation (and in the absence of incisive and urgent counter-measures), we should anticipate the elimination of as many as half of all species within the coming decades

(Myers, 1990b; Wilson, 1992). The population factor contributing to deforestation (almost four-fifths) translates into a present extinction rate of 120,000 species per year (a rate that is increasing rapidly), or at least 100,000 times the natural "background" rate.

f) Ultra-Rapid Urban Growth

The main distribution impact of population growth expresses itself in an urban growth rate that expanded developing-nation urban communities from 286 million people in 1950 to 1.3 billion in 1987, and is projected to further expand it to almost 4 billion by 2025 (Brown and Jacobson, 1987). This growth rate far exceeds the planning capacity of governments to accomodate it. The result is an outburst of shantytown and other slum-type settlements (Lowe, 1991). At least 1.2 billion people or 60 percent of developing-nation city dwellers now live on the margins of survival in conditions of extreme poverty and squalor (Hardoy and Satterthwaite, 1989).

g) Wastes

We might suppose that wastes are due to careless consumerism and negligent technology, with population growth playing a trifling role (Commoner, 1990). Developing nations, with three-quarters of the world's population, account for only one quarter of present global production of waste. But through population growth alone, they are projected to contribute 60 percent of all new waste generated between 1985 and 2025; and if we add in the factor of income growth as well, we find their share rises to 83 percent--even though per-capita waste would still be little more than one fifth of that of a developed-nation

citizen (Shaw, 1989).

Review of Population Impacts on Environment

In brief review, note that, according to an illuminating analysis by Harrison (1992), population growth in developing nations has accounted for:

- 72 percent of expansion of arable lands during 1961-85, leading to desertification, deforestation and decline of many natural environments;
- 79 percent of deforestation during 1973-88, leading to an average of at least 70,000 species extinctions each year;
- 69 percent of increase in livestock numbers during 1961-85, leading to soil erosion, desertification, deforestation and methane (greenhouse gas) emissions; and
- 46 percent of growth in carbon dioxide emissions from fossil fuels during 1960-88.

The sector summaries reveal environment/population interactions in illustration of the theme of critical linkages presented in Chapter II. Let us now consider how the European Community relates to particular environment problems in developing nations.

Particular Linkages to the European Community

By virtue of proliferant linkages both environmental and economic, the European Community interacts with developing nations in a manner that impinges upon population and environment factors, and vice versa. Herewith three examples of such linkages:

a) Tropical Deforestation

One fifth of tropical deforestation is attributable to over-heavy logging that not only removes a good part of the tree stock but leaves much of the residual forest injured beyond recovery (Myers, 1992b). This eliminates the scope for a second harvest within many decades; the amount of logged areas that are managed for sustained yield is less than half of one percent. Around 30 percent of the hardwood timber harvest goes to overseas markets in developed nations; and the European Community accounts for 30 percent of these exports by value. The imported timber bears a price that is far from reflecting the full costs of production (it does not include long-term and deep-seated damage to the left-over forest). So it is artificially cheap, and stimulates excessive consumption on the part of developed nations. To this extent, the European Community plays a part--an unwitting but an effective part--in tropical deforestation.

b) The Cassava Connection

In parts of Southeast Asia, tropical deforestation has been due to the expansion of croplands for cassava. Otherwise known as manioc, cassava is rich in calories, hence it has come into increasing use as a foodstuff for livestock in the European Community (Dijksterhuis and Sprang, 1988; Smit, 1988). The three main nations concerned, (the former) West Germany, Belgium and Netherlands, have been absorbing a sizeable share of internationally traded cassava. Most of the traded crop is grown in Thailand, from where the European Community imported 1.5 million tonnes of cassava in 1973, an amount that rapidly rose by

1982 to more than 8 million tonnes. The principal cassava growers have included a fast-increasing number of smallscale farmers, especially in the eastern and northeastern parts of the nation where they have established their crops at the expense of forest. The price for cassava does not reflect the concealed cost of deforestation. Fortunately the trade has recently declined a good deal.

c) Genetic Depletion

The mass extinction of species underway results in the depletion of genetic resources that could make many contributions to Europeans' welfare. In agriculture, all our major crops require regular infusions of fresh germplasm to expand their productivity and to maintain their resistance to disease and their environmental adaptability (this last attribute will become all the more important in a greenhouse-affected world). The commercial value of this genetic improvement was worth \$1 billion a year to American farmers ten years ago. We can also look to wild plant species for entirely new foods such as the tropical fruits and vegetables that increasingly appear in European supermarkets. In the medicinal sector, one pharmacy prescription in four is based on startpoint materials from wild species. The commercial value worldwide is at least \$40 billion a year, of which genetic resources contribute roughly 2 to 4 percent.

Thus the European Community derives many economic benefits from the genetic materials of wild species. Yet we enjoy these benefits after scientists have undertaken intensive screening of only one in 100 plant species, and fewer than one in 5000 animal species, to assess their

potential economic contributions. This indicates the European Community's stake in the survival of species, the great bulk of them located in developing nations--and already being eliminated at a rate of several hundred per day.

These three instances of EC/developing nation linkages are a small sample of abundant interactions, both economic and environmental. Similar linkages arise with respect to desertification, landlessness and global warming, together with the strongly associated factors of population, poverty and migration.

The "Big Picture" Interests of the European Community

As we have seen in Chapter I, population growth and environmental decline in developing nations, leading to declining prospects for sustainable development, have all manner of negative repercussions for the European Community. By reason of its own economic outlook and of social stability and political harmony worldwide, as well as the emergent phenomenon of mass migration, the Community will fare less well in a world characterized by a growing divide between the "haves" and "have nots".

True, we cannot always postulate immediate and obvious connections between developing-nation questions of population and environment on the one hand, and on the other hand the pre-eminent interests of the European Community. The linkages vary widely. In the case of the rising tide of immigrants from North Africa and other developing nations of the Mediterranean basin, the impact on the Community's interests is direct. In cases where environment and population problems contribute to

political instability and even outright conflict in areas of strategic value to Europe, e.g. the nations of the Jordan Valley, the impact is more indirect.

In some instances, such as sub-Saharan Africa where environmental decline and population increase are more widespread than in other parts of the developing world, the impacts are diffused in both space and time. But if the region degenerates into endemic poverty, social upheaval and political disintegration, this will mean the loss of trading partners and the waste of decades-long investment and financial aid on the part of the Community. It will raise humanitarian questions in the face of human suffering on an unprecedented scale. It will supply abundant scope for Gaddafi-style adventurism with prospect of proliferating conflicts and violence. Human degradation with scant hope of relief is the breeding ground for excesses of both the far left and the far right.

Regrettably, environment and population problems seldom generate the sense of urgency that accompanies economic crises and political instability, no matter how closely they might be related in the long term. If the urgent drives out the important today, the important can become the imperative tomorrow--when there may be much less room to manoeuver in response.

Of course it is easy to over-state the case for greater European Community involvement in environment and population issues way beyond its horizon. It would be a mistake to suppose that these problems are

often the main, let alone the sole, factor at issue in the failure to achieve sustainable development. It would equally be a mistake to suppose that these problems do not often play a substantive role. No more, and certainly no less.

Chapter IV

POLICY RESPONSES ON THE PART OF THE EUROPEAN COMMUNITY

"Without effective environmental protection, development cooperation can only lead to a dead end that could prove disastrous for mankind."

Helmut Kohl, 1988

"Those who make \$200 a year should not pay so that those who make \$10,000 a year can breathe clean air. We are all in the same planetary boat. A few of us travel first class, while most are in steerage. But if the boat sinks, we all drown together."

Ambassador Edward Kufuor, Chairman of Group of 77, 1991

This paper demonstrates there are multiple problems of population growth and environmental decline. In many instances these profound problems can still be turned into exceptional opportunities for counter-measures, both remedial and preventive. There is much scope for timely and incisive initiatives on the part of policy makers, with a highly positive payoff extending into the indefinite future. But time is at a premium.

1. Perception of the Problems in Their Proper Scope

What can the European Community do to promote the environment and population fields? First off, its policy makers can ensure they understand the two thematic areas in their proper scope. Environment and population issues are exceptionally interwoven, especially as concerns their causality and impacts. So policy makers must take account not only of the speed and scale of accumulating problems, but also of their multiple inter-relationships. Energy strategies affect crop production, and vice versa. Tropical deforestation influences climate change, and in turn, global warming is likely to affect

distribution of the world's forests. And so on. Most of these diverse interactions will grow more numerous and significant, and will have greater influence--both quantitative and qualitative--on more sectors of development and on more human communities.

Just as problems tend to be interlinked, so do solutions. Tree planting in developing nations not only supplies commercial timber and fuelwood. It conserves topsoil, reduces flooding and drought, supports irrigated agriculture and hydropower energy, supplies domestic water of sufficient quantity and quality, and slows the buildup of carbon dioxide. So too with energy: as we increase the efficiency of production and consumption, we achieve three other goals: we foster greater economic growth for each unit of energy expended, we reduce acid rain, and we slow carbon dioxide buildup. Probably the greatest example of these impact-reinforcing linkages lies with population planning. One of the best ways to reduce population growth is to reduce infant mortality, thus enhancing motivation for family planning; and one of the best ways to reduce infant mortality is to supply more potable water--which brings us back to tree planting.

For sure, it is difficult to modify existing policy patterns. But policy decisions taken today should be viewed in terms of a crucial choice between a difficult while still tolerable transition to a radically altered world, and a far more difficult transition to a profoundly perturbed world with many adverse consequences for human welfare and international stability.

2. Reflecting the Constraints of Interdependence

The global community of nations has now reached a stage where no individual nation can shield itself from many forms of environmental degradation and population pressure in other nations. Not even the most advanced and powerful nation or group of nations can insulate itself from environment/population problems and the economic hardships and political dislocations they generate in distant parts of the Earth. Interdependence is here to stay, an established fact of everyday life--however little certain political leaders are inclined to embrace it wholeheartedly (Hurrell and Kingsbury, 1992; Ramphal, 1992; Thomas, 1992; Wright, 1991).

Given the challenge of interdependence, with its problems and its opportunities, there is a growing premium on collective action to tackle collective problems. Global warming clearly demonstrates that we now face environmental problems to which all nations contribute and by which all will be affected. This highlights the imperative of cooperative endeavour--which in the case of developing nations means expanded support from developed nations. Similar considerations apply to other problems such as ozone-layer depletion and mass extinction of species. So while there is now less leeway for the European Community to "go it alone", there is increased scope for the Community to make common cause with other nations, especially developing nations. In turn, this postulates a policy framework that reflects the new constraints--the creative constraints--of interdependence.

Against these two background perspectives as concerns policy options for the European Community, let us now examine some sector-by-sector initiatives available.

3. Aid

The European Community--meaning both the individual nations and the Commission--supplied developing nations with a 1990 total of \$31 billion of aid (also known as Official Development Assistance, or ODA). This sum amounted to 57 percent of all ODA. But it equated to only 0.5 percent of Community GNP, falling below the United Nations' recommendation of 0.7 percent--though better than the developed nations' average, 0.3 percent (Table 7).

More pertinent still, the sum of \$31 billion worked out to only about one fifth of the amount by which the Community grew richer in 1990. (An annual 2-percent increase in Community affluence works out to an extra \$200 per citizen, or as much as the entire annual income of the 400 million poorest people.) If the Community's aid had been doubled to 1.0 percent of GNP (Netherlands and Denmark both supplied ODA approaching this level), it would have achieved much for developing nations: it would have been equivalent to roughly 30 percent of the collective GNP of the region to which the Community gives special attention, sub-Saharan Africa.

But only a little over 1 percent of ODA goes to population-related programmes and a similarly small amount to specifically environment programmes. There is great scope to expand support for the two programme areas that in many respects are the foundation for sustainable

development overall, especially for agriculture. There is little point in supplying aid of conventional sort for agriculture if it does not take explicit account of measures to protect soil, water, atmosphere, climate and whatever other environmental resources are critical to sustainable agriculture. Nor is there long-term purpose in growing extra food for extra mouths if it is apparent that the extra mouths will become so numerous that they will eventually overwhelm the best efforts to expand food production--and likewise deplete the capacity of agricultural lands to maintain food production.

Policy makers could also investigate the potential for "foreign-aid leverage" with respect to those developing nations that devote inordinate sums to military activities. In 1988, developing nations as a whole spent two and a half times as much on their military as they received in ODA (Sivard, 1991). Were ODA to be restricted to e.g. those nations that devote no more than 2 percent of their GNP to military activities (current average, almost 5 percent), this would release enormous sums for productive application in all manner of fields that promote sustainable development, including environment and population.

More important again, there is paramount need to incorporate environment and population factors into all development policies in a systematized and comprehensive manner--a measure to be heeded by policy makers in both developed and developing nations. The challenge is to modify policy makers' outlook so profoundly that they no longer look upon environment/population and development as discrete arenas of activity. Rather they should perceive them as two sides of the one

coin, inextricably interwoven. As long as the two are regarded as separate entities, policy makers will continue to consider environment as a constraint on development, to be articulated as little more than an "add on" factor rather than a "built in" dimension. Similarly they will view population-planning measures as an occasional option rather than an over-riding imperative.

With specific respect to environment, a sound initiative could lie with the introduction of "natural resource accounting" (Appendix 9). During the period 1971-84 Indonesia's GNP was conventionally reckoned to be growing at an average rate of 7.1 percent per year. But if account had been taken of resource depletion, the rate would have been reduced to only 4 percent per year, meaning that almost half the growth had been unsustainable (Repetto, 1986a).

4. Trade

The Community engages in much trade with developing nations. It exports more (30 percent of its export total) to developing nations than to the United States and Japan together; and the Community is the leading market for developing nations, taking 21 percent of their exports. This offers sizeable scope for the Community to influence its trading partners to pursue more substantive environment policies. An obvious example is tropical timber, which currently is almost entirely harvested through non-sustainable methods--to the long-term detriment of the Community which will see its timber imports declining as stocks diminish (tropical-forest nations themselves are expected for the most part to become net importers of timber by early next century). The

Community's imports of timber could be subject to levies sufficient to ensure reforestation in source nations of the tropics.

More importantly, the Community should re-examine its policies on trade restrictions as concerns imports from developing nations. At present, many such imports face developed-nation barriers in the form of taxes, quotas and the like. This costs developing nations a full \$100 billion of trade earnings foregone annually, or almost twice as much they receive through all foreign aid (George, 1992; World Bank, 1992). Were more foreign-exchange revenues available via expanding exports to the Community (notably food exports, the CAP notwithstanding), this would generate additional economic resources for environmental and population-planning purposes among other objectives of developing nations (and recall the demonstrable connection between economic advancement and fertility reduction).

Probably most important of all is the GATT connection. A successful GATT accord would increase the growth rate of developing nations by roughly 3 percent, with all that means for the funding of sustainable development (International Monetary Fund, 1989). True, liberalization of trade could lead to the erosion of environmental values if it simultaneously promoted free-for-all exploitation of environment-based resources (Arden-Clarke, 1991). But special provisions on this front are feasible enough, especially if sponsored by the European Community: to some (limited) extent, the Community already seeks to integrate environmental values into its trade policies.

Specially significant under the trade heading are the Community's food exports within the context of the CAP. The CAP supplies subsidies to Community farmers now amounting to \$40 billion per year in order to grow food way beyond the Community's needs (ironically, the Community now has several times more surplus food than would meet Africa's deficits). When artificially cheap food is released by developed nations onto world markets, this depresses food prices in developing nations, effectively depriving developing-nation farmers of food-export income estimated at \$30 billion per year (World Bank, 1991)--a sum equivalent to almost half of all ODA.

5. Debt

International debt is a major burden on developing nation economies. Among other restrictions, it limits their efforts to safeguard their environmental resource base and to pursue population planning. Developing nations owe in the order of \$100 billion to the European Community. As a measure of the debt burden, note that when we consider all flows of ODA plus new loans from developed nations to developing nations, and subtract this from debt repayments, we find that from 1983 to 1989 there was a net annual financial flow of \$40-50 billion from the South to the North. Fortunately the balance has been positive since 1990, but by an amount of only about \$10 billion per year, a sum that effectively cancels out one fifth of total ODA.

Steps toward debt-reduction have been taken by individual Community nations, notably Germany, France and the United Kingdom, to forgive

several tens of billion dollars' worth of public-sector loans to least developed nations of sub-Saharan Africa. This approach could well be expanded, and with respect to private as well as public debt. In the commercial sector, moreover, there is scope to change the laws on tax systems in order to encourage private banks to reduce debt without undue injury to their financial interests.

There is also opportunity for the Community to engage in debt-for-nature swaps and similar forms of "creative financing" as concerns the environment generally (the same applies to population) (Durning, 1989; French, 1992; Mikesell and Williams, 1992; World Bank, 1992). Additional policy leverage can be generated through debt-relief measures (and the same through aid and trade initiatives). The European Community should seek to influence those developing nations that engage in environmentally harmful practices, unwittingly harmful as these practices often are. For instance, covert subsidies serve to foster over-exploitation of tropical forests, over-loading of croplands, excessive application of pesticides, and wasteful use of water and energy (Kosmo, 1986; Repetto, 1986b; Repetto and Gillis, 1988). Elimination of these subsidies would not only safeguard environmental resources, it would promote economic efficiency as well.

6. Global Warming

The bulk of greenhouse gas emissions, especially carbon dioxide emissions, stems from developed nations. These nations have recently achieved much in energy savings: in 1988 they used one quarter less energy (mainly from fossil fuels, the chief source of carbon dioxide

emissions) than in 1970 to produce each \$1 of GDP. Further measures to curtail carbon dioxide emissions are underway through e.g. the carbon tax proposed for the European Community. This policy approach should be pursued with greater vigour. Without greatly increased efforts to stem global warming, there will be scant sustainable development for the entire world. While it is commendable that certain Community nations aim for a marginal decrease in carbon dioxide emissions by 2000 and still larger cutbacks early next century, they should bear in mind that if we are to stabilize climate we must aim at a 60-percent reduction in these emissions.

Fortunately there is immense scope to meet energy needs through the strategy that is most widely available and least exploited to date, viz. energy efficiency and conservation. Not only is this the cheapest response, it would serve to make Community economies more productive and competitive. For developed nations as a whole, they could--with present technologies and the right policy incentives--cut per-capita energy consumption by half while allowing for a 50-100 percent advance in living standards. As for developing nations, if they were to fully utilize all energy-efficiency and -conservation technologies now available, they could achieve immense economic progress with only an 11-percent increase in energy consumption; and they would save \$30 billion per year that would otherwise be needed to pay for imported oil and new power plants (Goldemberg et al., 1987).

A number of other policy options are available. These include the idea of "carbon emission trading permits", setting up a de facto market

of global scope (Grubb, 1989); and grandscale reforestation in order to absorb carbon from the atmosphere (Myers and Goreau, 1991) (for some details of a tree planting initiative on the part of the Netherlands, see Appendix 10).

Global warming can also be reduced by population planning. If present trends are projected from 1985 to 2100, population growth will account for more than one third of all the increase in carbon dioxide emissions and for close to half of the increase in developing nations (Bongaarts, 1992).

7. Ozone-Layer Depletion

The Community plans to phase out all CFCs and associated ozone-destroying chemicals by 1995. But the Community should consider bringing an end to all such chemicals still sooner in light of the growing evidence of ozone depletion in many parts of the world, including Europe.

8. Population

Thus far we have looked mainly at environment issues, albeit with some regard to their population dimension. Now for population itself. This paper has demonstrated that population growth exerts a pervasively adverse impact on developing nations' hopes for economic advancement, especially as concerns the environmental resource base that ultimately supports all economic activity and hence is a crucial factor in sustainable development. This determinant factor notwithstanding, there has been all too little attention given to population issues. This applies notably to initiatives to reduce population growth through:

1. Direct measures in the form of family planning, particularly with respect to the unmet needs of those hundreds of millions of couples who possess motivation for family planning but lack birth-control facilities; and

2. Indirect measures in the form of e.g. (a) elimination of child mortality, (b) enhancement of women's status through expanded opportunities for education and employment, and (c) reduction of widespread poverty (remember it is the most impoverished who tend to have the largest families).

Yet population issues have been attracting little over 1 percent of total ODA funds. This is quite unrealistic. It reflects a lack of understanding of the many population linkages, also population-environment linkages, that severely undercut the effectiveness of ODA in the form of support for agriculture, water resources, forestry, infrastructure both rural and urban, indeed sustainable development generally. Despite huge investments on the part of developed nations in developing nations' agriculture, for instance, there has been since the mid-1980s a marked decline in per-capita food production. This has been partly due to population increase (an additional 600 million people), and partly due to environmental degradation (soil erosion, desertification, salinization of irrigation systems, water shortages, deforestation-induced shifts in rainfall patterns, etc.). In turn, these deficiencies reflect in major measure the pressures of too many people seeking to gain food from limited agricultural lands. Of course other factors are at work: lack of fertile areas to be brought into

cultivation, and inadequate support measures such as extension services, credit facilities, marketing networks and the like. It is difficult to determine the precise amount of the problem that stems from population pressures in themselves. But plainly population pressures are prominent factors, often predominant factors.

In short, it would make sense to calculate (a) how much the original investments in agriculture are being undermined by population growth and associated problems of environmental run-down, and (b) how much additional investment in population issues would serve to reinforce the investments in agriculture. Despite its central significance, this calculation remains to be undertaken in even preliminary terms. It would be helpful, for instance, to determine what would be the outcome if particular projects were undertaken with and without the population calculus--bearing in mind too the multiplier effects, both positive and negative, generated through numerous linkages.

This is all the more pertinent in that population planning has been falling away in recent years. If we discount China--where too there has been some slowing in efforts to reduce the fertility rate--we find that population growth in developing nations has remained around an annual 2.3 percent for several years. The UNCED conference scarcely features the issue on its agenda, and the main documentation speaks merely of the need for "appropriate demographic policies". Plainly population deserves a far more prominent place in the Rio deliberations, and this supplies an admirable opportunity for the European Community to take a

substantial initiative.

Policy Framework

The Rio Conference apart, what can the Community do to promote population planning? First and foremost, its policy framework should ensure that all population factors are fully integrated into development planning across the board. This requires that policies be based on a comprehensive assessment of all population factors and their impacts, both present and future. In particular, policies should reflect such key questions as:

--What size of population, and with what distribution patterns, will be generated by a continuation of presently anticipated rates of growth?

--What effects will this have on the prospect for sustainable development, reflecting in turn the environmental-resource base?

--How far can sustainable development be fostered by reduced rates of population growth--and hence, how fast should rates of growth be brought down?

--What scope is there, given population structures, age distributions and the like, for rapid and sustained reductions in growth rates? What time horizons are relevant, e.g. the years 2000, 2025 and 2050, and the stage when zero growth is finally achieved? What does each of these time horizons imply for population-planning measures to be introduced forthwith?

Central to these considerations is the question of demographic momentum. Incisive and vigorous measures introduced today will exert a

compounding impact with progressively positive payoff for a long time into the future. Similarly, deferred action will lead to ever-increasing inertia in growth rates, making future efforts to reduce growth all the more difficult--more complex, more taxing, more costly, and with diminished success compared with investment. Just a one-decade delay in achieving the family-planning goals established for the 1990s (see below) could make an eventual difference of 4 billion extra people in global population (Sadik, 1992). In the particular case of Pakistan, with 115 million people in 1990, achieving replacement-level fertility by 2010 instead of the predicted 2035 would reduce the eventual population size by 222 million, or 193 percent of the 1990 total (McNamara, 1991; and for assessment of other nations, see Table 8).

Moreover, and as this paper has repeatedly demonstrated, population futures cannot be formulated in an "environmental vacuum" (or indeed in a "development vacuum" overall). There are many intimate relationships between population growth and the environmental-resource base that ultimately underpins all socioeconomic endeavours and hence the scope for human communities to sustain themselves. This means that all population factors should be evaluated with respect to their linkages to environmental questions--in a manner as integrative as are the interactions of population and environment in the real world. Policy makers must tackle both these fronts together if they are to make progress on either front. What adverse impacts will be generated through continued population growth, manifested through e.g. overloading of farmlands, reduction of water supplies, decline of forests, spread of deserts, depletion of the ozone layer, and global warming? How far will

all this undermine prospects for sustainable development? Conversely, how far will efforts to reduce population growth serve to safeguard the carrying capacity of environmental-resource stocks?

Key question: How are these population factors to be "operationalized", i.e. expressed through development planning, programmes, projects and other delivery mechanisms, and undertaken in systematized fashion? One illustrative approach is to introduce a "trip wire" device in order to ensure they are steadily and firmly institutionalized: all development measures should be subject to population impact assessment (akin to environmental impact assessments). In practical terms, development planners should be formally required to take specific account of the population dimension of all their activities. For instance, they should methodically ask themselves how far will the effectiveness of their programmes, projects, etc., be reduced by population factors? How far will their activities serve to aggravate environmental degradation and thus curtail long-term carrying capacity for ever-growing populations? On the more positive side, they should ask themselves how far their activities will help to reduce child mortality and poverty, to increase the overall status of women, and to tackle other questions that are closely connected with population concerns.

To date, these critical questions are considered (if considered at all) as little better than add-on factors--rather than as built-in factors that deserve to be accorded full and explicit consideration in each and every development sector. Far from being a factor of

peripheral importance, population should rank as a significant factor in most if not all all development endeavours. We are a long way from achieving a systematized response of that sort, certainly with scope and scale to match the challenge.

At the same time, the Community and its member states should do more to coordinate their policy and planning responses on the population front with parallel measures on the part of United Nations agencies (notably UNFPA and UNICEF), the World Bank group among other multilateral development banks, and numerous NGO bodies that have long been active in the field, in order to generate a better integrated strategy. This applies too at the individual country level via agency/government development dialogues.

To cite a specific instance of incisive intervention available, the Community should consider the opportunity to deploy leadership now that the United States, formerly a front runner in the population field, has partially withdrawn from funding of family planning. U.S. support for the two principal organizations in question, the United Nations Population Fund and the International Planned Parenthood Federation, has been suspended for several years and looks little likely to be restored within the foreseeable future. (In the case of IPPF, this has meant an annual shortfall from 1985 onwards of \$17 million, or one quarter of its income.) As a result, there have been severely adverse repercussions for family planning efforts in many developing nations. Here, then, is an admirable chance for the Community to engage in the more aggressive type of initiative that is increasingly demanded by a deteriorating

situation.

Thus far we have engaged in an extended appraisal of some broad-scope issues. Detailed assessment of these issues will supply the appropriate policy framework for specific measures, six of which we shall now consider.

Increased Support for Family Planning

Latest estimates indicate that population assistance from external donors to developing nations will have to be expanded from \$630 million in 1990 to as much as \$4.5 billion in 2000, by comparison with developing-nation contributions which will need to rise from \$3.5 billion to \$4.5 billion. This means that developed-nation support will have to be increased from today's 1.3 percent of total ODA to 4 percent (still a trifling proportion in light of payoffs) by the year 2000. (Given the expansive benefits from containing population growth, it is remarkable that developed nations have even allowed their support to fall away somewhat in recent years, from 2.1 percent of ODA in the 1970s to 1.3 percent today.) Nor should the required increase be viewed as costly. In order to make this contribution to attaining the medium population projection of 6.3 billion by 2000, developed-world taxpayers would have to provide no more than one U.S. cent per day (Potts, 1990).

As a measure of what can be achieved on the family planning front, note the recent record of Thailand. In 1969 the fertility rate was 6.5, which dropped to 3.2 in 1978, 2.3 in 1984 and 2.1 in 1989. Had the government not implemented its National Family Planning Programme, the

1989 population would have been 67 million rather than 54 million (Bennett et al., 1990).

Unmet Needs in Family Planning

Another policy option lies with "unmet needs" as concerns family planning. The term refers to the needs of those women who possess the motivation for family planning but lack the birth-control facilities. Women with these unmet needs are estimated to total between 25 and 50 percent of developing-nation women of reproductive age (the range reflects different nations), total of at least 300 million (Westoff, 1991). As a result of these unmet needs, one birth in five in developing nations is considered to be unwanted (Sadik, 1992). Insofar as it is a United Nations-recognized right for parents to have as many or as few children as they desire, they should be supplied with contraceptive facilities on humanitarian grounds alone, even if there were no population problem. A policy initiative along these lines would cut the eventual global population by well over 2 billion (Bongaarts, 1990).

Reducing Child Mortality

For those women who lack motivation, a sound response is to reduce child mortality totalling 14 million per year. True, this would increase population growth--but only temporarily, and necessarily. Until parents can be assured their children are more likely to survive, they will keep on producing as many as they can by way of insurance. Through mass immunization campaigns and counter-diarrhoea therapies, we can save at least 9 million of those children today, and still more in

future years as "in the pipeline" population growth causes the number of at-risk children to increase. If much of the extra cost were again covered by developed-world taxpayers, it would amount to only one U.S. cent per week. As in many cases of population-related issues, the question is not "How can we afford to do it some day?", it is "How can we possibly afford not to do it right away?" So effective are the preventive measures, and so practicable is their provision, that we have already reduced the annual toll by 3 million in just the past few years. But much greater opportunity lies ahead. During the 1990s we could easily save a total of 100 million children. This is a super-scale opportunity that has been extended to no other human generation in the past.

Enhancing The Status of Women

A still more important component in population planning is enhancement of the status of women. Without this, the specific measures listed above will avail only a fraction of what they could. Women need to enjoy far better opportunities for health, education and employment, to attain a rightful social standing in society, and to play their proper part in development activities generally. Of course, women should be enabled to enjoy their full share of development benefits as a simple matter of equity. But their present disadvantaged status is all the more regrettable in that they plainly occupy a central position in the population sphere, as well as in numerous development sectors (Leslie and Paolisso, 1989; Sadik, 1989; Smyke, 1991; Vickers, 1991).

Moreover, women play a significant, albeit little recognized, role as de facto "environmental managers." Their efforts to gain their families' livelihoods mean they are often more closely involved with environmental resources (soil, water, forests and the like) as well as with the management of household water, sanitation and domestic waste, than are men (Dankelman and Davidson, 1989; Rodda, 1991). In several areas of sub-Saharan Africa, women are responsible for up to 70 percent of the production, processing and marketing of food, with all that entails in terms of the environmental basis for agriculture. In Kenya, they are the chief participants in the National Soil Conservation Programme which has resulted in the terracing of more than 360,000 farms, or 40 percent of the nation's total.

At the same time, women are often denied the opportunity to contribute to sustainable development because they are over-burdened with bearing and rearing children. Their status within the community tends to be defined by their capacity to produce large families, often larger than they can cope with. Their lack of education and job security, together with their poor status generally, means there is pressure for women to marry early--a factor that further promotes high fertility, especially in nations where family income is supported by children's labour.

Above all, these measures are valid in their own right and should be supplied on basic humanitarian grounds.

Reduction of Poverty

Population growth is most pronounced among the most impoverished communities who subsist off a cash income of less than one dollar a day--and who also tend to cause an undue amount of environmental degradation. In major measure these people have large families as a mode to counter poverty (children's labour on farms, "insurance" against old age). So the population problem can also be tackled through a direct attack on poverty, which already affects more than one quarter of all developing world people--and is spreading. The Community's development policies in general should be increasingly focused on these people and their paramount needs. This will require a shift in emphasis to those development sectors such as subsistence agriculture that have hitherto been somewhat neglected insofar as they lie outside the cash economy. The spinoff benefits for population planning can be large indeed, even if mainly discounted to date. At the same time, an attack on poverty would help the environmental cause. Multiple synergisms apply.

Building on the Past for a More Expansive Future

The Community has engaged in some population activities that, marginal as they may seem to some observers, supply a basis for a greatly expanded effort in the future. Population-related aid flows from the eight largest Community donors totalled \$116 million in 1989. Just three nations contributed \$92 million (79 percent of the total): Netherlands \$33 million or 1.3 percent of its ODA, Germany \$31 million or 0.5 percent, and United Kingdom \$28 million or 1.1 percent. These flows were in line with the average for developed nations as a whole, 1.3 percent of ODA (but note Norway, 4.7 percent). Worthy as

were these contributions, they were far from measuring up to the scale of the challenge; and as emphasized above, they were generally supplied as an appendage to established development sectors rather than being integrated from top to bottom and from start to finish.

More promisingly, the Community has directed increased attention to issues of environment. A 1989 Council Resolution dealt at length with environmental problems and perspectives. A more recent Council Resolution, in March 1992, presenting a Community Programme of Policy and Action in Relation to the Environment and Sustainable Development, has spoken of the need for "global strategies ... (and) programmes of sustainable development particularly in the developing countries", and "the promotion of policies and programmes designed to improve the quality of human life worldwide through more equitable distribution of natural resources, alleviation of poverty, food security and improved health standards and life expectancy." An associated document Towards Sustainability (also March 1992) has emphasised "global concerns about the climate change/deforestation/energy crisis, (and) the seriousness and persistence of problems of underdevelopment"; and it has asserted "We recognize our special responsibility for the environment both to our own citizens and to the wider world." These issues and plans have been further covered in recent documents such as A Common Platform: Guidelines for the Community for UNCED 1992, and in numerous statements about the Community's development aid activities through its ACP and ALA programmes, many of which now feature an environmental dimension.

This is well and good as concerns the environment in itself. But it ostensibly supposes that the environmental cause can be promoted in a "population vacuum". Far from positing population as central to these considerations, the issue is rarely mentioned; and such population measures as have been undertaken can be characterized as ad hoc reactions rather than strategic responses. This postulates a fundamental expansion of the Community's policy purview to incorporate population concerns into all development-support activities. A worthwhile modus operandi could be developed in the form of a follow-up to the 5th Action Plan, using this document as a "bridge" to a comprehensive Population Action Plan.

A further useful first-stage approach can be found in a recent policy appraisal by one Community member, the United Kingdom, entitled Population, Environment and Development (U.K. Overseas Development Administration, 1991). This document goes some way to exploring the opportunity for greater emphasis on population as a central if not a primarily determinant factor in development prospects. But this effort is less vigorous and incisive than it might be: it fails to demonstrate a spirit of sufficient urgency, and it does not consider, for instance, the concealed costs of continued inadequate effort on the population front. Nor does it specify how population needs and opportunities are to be factored into existing systems of policy formulation, planning and programming.

In brief review, then, the Community should embark on a radical departure in the population field. In order to operationalize a new focus on population needs, it should:

--Engage in a full-scale overhaul of its policy approach to population issues in a proper broad sense, relating them especially to questions of environment and sustainable development generally;

--Investigate the scope to integrate population factors into its main development programmes, notably as concerns agriculture, energy, forestry, health, employment, human settlements and poverty alleviation;

--Systematically expand its population efforts through its specific aid programmes for the ACP and ALA regions, in conjunction with parallel activities on the part of other major sources of development aid such as the other developed nations, the United Nations agencies, the World Bank group and NGO bodies; and

--Explicitly appraise the Community's own long-term self-interest in these issues, with particular respect to its hopes for strengthened relationships with developing nations as concerns trade, investment and debt, and with special regard to the prospect of greatly increased international migration.

Population Policy for Community Nations

While there is an obvious premium on expanded population policies for developing nations, developed nations might well consider their own need for population policies. Should they not decide, precisely and explicitly, how many, or how few, people they want, in accord with their carrying capacities at specified levels of affluence and with particular technologies deployed to achieve that affluence? Having determined this

key question, they could then devise the measures to achieve their target populations by a particular date. In surely all cases, they would find that their present populations are too large to sustain without profound and often irremediable injury to ecosystems both local and worldwide--as witness their contribution to the problem of global warming alone.

This policy initiative is rarely considered. Indeed, it is hardly ever perceived as a worthwhile option at all. Not a single developed nation has indicated it wishes to reduce its population growth rate, let alone to bring the rate down to zero by some specific time (and let alone to eventually reduce it to a level within sustainable carrying capacity). The only policy measures are actually directed at increasing the population growth rate in a few nations; France, Italy and Germany, for instance, want to increase their fertility. They do this on the grounds that they fear the "greying" of their populations, meaning that as their populaces grow older (due largely to increased longevity), there will be an unprecedentedly large number of people in the retired-from-work and hence unproductive categories, especially in relation to the number in the productive categories (Ward, 1990). It is projected that by 2030 the European Community will feature one pensioner for every three workers, meaning that workers will have to contribute proportionately more to state pension funds.

Certainly these are legitimate concerns. But there are counter-measures apart from increasing the work force. There could be emphasis on quality as well as quantity of workers; and as people remain healthy

and active into their later years, the retirement age could be extended. In any case, the longer the issue is deferred, the more of a problem it will become. Measures to increase fertility as an interim expedient merely postpone and aggravate the day of reckoning.

But while this demographic question deserves to be addressed, it is hardly ever raised, even though an implicit answer is being continuously supplied by the Community's use--often mis-use and over-use--of its environmental resource base, increasingly with spillover consequences for all other nations. The problem is being resolved by default rather than by design. Since it is built into developed-world people's affluent lifestyles, should these nations not move from implicit action (or inaction) to explicit response as concerns their population growth? Fortunately this population growth problem could often be resolved through a simple expedient: eliminate all unwanted births.

True, some observers assert that labour shortages can be met by immigrants. This could be a valid response so long as mass immigration does not generate social tensions and cultural conflict. But the debate on immigration policy is generally pursued with little reference to population policy, even though the two are implicitly and intimately related.

9. Immigration and Environmental Refugees

Immigration from developing nations, both legal and illegal, is a major concern of the European Community. And rightly so: already there are substantial numbers of immigrants within the Community, estimated to

total 15 million legal entrants and 5 million illegal, many of them from developing nations in North Africa and the eastern Mediterranean (Kuijsten, 1991; Loescher, 1989). France, with 11 percent of its population made up of immigrants, is struggling to integrate 4 million arrivals from North Africa, notably in those localities that are becoming predominantly Muslim.

Some observers suppose the biggest source of immigrants in the immediate future will be Eastern Europe. But in the longer term, the great bulk will surely stem from developing nations (Tapinos, 1990). The present situation, let alone the future outlook, is giving much concern to the main nations of entry, viz. Spain, Italy and Greece. It is also leading to a good deal of political discord in e.g. France and Germany that ostensibly fear "swamping waves" of immigrants as adverse economic and environmental factors in developing nations, aggravated by population pressures, foster fast-growing multitudes of future immigrants. In just North Africa and the eastern Mediterranean, population growth, allied with economic hardship and massive unemployment, threatens to persuade far larger numbers of would-be migrants to look toward Europe. In developing nations of the Mediterranean there are 195 million people today, projected to reach 291 million by 2010 (a 49-percent increase) and 384 million by 2025 (97 percent). This latter total is 39 million more than the entire populace of the European Community today.

The proper policy response is to promote sustainable development in nations concerned. In particular, an enhanced effort should be mounted in the nations of North Africa, with emphasis on both environment and population programmes. This would surely prove more cost effective in the long run than measures to accomodate many millions of unwanted immigrants into Europe from North Africa. True, there will be some opportunity to draw on North African immigrants to supply labour needs in the Community. The work force of Western Europe is projected to fall by 14.5 million by 2025, and the work force of North Africa to grow by 56.6 million (Sadik, 1992). But even if North Africa's economies grow in a manner to absorb many more workers, the number of workless people in North Africa is inevitably going to be many more than can be absorbed by Europe (their present GNPs are only 3 percent those of Community nations). The answer is to provide them with motivation to stay at home by virtue of expanded employment opportunities through sustainable development. A parallel answer is to engage in population planning of a scale to reduce the projected total of work-seeking North Africans.

Much the same applies to other developing nations adjacent to Europe, viz. those of the eastern Mediterranean. Not that immigration pressures are likely to be confined to the Mediterranean basin, though these enjoy the easiest access to Europe. As international travel becomes cheaper and disadvantaged communities increase in numbers in more distant lands such as sub-Saharan Africa and the Indian sub-continent, these could well be a growing source of would-be immigrants too. Already there is reportedly a total of 400,000 immigrants, half of them illegal, from sub-Saharan Africa in Italy alone.

In the longer term, moreover, there is the prospect that global warming, working in synergistic accord with other environmental problems plus fast-growing population pressures, will precipitate migration that could eventually entail hundreds of millions of people from developing nations (Myers, 1993; and see Appendix 7). This places all the greater premium on anticipatory action to not only stem global warming and reduce population growth, but to establish solid development foundations in developing nations so that their citizens will enjoy greater capacity to cope with global warming without recourse to international migration.

10. The Ethical Dimension

It is fitting to conclude with what could eventually turn out to be the biggest policy determinant of all. In the Introduction we noted that a prime motivation for the European Community to support developing nations lies with humanitarian concerns. This potent issue reaches beyond real-politik factors. It postulates that we not only exist as members of individual nations and communities. We are all participants in the common human enterprise that encompasses people right around the world. "Seek not to know for whom the bell tolls, it tolls for thee" (John Donne). This is all the more pertinent for the European Community in that, being one of the most affluent societies that have ever existed on Earth, it bears a responsibility for the disadvantaged majority of humankind.

There is a further ethical aspect to policy. It reflects the long-term repercussions of our environmental assaults on the biosphere

(Bourdeau et al., 1989; Norton, 1987). We are currently polluting our ecosystems on a scale that, if the pollution were to be suddenly terminated in, say, the year 2010, the length of time needed for natural processes and human efforts to make good the damage would certainly be many decades. If we were to stop the spread of deserts in the year 2010, it would take at least a century to push them back again; and the same to allow the ozone layer to recover. Soil erosion would require several centuries before soil stocks could be replenished; and much the same would apply to tropical deforestation and global warming. All these restorative efforts would be needed to compensate for environmental injuries imposed mainly within half a century.

(The biggest biospheric impoverishment lies with mass extinction of species. Evolution will eventually generate a replacement stock of species to match today's in abundance and variety. But so far as we can discern from recovery periods in the wake of mass extinctions in the prehistoric past, the "bounce back" phase will certainly extend for 5 million years--or 20 times longer than humankind has existed as a species.

(In effect, leaders and citizens of the present generation are taking decisions that will profoundly affect many generations into the future. No human community in the past has wielded such capacity to impoverish communities that come after. Nor has any community of the past possessed such capacity to safeguard the planet at a time of unprecedented threat. This prospect demands an unprecedented response on the part of policy makers.

Chapter V

CONCLUSION

"War is often thought of in terms of military conflict, or even annihilation. But there is a growing awareness that an equal danger might be chaos--as a result of mass hunger, economic disaster, environmental catastrophes and terrorism. So we should not think only of reducing the traditional threats of peace, but also of the need for change from chaos to order."

Willy Brandt, 1989

This paper has demonstrated there are multiple interacting factors of environment and population that reduce developing nations' hopes for sustainable development. What--to return to the primary rationale for this paper--is the interest of the European Community in these problems?

Envisage a future where the problems persist, stalling sustainable development. The overall outcome could be a continuing downward spiral of poverty in many developing nations, associated with deficits of food, energy and water, plus urban squalor and widespread unemployment. In turn, these factors could precipitate economic stagnation, social frustration, political upheaval, and even government paralysis or collapse.

What happens when the negative cycle takes hold in nations that are important to the European Community by reason of aid, trade, investment, political affinity, strategic location and security interests? The Community could find itself increasingly beset by requests for further aid and humanitarian help. It could even face "economic aggression" in the form of trade cartels, market closures, nationalization of assets and debt cancellations. Were the governments

of beleaguered nations to seek to relieve their domestic tensions at any cost, they could become increasingly inclined to over-exploit their environmental resources in order to meet immediate threats. Further, they could become characterized by autocratic and repressive regimes, and build up their military to contain internal conflicts or resort to excessive international assertiveness to gain leverage abroad. If many other developing nations followed suit, widespread political instability could severely undermine the interests of the European Community as well as those of other developed nations. We cannot predict exactly how these factors will interact, or how far--in light of the global traffic in arms, the prevalence of terrorism and the proliferation of nuclear devices--they will lead to violence. But it is realistic to suppose that tensions and conflicts, whether domestic or international, could easily escalate and multiply. They could even destabilize the emergent new world order.

The fact that it is often difficult for us to perceive all the linkages between increase in human numbers and decline in environmental security on the one hand, and rise in instability and violence on the other hand, may tell us less about the nature of the linkages than about our limited capacity to think concisely and systematically about population and environmental concerns that have often fallen outside policy makers' purview. Those connections that are more apparent may not lend themselves to quantification, by contrast with "conventional" connections that are readily measureable and thereby carry greater weight with policy makers. We should not be preoccupied with what can

be counted to the detriment of what also counts. In the case of linkages that are difficult even to identify and define, we should remember that, as in other situations of uncertainty where a negative outcome carries unusually severe penalties, it will be better for us to find we have been vaguely right than precisely wrong.

However multi-faceted, subtle and difficult to discern are these linkages between developing nations and the European Community, they are real and significant--and they are growing more numerous and influential. Fortunately they are all amenable to remedial measures through policy interventions, provided they are recognized in due time and with attention to their true extent. The key question is whether the European Community will recognize its interests in their proper scope, and respond accordingly. The Community will have to respond sooner or later: either sooner, through cooperative measures of sufficient scope, or later, through measures to grapple with the problems of an indivisibly impoverished world.

This is all the more pertinent in light of the expanded leadership role within the global arena that is becoming increasingly available to the European Community as a geopolitical force. As the Community moves to safeguard its interests in developing nations, it will need to engage in a growing array of collaborative endeavours. As more and more nations come to recognize their interest in the common global environment, the attack on collective problems through collective effort should gather momentum. This collective approach places a premium on leadership--an ingredient that is all the more significant in light of

the pre-eminent scientific skills, technological know-how, political acumen and financial resources of the European Community. The last item, reflecting the Community's economic prowess, is particularly pertinent. In any case, it need not cost the Earth to save the Earth; indeed, because of growing interdependency relationships between the Community and developing nations, support for developing nations will prove to be a singularly profitable investment all round. Although certain rich nations protest they have never been poorer, it is time to recognize that developing-world poverty has become a luxury we can no longer afford.

When faced with crises, policy makers can do more than react. They can turn crises to advantage. As old presuppositions and the policy regimes they supported are overtaken by events, the process opens up new opportunities for exceptionally creative initiative. What may now be seen as politically impossible could soon become politically imperative. There is a growing convergence between the idealistic and the realistic.

Let us bear in mind the most over-riding factor of all. Change will come, whether we positively pursue it or not, whether it arrives by design or by default. Fortunately there is still time--though only just time--to choose the courses preferred. Through urgent and incisive action, the European Community can generate a sizeable payoff for itself as it moves to safeguard its stake in the global environment and in the population issues involved.

Appendix 1

THE AGRICULTURAL RESOURCE BASE IN DEVELOPING NATIONS

In 31 developing nations, agriculture accounts for 30 percent or more of GDP, by contrast with 3 percent in the United States. These nations also feature high population growth rates (2.4 percent or more per year) and low incomes (per-capita GDP below \$500). So they are caught in the double bind of having to depend heavily upon their natural-resource base to feed their fast-growing numbers while lacking revenues to engage in conservation of the natural-resource base and to make their agriculture more productive (while of course lacking the means to purchase food elsewhere) (van den Oever, 1992).

In developing Asia, agriculture accounts for 70 percent of employment (by contrast with only 12 percent in Japan). Exports based on natural resources amount to 40 percent of all exports (World Bank, 1988). In Central America, which is economically more advanced than Asia, agriculture, together with other sectors based on natural resources such as forestry and fisheries, account for more than half of all employment and for the bulk of export earnings (Leonard, 1986).

Appendix 2

CARRYING CAPACITY: THE CASE OF KENYA

Kenya's present population of 25 million people is projected to expand to 113 million by the time zero growth is attained at some stage in the 22nd century. Yet even if the nation were to employ Western Europe's high-technology agriculture, it could not support more than 52 million people off its land resources (Harrison, 1984)--and even if it were to achieve the two-child family forthwith, the population would still double because of demographic momentum (51 percent of Kenyans are age 15 or under, meaning that proportionately large numbers of potential parents are already in place). So Kenya will have to depend on steadily increasing amounts of food from outside to support itself. But in part because of its high population growth rate, 3.8 percent, its per-capita economic growth is only 1.9 percent. Moreover Kenya's terms of trade have been declining throughout the 1980s, and they are barely positive today (World Bank, 1991). So Kenya faces the prospect of diminishing financial reserves to purchase food abroad. Its export economy will have to permanently flourish in a manner it has never achieved to date if the nation is to be able to buy enough food to meet its ever-growing needs.

Kenya shows many signs, then, of already being in an "overshoot" situation as concerns its carrying capacity. The time to tackle the situation was during the far-back period when its population was only starting to grow rapidly--and all seemed well in terms of its capacity

to feed itself for a while. The source of its population dilemma was becoming entrenched. Other nations with currently satisfactory capacity to ensure their food supplies might ponder Kenya's experience. The main opportunity for Kenya to relieve its situation lies with an immediate and vigorous effort to slow its population growth. Were the two-child to be achieved in 2010 instead of the projected 2035, Kenya's ultimate population could be held to 72 million, 41 million less than expected (McNamara, 1991).

Appendix 3

CFC PRODUCTION AND CONSUMPTION: THE CASE OF CHINA

Much of the developing nations' growing demand for cooling chemicals is centred on refrigerators, this being the largest and fastest-expanding use of CFCs in developing nations. China intends to greatly increase its stock of refrigerators; to date only one household in ten possesses a refrigerator. The nation has built 12 CFC-production plants in order to accommodate the refrigerator needs of many more of today's 250 million households (a figure that reflects China's huge population). By the year 2000 refrigerants production is to be expanded ten-fold, which will still leave per-capita output only one fifth that of the United States. But China's vast human numbers--1.15 billion today, growing by 16 million a year--would make the refrigerants' impact, if based on CFCs, a critical factor for the ozone layer (Isaksen et al., 1990). Fortunately China (also another major producer and consumer of refrigerants, India) has recently indicated its readiness to join in the Montreal and Helsinki initiatives and follow-up measures to reduce CFC production.

Appendix 4

THE EUROPEAN COMMUNITY: IMPACT OF POPULATION GROWTH

The European Community nations feature little population growth as compared with developing nations (Table 2). But it is not insignificant, especially not when allied with a high rate of resource consumption and negligent technology. To give an idea of the impact of a growth rate of around 0.5 percent and producing an extra 700,000 Community citizens per year, note that according to the analyses of Harrison (1992), population growth in developed nations as a whole (of which the Community comprises 28 percent of today's populations) has caused:

- a 59-percent increase in livestock numbers during the period 1961-85, contributing to soil erosion and methane emissions among other environmental problems (the remaining 41 percent has been due to increased consumption);
- a 21-percent increase in fertilizer use during the period 1961-88, leading to water pollution and global warming; and
- a 35-percent increase in carbon dioxide emissions during the period 1960-88, contributing to global warming.

These figures demonstrate the sizeable impact of even a small population of growth when working in conjunction with high levels of consumption.

ENVIRONMENTAL DISCONTINUITIES

Environmental discontinuities can occur in many forms. Consider the case of fuelwood, bearing in mind that most people in developing nations derive their energy from fuelwood. A salient consequence of deforestation (see Chapter III) is shortage of fuelwood. In 1980, 1.2 billion people were meeting their fuelwood needs only by cutting wood faster than it was being replenished by natural growth; and 112 million people could not meet even minimum needs without over-harvesting stocks. By the year 2000, 2.5 billion people, or around half of all developing-nation people, are projected to be gaining their supplies only by over-harvesting, and 350 million people will be facing absolute shortages (Postel and Heise, 1988).

Now visualize a situation where a stock of this potentially renewable resource can suddenly become overwhelmed by rapid population growth. As long as the number of wood collectors in a particular locality does not exceed the capacity of their tree stock to replenish itself through regrowth, the community can exploit the resource indefinitely. The community may keep on increasing in numbers for decades, indeed centuries, and all is well provided it does not surpass a critical level of exploitation. But what if the number of collectors grows and grows until they finally exceed the self-renewing capacity of the trees--perhaps exceeding it by only a small amount? Quite suddenly a point is reached where the tree stock starts to decline. Season by season the self-renewing capacity becomes ever-more depleted: the

exploitation load remains the same, and so the resource keeps on dwindling more and more--meaning in turn there is an ever-increasing overloading of the resource. The vicious circle is set up, and it proceeds to tighten, when once the level of exploitation becomes non-linear.

Note in particular that this scenario applies even if the number of collectors stops growing. The damage is done. But if the number of collectors continues to expand through population growth, the double degree of overloading (derived from an ever-dwindling stock exploited by ever-more collectors) becomes compounded. There ensues a positive feedback process that leads to fuelwood scarcity, and then all too quickly the stock is depleted toward zero. It is a process that occurs all the more rapidly as the stock is progressively depleted.

The essence of the situation is that the pace of critical change can be rapid indeed. As soon as a factor of absolute scale comes into play, the self-sustaining equilibrium becomes disrupted. A situation that seemed as if it could persist into the indefinite future suddenly moves on to an altogether different status. It is as if two lines on a graph approach each other with seeming indifference to each other, then when once they cross the situation is radically transformed.

We encounter this non-linear relationship between resource exploitation and population growth with respect to many other resource stocks, notably soil cover, fisheries, water supplies and pollution-absorbing services of the atmosphere (Keyfitz, 1991). Whereas resource

exploitation may have been growing gradually for very long periods without any great harm, the switch in scale of exploitation induced through a phase of unusually rapid population growth can readily result in a slight initial exceeding of the sustainable yield, whereupon the debacle of resource depletion is precipitated with surprising rapidity.

Certain resource shortages are likely to interact with each other in a manner to produce a mutually amplifying impact. That is to say, the compounded product will be greater than the sum of separate impacts. Indeed a synergized interaction can be an order of magnitude more powerful than the simple sum of individual outcomes. Consider, for example, the agricultural sphere in relation to genetic depletion. The higher temperatures and reduced soil moisture expected in a greenhouse-affected world will not be appropriate for most crops, in that they are finely tuned to current climatic regimes. Hence the need to expand the genetic support for our crops will place a premium on germplasm variability to build up drought resistance among other environmental adaptations. Yet the gene reservoirs for crop plants are being more rapidly depleted than ever, leaving a severely reduced genetic resource base. Moreover, by the time we need the extra genetic variability to breed drought resistance, etc., into our crops, there are likely to be twice as many people to feed.

Also in the agriculture sector and with respect to the reduction of biodiversity, note that the number of insect and mite species that now qualify as agricultural pests is about 9000. Many potential pests,

tens of thousands more, are held in check through natural enemies in the form of insect predators and parasites. It is these predators and parasites, many of them unusually susceptible to summary extinction, that will be tend to be preferentially eliminated during the mass extinction of species now underway. As a result, we may well witness a swift increase in pest deprecations on food crops--again, at a time when there will be many more people to feed.

When we consider all environmental disruptions together, plus the impacts of population growth, there is potentially a multitude of synergistic interactions that could have marked adverse impact. As a result, there is good reason for us to anticipate a greater environmental debacle, arriving more rapidly, than is usually predicted.

Appendix 6

GLOBAL WARMING

We have seen in Chapter II that population growth plays a sizeable role in global warming processes. If there had been no population growth, there would have been far less buildup of carbon dioxide. But how much less? Is it more or less the amount suggested by the calculation presented? What if economic growth patterns had worked out differently, with alternative levels of demand for fossil-fuel energy--especially insofar as a greater proportion of the reduced growth would presumably have taken place in industrialized nations? What if the growth in energy demand and the technology deployed to meet it had worked out in a manner that meant greater per-capita consumption because of shifts in e.g. pricing patterns and trends? There is a host of these "what if" questions that can be raised about the analysis, showing that it is far from so clear cut as might appear at first glance. Moreover it says nothing about the sectors of the world populace that have been contributing more than others. A disaggregated analysis would present a much more revealing picture.

The global-warming potential of future population growth is exemplified by the case of India. With a current per-capita income of only \$330 per year, i.e. about one-sixtieth that of the United States, India's electricity capacity today is only 55,000 megawatts, roughly twice that of New York State. Although the country possesses only moderate coal reserves, it is exploiting them so fast that it now ranks as the world's fourth coal burner. In 1950 its coal use was only 33

million tonnes, but by 1989 it had soared to 191 million tonnes (while production of crude oil, another fossil fuel, rose from 0.3 million tonnes to 30.4 million tonnes; and total power generation increased from 5 billion kwh to 217 billion kwh) (Dave, 1988). The government plans a number of energy-based initiatives for development; for instance, to supply electricity to half the houses in the country. This goal alone will require the production of an additional 80,000 megawatts of power, by comparison with the present total capacity of 55,000 megawatts. It is anticipated that this measure, together with other development plans, will shortly induce a doubling of India's carbon emissions.

Within this context a paramount factor lies with population, both its size and growth rate. India's present population of 877 million people, growing at 2.0 percent per year, is projected to reach 1,043 million by the year 2000 and 1,375 million by 2020. Even with its low per-capita income (the C factor of the $I = PCT$ equation), and its less-than-advanced technological capacity (the T factor), India's huge population (the P factor) makes for a disproportionately large potential contribution to global warming. But suppose India managed to reduce its fertility rate to replacement level (almost half the present number of children per completed family) within the next three to four decades; and suppose that at the same time it did no more than double its per-capita use of commercial energy (roughly matching that of China today), using coal for the purpose. This increase, given the multiplier effect of the huge present population and its rate of growth, would result in India's emitting carbon dioxide at an annual per-capita rate of one tonne, or roughly the world average in 1990. Because of the population

factor, this would still be enough to more than cancel out the benefits of a putatively extreme step elsewhere, viz. the termination forthwith of all coal burning on the part of the United States without replacing it with any other carbon-containing fuel (Ehrlich and Ehrlich, 1990).

Fortunately there is much scope to contain carbon dioxide emissions through across-the-board implementation of energy efficiency and energy conservation measures--provided the appropriate policies are set in place. According to analyses of the Rocky Mountain Institute (Lovins, 1989; see also Goldemberg et al., 1987, and Holdren, 1990), the 2025 world of 8 billion people and with an economy five times its 1975 level could be supported with only a portion of the energy utilized today.

So much for carbon dioxide. Let us move on to another greenhouse gas, methane, which is 20 times more potent, molecule for molecule, than carbon dioxide as a source of global warming. It is increasing more rapidly. It now accounts for 18 percent of global-warming processes (Table 3). Half of all anthropogenic emissions of methane come from rice paddies among other irrigated lands and from ruminant livestock. These two sources have expanded mainly to meet the needs of more people to feed, also due to demand for improved diets. Irrigated lands have increased by 1.9 percent per year for much of the period since 1970, roughly the same as the rate of population growth; cattle numbers have grown by 0.9 percent per year, less than half as much. The greatest expansion by far has occurred in developing countries, in line with their need to feed fast-growing populations. Their rate of methane emissions cannot be readily reduced (by contrast with the case for

carbon dioxide) on the grounds that they do not reflect wasteful consumption. Rather they are likely to keep on expanding to stay apace with population growth: the IPCC Working Group III Report projects a 45-percent increase in meat and dairy production by 2025, with a parallel increase in methane emissions. While there are a few technological adaptations that could eventually help the situation, the most practical long-run way to reduce the rise in methane emissions from these two sources is by slowing the growth in human numbers (Harrison, 1992).

There is a further aspect to the population/global warming connection that is still more significant. It relates to the prospects for agriculture and food supplies in a greenhouse-affected world. Recent research and analysis (Daily and Ehrlich, 1990) have generated a model that calculates population size, and the production, consumption and storage of grain under different climate scenarios over a 20-year projection period. Grain supplies over half of the calories in an average diet when consumed directly, and a substantial part of the remainder when consumed in the form of meat, eggs and dairy products; one tonne of grain per year can provide four adults with adequate diets and five adults with subsistence diets. Grain also accounts for the vast majority of international trade in food. According to the model cited, each one tonne deficit in grain production results in two deaths--a distinctly conservative calculation.

The model postulates an entirely plausible greenhouse scenario for early next century, in the form of a 10-percent reduction in the global grain harvest on average three times a decade (the 1988 droughts in just the United States, Canada and China resulted in almost a 5-percent decline). Given the way the world's food reserves have dwindled almost to nothing in recent years as a result of droughts, it is not unrealistic to reckon (according to the model) that each such grain-harvest shortfall would result in the malnutrition deaths of between 50 and 400 million people (Daily and Ehrlich, 1990).

In addition, global warming may well reduce croplands by as much as one third (within a range of 10 to 50 percent), due to increased temperatures and reduced rainfall, plus coastal flooding (Schneider, 1989; see also Pimentel et al., 1990). Global warming's impact could be specially severe in developing lands of the tropics, since they tend to be more vulnerable to climatic change. Moreover, developing countries have next to no food reserves for the most part, and their citizens often subsist off marginal diets already. Worst of all, these countries have all too limited capital and infrastructure with which to adapt to changing climate. Yet according to the 1990 IPCC Report, the regions that appear to be at greatest risk of extreme climatic dislocations for agriculture are often those where marginal environments sometimes make agriculture an insecure enterprise already: the Sahel, southern Africa, the Indian sub-continent, eastern Brazil and Mexico. Latest climatic models show patterns of drought increasing in frequency from 5 percent of the time under the present climate to 50 percent by the year 2050 (Houghton et al., 1990; see also Rosenzweig and Parry, 1992).

On top of all this, the leading grain producers in the developed world are North America, Europe and Australia, also Ukraine and Russia, accounting for well over 40 percent of global grain production. Yet precisely these regions (except possibly Australia) could well incur relatively more severe climatic consequences in a greenhouse-affected world. Even if one allows for a "fertilizer effect" on grain production as a consequence of enhanced carbon dioxide levels in the atmosphere, leading to 5 to 10 percent increases in grain production every 3 to 5 years, this does not prevent the projected deaths of over 800 million people during a 20-year period (Daily and Ehrlich, 1990).

Appendix 7

ENVIRONMENTAL REFUGEES

Global warming is likely to engender large numbers of environmental refugees. Already there is a large number of refugees worldwide. Many of them can be classed as environmental refugees, being people who can no longer gain a secure livelihood in their homelands because of drought, soil erosion, desertification and other environmental problems. In their desperation they feel they have no alternative but to seek sanctuary elsewhere, however hazardous the attempt might be. According to latest estimates (Jacobson, 1989), there are at least 10 million of these destitutes today, almost all in developing nations and mostly in the poorest nations. They are people who have abandoned their homelands on a semi-permanent basis, having no hope of a foreseeable return. They total as many as all other refugees (political, religious, racial) combined. The figure of 10 million is certainly on the low side, since governments generally take little official account of this unconventional category of refugees.

To put the figure of 10 million in perspective, recall that at the end of World War II there were roughly 8 million homeless people wandering around Europe. But while the present human tragedy is unprecedented, it is trifling as compared with what could well lie ahead. A possible scenario for Egypt is indicative. The River Nile currently supports a 10-km. wide strip of farmlands plus the delta plain, totalling 40,000 square kilometers or a mere 4 percent of national territory. In this area live 55 million people today, making

for a local population density of almost 1400 per square kilometer. Egypt already has severe difficulty in feeding itself. But global warming will cause the present problem to be compounded by sea-level rise.

Now consider the impact of a one-meter rise in sea level. While this is not anticipated till toward the end of the next century, an equivalent impact could arrive much sooner due to long-term and rapid subsidence in the Nile delta area. The result could well be that the delta plain will be permanently flooded as much as 30 kilometers inland. As a further result, saltwater would intrude much further up the Nile's course. Overall upshot: Egypt could lose one-fifth of its habitable land and much of its primary breadbasket. Ten million people now live in that sector of the delta that is only one meter above high tide. It is not unrealistic to anticipate that sea-level rise will displace as many as 20 million people (allowing for population growth as well) within the foreseeable future (Milliman et al., 1989). This prognosis, moreover, is cautious and conservative. There will be additional problems such as intrusion of saltwater up the foreshortened Nile, which will further reduce the irrigated lands that support virtually the whole of Egypt's agriculture.

Further afield, sea-level rise could eventually cause the displacement of 120 million people in Bangladesh, 100 million in other delta zones, and 40 million in more extended coastal zones, plus 23 million in small-island nations (Jacobson, 1989; Myers, 1993; United Nations Environment Programme, 1989). The total is more than 300

million people. Not all of them would try to seek sanctuary in Europe, since closer refuge may be available in e.g. North America and Australia. But the portents are plain and daunting. In addition there would surely be many more millions fleeing from greenhouse-derived dislocations for agriculture, two of the worst hit regions (so far as we can discern from climate models with their many uncertainties) being North Africa and sub-Saharan Africa.

(These, then, are some estimates of the numbers of environmental refugees that may become an everyday part of our future world. Of course, the estimates are very much a case of "best judgement" guesstimates--exploratory at most. Some of them could be off target by tens of millions. Albeit rough and ready, they supply an initial insight into the size of the upcoming problem of environmental refugees.

(Not so uncertain is the consequence for the European Community, for other developed nations too. Aside from efforts to seal off the Community's borders, one should bear in mind too that the refugees would feel justified in seeking sanctuary in developed nations on the grounds that it would be the latter nations that would have largely set up the problem of the greenhouse effect.

No doubt about it, the repercussions would be profound (Loescher and Monahan, 1989). As sometimes perceived by host nations, refugees arrive with "unwanted luggage" in the form of alien customs, religious practices and eating habits, plus new pathogens and susceptibility to local pathogens. Resettlement is generally difficult, full assimilation

is rare. Economic and social dislocations would proliferate, cultural and ethnic problems would multiply, and the political fallout would be extensive if not explosive. We are all too familiar with the strains generated for host nations when they have to face hordes of refugees fleeing from drought, famine, floods and other disasters. To cite a former United Nations High Commissioner for Refugees, Prince Sadrudin Aga Khan, present refugees form "a perfect recipe for widespread human suffering, social disorder and political instability."

Yet our experience to date will prove a pale portent of what lies ahead. Thus far refugees have been viewed as a peripheral concern, a kind of aberration from the normal way of things. In the world of the future, they are likely to become a predominant feature of our one-Earth landscape. It requires a leap of the imagination to envisage hundreds of millions of refugees thronging the world. Yet amid the din of international debate on climate change, we hear all too little about environmental refugees. Few people, let alone political leaders, think much about the emergent problem in its full scope--even though the Community already pays about \$6 billion (in welfare outlays and the like) a year to accomodate the new arrivals--or 27 percent of what the Community now supplies in foreign aid.

Appendix 8

LEADING ENVIRONMENTAL SECTORS: DETAILED ASSESSMENTS

1. Soil Erosion

It is roughly reckoned that agricultural lands are losing topsoil at a rate of 24 billion tonnes per year above the natural formation rate (Brown and Wolf, 1984; see also Pimentel, 1992). This is equivalent to all the topsoil on the extensive wheat-growing lands in Australia. Were erosion to continue at the present rate, there would be little topsoil left on most agricultural lands by the middle of next century. Of course the pattern is far from equally distributed, and many localities have already lost much of their topsoil. The costs to soil fertility and hence to agricultural production are high: unchecked erosion could well cause a decline of almost 30 percent in food output from rainfed croplands during the 25 years from 1985 to 2010 (Sfeir-Younis, 1986).

The problem is due to several factors apart from population growth, notably poverty. Impoverished peasants cannot afford the conservation measures needed to protect soil cover. But in many areas, population growth serves to induce farmers to over-use and even exhaust the soil. The shrinking size of land holdings in many areas of the developing world--a factor leading to over-loading of croplands--is a direct result of rapid population growth (combined with poor agricultural practices, lack of rural infrastructure and other non-population factors). In Nepal, for instance, a nation where farmsteads are already small and steep slopes are specially prone to soil erosion, the population growth rate remains high, 2.5 percent per year, resulting in constant division

of farmsteads into ever-smaller plots. The average size of upland farms has been reduced from over 3 hectares 30 years ago to barely 1 hectare today. In the over-crowded plains along the Indian border, farms are so tiny (many only one third of a hectare or less) that many farmers can no longer make a living from the land. This forces them to open up marginal lands on steep slopes, thus spreading the problem of soil erosion.

2. Desertification

An even more severe form of land degradation, desertification threatens 45 million square kilometres or a full one third of Earth's land surface. It also undermines the livelihoods of at least 850 million people, with costs in terms of agricultural output foregone exceeding \$30 billion per year. At least 60,000 sq. kms. of agricultural land are eliminated through this cause each year, and another 200,000 square kilometres are impoverished, resulting in reduced yields and requiring costly remedial measures (Dregne and Tucker, 1988; Mabbutt, 1984). As in the case of soil erosion, desertification stems in part from faulty agricultural policies, lack of extension services, inadequate attention to subsistence agriculture, perverse pricing practices, inadequate credit and marketing facilities, and over-regulation on the part of governments among other deleterious factors (Blaikie, 1985).

But population pressures play a salient part as well. Population growth is generally higher in semi-arid and arid lands than elsewhere. In over half of the 34 predominantly dry countries (those in which more

than three-quarters of total area is dry), population growth has remained at 3 percent or more since the mid-1970s (Grainger, 1990).

The two issues treated here, soil erosion and desertification, are the main forms of land degradation in developing nations. In principle, it would be possible through improved agricultural policies, agrotechnologies and the like, to safeguard the food resource base, even to make it still more productive. But the experience of the 1980s, when population growth became an ever-more prominent factor, shows that agricultural lands have been deteriorating and per-capita food production declining in much of Southern Asia, sub-Saharan Africa and the Andean nations. Agronomic strategies assume stability in the environmental state of the resource base, whereas the reverse is true in many agricultural zones. There are all too few instances where new technologies for soil conservation and crop management have kept pace with the demands of fast-growing human numbers. On the contrary, productive capacity has been declining steadily in entire regions. As for the future, the prospect is that sub-Saharan Africa's already overburdened lands will need to support an extra 755 million people by the year 2025 (155 percent more), and India's an extra 507 million (59 percent more).

Land degradation hits hardest at those least capable of withstanding it, the world's "bottom billion" poorest people--precisely those who often cause most land degradation (as a consequence of their poverty), and precisely those who generally feature the highest fertility rates. Thus the land degradation problem will keep on being

compounded by the predominant and most persistent factor of all, population growth.

3. Water Deficits

Water consumption has doubled twice this century, and demand could well double again during the next two decades, primarily because of population growth (Falkenmark and Suprpto, 1992). Yet in 88 developing nations with 40 percent of the world's population, water deficits are already a serious constraint on agriculture, industry and public health; at least 2 billion people suffer chronic deficits (Falkenmark, 1990 and 1991; Falkenmark and Chapman, 1989; la Riviere, 1989). How much this is due to population growth in itself is difficult to determine, because advancing technology often feeds demand while also offering scope for repeated re-use of what should be an intrinsically renewable resource. But in general terms, there is a sizeable contribution from population growth in conjunction with lack of socioeconomic infrastructure.

According to pioneering analysis by Falkenmark (1990 and 1991), a society typically experiences "water stress" when the number of people competing for each annual "flow unit" of 1 million cubic meters of water reaches 2000, or 500 cubic meters per person. After this point, it is almost certain there will be inherent water-deficit problems, often acute scarcity and even outright shortages. In fact, many developing nations with inadequate socioeconomic infrastructure find the "water barrier" level comes into play when only 1000 people compete for each flow unit.

By the end of this decade, most nations of North Africa, a region of special interest to the European Community, also of East Africa, are projected to exceed the 2000-person measure of scarcity, five of them having less than 1000 cubic meters of water per person. Most of these nations have annual population growth rates exceeding 2.5 percent. This opens up scope for a "risk spiral" concerning water supplies (Falkenmark, 1989). Driven by population growth and fuelled by hydro-climatic factors of arid-land environments (the one reinforces the other's impact), the phenomenon of accelerating water shortages argues for greater attention to be directed at a resource-scarcity problem that could eventually match established shortages of food and energy.

4. Tropical Deforestation

Tropical moist forests are expected to lose almost 150,000 square kilometres of their expanse during 1992. This will amount to roughly 2 percent of remaining forests, and will constitute an annual deforestation rate almost twice as large as of 1980 (Myers, 1992b).

How much tropical deforestation can be attributed to population growth? According to an exploratory and illuminating assessment (Harrison, 1992), the amount is 79 percent, the other 21 percent being attributable to factors such as increase in agricultural expansion due to enhanced per-capita food consumption. Based on a speculative rather than a conclusive calculation, the analysis demonstrates that population growth is the predominant factor in tropical deforestation.

Note, moreover, that almost three-fifths of present deforestation is due to the slash-and-burn cultivator. He manifests himself not so much as a shifting cultivator of tradition (practising a self-renewing mode of forest exploitation), but as a shifted cultivator, or displaced peasant, viz. a smallscale farmer who finds himself landless in traditional agricultural territories and feels himself obliged to migrate to the last unoccupied public lands available, the forests. Populations of these shifted cultivators are usually increasing at annual rates far above the rates for nation-wide increase (Bilsborrow, 1987; Lynch, 1990; Myers, 1989; Peters and Neunschwander, 1988; Schuman and Partridge, 1989; Thiesenhusen, 1989). The best known case is that of Rondonia, Brazil, where the numbers of smallscale settlers increased at a rate that surpassed 15 percent per year for much of the period 1975-87, whereas the population growth rate for all Brazil averaged only 2.1 percent (Malingreau and Tucker, 1988). There are similar mass migrations into tropical forests, albeit with lower rates of population increase, in Ecuador, Peru, Bolivia, Ivory Coast, Nigeria, India, Thailand, Vietnam, Indonesia and the Philippines. In all these instances, population growth is a significant if not the predominant factor in deforestation.

But one must be careful not to over-simplify the situation. A host of related factors frequently operate in addition to population growth. They include pervasive poverty among peasant communities, maldistribution of traditional farmlands, inequitable land-tenure systems, ineffecient agricultural technologies, insufficient political emphasis on subsistence farming, lack of rural infrastructure, and

faulty development policies overall. In Brazil, for instance, 5 percent of farmland owners possess 70 percent of all farmlands, while 70 percent cultivate only 5 percent of farmlands--an increasingly skewed situation that fosters landlessness on the part of peasant farmers. In addition, a further 1.7 million Brazilians enter the job market each year, over half of them failing to find enough employment to support themselves, many of them joining the forest-bound migrants in search of land and livelihood.

There is much scope in future population growth for still larger throngs of shifted cultivators to accelerate deforestation. By the year 2030, 80 percent of the world's projected population of more than 8 billion people are expected to be living in tropical forest nations. This translates into 6.4 billion people, 1 billion more than exist today. Given the demographic momentum built into processes of population growth, and even allowing for expanded family-planning programs, population projections suggest that in those nations where economies appear to likely to remain primarily agrarian, there will be progressive pressures on remaining forests, extending for decades into the future. For instance, Ecuador's population is projected to increase from 12 million today to 24 million before it attains zero growth in about a century's time; Cameroon's from 11 million to 67 million; Ivory Coast's from 13 million to 83 million; Madagascar's from 12 million to 49 million; Myanmar's from 42 million to 97 million; Indonesia's from 181 million to 345 million; and Vietnam's 68 to 168 million. Unless there is a marked reduction in population growth, together with

resolution of the landless-peasant phenomenon (a prospect that appears less than promising (Sinha, 1984)), it is difficult to see that much forest will remain in just a few decades' time in most of the nations cited.

5. Mass Extinction of Species

Of Earth's estimated stock of 35 million species (the actual total could be rather smaller or a good deal larger), some 30 million are believed to exist in tropical forests (Erwin, 1988). So the mass extinction of species underway is largely located in tropical forests, which, as we have just seen, are being eliminated at ever-more rapid rates. Various analyses (Ehrlich and Wilson, 1991; Myers, 1990b; Raven, 1988; Wilson, 1992) indicate we could witness the demise of several million species by the year 2000, and conceivably as many as half of all species within the longer-term future.

According to a summary calculation (based upon Wilson, 1989), the 1992 tropical deforestation rate of almost 2 percent per year implies that population growth (which, as we have noted, accounts for 79 percent of annual deforestation) causes a species loss of almost 0.4 percent per year. If there are 30 million species in tropical forests, this works out at almost 120,000 species per year. Tentative as this latter figure is, it is offered for the purpose of shedding preliminary light on population growth's contribution to mass extinction. Note too that according to some recent calculations, as much as 4.5 million square kilometres of wildlife habitat will have to be converted to human purposes by 2050 in order to feed growing populations and cater for

rising nutritional levels under the medium population projection (for the high projection, 6.5 million square kilometres, and for the low projection, 3.3 million square kilometres) (United Nations Environment Programme, 1990). For comparison, the world's protected areas in 1990 totalled 6.5 million square kilometres.

6. Ultra-Rapid Urban Growth

Population growth expresses itself not only in sheer increase in human numbers but in distribution patterns. Increasingly they are concentrated in urban areas. In 1950, only 29 percent of humankind was urbanized, but today the proportion is approaching 50 percent. By far the greatest part of this urbanization trend is taking place in developing nations, where urban populations are projected to surge from a total of around 1.5 billion people today to well over 4 billion by 2025--by which time developing nations will be almost as urbanized as developed nations (Brown and Jacobson, 1987; Hardoy and Satterthwaite, 1989). This makes for one of the most extreme demographic phenomena since people started to gather in urban communities 5000 years ago.

There is some benefit in urbanization in developing nations from the population growth standpoint. City dwelling people have smaller families; there is no need to have large numbers of children to help till farm fields. It gets people off the land; as long as rural areas have to support over-large communities, there is soil erosion, desertification, deforestation and degradation of watersheds.

But given the extreme speed of urban growth, the result is extreme overcrowding. While Chicago has only around 2500 people per square kilometre, and London 4000, Cairo has 24,000, Mexico City 34,000, Manila 43,000 and Calcutta 88,000 (United Nations Centre for Human Settlements, 1987). The environment and development repercussions are profound, as urban authorities try to provide infrastructure and basic services such as housing, energy, water, sewage disposal, transportation and general utilities (Drakakis-Smith, 1987; Hardoy and Satterthwaite, 1990). Vast throngs of people subsist on the margins of survival (Lowe, 1991). At least 1.2 billion people, or 60 percent of developing-nation city dwellers, live in squatter settlements, often shantytowns fashioned from cardboard, plastic, canvas or whatever other material is available. The number of urban households without safe water increased from 138 million in 1970 to 215 million in 1988 (a 56-percent increase in just 18 years), and that of those without adequate sanitation rose from 98 million to 340 million (247 percent) (Cairncross et al., 1990; Hardoy and Satterthwaite, 1989).

Much of this urbanization trend and the extreme squalor it engenders can be attributed to population growth. True, other factors are at work, such as misguided policies for urban planning, especially in the form of outmoded building regulations. But population growth must be counted the principal factor. As far back as the 1970s, urban communities had to accommodate another 30 million people each year--a challenge that plainly exceeded the planning capacities of governments. During the 1990s, the total could well be twice as many, and by 2025 it could reach 90 million each year.

Appendix 9

NATURAL RESOURCE ACCOUNTING

Natural resource accounting (NRA) entails a radical revision of the way in which governments assess the state of their economies. To date, our economic accountancy procedures fail to reflect our use, or rather mis-use and over-use, of environmental resources. National budgets and other annual audits rarely consider the depletion of environmental resources, nor do they portray the decline in goods and services that these resources generate. So while we hear much about rates of economic growth, we hear all too little, in equally systematized form at least, about rates of environmental resource depletion. This discrepancy between the way we appraise our economic activities, and the way we evaluate the state of the environmental-resource base that ultimately sustains economic activity, leads to a grossly distorted view of our economic health (Folke and Kaberger, 1991; Lutz and El Serafy, 1988).

When we make use of human-made assets such as equipment and buildings, we write off our use as depreciation. But we do not view our environment as productive capital, even though we utilize it as such. When we excessively exploit forests, over-work croplands until the soil erodes, and use our skies as a free garbage can and our rivers as costless sewers, our income as revealed via GNP actually registers an increase. When we engage in efforts to reduce or repair the damage, those economic activities are also registered as additions to GNP.

In the United States, for instance, GNP has registered an almost continuous rise for many decades. But NRA reveals that an alternative measure, "sustainable economic welfare" (Daly and Cobb, 1989), flattened out in the late 1960s and has registered a slight decline since the early 1980s. If we continue to ignore the goods and services of environmental resources, we may drive the sustainable economy down even while GNP rises: this will be the consequence of treating the environment and economics as not only separate sectors but as polar opposites.

In short, NRA would correct the partial accounting system employed at present, with its misleading signals for use of the environmental-resource stocks that ultimately underpin all economies. Being a policy intervention of comprehensive scope, it would quickly start to generate a plethora of accurate messages as concerns our legitimate use of the environmental-resource base. In turn, policy makers would soon find they had little option but to engage in a whole series of adjustments when evaluating their policies, programmes, projects and other activities. The immediate knock-on effects would be significant and widespread, and would speedily generate their own multiplier effects. As a high-leverage intervention, NRA would engender linkages thinking throughout environment and development spheres alike.

A policy measure parallel to NRA lies with adjustment of those pricing policies that likewise send out perverse messages about sustainable use of environmental resources because they do not reflect all costs of production. The adjustment strategy is sometimes known as

"full social cost pricing". Suppose, for instance, we were to internalize the many externalities of fossil-fuel burning, perhaps through a carbon tax to reflect acid rain, CO2 emissions and other forms of pollution. We would then be obliged to pay a price for fossil fuels that reflect all costs entailed. The price of a litre of petrol might well double in European countries (and increase much more in North America).

The result would be to induce massive shifts in our perception of the role of (formerly cheap) petrol in our economies, and to bring an end to the semi-free ride we currently enjoy. Car transportation would swiftly decline, with a concomitant shift to public transport systems that, reflecting suddenly expanded demand, would be enhanced by both official and private bodies. In turn, there could emerge a trend for the business sector to relocate its facilities in the direction of where workers live, instead of requiring workers to take polluting trips to work each day. The ramifications would ripple throughout our economies, our societies, and our understanding of our status vis-a-vis our environment-support base. The process would foster linkages thinking in abundant ways, whether on the part of policy makers, business leaders or private citizens. In other words, we would find ourselves obliged to think again not only when we visit the petrol station but when we visit the supermarket--indeed at dozens of points in our daily lives. The overall effect would be to incorporate environmental values right across the economic system, and to do it in systemic fashion.

This policy initiative, like that of NRA, should be supported with a number of related measures such as fiscal incentives and disincentives, adaption of discount rates, establishment of environmental indicators, and implementation of the precautionary principle and the polluter pays principle (for detailed discussion, see for example Pearce et al., 1989 and 1991)

These various policy interventions would require a radical reorientation in shift policy makers' outlook from their erstwhile mode of linear thinking, i.e. non-linkages thinking. Attitudes and perceptions are deeply entrenched in myriad ways, inducing an institutional inertia in virtually all spheres of human activity. This inertia factor is a super-powerful force (though a new form of inertia can work to our benefit when once the corrective measures are in place, generating a constructive form of momentum). The longer we delay in adopting corrective measures, the more deeply the present patterns of activity will become entrenched.

Appendix 10

GRANDSCALE TREE PLANTING TO OFFSET CARBON DIOXIDE EMISSIONS

The Netherlands government plans to engage in extensive reforestation in that part of the world where trees put on biomass fastest, the humid tropics, and specifically in several nations of Latin America. The purpose is to offset carbon dioxide emissions from two new Dutch coal-burning power plants. Tree planting costs in 2500 square kilometres of Latin America will be only 8 percent as much as in Netherlands; and Netherlands would be able to counterbalance only 1 percent of its carbon dioxide emissions if it were to reforest 10 percent of its national territory, more than doubling its forest estate.

A more productive response of course would be for Netherlands to engage in stringent cutbacks in its carbon dioxide emissions, enough to obviate the need for tree planting measures overseas. The nation is instituting a substantial carbon tax, but this will not be nearly enough to eliminate its carbon dioxide contribution to global warming.

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Table 1

WORLD POPULATION GROWTH
(medium projections)

| | <u>Population 1991</u> (billions) | <u>Growth Rate</u> (annual %) | <u>Population Projections</u> | | | <u>Per-Capita GNP</u> <u>1989 (US \$)</u> |
|--------------------|--------------------------------------|----------------------------------|-------------------------------|-------------|-------------|--|
| | | | <u>2000</u> | <u>2025</u> | <u>2100</u> | |
| World | 5.4 | 1.7 | 6.3 | 8.6 | 11.6 | 3,760 |
| Developed Nations | 1.2 | 0.5 | 1.3 | 1.4 | 1.5 | 16,990 |
| Developing Nations | 4.2 | 2.1 | 5.0 | 7.2 | 10.1 | 750 |
| European Community | 0.35 | 0.2 | 0.35 | 0.36 | 0.35 | 14,079 |

Source: McNamara, 1991; United Nations Population Division, 1991; World Bank, 1991 and 1992.

Table 2

THE EUROPEAN COMMUNITY: POPULATION DATA

| <u>Nation</u> | <u>Population</u> | <u>Growth Rate</u> | <u>Population Projections</u> | | | <u>Per-Capita</u> | <u>Population</u> |
|--------------------|-------------------|--------------------|-------------------------------|-------------|-------------|---------------------------|--------------------|
| | <u>1991</u> | (annual %) | <u>2000</u> | <u>2025</u> | <u>2100</u> | <u>GNP 1989</u> (US\$) | <u>per sq. km.</u> |
| Germany | 79.5 | -0.1 | 78 | 72 | 61 | 16,200 | 1494 |
| Italy | 57.7 | 0.1 | 58 | 58 | 58 | 15,150 | 1284 |
| United Kingdom | 57.5 | 0.2 | 57 | 58 | 59 | 14,750 | 1577 |
| France | 56.7 | 0.4 | 58 | 61 | 62 | 17,830 | 694 |
| Spain | 39.0 | 0.2 | 43 | 48 | 51 | 9,150 | 518 |
| Netherlands | 15.0 | 0.4 | 15 | 15 | 15 | 16,010 | 2704 |
| Portugal | 10.4 | 0.2 | 11 | 11 | 11 | 4,260 | 756 |
| Greece | 10.1 | 0.1 | 10 | 10 | 10 | 5,340 | 510 |
| Belgium | 9.9 | 0.1 | 10 | 10 | 10 | 16,390 | 2180 |
| Denmark | 5.1 | 0.0 | 5 | 5 | 5 | 20,510 | 800 |
| Ireland | 3.5 | 0.6 | 4 | 5 | 6 | 8,500 | 334 |
| Luxembourg | 0.4 | 0.2 | 0.4 | 0.4 | 0.4 | 24,860 | 1012 |
| European Community | 345 | 0.2 | 349 | 363 | 348 | 14,079 | |
| Developed nations | 1,219 | 0.5 | 1,274 | 1,412 | 1,457 | 16,990 | |
| Developing nations | 4,165 | 2.1 | 5,018 | 7,234 | 10,112 | 750 | |
| World | 5,384 | 1.7 | 6,292 | 8,645 | 11,569 | 3,760 | |

Sources: McNamara, 1991; Population Reference Bureau, 1991; World Bank, 1991 and 1992

Table 3

SOCIOECONOMIC INDICATORS: SELECT DEVELOPING NATIONS

| Nation | Population 1991 | Population Growth | | Fertility Rate 1990 | Food Production per capita (1979-81 = 100) 1987-89 | Agricultural Population per Hectare Arable Land 1987 | | Cereal Imports per capita 1986-88 (kgs) | % Urban 1980 (& growth rate %) | Adult Literacy M/F 1990 | Access to Safe Water 1985-88 (%) | Family Planning Users 1990 (%) | GNP per capita (US\$ 1989) |
|-----------------|--------------------|-----------------------|-----------------------|---------------------------|---|--|------------------|---|---|-------------------------------|--|---|----------------------------------|
| | | Rate (%) per year) | Rate (%) per year) | | | 1986-88 (kgs) | 1986-88 (kgs) | | | | | | |
| Egypt | 55 | 2.9 | 4.0 | 109 | 8.2 | 174 | 47 (3.7) | 63/34 | 73 | 38 | 640 | | |
| Ethiopia | 53 | 2.9 | 6.8 | 91 | 2.4 | 20 | 13 (5.5) | n/a | 19 | n/a | 120 | | |
| Nigeria | 123 | 2.8 | 6.6 | 96 | 2.1 | 7 | 35 (5.5) | 62/40 | n/a | 5 | 250 | | |
| South Africa | 41 | 2.7 | 4.2 | 90 | 0.4 | 12 | 59 (3.2) | n/a | n/a | 48 | 2470 | | |
| Bangladesh | 117 | 2.4 | 5.1 | 93 | 8.2 | 20 | 16 (6.1) | 47/22 | 81 | 31 | 180 | | |
| China | 1151 | 1.4 | 2.3 | 128 | 7.7 | 12 | 33 (5.4) | 84/62 | 74 | 71 | 350 | | |
| India | 859 | 2.0 | 4.1 | 113 | 3.0 | 1 | 27 (3.8) | 62/34 | 75 | 34 | 340 | | |
| Indonesia | 181 | 1.7 | 3.1 | 124 | 3.8 | 11 | 31 (4.6) | 84/62 | 46 | 48 | 500 | | |
| Pakistan | 118 | 3.0 | 5.9 | 103 | 2.9 | 9 | 32 (4.5) | 47/21 | 56 | 8 | 370 | | |
| Turkey | 59 | 2.2 | 3.3 | 97 | 0.9 | 13 | 61 (4.2) | 90/71 | 78 | 63 | 1370 | | |
| Brazil | 153 | 1.9 | 3.2 | 115 | 0.5 | 27 | 75 (2.7) | 83/80 | 97 | 66 | 2540 | | |
| Mexico | 86 | 2.3 | 3.1 | 98 | 1.1 | 54 | 73 (2.7) | 90/85 | 71 | 53 | 2010 | | |
| For comparison: | | | | | | | | | | | | | |
| EC | 345 | 0.5 | 1.7 | n/a | n/a | n/a | 75 | 100/100 | 100 | n/a | 14079 | | |

Source: United Nations Population Fund, 1992

Table 4

HUMAN AND ENVIRONMENTAL INDICATORS

| | <u>Developed Nations</u> | <u>Developing Nations</u> | <u>World</u> |
|--|--------------------------|---------------------------|---------------|
| Population 1991 (millions) | 1,219 | 4,165 | 5,384 |
| --growth rate, % | 0.5 | 2.1 | 1.7 |
| --annual increase 1991 (millions) | 6.1 | 87.5 | 91.5 |
| GNP 1989 (US \$) | 15.2 trillion | 5.0 trillion | 20.2 trillion |
| --per capita | 16,990 | 750 | 3,760 |
| Under-5 Mortality 1990 (per 1000) | 12 | 70 | 63 |
| Daily Calorie Supply, % of need 1985 | 132 | 107 | 113 |
| Exports/Imports Ratio 1987 | 0.79 | 0.96 | 0.87 |
| --Terms of Trade 1987 (1980 = 100) | 103 | 83 | 86 |
| Arable Land per Capita, Has. | 1.5 | 0.7 | 0.8 |
| Primary Energy Use 1989 | | | |
| --total (PJ) | 247,630 | 87,870 | 335,500 |
| --per capita (GJ) | 205 | 22 | 63 |
| --total fossil-fuel use (PJ) | 215,746 | 78,842 | 294,588 |
| --average annual increase in energy use 1984-89 (%) | 1.9 | 5.7 | 2.8 |
| Total CO2 Emissions from Fossil Fuels 1987 (mill. tonnes C) | 3,900 | 1,600 | 5,500 |
| --per capita (tonnes C) | 3.2 | 0.4 | 1.0 |
| All Greenhouse Gases (mill. tonnes C equivalent) 1987 | 3,200 | 2,400 | 5,600 |
| --per capita (tonnes C equivalent) | 2.6 | 0.6 | 1.1 |

Sources: United Nations Development Programme, 1990; World Resources Institute, 1992; World Bank, 1992

Table 5

GREENHOUSE GAS EMISSIONS, 1987

| <u>Nation</u> | <u>Total GHG Emissions</u> (mill. tonnes C.) (& % of world total) | <u>Carbon Dioxide</u> (mill. tonnes) | <u>Methane</u> (mill. tonnes) | <u>CFCs</u> (mill. tonnes) | <u>Per-Capita GHG Emissions</u> (tonnes C.) |
|-----------------|--|---|----------------------------------|-------------------------------|--|
| Germany (W & E) | 201.2 (3.6) | 300.0 | 4.2 | 0.06 | 3.3 |
| United Kingdom | 160.3 (2.9) | 170.0 | 4.3 | 0.05 | 2.8 |
| Italy | 101.4 (1.8) | 110.0 | 2.2 | 0.05 | 1.7 |
| France | 100.0 (1.8) | 96.0 | 2.8 | 0.05 | 1.8 |
| Spain | 49.9 (0.9) | 57.0 | 1.7 | 0.035 | 1.3 |
| Netherlands | 43.6 (0.8) | 36.0 | 1.3 | 0.013 | 3.0 |
| Belgium | 28.6 (0.5) | 28.0 | 0.5 | 0.009 | 2.9 |
| Greece | 16.3 (0.3) | 20.0 | 0.4 | 0.009 | 1.6 |
| Portugal | 7.8 (0.1) | 9.7 | 0.4 | 0.009 | 0.8 |
| Denmark | 16.7 (0.3) | 17.0 | 0.3 | 0.005 | 3.3 |
| Ireland | 8.1 (0.1) | 8.8 | 0.5 | 0.003 | 2.3 |
| Luxembourg | 2.4 (0.04) | 2.6 | 0.01 | n/a | 6.5 |
| EC Total | 736.2 (13.2) | 855.1 | 18.6 | 0.3 | 2.3 |
| For comparison: | | | | | |
| USA | 1213.9 (21.7) | 1214 | 40.0 | 0.2 | 5.0 |

Note: It is roughly reckoned that carbon dioxide contributes 49 percent to global warming, methane 18 percent, nitrous oxide 6 percent, CFCs 15 percent and ozone 12 percent.

Source: World Resources Institute, 1992

Table 6

CFC PRODUCTION BY LEADING EC NATIONS, 1987

| <u>Nation</u> | <u>Tonnes</u> | <u>% of Global Total</u> |
|--------------------|---------------|------------------------------|
| France | 140,000 | 11.8 |
| United Kingdom | 130,000 | 11.0 |
| West Germany | 125,000 | 10.6 |
| Netherlands | 77,000 | 6.5 |
| Italy | 76,000 | 6.4 |
| Spain | 69,000 | 5.8 |
| Greece | 17,000 | 1.4 |
| European Community | 634,000 | 53.7 |
| United States | 450,000 | 38.1 |
| World | 1,180,000 | 100.0 |

Sources: Benedick, 1991; United Nations Environment Programme, 1991

Table 7

OFFICIAL DEVELOPMENT ASSISTANCE, 1990

| | <u>Billions US\$</u> | <u>% of GNP</u> |
|--------------------------------------|----------------------|-----------------|
| France | 9.4 | 0.79 |
| Germany | 6.3 | 0.42 |
| Italy | 3.4 | 0.32 |
| United Kingdom | 2.6 | 0.27 |
| Netherlands | 2.6 | 0.94 |
| Denmark | 1.2 | 0.93 |
| Belgium | 0.9 | 0.45 |
| Spain | 0.6 | 0.16 |
| Portugal | 0.1 | 0.22 |
| Ireland | 0.06 | 0.16 |
| Greece | 0.04 | 0.07 |
| European Community total | 27.2 | 0.5 |
| including aid from the Commission | 31.0 | 0.5 |
| USA | 11.4 | 0.21 |
| Japan | 9.1 | 0.31 |
| All ODA | 54.1 | 0.35 |

Source: Organization for Economic Cooperation and Development, 1991.

Table 8

POPULATION SIZE SCENARIOS

(millions)

| <u>Nation</u> | <u>1991 Population</u> | <u>Ultimate Population</u> <u>if Replacement</u> <u>Fertility Achieved</u> <u>in 2010</u> | <u>Ultimate Population</u> <u>if Replacement</u> <u>Fertility Achieved</u> <u>in 2035</u> | <u>Difference</u> <u>Due to Delay in</u> <u>Reaching Replacement</u> <u>Fertility (and % of</u> <u>1991 population)</u> |
|---------------|------------------------|--|--|---|
| Ghana | 15.5 | 46 | 66 | 20 (133) |
| Kenya | 25.2 | 72 | 113 | 41 (171) |
| Pakistan | 117.5 | 334 | 556 | 222 (193) |
| Nigeria | 122.5 | 341 | 617 | 276 (232) |

Source: McNamara, 1991