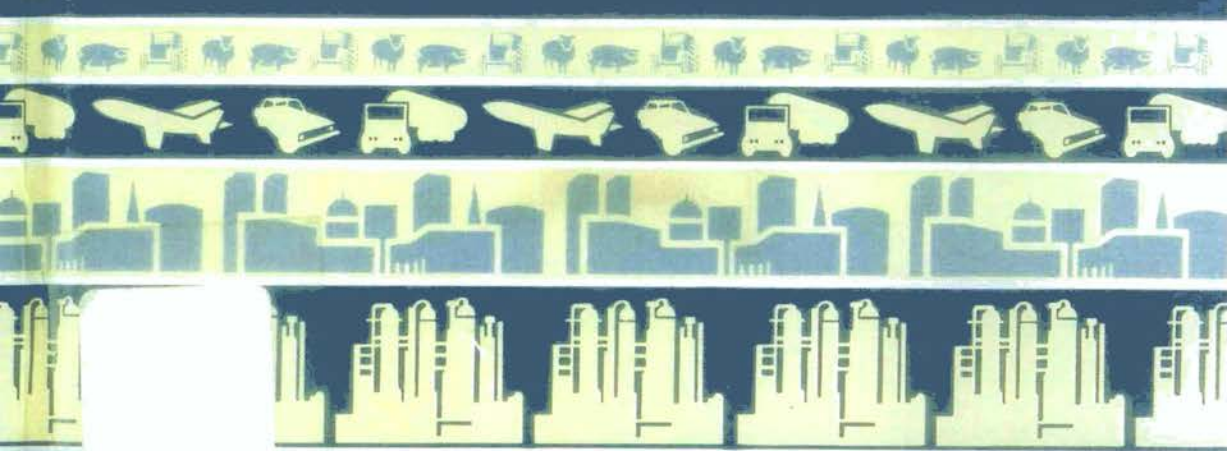
United Nations Environment Programme

Earth and Us

Population-Resources-Environment-Development

Edited by
Mostafa Kamal Tolba
•
Asit K. Biswas



Butterworth-Heinemann

Earth and Us

Population – Resources – Environment – Development

Edited by
Mostafa Kamal Tolba
Executive Director, United Nations Environment Programme, Nairobi, Kenya

and

Asit K. Biswas
President, International Society of Ecological Modelling, Oxford, UK

BUTTERWORTH
HEINEMANN

Butterworth–Heinemann Ltd.
Halley Court, Jordan Hill, Oxford OX2 8EJ

PART OF REED INTERNATIONAL P.L.C.

OXFORD LONDON GUILDFORD BOSTON
MUNICH NEW DELHI SINGAPORE SYDNEY
TOKYO TORONTO WELLINGTON

First published 1991

British Library Cataloguing in Publication Data

Earth and Us: Population–resources–environment–development.
1. Economic development. Environmental aspects
I. Tolba, Mostafa Kamal II. Biswas, Asit K.
330.9

ISBN 0-7506-1049-2

Library of Congress Cataloging-in-Publication Data

Earth and Us: Population–resources–environment–development/
edited by Mostafa Kamal Tolba, Asit K. Biswas.
p. cm.
Includes bibliographical references and index.
ISBN 0-7506-1049-2 :
1. Economic development–Environmental aspects. 2. Developing countries–Economic policy. 3. Developing countries–Population.
I. Tolba, Mostafa Kamal. II. Biswas, Asit K.
HD75.6.P66 1990 90-2547
33.7–dc20 CIP

Composition by Genesis Typesetting, Laser Quay, Rochester, Kent
Printed and bound in Great Britain by Courier International Ltd., Tiptree, Essex

Earth and Us

Population – Resources – Environment – Development

Contents

Preface

Ever-increasing human activities have put a considerable strain on the earth's resources, both renewable and non-renewable. Equally, the sheer scope and scale of these activities throughout the globe have started to affect and sometimes seriously to distort the earth's delicate natural mechanisms, which had attained a balance developed over a prolonged period of time. Many recent scientific studies now clearly indicate that the earth's "homeostatis" is now faced with increasing danger.

Neither on the individual nor on the communal level has humanity ever sought expressly to disrupt these delicate balances. In the past, we were often not aware of the long-term impacts of the various cumulative human activities. But the latter, whatever their purpose or intent, have ultimately all contributed to this result. Thus, we are now paying for the results of our past ignorance or inaction.

But with the tremendous increase in our knowledge-base during the recent past, we can now predict the overall environmental impacts of human actions with much more certainty than was possible even two short decades ago. It is crucial for us to use the opportunity this represents. Future generations must not find our present activities to be at the root of their environmental problems.

There are very close and intricate interrelationships between population, resources, environment and development. Changes in one affect the others, positively or adversely. Some of these changes are immediately visible, others may take a long time before they can be discerned.

In the past, in our pursuit of development, too much emphasis was placed on economic growth and not enough on the environmental impacts of such growth rates and patterns. To achieve this "growth" the earth's resources were plundered, with little thought for the future. Today, however, few would argue that our past practices should be allowed to continue unchanged or that such practices are sustainable.

Indeed, the results of our past practices are all around us. We can easily observe the extent and magnitude of numerous disturbances at global, regional, and national levels. For example, biological diversity is rapidly diminishing, and this will undoubtedly have a major impact on food availability and health for future generations. Ozone depletion, climatic changes, accelerated desertification, rapid deforestation in the tropics and sub-tropics, and extensive pollution of our air and water resources are all major environmental problems humankind is facing at present because of some of our past unsustainable actions and practices.

In the present text we have attempted to bring together the ideas and thoughts of some of the leading international statesmen, political leaders, economists and environmentalists, on the complex interlinkages between "earth and us". The various chapters examine aspects of the nexus between population, resources, environment and development, and outline their views on what can be done in the future. Thus, this book is designed to complement existing texts which deal with similar subjects, such as "Environmental Perspective to the Year 2000", "Our Common Future", and other important publications by the various United Nations Agencies, World Bank, World Resources Institute and Worldwatch Institute. We expect the book to contribute to the overall debate for the further clarification of various complex environmental issues, and also to enhance the environmental consciousness of the world.

Finally, we would like to express our appreciation to all the eminent people who have taken time from their extremely busy schedules to prepare the various chapters. For this we are truly grateful.

Asit K. Biswas
President
International Society for Ecological Modelling
Oxford, England

Mostafa Kamal Tolba
Executive Director
United Nations Environment Programme
Nairobi, Kenya

Environment and development

Kenneth D. Kaunda
President of the Republic of Zambia

Basic overview

The global environment is an interconnected web. The links that exist among the natural systems of air, water, land and living biota are often global. Undue disturbance of any one of them can have unexpected results that are remote in both space and time.

The human race relies completely on the environment and therefore we must manage it wisely. The prosperity of nations and individuals is dependent upon the quality of the environment and the availability of natural resources. Yet, it is principally human activities that degrade the global environment and contribute to the depletion of the world's natural resource base. Our future health and wellbeing depend on our ability to manage the earth's environment successfully.

The population of sub-Saharan Africa is growing faster than that of any other region of the world. Although total agricultural output has risen, it has not kept pace with population growth. Per capita agricultural production and per capita food production have both fallen consistently over the past 20 years, resulting in increased poverty and malnutrition. More than 100 million people are presently acutely malnourished. Given that 71% of the labour force is in agriculture, and that 77% of the population live in rural areas, the health, nutrition and income of the majority of Africans are inseparably linked to agriculture. In a continent where the use of fertilizers, irrigation and new improved seeds is the lowest in the world, agriculture depends on the health of the environment and vice versa.

Africa's environment is not naturally favourable to agriculture. The soils are relatively poorer – 55% have severe fertility constraints. In addition, many African soils have limited water retention capacities and are highly susceptible to erosion. Sub-Saharan Africa shares with other tropical regions the problems of rain that falls predominantly in erosive downpours, the stresses that dry seasons place on vegetation, the high temperatures that accelerate decomposition of organic matter, and the absence of a cold winter to kill the pests and reduce disease. Rainfall is highly variable and prolonged drought is a constant threat.

Human activites have degraded the already fragile natural resources base. Traditional agricultural systems – shifting cultivation and nomadic pastoralism – used abundant land for only a limited time before abandoning it, a practice that allowed natural restoration of the land through long periods of inactivity. Fallow periods, due to increasing population density, have been reduced greatly in many areas and are no longer sufficient to restore fertility or provide adequate grazing or

fuelwood. In many countries, crop yields are stagnant or declining, fallow land and farmland are overgrazed and fuelwood needs are met by depleting the stock rather than replanting. Vegetation cover is weakened, runoff increases erosion and top soil is irrevocably lost, further reducing soil fertility and continuing the downward spiral.

In many developing countries, recognition for social economic change has been placed on agro-related development despite numerous drawbacks.

Concepts of development

In direct recognition of the need to diversify their national economies, many developing countries have devoted much emphasis on developing their considerable natural resources base. Strong bias has been laid towards the development of agriculture.

The coordination of development activities within a comprehensive ecological framework is necessary if there is to be an overall betterment of social conditions of life in the developing world.

The concept of 'development' cannot be absolutely defined since its basis is a contrasting comparison between one set of nations and another. In this context, development should be considered a relative, and therefore open-ended, term whose area of empirical reference lies beyond that essential threshold which sustains minimum conditions of viability for the environment as a system, whether it be the organism or the society. In this context, therefore, 'development' is the absence of conditions of under-development. It should be defined in terms of its functional implications.

A minimum definition of 'development' is that it involves a conscious and deliberate intervention into the empirical *status quo ante*, a purposive action to alter sets of conditions within the environment, as in attempts to improve food supply or in any other institutional area of human endeavour.

The world has recognized that developing its environmental resources is an intervention in the affairs of nature, and, therefore, it tends to have consequences both intended and unintended. Development programmes are elements in the ecological dialect in which all life is interrelated and must be examined as such.

All technological innovations in agriculture, industry or medicine tend to upset the balance of nature or the natural order. Since nature is never in a static equilibrium (because the interrelationships between its physical and biological components are endlessly changing), the real problem is not how to maintain the balance of nature, but rather how to change it in such a way that the overall result is favourable for the human population and other forms of life.

Environmental resources: the base and the options

Agricultural resources

Earlier approaches were aimed only at increasing output, both livestock and crops, in terms of total gross production, as distinct from total gross production per capita. Through a carefully thought-out policy of pricing, incentives and subsidies on agricultural inputs such as fertilizers and seeds, the developing world should be able

to prop up small-holder farmers whose contribution is well above 60% of the national output of many countries.

The policy of placing emphasis on small-scale farmers has other social, political and economic benefits. However, this is currently being threatened given the increasing trend towards removal of subsidies on inputs in a number of countries.

With the increasing emphasis on agriculture in many developing countries, to provide the fulcrum of economic advance, fundamental issues have to be addressed. Agriculture is dependent on such ecological processes as soil regeneration and nutrient recycling. The processes are particularly endangered when efforts to increase productivity are conducted without due regard to the need for conservation as a management practice.

A major obstacle in the Third World's drive for agriculture is that despite there being distinct areas of good soil, much of the land is of poor fertility with a soil structure that is susceptible to erosion.

Population pressure in localized areas of many countries both in terms of humans and livestock is aggravating the problem of soil erosion. Rangeland degradation, a result of overgrazing and soil erosion, is becoming a severe constraint in increasing livestock numbers.

Nutrient deficiencies and imbalance are now becoming a global concern. Some heavily fertilized soils are actually experiencing declining yields, mainly due to heavy doses of fertilizers intended to increase productivity, but which have actually acidified the soil.

In view of these observations, and with regard to the global overall objective of increasing agricultural production on a sustainable basis, certain measures should be considered.

There is a need to update a global interagency study to determine those areas of worst soil erosion and obtain basic data on losses. Investigations on soil conservation techniques such as specific cover crops, crop rotation, fertilizers, contour tilling, minimal tillage and others, so as to define which are most appropriate to the needs of different farming systems of the world; and to define methods, especially those which demand less labour, financial arrangements and incentives for their implementation. This will involve strengthening the institutions dealing with the environment to increase their capabilities for soil conservation research and land capability studies in their respective regions.

Other measures include a more integrated extension policy, with workers having a basic knowledge of conservation techniques that should be imparted to the farmer, and encouragement of community participation in conservation works.

As regards rangeland degradation, greater attention to rangeland management as well as other livestock matters, both in extension and farmer training, is an important necessity.

Forest resources

Studies of forest resources worldwide have been poorly coordinated and hampered by expensive and inefficient technology. For these reasons global data on forests are controversial. Some of the most comprehensive statistics are more than a decade out of date. However, what is indisputable is that the scale and rate of utilization and destruction are far higher than estimates make them.

It has been observed that the global forest estates are capable of providing a wide range of benefits, with the necessary planning for development. It should be noted

further that forest industries do have a multiplier effect in economic development, providing rural employment and many opportunities for forward linkage. Unfortunately, forest industries in many countries are no closer to realizing this potential. Many countries continue to be net importers of reconstituted forest products and pulp and paper despite having sizeable forest estates.

The demand for forest products is increasing at such an alarming rate that the overall effect has been massive deforestation. Deforestation, particularly in many developing nations, is closely associated with traditional types of farming such as lopping of trees and subsequent burning to derive ash which is known to contain sizeable plant nutrient requirements. This results in shifting cultivation. After nutrients are depleted, the cycle is repeated, leaving vast dustbowls.

Energy requirements, particularly in the rural areas of many countries and including the urban poor, remain dependent on wood and woodfuel with consequent deforestation. In procuring charcoal or firewood, large areas are being deforested, given the lack of acceptable alternatives.

A major cause of woodland loss also includes large-scale clearing of forests for settled agriculture. When carried out on the wrong types of soils, such clearance has had serious ecological consequences.

Other causes of forest degradation include overgrazing, insofar as it inhibits woodland regeneration after fuelwood cutting or clearance of any sort. Late dry season burning in savannah-type climates, which sometimes is conducted to maintain pasture, can spread easily when out of control and kill regenerating seedlings. In riverine forests, along headwaters of streams where vegetation cover is necessary for maintaining water flow, this can be particularly destructive.

Several effects of deforestation have been identified. Vegetation cover is a prerequisite for a balanced hydrological regime. Deforestation results in a litter layer that soon decays making it difficult for water to infiltrate the soil. Hence, rainfall runoff increases which, in turn, causes floods and leaves the soil behind relatively dry; thus poor use is made of the little available moisture. In addition, these floods sweep soils into river beds thereby making them shallower and shallower. In the southern hemisphere most rivers are drying up as a result of this action.

Uncontrolled runoff exacerbates soil erosion made worse by the use to which the cleared land is subjected.

Other environmental costs of deforestation not directly associated with soil and water conservation include loss of genetic diversity, shelter and loss of potential economic income.

This brief outline makes obvious the fact that sustainable development of agriculture, energy supplies, water supply and distribution, as well as certain industries, at least in part, are dependent upon the wise management of forest resources.

Nations have recognized the role of forest resources and are currently promoting the concepts of farm forestry in order to help make good the problems of soil infertility and erosion. Further, dissemination of knowledge as regards integration with agriculture through agroforestry is being encouraged alongside planned forward linkage to small forest product industries such as bee-keeping and furniture enterprises.

Efforts should be made to conduct inventories on forest resources, particularly in areas such as those of prime forests and those suffering severe deforestation. The inventories should provide data on natural forest management research, especially

for assessing sustainable yields and finding ways of securing regeneration where there is conflict with other land uses, a direct result of population pressure.

Further observations should be focused on community forestry, in particular for fuelwood, and in this regard the need for involving increased extension and back-up facilities, as well as applied research into appropriate species and techniques – including soil ameliorating species such as *Acacia* and *Leucaena*, should be identified. Research into the ecological consequences of eucalyptus and pine cropping, with a view to defining appropriate succeeding rotation, should also be carried out.

Alongside the determination of those critical water catchment areas which are currently suffering deforestation, the definition of measures and adequate woodland cover, and the creation of suitable watershed management plans, nations should analyse various recommendations relating to improving the efficiency of fuelwood use and its substitution by hydro-power, which is abundant in a significant number of countries.

Water resources

The global emphasis on rapid agricultural development puts water in very high demand, besides its other uses, such as industrial and domestic requirements.

The world's development of water resource potential is very great in many areas. However, total irrigated land constitutes a small percentage of the total potential and is presently mostly associated with the developed world.

Dam projects have been suggested but the initial planning has not so far been integrated properly in many countries. The basic aims of water development projects have mostly been single purpose, emphasizing hydro-power production or domestic water supply, and totally ignoring, among others, the irrigation potential.

Some have had adverse environmental effects with the best example being the Kariba Dam between Zambia and Zimbabwe in Southern Africa.

The Kariba Dam has increased the tsetse fly population in the area, i.e. previously uninfested areas are now infested as a result of new vegetation formulations favoured by the tsetse. Fisheries development opportunities remain under-exploited.

Soil erosion has been exacerbated by the resettled human population which has been forced on to marginal lands. The human population has so far been unable to adjust to a new single season cropping, after losing the drawdown advantage of double cropping along the Zambezi under natural conditions. Persistent drought conditions exist despite the presence of a large water body, though irrigation could fairly easily be instituted with no more than minimum capital outlay.

Conflicts in water use are on the increase with increasing human population and industrial activity; the Kafue River in Zambia is one example but worse examples exist elsewhere. In the copperbelt towns of the north, industrial and mining effluents, as well as sewage, continue to be directly discharged into the river system without treatment. Its headwaters suffer massive deforestation. Agricultural fertilizers and pesticides contribute to the polluting effect. Domestic water needs continue to rise with increasing population.

Zambia, however, has realized that the country could experience severe water shortages by the year 2000. The conservation requirements that have become too apparent include the need for better water management practices such as forest land protection and management, grassland management, water harvesting

techniques and engineering devices such as multipurpose dams, boreholes, etc. These are costly but essential.

More specifically, observations indicate that water shortages are a major limiting factor in many agricultural development projects in many countries. Several considerations are now in process and include:

(1) Encouraging the development of integrated multi-purpose (irrigation, domestic water supply, hydro-power, fisheries) river basins through the construction of wells, boreholes, irrigation channels, dams and pumping installations to capture more benefits.
(2) Adopting techniques of rain and runoff harvesting so as to supplement moisture supplies.
(3) Conducting studies of water supply and demand in the major river basins (as well as other important river basins) with a view to preparing water resource management programmes, with particular attention paid to pollution loads and dilution factors required to support growing quantitative and qualitative demands for water.
(4) Expanding water resource research particularly inventory and pollution monitoring and control so as to generate data for water development and management.

Fisheries and wildlife

Fisheries

The world has a significant potential for increasing food procurement from even the existing fisheries. Fisheries are an environmental resource that not only provide necessary nutrients to humans, but also give employment, among other benefits.

However, various problems exist and, briefly, include inadequate knowledge of the potential of the resources and inability to monitor them, which has led to localized over-fishing as well as missed opportunities.

Other constraints include unsuitable fishing practices such as using nets and mesh which are too small, spoilage of fish due to poor handling or preservation, inadequate capital investment as well as extension and law enforcement services.

To put the exploitation of fisheries on a sustainable basis, certain basic requirements are immediately necessary, notably:

(1) Developing the potential for aquaculture so as to make use of farm waste products and decrease pressure on natural fish stocks, bearing in mind associated environmental health problems, if not carefully undertaken.
(2) Appraising fish stocks and their biological productivity in most of the water bodies (particularly those upon which many fishermen's livelihood depends and which are suffering reduced yields) and programmes prepared for their improved management.
(3) Strengthening research, law enforcement and extension capabilities of the appropriate responsible authorities and conducting investigations of the effects of certain fishing techniques such as pursuing off-shore fish populations on all the major lakes.
(4) Initiation of a long-term programme for fisheries, based on the principles of sustainable development.

Wildlife

National parks and wildlife sanctuaries constitute, for many developing countries, immense tourism potential. Tourism is rated as a big foreign exchange earner.

Several benefits directly accruing from wildlife include income from employment opportunities created by wildlife enterprises, such as tourist camps and hotels, as well as indirectly through multiplier effects. Tourism, which is wildlife-based in many countries, offers a good alternative economic base in line with economic diversification programmes. Other benefits include those derived from tax revenues as well as preserving a rich biological diversity formed over millions of years.

A more sustainable utilization of wildlife in many countries faces serious constraints, mainly related to a lack of public participation and support for wildlife management and conflict over land use and agricultural encroachment.

Significant loss of wildlife stocks and hunting opportunities are now beginning to register given the intensified poaching mainly for commercial species such as rhinoceros and elephant. This problem is exacerbated by:

(1) low finances to enable responsible institutions to contain this scourge;
(2) deficiencies in the laws which were enacted before wildlife was recognized as having economic benefits.

Wildlife resource conservation is not compatible with such land uses as agriculture, forestry, hydro-power development or mining. This incompatibility has not always been recognized, much to the detriment of the wildlife resource development.

Research and inventory are essential prerequisites in wildlife management and should be updated regularly to generate and make available essential data on the park ecosystems. Shortages of funds and personnel continue to inhibit the national parks and wildlife institutions globally in conducting such essential functions.

Despite these operational difficulties nations continue with the anti-poaching drive. This requires financial, material and manpower resources in the form of better communications and changes in laws affecting convicts. Strengthening the institutions dealing with national parks is a prerequisite in this compaign, placing emphasis on a massive educational information programme for the people.

Other development projects particularly near or in wildlife sanctuaries should clearly be reviewed to assess compatibility.

Observations

The world today should clearly understand that an increase in population demands an increase in both food and energy requirements, resulting in increased environmental degradation if not carefully managed.

The chief cause of environmental degradation is, therefore, population growth because of the pressure it puts on land-use and other requirements such as energy.

The global resources base is clearly very viable and needs inputs in the form of appropriate planning, funding and harmonization.

In the depressing global economic situation in which the world finds itself, the advantage of having a sizeable population (in absolute numbers) confronted with a huge agricultural potential, not to mention other environmental resources, cannot

be over-emphasized. Agricultural development offers the major alternative both as an economic activity as well as an instrument for rural development for many countries particularly in the developing world.

For agriculture to be sustainable, dependent resources such as water, soil and forest must be conserved and properly developed. Conservation can only be achieved if this purpose is clearly defined and the overall development for the world population is taken into account. Much depends on community participation through political mobilization and extension, based on simple rather than highly mechanized systems.

Planning should be integrated, taking account of the variable human economic activity. Stabilization and reducing population growth rate is conducive to achieving sustainable development.

Concluding remarks

Human activities are altering the global environment in various ways, too often to its detriment and the detriment of the people. Somtimes the effects are direct and obvious, but most often effects are subtle, indirect, delayed or entirely unexpected.

Deforestation, over-cropping and other stresses – caused by pressures to feed a rapidly growing population – inevitably lead to declining soil fertility and water holding capacity. This decline, in turn leads to increased soil erosion and further degradation of the soil's capacity to support agriculture and so on in a steeply downward spiral.

Pollutants are conveyed by the natural flows of water and wind far from their point of origin, frequently across international boundaries. The person who becomes ill from drinking polluted river water may be hundreds of kilometres from the source of the pollutants. Groundwater may become contaminated by hazardous wastes seeping from an abandoned dump many years after the dumping took place. The unanticipated risks of an increased incidence of cancers and other effects of depletion of the ozone layer are becoming known years after chlorofluorocarbons (CFCs) began to be widely used.

The environmental impacts of human activities in these examples are largely negative. But they need not be. People can also affect the environment positively and a number of signs indicate a growing commitment to sustaining and improving the global environment. Public support for environmental protection and for governmental spending to achieve it is becoming higher.

There is also a growing recognition that effective management of natural resources and protection of the environment require cooperative actions by many nations. The result is a growing number of international negotiations and formal agreements on issues of shared natural resources and transboundary pollution. Although many of these agreements have achieved little actual reduction in pollution so far, they often embody research, monitoring, assessment and consultation activities designed to lead to further action.

Of late, several small steps which hold significant promise for the future are becoming evident.

In May, 1986, an unprecedented special session of the United Nations was held on the problems of Africa. There was remarkable agreement on the need for both African governments and the donors of international assistance to focus on agricultural development. The necessity of ensuring the sustainability of

agricultural development was also widely recognized. Unfortunately, the financial resources needed to accomplish the session's lofty goals may not materialize.

Progress has also been made on other fronts, particularly a gathering commitment to carry out the tropical forestry action plan and the slow but steady progress towards an enforceable agreement to control CFC emissions.

Note must also be made of another important recent event, one that could have a profound impact on our understanding and, therefore, our ability to manage the global environment. At the 21st General Assembly of the International Council of Scientific Unions (ICSU) in September, 1986, an ambitious long-term 10–20 year) programme of global scientific research was unanimously approved – the International Geosphere–Biosphere Programme (IGBP). Its goals are unprecedented in scope – to describe and understand the interactive physical, chemical and biological processes that regulate the total earth system, the unique environment it provides for life, the changes that are occurring in this system and the manner in which they are influenced by human actions. The programme amounts to the birth of a new scientific discipline – earth systems science – that may ultimately enable us to use the earth's resources ever more intensely, yet without damage to their integrity.

Environmental concerns in the Third World

Robert G. Mugabe
President, Republic of Zimbabwe, and Chairman, Movement of Non-Aligned Countries, Harare, Zimbabwe

Preparing strategies for sustainable global development and its impact on the environment is a daunting task. It calls for imagination, determination and above all a vision of a common future. It requires a review and mastery of a vast range of complex technical and political concepts. The report of the Brundtland Commission, together with those of the Brandt Commission on north-south issues and the Palme Commission on security and disarmament issues, now form the third leg of this great triad on which peace, security and the well-being of all of us can be built.

The errors of our ways can be mercilessly exposed and we can be castigated for foolishly acting the part of the biblical prodigal son, when we know that we do not have a wealthy and magnanimous father to run to after the fun is over. The development path we have chosen is unsustainable. Our use of the earth and its bounty has been selfish, haphazard and extravagant. Present developmental trends threaten to radically alter the planet, threatening the lives of many of its species, including, ultimately, humankind itself. Each year six million hectares of productive dry land turn into worthless desert, 11 million hectares of forest are destroyed, and acid precipitation kills forests and lakes and acidifies vast tracts of soil beyond reasonable hope of repair. The burning of fossil fuels emits carbon dioxide into the air, causing a gradual warming of the globe – the so-called greenhouse effect. By early in the next century global temperatures may have been raised enough to cause a shift in agricultural production areas, raise sea levels to flood coastal cities, and disrupt national economies. Other industrial gases threaten to deplete the planet's protective ozone shield to such an extent that the number of human and animal cancers would rise sharply and the food chain of the oceans would be disrupted. Industry and agriculture place toxic substances into the human food chain and into the underground water tables beyond reach of cleansing. We use resources such as land, trees and animal life at rates that deny those resources the time to regenerate themselves.

This indeed is a sombre picture of our present misdeeds and possible future if we carry on as before. From this it is clear that we cannot go on as in the past. We must change our ways. There are compelling political, economic, social and moral imperatives for doing that. We inherited the earth from our forefathers and hold it in trust for our children. It is a debt of honour that we should pass it on in a livable state – at the very least the state in which it was passed on to us.

Therefore all nations have a duty to address the challenge facing us, for what happens in one part of the globe has consequences for all. The disappearance of rain forests in the tropics and the loss of plant and animal species and changes in

rainfall patterns caused partly by desertification and deforestation in developing countries have their impact on the developed countries, while the release of carbon dioxide and of gases that react with the ozone layer, mainly by the industrialized countries, have their own implications for the developing countries. Many of the risks stemming from productive activity and the technologies we use cross national boundaries. Though the activities that give rise to these dangers tend to be concentrated in a few countries, the risks involved are shared by all, rich and poor – those who benefit from them and those who do not – and most who share in the risks have little influence on the decision-making processes that regulate these activities. Perhaps the most pertinent example in this connection is the existence of nuclear weapons and the possibility of nuclear war. The existence of nuclear weapons means that the fate of five billion people, the planet Earth itself and all the species upon it is in the hands of a few people. Even without a nuclear war, Chernobyl and Three Mile Island have happened. Radioactive wastes from the nuclear industry remain hazardous for centuries.

There is no question that preventable poverty is one of the major causes of environmental degradation today. Poverty pollutes our environment. Those who are poor and hungry will often destroy their immediate environment in order to survive. They will cut down their forests. Their livestock will overgraze the grasslands and in growing numbers will crowd into congested cities. They will overuse marginal land.

This explains why the greatest environmental change is occurring in developing countries. These countries are poor. They are faced with falling commodity prices, a rise in protectionism, a crushing debt burden and dwindling or even reverse financial flows. If their commodities bring little money, they must produce more of them to bring in the same amount or at times even less. To do this, they cut down trees, bring under cultivation marginal land, overgraze their pastures and in the process make desert out of previously productive land.

But in these actions the poor have no choice. They cannot exercise the option to die today so as to live well tomorrow. Developing countries are caught in a vicious circle.

I am reminded here of the story related be a former Yugoslav Foreign Minister, Mr Marinkovitch, to the Commission for European Union in January 1931. In replying to criticism by industrialized states, he illustrated the dilemma in which his country found itself, thus:

> 'Last year, when I was in the Yugoslav mountains, I heard that the inhabitants of a small mountain village, having no maize or wheat on which to live, were simply cutting down a wood which belonged to them . . . and were living on what they earned by selling the wood . . . I went to the village, collected together some of the leading inhabitants and endeavoured to reason with them, just like the great industrial states reason with us. I said to them: "You possess plenty of common sense. You see that your forest is becoming smaller and smaller. What will you do when you cut down the last tree?" They replied to me: "Your Excellency, that is a point which worries us, but on the other hand, what should we do now if we stopped cutting down our trees?" I can assure you that the agricultural countries are in exactly the same situation. You threaten them with future disasters, but they are already in the throes of disasters.'

Developing countries today find themselves in a similar predicament. They know that cutting down trees and the destruction of tropical forests will lead to soil

erosion and future disasters, but their problem is survival today. The answer to their predicament does not lie in demanding that the International Monetary Fund (IMF) and the World Bank or other institutions do not give them assistance until they promise not to destroy the tropical forests. Such conditionality would be self-defeating. What is needed is the injection of more resources to enable the developing countries to formulate development programmes that have environmental safeguards. To ask us to plan for our survival tomorrow when our survival today is in doubt is to demand too much of us, for it is only when we can survive today that we can talk of tomorrow.

The cause and impact of poverty on the developing countries and on our common environment can be clearly articulated. The developing countries have had, over the past few decades, to face life-threatening environmental concerns. They have operated in a world in which the resources gap between most developing and industrial nations is ever widening; in a world where the industrial nations not only dominate the rule-making of some key international bodies, but have already used much of the planet's ecological capital. This inequality is the planet's main environmental problem and also its main development problem.

In short, it is largely the current inequitable international economic system, which takes more out of the poor nations than it puts in, that the major cause of environmental degradation in the developing world. The decline in commodity prices compels developing countries, many of which are heavily dependent on primary commodities, to overuse their fragile soils in the hope of raising enough money to enable them to purchase the ever more expensive manufactured goods from the industrialized world. Trade barriers in many industrialized countries make it hard for developing countries to sell their goods for reasonable returns, putting yet more pressure on the ecological system. External debt devours nearly all the export earnings of the developing poor nations, leaving them with little or no export earnings at all for domestic investment and development.

Recent figures of the United Nations indicate that about 70% of the total debt of developing countries is owed by countries whose exports of primary commodities account for 50% or more of their total exports. For sub-Saharan Africa primary products account for more than 90% of total exports. The creation of stable markets and the establishment of just and fair prices for primary commodities in the international markets could be a significant starting-point on the road to sustainable development in the developing world. For that to happen, commodity markets need a thorough restructuring. Both producers and consumers should cooperate in bringing stability to the commodity markets and should share the benefits of trade equitably.

The current negative economic trends must be reversed. For this to happen, it is imperative that a solution to the crisis of external indebtedness be found. According to recent projections the total external debt of developing countries will be about US$ 1020 billion by the end of 1987. Under present circumstances such a debt cannot be repaid. We in the Non-Aligned Movement view the debt crisis as a major symptom of the prevailing inequitable international economic relations. The crisis highlights the urgent need for the international community to adopt a coherent approach to the interrelated problems of money, finance, debt, trade and development that confront us today. That is why we believe that the early convening of an international conference on money and finance for development with universal participation is already overdue.

We now have an opportunity to address some of these major problems. In a

world where in most fields, from the arms race to regional crises and the ailing international economy, humankind seems to have lost control over its destiny, it is clear that we are not condemned to keep sliding down the precipice. Solutions are not only possible, but well within our grasp, if only there is the requisite political will and international cooperation. What we need therefore are policies that can sustain and expand the environmental resources base. The time has come to take the decisions needed, based on the latest and best scientific evidence, to secure the resources to sustain this and coming generations.

That is the challenge to us. We can do it, but we cannot succeed except in a context of multilateralism.

This is the heart of the matter. What is needed is greater democratization of international decision-making processes so as to enhance international cooperation for the management of economic and ecological interdependence. But what we have seen in the last decade and a half is a standstill in global cooperation and at times even a retreat from multilateralism. We need to reverse these trends if we are effectively to address our common future.

Climatic change, environment and development

Maumoon Abdul Gayoom
President, Republic of Maldives

We are facing a potential crisis confronting our planet and its population – the crisis of environmental destruction man has brought upon himself. Man's action over many centuries has transmuted the natural order of his environment to the point where the whole world is ensnared in the consequences. As the scale of man's intervention in nature increased, the scope of nature's repercussions has multiplied. Consequences of the actions of individual nations have reverberated globally, and all mankind's present and future generations may suffer the penalties for the errors of a few.

Today, the world is faced with risks of irreversible damage to the human environment that threaten the very life-support systems of the earth – the basis for man's survival and progress. According to studies conducted by the United Nations Environment Programme, 35% of the earth's land surface, an area larger that the African continent, and inhabited by more than 20% of the world's population, is at risk from desertification. Up to a total of 20 million hectares of tropical forests, an area nearly the size of the United Kingdom, is estimated to be lost each year. As many as from half a million to a million species of life on earth could be extinguished over the next two decades. These are all without precedent in human history. The words 'environmental trends' have now come to embody a host of appalling global predicaments such as desertification, mass deforestation, loss of genetic resources, water pollution, toxic air emissions, hazardous wastes, acidification of the environment and world sea level rise.

Scientists all over the world now accept the fact that concentrations of atmospheric carbon dioxide and other greenhouse gases will continue to increase in coming decades, mainly as a result of human and industrial activities. They agree that these gases effectively enhance the greenhouse effect and deplete the stratospheric ozone layer and that these effects will, among several other critical implications to life on earth, gradually raise the earth's temperature and change its climatic patterns. Such global warming would not only thermally expand the oceans but also melt the polar ice-caps. World sea level will consequently rise significantly faster than during the past century. Scientific findings now predict a possible mean sea level rise of about one metre within a century. Such a rise would have critical impacts on all coastal and island nations, and prove physically, socially, and economically disastrous.

The predicted effects of the change are unnerving: there will be significant shoreline movement and loss of land. A higher mean sea level would inevitably lead to increased frequency of inundation and exacerbate flood damage. It would

swamp fertile deltas, causing loss of productive agricultural and land vegetation, and increase saline encroachment into aquifers, rivers and estuaries. The increased costs of reconstruction, rehabilitation, and strengthening of coastal defence systems could turn out to be crippling for most affected countries.

A number of scientists and organizations have independently carried out preliminary case studies on the possible effects of sea level rise on different key coastal areas of the world such as the Netherlands, the United States, Egypt, Bangladesh and the Maldives.

The study conducted in the Netherlands estimated that a one metre rise in sea level would make it 10 times more likely that the advanced coastal defence infrastructure presently protecting the country will be overtopped. Tidal wetlands, areas of high agricultural and horticultural importance, and densely populated urban industrialized zones, including the Rotterdam harbour area, will be threatened by erosion, salination, or increased vulnerability to storm surges.

According to studies compiled by the United States Environmental Protection Agency, a sea level rise of a few metres would, in the United States, inundate major portions of Louisiana and Florida, as well as beach resorts along the coasts; a rise of one or two metres by the year 2100 could destroy 50–80% of United States coastal wetlands. The studies revealed that in the case of Egypt, a one to three metre rise in sea level could erode up to 20% of the nation's arable land, unsettling up to 21% of the country's population, or more than 10 million people. In Bangladesh, this rise could swamp up to 27% of the total land area, displacing up to 25 million people.

As for my own country, the Maldives, a mean sea level rise of two metres would suffice to virtually submerge the entire country of 1190 small islands, most of which barely rise more than two metres above mean sea level. That would be the death of a nation. With a mere one metre rise, also, a storm surge would be catastrophic, and possibly fatal to the nation.

We in the Maldives have seen and lived through grim experiences which would be the indicators of the dire consequences of global environmental change provoked and aggravated by man.

Geographically, the Maldive Islands lie in the equatorial calm of the northern Indian Ocean, away from cyclone paths. The brief annual monsoonal turbulences and the occasional high tidal swells have hardly ever endangered the 195 000 inhabitants of the islands. Until now! This year, the frequency and magnitude of unusual tidal wave action have risen alarmingly. The period from 10 to 12 April recorded the highest sea level seen in the country, during which unusual high waves at high tide struck the islands with a ferocity that inflicted extensive and unprecedented damage throughout the country. Male', the capital island, housing a quarter of the nation's population, suffered the worst of the ordeal. One-fourth of the urban land was inundated by salt water, and 30% of the land reclaimed during the last seven years was completely washed away.

The nation's only international airport sustained extensive damage to its physical infrastructure and installations. Along the full length of the archipelago, large parts of several islands on the south and south-eastern atoll rims were extensively flooded or inundated. Breakwaters, harbours, boats, causeways, houses and property fell victim to the ocean's assault. Agricultural crops and vegetation succumbed to the salt water encroachment above and below ground level. Throughout the country, beaches were damaged, placing at risk one of our chief income generating natural resources.

The incident was branded a freak at that time, but it recurred in the southern atolls, though to a lesser extent during June and September, and we are now compelled to accept the traumatic reality that the worst may yet be to come.

It was the testimony of ordinary people that has convinced us of the human costs of such environmental destruction. As such, let me give the testimony of the people of the Maldives.

The rich and developed nations clearly have the wealth and the land to defend themselves from a rise in sea level even if they wait for it to occur, yet they are already preparing. Because small states are more vulnerable, we have to prepare sooner. But the Maldives lacks the economic, technical and technological capability to deal with the formidable prospects of a significant rise in sea level. We did not contribute to the impending catastrophe to our nation; and alone, we cannot save ourselves.

The profound dilemma of environmental transition is a global one and its implications are worldwide and long term. Though the Maldives and other low-lying archipelagic nations may have to suffer the most immediate and the most extreme effects of a global sea level rise, there is a potential danger to a significant portion of the world's population in the near future. The costs of lethargy and complacency in investing in environmental protection and improvement are clearly spiralling. Measures cannot be taken in isolation. No one nation, or even a group of nations, can alone combat the onset of the global change in environment.

Given the trends of international involvement in the issue of environment, the Maldives can only offer the experience of an endangered nation. The Maldive Islands are not merely the home of a few thousand people – they are a unique natural phenomenon, found nowhere else on this earth. It is the phenomenon Thor Heyerdahl, the Norwegian explorer, describes in his book *The Maldive Mystery* as '. . . green jade necklaces and scattered emerald jewelry placed on blue velvet . . .', with each islet a 'separate gem set in a ring of golden beach sand . . .'.

The Maldives possesses delicately balanced fragile and transient environmental ecosystems in its atolls of coral islands and reefs. It is endowed with islands crowned with green palms and lush tropical vegetation, fringed with white sandy beaches, and inset within stretches of clear turquoise lagoons and living reefs. A beauty canopied by blue skies and nurtured by pure fresh air and warm sunshine.

It is now a distressing probability that the environmental change caused by industrial progress in the developed world may slowly drown this unique paradise in its entirety. The country's ecosystems alone, by virtue of their uniqueness and vulnerability, deserve protection. Our authorities are monitoring the sea level changes with two gauges recently installed as part of the Intergovernmental Oceanographic Commission's Global Sea Level Network. Elementary monitoring and research activities on these ecosystems are being initiated in the country. We need to monitor the increases and understand the response of our coral reefs. We hope that this activity, if augmented by a concerted international effort, can evolve into a worthy scientific research programme which can ultimately help save millions of lives around the world. With such help, the Maldives can be protected and preserved as a biosphere reserve for scientific study, or an environmental sanctuary of aesthetic beauty and tranquillity which can benefit all the world.

It is in the interest of all the world that climatic changes are understood and the risks of irreversible damage to natural systems, and the threats to the very survival of man, be evaluated and allayed with the greatest urgency. The world has already seen the first few steps of this new and much needed awakening. The World

Meteorological Organization and the International Council of Scientific Unions are promoting the world climate research programme. National and international organizations and movements are trying to make headway against the rising tide of environmental destruction, and the list is too long to be cited here. All these efforts, and specifically the United Nations Environment Programme's initiative actions, such as signified by the World Commission on Environment and Development and the recent and historic Montreal Protocol, an agreement to reduce the worldwide use of chlorofluorocarbons, bring rays of hope into the bleakness of the issues. But this is not enough. The hope must be sustained and realized. In the face of a global threat, anything less than an all-encompassing international commitment and effort can become futile in this colossal struggle.

The economic, technical and technological resources are available collectively. It is not too late to save the world. It is not too late to save the Maldives and other low-lying island nations. Only the vital collective commitment is missing. And I believe we can initiate such a commitment.

Life on earth

HRH Duke of Edinburgh
Buckingham Palace, London, United Kingdom

The great difficulty about 'life' is that we humans are part of it, and it is therefore almost impossible to study it objectively. It is made even more difficult by the fact that human attitudes to the living world have been largely conditioned by philosophical speculation and religious dogma developed at a time when the human population believed itself to be struggling against nature for its very survival. It therefore tends to be anthropocentric and gives scant attention to the welfare of all the other life-forms which share this planet with us.

Scientists have undoubtedly discovered a very great deal about life, but man's relationship to the natural world is not a matter of science, it is a matter of concept and conscience. The 'Big Bang' may explain, to the satisfaction of physicists, the origin of the universe and of our planet Earth, but it does nothing to answer the questions about what are we doing here? What is the point of existence? Is there anything beyond this life? Was the world created by a Supreme Being? Is everything that has happened since the creation part of His plan, or is it all a matter of chance? Questions which I imagine men have been asking ever since they discovered the power of speech.

All these questions are quite reasonable. They are the product of man's ability to speak and to reason. The problem is that, as a result of man's ability to express his thoughts, there are so many conflicting answers. You can take your choice between creation and evolution; between the natural and the supernatural; between man made in the image of God and man the end of the evolutionary process; between body and brain or body and soul; between death after death or life after death or even reincarnation. You can also choose between conservation for the sake of man, or conservation for the sake of nature. Anthropocentric or altruistic?

These are philosophical choices, but it is from these choices that many others are derived. For example, when the Bible says that man shall have 'dominion' over God's creation, the choice is between understanding dominion as in 'having power over', or dominion as 'having responsibility for'.

Coming nearer to the conservation of nature, the choice is between accepting the natural system as it was created – or as it evolved – with all its perfections and imperfections, or whether we choose to believe, with Isaiah, that the natural system can be perfected. You will doubtless remember that in Chapter II he wrote:

> Then shall the wolf live with the sheep,
> and the leopard lie down with the kid;
> the calf and the young lion shall grow up together,
> and their young shall lie down together.

The lion shall eat straw like cattle;
the infant shall play over the hole of the cobra,
and the young child shall dance over the viper's nest.
They shall not hurt or destroy in all my holy mountain.

It is very attractive to believe that it is possible to do away with all that we find unpleasant and unattractive; that pests and diseases can be eradicated, that natural disasters, earthquakes and storms can be prevented; that predation can be made no longer necessary. Whatever choice you make, the consequences are obviously very important.

For my part, reverence for nature means the reverence for the system as it is, warts and all. If there is anything that is to be perfected – and could be perfected – it is human behaviour. It is perfectly possible to do without war, without terrorism, without tyranny, without over-population and particularly without thoughtlessly wrecking the natural system by over-exploitation of what we call natural resources. It seems quite extraordinary to me that while we have developed such strong moral and religious feelings about the sanctity of human life, we seem to have failed to do anything to establish the sanctity of the natural system on which we depend for our existence. Whole libraries of books have been turned out on the subject of the economics of money and the subject is taught in every university; virtually nothing has ever been written, or taught, about the economics of nature. I do not accept the wholly unrealistic concept that 'being nice to animals' is a proper substitute for an understanding and a respect for the natural system as a whole.

Some choices depend to a large extent on self-interest. A farmer with the exclusive use of his own land will ensure that he keeps enough seed corn to plant for next year's harvest. He will also keep enough cows or ewes or sows to breed next year's crop of animals for the market. In other words he is respecting the natural system and practising what ecologists refer to as maintaining a sustainable yield. This is the basis of the economics of nature. It is just as important as the economics of money, since no human activity can be considered in isolation from the natural world which is our life support system.

In contrast to the principle of harvesting, is the exploitation of what appear to be free-for-all natural resources. Apart from nations with exclusive rights to their coastal waters, most of the oceans are open to the fishing fleets from all nations which are free to exploit the natural populations of fish by whatever means are available, irrespective of the damage the methods may do to other marine creatures and birds. Each fleet is anxious to get what it can because the fishermen know that if they don't catch whatever fish are there, the other fleets will do so. It is obviously in the common interest to limit the total catch to maintain a sustainable yield, but it is against the interests of the individual.

A more critical example is the exploitation of natural tropical forests. Governments burdened with debt see them as a source of revenue, squatters see them as covering cultivatable land and ranchers see them as potential grazing. The result is that forests are disappearing faster then they can regenerate. The choices here are between harvesting and exploitation.

A recent edition of *The China Environmental News* reported that rapid deforestation in China's main forest areas has allowed deserts to expand and resulted in an increase in natural disasters. Tree cover had dropped from more than 50% in some areas to between 35 and 20%. In the south-west of Sichuan province the cover had dropped from 20% to 12% since the 1950s. As a result the country is losing 50 billion tons of soil to erosion every year.

The fact that some natural resources are more in demand than others also causes problems. In Scotland, for instance, deer and sheep have always been in greater demand than foxes, wolves or eagles. The latter are therefore branded as predators and every effort was made to keep their numbers to the minimum. Having removed most of the predators it then became necessary to limit the deer population to the number that can be supported on the area available. In other words, once you have interfered with the balance of nature it becomes necessary to maintain the balance by artificial means. This means that some animals have to be killed in the interest of maintaining the health and viability of the species as a whole as well as for the benefit of other more vulnerable species. Unfortunately there are many people who object to that sort of thing.

The fact is that mankind has so interfered with the balance of nature all over the world that it is now essential to take steps to maintain the balance by artificial means. Indeed, this is the basic role of the modern ecologist and all those who are concerned with the conservation of nature. It has now become impossible to attempt to maintain wildlife on earth by simple protection or non-interference.

To give a rather extreme example of the consequence of interference in the natural balance; the great kiskadee, a large yellow-breasted fly-catcher, was introduced into Bermuda from Trinidad in 1957 to control the anolis lizards. The lizards had been introduced to control Mediterranean fruit flies, but had preferred to eat the beneficial ladybird beetles and parasitic wasps, the latter introduced to control oleander scale, itself an accidental introduction. Nothing now controls the kiskadees and their numbers have soared from 200 to 60 000.

The Galapagos Islands provide a different example. Visitors and settlers on the islands have introduced a number of exotic species over the years. Rats, cats, dogs, goats and donkeys have all gone feral and they have caused mayhem among the indigenous populations, particularly among the giant tortoises and ground-nesting birds. The only way to give the natural inhabitants of the islands a reasonable chance to survive is to attempt to exterminate the destructive introduced species.

Some species are obviously at greater risk of extinction than others and therefore greater efforts are made to ensure their survival, but individual species cannot be protected unless they have somewhere to exist and something to exist on. They have to have a habitat and a source of food and they have to share it with all the other species which exist in that habitat. This means that these habitats have to be protected from human encroachment and managed for the benefit of the wild inhabitants.

Ecology is not concerned with the fate of individual animals. It accepts the concept of the exploitation of surplus natural resources because that is the way the natural system works, but it must always be done on the principle of maintaining a sustainable yield.

Grazing animals depend on the renewal of their natural pastures, predators depend on a viable population of their prey. The system ordains that if populations get too big to be sustained by the resources available, sickness, starvation and death redress the balance with what we might think is cruel efficiency. The inexorable rule of nature is that if you mess up your environment you will have to pay a heavy price sooner or later.

This is a fact of the natural system that humanity has simply refused to learn – to its very great cost. Just look around the globe today and you cannot fail to notice that all the areas which at one time supported highly successful and civilized populations are either deserts or they have reverted to jungle. The reason is quite

simple, they over-exploited their natural resources and they paid the price. It is naive in the extreme to imagine that we can escape the same fate for very much longer. We are only managing to put off the evil hour by frantically digging up and using mineral resources that can never be renewed. As if that were not enough, we are polluting the atmosphere, the land and the waters with every kind of noxious substance. The 'greenhouse effect' alone could well have devastating consequences for all life on earth.

The choice in conservation is therefore between the welfare of individual animals and maintaining a balance so that all species of both plants and animals have a reasonable chance of survival.

Strangely enough this duality of option is a reflection of the duality of man's brain. The left brain produces the reasonable answers after objective scientific research, while the right brain prefers the acceptable and emotionally satisfactory answers. How often do people say 'that may be so, but I prefer to believe' or 'I like to believe . . . this, that or the other'.

This duality of brain has created great problems for modern man. When religion provided the 'satisfactory' answers to imponderable questions, and practical experience was limited to fairly simple technology, there was no great conflict between experimental fact and belief. Today the volume of scientific fact has grown to enormous proportions, and much of it is in direct conflict with traditional concepts.

This conflict produces a very difficult situation. Scientific fact is not just verifiable, it is also reproducible, which means that whole systems of engineering can be based on the certain knowledge that if the rules are followed the outcome is predictable.

It is also significant that successful engineering makes money. This is in stark contrast to the supernatural, whether it is religious or mythological. In the latter cases the truth may be equally certain, but it is not verifiable, and the outcome of following the rules is seldom predictable. It is, of course, possible to exploit magic and mythology commercially, but it could hardly be described as manufacturing industry.

While the scientist may be motivated by the desire for knowledge, the engineer is more likely to be motivated by the desire to make a living and, as the sum of the successful activities of engineers and manufacturers – within the legal and financial restraints imposed by governments – is equivalent to the national economy, there is an understandable public pressure for schools and colleges to concentrate on utilitarian subjects to the exclusion of cultural and aesthetic development. In other words, the development of the left brain is given a great deal more attention than the right brain.

Viewed from the practical, intellectual and reasonable aspect, this may well appear to make a lot of sense. The trouble is that neglect of the development of the right brain leaves it in a state of vacuum. The knowledge of the left brain is not balanced by the insight, judgement and understanding which the right brain should be providing.

This means that the right brain is ready to absorb the first plausible ideas that it happens to come across. The occult, obscure religious rites, parapsychology, astrology and similar attractive but irrational notions are sucked into the vacant space without any discrimination or critical faculty.

Furthermore, in the absence of an understanding of the way the natural system works, it is only to be expected that there will be an emotional reaction to the less

attractive features of the system. I also suspect that the use of drugs might be seen as a substitute, or short cut, to filling the vacuum in the right brain.

You may well think that I have drifted rather a long way from my subject, but I mention all this because man's attitude to nature is partly a function of the left brain and partly a function of the right brain. It is easy enough to encourage an emotional concern for nature and the living world, it is a great deal more difficult to teach the facts of life. I know this from personal experience. I get more letters about the treatment of animals, both domestic and wild, than I do about whole species under threat of extinction.

Everyone can comprehend the idea of cruelty, very few can comprehend the extinction of a species. Everyone has views on hunting, which, if properly conducted is a sustainable use of resources; but very few accept any personal responsibility for the pollution of the natural environment or for human encroachment and disturbance of the habitats of wild animals and plants, which cause serious and, in some cases, irreparable damage.

For nearly 100 years there was no life at all in the lower reaches of the River Thames. I suspect there would have been an outcry if this had been due to the activities of fishermen. In fact it was due to toxic effluent from the human population and it was only cleaned up because it caused such an unpleasant smell. It took very much longer for ecologists to even partially recreate the conditions which would allow life to return to the river.

It is true that species of wild animals and plants have been becoming extinct for very many years – the dinosaurs disappeared from the earth 120 million years ago, and the reason is still not entirely understood. What modern man has failed to grasp is that the number of species under threat of extinction and the rate at which species are becoming extinct, is increasing all the time. The fate of many has already been sealed. Once the population of a species gets below a minimum viable number, or its genetic diversity is reduced below a certain level, its extinction is inevitable.

This is not happening from natural causes, but as a direct consequence of the growth of the human population and the increasingly destructive effects of the exploitation of renewable and non-renewable natural resources and of human activity in general. Typical examples of the latter are acid rain, the destruction of the ozone layer and the build up of the carbon dioxide layer, causing the so-called 'greenhouse effect'.

To this you may well feel like saying 'so what?'. The fact is that, in spite of all mankind's inventiveness and technological skills, it would be quite impossible for man to try to live on this planet without the life support system provided by the rest of the living world.

Many people are concerned about the risks of nuclear power stations and the disposal of nuclear waste. Even more are, quite rightly, worried that some fanatical group of politicians could start a nuclear war and create a nuclear holocaust. At the moment this is, fortunately, just a possibility. It is a risk, but it is only a potential risk. The risk to all life on earth through the irresponsible destruction of the natural world by ordinary people going about what they see as their lawful occasions, is not potential, it is actual, the damage is being done here and now, with long-term consequences just as destructive as a nuclear holocaust. Whoever said that the world would end, not with a bang but a whimper, may well have been more accurate than he expected.

The carbon dioxide consuming forests are being exploited faster than they can

regenerate; the natural resources of the oceans are being wantonly destroyed; the waters, the land and the atmosphere are being polluted at such a rate that even the most drastic remedial measures could not be effective for very many years, and then only if the explosion of the human population could be contained within reasonable limits.

The facts are there for all to see, but they are not 'satisfactory', they are not palatable to people who have grown up in the understanding that the world was created by a benevolent merciful God specifically for their enjoyment. Therefore, all must be right with this wonderful world and we are here for the sole purpose of exploiting its apparently limitless resources to make a prosperous living and then to enjoy life to the full on the proceeds.

It is difficult enough to persuade the supposedly educated populations of the developed world that this is a dangerous fallacy. How do you get the message through to communities that are living exactly the same life style as their ancestors 20 000 years ago? Furthermore the job is made almost impossible by our well-meant attempts to raise the standards of living of such people. Untold economic resources have been invested in the so-called Third World, particularly during the last 30 years. But what is there to show for it? There appears to be more starvation, more desertification, falling food production, deforestation, soil erosion and increasingly erratic climates. All this in addition to social unrest, terrorism and civil war brought about by ideological conflict and the pressures of rapid population increase, urbanization and industrialization. And it still goes on. Far more resources are committed to economic development than are made available for the care of the natural economy.

In one respect only can this massive investment be said to have been successful. There are now three times as many people living in this Third World and the population is still rising. Such numbers could not have been sustained even 50 years ago. This is quite an achievement, but I doubt whether it was ever intended by the developers. Instead of the same number of people enjoying higher standards of living, we have achieved the situation where three times as many people are living at the same, or below, the standards their parents enjoyed 50 years ago. Even to achieve this has meant a threefold increase in the demand for resources and in the populations of domestic animals, with all this means for the state of the natural vegetation.

It is perfectly possible to increase the world output of food. The 'Green Revolution' was a staggering success, but lack of food is no longer the critical factor. The starvation which exists could be cured; statistically there is enough food in the world. What cannot be cured is the growing demand for resources. At its simplest, even if we could get the food to those who are starving, with what are they going to cook it? With no more natural resources than semi-arid desert, how are the products of modern technology to be afforded?

If you manage to increase the population of nomadic communities, that are dependent on grazing their flocks, there is no way you can increase the natural pastures on which these flocks can feed. Furthermore, if the human population increases, the size of the flocks is also bound to increase. The western answer is to try to settle such communities in permanent villages and to create artificial pastures. Splendid, but what about the life style to which they have become adapted?

We tried much the same thing in the developed world. Our prosperity has risen dramatically since technology allowed us to abandon the agricultural way of life.

But it has been achieved by creating massive urban/industrial complexes with all their problems of mass industrial employment – and unemployment – inner city decay, social unrest, crime, drug-taking and all the rest of what we call the modern evils. Perhaps it was a fair exchange, but surely we should think twice about forcing the same sort of changes on populations that do not have the resources to maintain the standards to which we have become accustomed.

It seems to me that the people of this world are facing the same dilemma as the man on the desert island. He has a coconut tree, which provides him with food, but he has decided to cut it down to build a shelter. He is very comfortable in his shelter but he has just begun to notice that his store of coconuts is beginning to run out.

When we talk about economic development and the conservation of nature we have to use both our minds as well as our hearts if we are to ensure that future generations can enjoy just a fraction of the benefits of the natural world that has been left to us by previous generations. We must look at the unpalatable as well as the palatable truths. We can no longer afford to believe that learning the facts or that an emotional response are sufficient unto themselves. Knowledge and emotion have got to be coupled with insight and understanding.

The most important thing to remember is that life on earth is an integrated whole. The natural system includes the sun and the moon, the wind and the rain, the rivers and the soil, the plants and the animals, the seas and the oceans. You may be able to get away with a certain amount of tinkering, but there comes a point when one part after another breaks down and the whole system reaches the brink of collapse.

What is known as the 'catastrophe theory' suggests that everything has its final breaking point when it will suddenly, and without warning, switch from a stretched, but apparently stable, situation into complete breakdown. The single purpose of the World Wildlife Fund, the International Union for the Conservation of Nature and Natural Resources and all the conservation organizations of the world, is to try to ensure that the natural system – that intricate web of life on this planet earth, never reaches that point.

Conservation for development

Rajiv Gandhi
former Prime Minister of India, New Delhi, India

The miracles of modern science and the towering achievements of technology have given us a measure of mastery over Nature. Economic progress has, however, engendered a callous disregard of the harmony within the ecological system. Therefore, we have to consciously remind ourselves: we are a part of Nature; we are not apart from Nature. We are a strand in the single fabric whose warp and weft link together all that is of the earth and the water, the air and the sky.

We have learnt to our cost that development which destroys the environment eventually destroys development itself. And we have learnt to our benefit that development which conserves the environment conserves also the fruits of development. There is, thus, no fundamental dichotomy between conservation and growth.

Yet, striking the right balance between the environmental imperative and the demands of development is not that simple. Conservation imposes an escalation in costs. When resources are limited, the increased cost of any one project necessarily means less investment for others. This appears to imply a curtailment of economic growth. When the environment is not protected, damage to the environment will extract its price – from those living in the vicinity, from others at a distance, or even from coming generations.

We do not know enough about the impact on the environment of development decisions. We also do not know enough about how best to offset damage to the environment. There are no easy solutions. Yet, we cannot ignore environmental considerations. We have to strive for the optimum mix through increased knowledge and increased awareness.

In India, we are seeing a growing awareness of the symbiotic relationship between the protection of the environment and sustainable development. There is the renowned chipko movement in the Himalayas, where women prevent the wanton felling of trees by throwing themselves protectively around tree-trunks. Island communities join hands to stop the coral-mining which destroys their lagoons. Villagers band together to stop goats from grazing on the bramble planted to halt the advance of the desert. Environment groups are active. In our Parliament, members are increasingly receptive to environmental concerns. They are beginning to demand that the conservation of the environment be guaranteed before major development projects are undertaken.

At one time, environmental issues related mainly to the quality of life of the affluent. Today, in developing countries like ours, we are primarily concerned with

the lives of the poorest. When village ponds and wells go dry, it is the poor who trek to ever-more distant sources for water. When forests are destroyed, it is the poor who go farther and farther afield in the search for fuelwood. As lands are degraded and forests recede, it is the poor and their animals who, in the dry season, trudge hundreds of kilometres in search of grazing lands. It is the livelihood of the poor, and their hopes, that shrivel in the arid anguish of drought and are drowned in the raging fury of floods.

It is also the poor who suffer most from pollution. When waterborne epidemics strike the urban slums, it is the poor who are afflicted by disease and even death. When factories spew harmful gases into the air, it is the workers in the nearby housing colonies who suffer the contagion. When industrial units discharge their effluent into rivers, it is the poor fisherfolk who are deprived of their incomes.

Although they bear the brunt of environmental damage, the poor are themselves not very responsible for any of that damage. For centuries, they have lived in harmony with nature. The problem is caused by large-scale commercial exploitation, which garners the profits but escapes the consequences. Yet, when laws are passed and rules are made to conserve the environment, the burden falls on those who have gained the least and suffered the most. The people of the forest cannot suddenly be cordoned off from its bounty. Fuel and building materials must be made readily available, at prices they can afford. Shepherds and cowherds must be found alternative pastures or provided with fodder. To be effective, conservation must be humane. That is the challenge before us.

A large number of animal and plant species are seriously threatened. Apart from the ethical and aesthetic case for protecting these disappearing species, it is possible that answers to unsolved problems of health and survival might be found in the yet undiscovered secrets of these gene pool reserves.

We in India are now developing mechanisms to control pollution and check the deterioration of the environment. We assess the environmental impact of development work so as to harmonize development with the environment. We carry out research and take the results out to the field. We promote environmental awareness among the people. We hope this will lead to greater vision, concern and care in the planning, designing and implementation of development projects. We learn as we go along.

We are trying to integrate these complex environmental issues into our design of development. There are no easy or ready-made answers. In principle, we would wish to give equal priority to development and conservation. In practice, there are major gaps in knowledge, many intangibles and unknown quantities. Experts disagree and assessments vary.

Conservation is not a national task alone. Even as peace is indivisible, so is the world environment. The 'One World' which India's first Prime Minister, Jawaharlal Nehru, spoke of so often is a world which already exists in the physical laws governing the environment. The environment everywhere is jeopardized by the noxious fumes and life-killing wastes of industrial pollution. The poisoning of the rivers and the seas deprives and endangers all of us, all over the world. The accumulation of carbon dioxide in the atmosphere and the threat to the ozone layer put the innocent as much at risk as the polluters themselves.

Worst of all is the passing on of pollution and environmental hazards beyond one's boundaries. There is no political boundary which delimits the spread of poisonous gases, no line on a map which radiation cannot cross, no national frontier at which effluents can be turned back. All those affected by such

transnational consequences of environmental damage must have an equal say in the resolution of problems. We must also keep the global commons and space free of environmental depredation. The conservation of the earth's environment has to be ensured through democratic discussions and decisions in international forums.

The conservation of the world's environment also requires concerted international action to reduce disparities between countries. The compulsions of development and limitations of financial resources tempt many developing countries to exploit their natural resources beyond endurance, ignoring environmental safeguards. If the world economy is to move to more sustainable paths of development, the crucial requirement is to widen the options available to developing countries for growth.

A world economic system which denies itself the benefits of interdependence is both unjust and inefficient. Growth in the developing countries is being hampered by protectionism, by the deteriorating real terms of trade, by the unfavourable conditions for the transfer of technology, and by the curtailment of the flow of development assistance.

Programmes of conservation must, therefore, address themselves to iniquities in the international economic order. For example, the largest share of the world's natural resources has been pre-empted by a few countries. The average citizen of the industrialized countries consumes ten times more fossil fuels and minerals than the average citizen of the developing world. The world's resources just cannot sustain such profligate consumption of energy and materials.

Neither can developing countries be denied the right to develop nor are the world's natural resources sufficient for all to follow the greedy path to growth. What then is the answer to the conundrum? The answer lies in more rational patterns of consumption, more efficient utilization of depletable resources by the developed countries, and more equitable access to these resources for the developing countries.

The international community must also address itself to safety measures in high-risk industries. Bhopal, Seveso and Chernobyl have shown how vulnerable we are. It is incumbent on the management of such industries to ensure the utmost vigilance in design, operations and maintenance. Valuable lives cannot be lost to inefficiency, indifference, negligence or worse.

All other environmental dangers pale in comparison to the ever-accumulating stockpile of nuclear weapons. We must remove the threat of thermonuclear war wiping out, in a wink of history, life as we know it from our common planet. All nuclear weapons must be dismantled.

Unfortunately for us, at the present time the earth is one, but the world is not. We must recognize that even as development which degrades the environment is self-defeating, so do impediments to development endanger the environment. We must also recognize that environmental issues are closely linked to the larger issues of peaceful coexistence and international cooperation, disarmament and development. Any unidimensional perspective on environment would be gravely misplaced. Environment is an international issue, to be placed in the context of international cooperation, to be pursued through international institutions, to be linked to all aspects of international relations. Conservation is each nation's task. But a task which can be accomplished only in the setting of a cooperative world order.

In one of his most famous slokas, Guru Nanak Dev, the founder of the Sikh religion, sang:

Air is the vital force,
Water the Progenitor:
The vast Earth is Mother of All.

The verse sums up the Indian tradition of respect for Nature, respect for all that gives us life, respect for the sources of our well-being on earth. In our tradition, there is no arrogance towards Nature, no desire to dominate it. Our ancient wisdom teaches us to seek harmony with all creation. All creation is interdependent.

Our common future

Gro Harlem Brundtland
Prime Minister of Norway, Oslo, Norway

The World Commission on Environment and Development was given a challenging mandate by the General Assembly. We were asked to take a fresh look at the interrelated issues of environment and development and to define shared perceptions on long-term environmental issues and aspirational goals of the world commmunity to the year 2000 and beyond. Since our Commission's inception, there has been an endless information flow about increasing threats to the global environment and about environmental disasters often caused or aggravated by our own policies and actions.

Poverty is the main cause and effect of environmental degradation in many developing countries. Clearly, it is totally unacceptable and incompatible with human decency and solidarity to even suggest that the poor must remain in poverty in order to protect the environment! What are needed are national and international strategies that offer real options, that secure and enhance incomes as well as the environment on the local, national and international levels.

Present development patterns cannot be allowed to continue. While economic and social development suffer from severe national and global imbalances, threats to the environment are becoming global in scope and devastating in scale. The survival of this planet requires that we must act now.

There is no doubt that the necessary changes are possible. Our report, entitled *Our Common Future*, is not a prophecy of doom, but a positive vision of the future. Never before in human history have we had greater possibilities. The time and the opportunity have come to break out of the negative trends of the past. We need not only a new vision, but political commitment and a broad mobilization of human ingenuity. We need intensified multilateral cooperation based on recognition of the growing interdependence among nations. The idea of sustainability and the interlinked issues of environment and development have now risen to the top of the international political agenda. Our common concerns for the future can create a momentum for change.

The overriding political concept upon which our report is founded is that of sustainable development, a broad concept for social and economic progress. We define it as paths of human progress that meet the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs. It requires political reforms, a fair access to knowledge and resources, and a more just and equitable distribution within and among nations.

Poor people must not be condemned to remain in poverty. It is mass poverty

which drives millions of people to overexploit thin soils, overgraze fragile grasslands, and cut down yet more of the rapidly disappearing tropical forests, these great lungs vital for the global climate and thereby for food production.

The world is now faced with many serious problems of environmental deterioration. Global warming is expected to change agricultural and settlement patterns and to flood seaports. Acidification is moving into the developing world. Six million hectares of productive dryland turns into desert each year. Against this grim backdrop, the recent achievements on the protection of the ozone layer are indeed most welcome.

All nations will ultimately share the same destiny. Our environment and economies have become so intertwined that we may no longer choose to remain apart. The environment respects no national boundaries. We cannot continue to act as if it did.

Sustainable development recognizes that there are thresholds inposed by nature, but not limits to growth itself. In a world riven by poverty, growth is absolutely necessary. Growth is the only answer to the problems of developing countries. But the contents of growth must be changed. Growth cannot be based on overexploitation of the resources of the Third World countries. Growth must be managed to enhance the resource base on which they all depend. The environment and the natural resources of developing countries must cease to be the victims in a world economy troubled by serious imbalances. The victims must instead become allies in the struggle for our common survival.

Debilitating debts, soaring interest rates, interrupted financial flows, and adverse terms of trade offer developing countries few options but to overuse their resource base while their capacity to address environmental issues remains low. These trends have too long been working against developing countries. New international economic conditions must be designed to enhance the resource base of developing countries.

The industrialized world must take a full share of responsibility to ensure that the international economy helps rather than hinders sustainable development. This is also in its own interest. Commodity markets must be strengthened. Restrictive trade practices should be abolished. Terms of trade must change to favour developing countries rather than to improverish them.

Urgent action is necessary to alleviate the debt crisis in ways that represent a fairer sharing between debtors and lenders. The massive drain of resources from developing countries must be reversed. What are needed are new loans on concessional terms, new investments, and economic reform.

Strongly increased assistance from external sources will be needed in many countries. Donors, lenders, and investors must make a fundamental commitment to sustainable development. There is no alternative to substantial increases in financial flows. Additionally – both in quantity and in quality – development must be based on equality and mutual self-interest. Internationally agreed targets are far from being met. The concern for our environment and our common future should help us to move forward, to the benefit of us all.

Sustainability objectives should be of serious concern to everyone. Global awareness among governments, aid agencies, and others concerned with development of the necessity of integrating environmental considerations into economic decision-making and planning at all levels should be enhanced. The demand for higher quality and environmental sensitivity in aid and lending with substantially increased aid flows should be closely coupled.

Some countries might be sceptical about the application of the sustainability criteria in aid and lending and perceive it as a new form of conditionality.

It is clear, however, and it should be emphasized, that this integrated process must be made operational by the governments themselves as part of their national strategies for development. External assistance will be needed to help many countries establish their professional and institutional capacity to conduct this integration in practice. Such assistance must come at the request of countries concerned and must be assisted by the international community. Growth must promote a fair distribution of income. It must be firmly based on the stock of natural capital that sustains it.

To achieve this, full integration of environment and economics into decision-making at all levels, nationally and internationally, is essential. We must attack the problems at their source. We must clearly recognize that the policies of sectoral ministries such as Ministries of Finance, Industry, Energy, Agriculture are the ones that determine the state of the environment and consequently our options for the future. Sustainable development objectives must be integrated into the goals of all branches of public administration as well as the legislative bodies and municipal democratic institutions. We must break away from our sectoral ways of viewing economy and ecology. We must learn to accept the fact that environmental considerations and economic growth are parts of a unified management of our planet. The one is dependent upon the other.

It is indeed appropriate that the United Nations assumes a key role in pursuing the basic objectives for our survival: peace, development, and environment. The United Nations system was brought into existence to provide multilateral solutions to shared problems. At this point in history, when we face the prospect of genuinely cooperative relations between the major powers, should we not have the courage to use our global international organization to provide political and intellectual leadership in saving this planet from degradation and collapse? We should adopt sustainable development as a central goal of the United Nations itself, assisted in that process by a strengthened United Nations Environment Programme, which can then fully perform its catalytic role. Time has come to move forward towards a true revival of multilateralism.

A broad and genuine process of global change will entail a further evolution of open societies, based on more effective popular participation in decision-making. The status of women will have to be further enhanced. Political reforms and broad access to knowledge and resources are required. Disabled people, whose handicaps may come from hunger, war, or environmental decline or disasters, must participate on an equal basis. The non-governmental organizations play an essential part. Their access and influence are central to sustainable development. They play an active role in translating political programmes into action. Industry should be at the forefront and be encouraged to develop more sustainable techniques. Trade unions must be seriously engaged in this essential process. Most important of all is the interaction between all these key players, based on exchange of information, creative dialogue, and inspiration.

Ushering in the era of sustainable development

Barber Conable
President, The World Bank, Washington DC, USA

A new era is opening in the history of development . . . and not a moment too soon. It is the era of managing natural resources, not exhausting them, of linking economic growth and environmental protection in strategies for sustainable development.

As evidence of ecological damage in the Third World has multiplied, it has shown that development cannot bring lasting relief to the poor if it does not also take lasting care of the resources on which they and all human life depend. Developing nations and development institutions have learned that sound ecology is not only good economics; it is essential for survival. It can be compatible with growth.

Seeing that connection, however, is not the same as applying it. That is a tougher economic, political and social challenge and one the World Bank is addressing with new determination, new resources and, most importantly, new support from its member countries. Together, we are only at the beginning of this era of sustainable development. We are working against time but in the right direction.

The World Bank officially recognized the emerging importance of environment as a development issue two years before the United Nations Conference on the Human Environment was convened in Stockholm. In 1970, the institution – the first in its field to do so – began to review the projects it supported to uncover and evaluate potential environmental damage.

Since then, the alarming pace of environmental degradation in the developing countries has attracted people of goodwill everywhere – the multilateral and bilateral aid agencies, environmental and other non-governmental organizations – to push more forcefully for the integration of sustainable natural resource management into the development process.

The challenge of sustainable development is to reconcile the objectives of promoting growth, alleviating poverty and protecting the environment. While these objectives may generally support each other in the long run, it is often more difficult to ensure their short-term compatibility. Given the limited financial resources allocated to development assistance, it is essential that the attack on poverty should include a defence of sound ecology.

In its report, *Our Common Future*, the World Commission on Environment and Development (the Brundtland Commission) focuses on this question and describes the many facets of environmental considerations that need to be woven into development work. Beyond analysing the problems and the extraordinary

complexities of the many interlinked issues involved, the Brundtland report proposes an agenda for change.

At the World Bank, we are responding to that challenge. Although the institution had long been dealing with environmental issues before my arrival in July 1986 I have made these concerns a priority and set about strengthening the Bank's own capability to harmonize environmental protection and development. *Environment, Growth and Development*, a discussion paper prepared for the April 1987 meeting of the Development Committee, first pulled the policy strands together.

In depicting the intricate repercussions of environmental issues the paper points out that, contrary to popular perceptions, large-scale projects do not provoke the most serious environmental problems in developing countries. Rather the combined effects of countless small-scale activities that use fragile tropical soils, limited water resources and forests in an unsustainable manner do the most widespread harm. At the heart of the problem is burgeoning population pressure, an issue which must be addressed on a priority basis. Moreover, inappropriate land tenure, economic incentive, taxation and resource conservation policies compound the damage.

In urban areas development assistance has failed to keep pace with the appalling problems of overcrowding and deteriorating human health. Millions of the urban poor live in insanitary conditions without safe drinking water, surrounded by industrial and municipal pollution. Industrial accidents in the developing countries can devastate the lives of families too poor to afford the cost of relocation or reconstruction.

While the Bank and other agencies have issued environmental guidelines for containing pollution and reducing the risk of industrial accidents, consistent implementation of those guidelines is no easy task.

Moreover, investment policies, including those of the World Bank, have generally focused on measures to increase food production and to address immediate problems of rural poverty. As a result, the more intractable longer-term problems, such as desertification, spreading salinization of irrigated lands and over-exploitation of tropical forests, which are exacerbated by the pressure of too many people on too little land, tended to be overlooked and to receive disproportionately lower financial support.

One of the main messages of the 1987 paper prepared for the Development Committee is that progress towards tackling these formidable issues will depend on integrating environmental management into economic policies at all levels of government and into international development assistance work. In the same vein as the Brundtland report, the paper calls for concerted action and cooperation in the environmental arena. While the governments of developing countries will have the leading role, multilateral and bilateral agencies must help them, and all parties must collaborate more with non-governmental organizations.

Out of the World Bank's own reorganization has come a new structure to strengthen the Bank in the continuing policy dialogue with governments of its member countries on environmental issues and sustainable development and to incorporate more broadly and systematically environmental protection considerations into Bank lending.

In addition to creating a central Environment Department with three divisions, the Bank has established four Environment Divisions, one in each of the Bank's regional operations units. Altogether, these units are staffed by some 60

environmental experts: ecologists, sociologists, anthropologists, biologists, natural resource economists, environmental engineers, hydrologists and agronomists. As part of their work, they act as environmental advocates throughout the Bank.

Changing attitudes in the developing countries also prompted the upgrading of the Bank's environmental arm. Many Third World governments now recognize that environmental degradation can compromise long-term economic growth unless appropriate policies and institutions pay heed to natural resource management. No longer considering environmental protection a luxury reserved for the rich nations, a growing number of developing countries have come to realize that they must include provisions in their development plans to slow unsustainable population growth, to stem the depletion of their natural resource base and to stamp a greater measure of permanency on development activities.

In taking up the challenge of sustainable development, the Bank is building on a solid foundation of project experience. Since the Stockholm conference, the Bank has helped finance more than 1500 environmental components that were added to its power, transportation, industry and agriculture projects. A few projects were also designed to improve soil conservation and the management of forests, rangelands and watersheds; to prevent desertification; to conserve water resources and fisheries; and to preserve genetic diversity in wildland areas. The Bank also financed many more projects to establish sites and services for urban housing, to upgrade slums, to improve water supply and sewerage as well as solid waste management, to develop renewable energy resources, to control urban pollution, to improve health and to slow population growth.

For the future, however, the Bank recognizes clearly that a project-by-project focus is too narrow to address the national or regional problems related to natural resource degradation. Gradually, the Bank has moved towards broader-based multi-sector operations that contain a range of mutually reinforcing investments and policy reforms.

At the World Bank sustainable development is being pursued on two levels.

First, we are reviewing projects more systematically and comprehensively. Consistent with the Brundtland Commission's recommendations, we will strive to anticipate the complex ecological and behavioural consequences of large-scale development projects and to promote appropriate defence against those consequences. We are putting stronger emphasis on identifying projects that not only meet economic growth and poverty alleviation criteria, but also directly address environmental issues or ease the problems of environmental management. Recent projects of this nature deal with water supply and pollution control, social forestry, watershed management and industrial pollution control, while new projects being prepared will address wildlife management and directly support conservation.

Second, the Bank is systematically incorporating environmental issues into the five elements of the Bank's country assistance work: policy dialogue, economic analysis, sector work, lending programme and aid coordination. Putting environmental considerations high on the agenda of all our relevant activities, we will uphold our commitment to sustainable development.

In collaboration with other agencies and non-governmental organizations, the Bank is assisting beneficiary countries to develop methodologies and strategies for identifying, controlling and taking environmental considerations into account in their own policies, incentives and institutions. Our goal is to improve their capacity

to manage and preserve the natural resource base vital for future growth. Here again, the underlying assumption governing this work is that environmental issues and prudent resource management should be an integral part of economic policy, if sustained economic development with equity is to be achieved.

The mechanisms for pursuing these goals have been established. Within two years, the Bank will have produced summary reports on critical environmental issues facing all our major borrowers which will serve as guides to action. We will also conduct in-depth studies focused on developing policy, institutions and implementation capacity in a number of countries – selected according to their intrinsic ecological importance and the perceived commitment of their governments to improved natural resource management. Because of the diverse environmental problems and institutional arrangements of the selected countries, the Bank will be able to test a variety of approaches and methodologies. In addition to these country-specific studies, we have a regional Mediterranean programme under way which will complement and support the United Nations Environment Programme's ambitious Mediterranean Action Plan.

At the global level, the Bank has taken steps to mobilize resources and improve aid coordination by playing a lead role in formulating a Tropical Forest Action Plan, an initiative that already has doubled aid and community support for reforestation, watershed rehabilitation and fuelwood planting. We are exploring the possibility of a similar global initiative for conserving biological diversity in tropical rain forests, wetlands and marine environments.

A broad research effort has begun on some of the global and regional environmental issues that spill over national borders. These require in-depth examination of underlying socioeconomic and technical causes as the prerequisite for formulating effective environmental management strategies. On the problem of desertification, for example, the Bank has established a task force to conduct a number of studies and to plan closer collaboration with UNEP and FAO. Alternative approaches for land stabilization and improvement in a number of African countries are being studied. The attack on salinity, which has resulted in the degradation of some 40 million hectares of farmland in arid regions, will require a more concerted effort to monitor water tables and salinity levels and increased investments for adequate drainage.

The reduction of industrial disasters, such as those that occurred at Bhopal, Chernobyl or Basel, is most important. Techniques for environmental risk analysis and improved management for accident avoidance are being developed. The Bank is benefiting from the experience of the EEC countries and outside scientific and industrial organizations in formulating its own programme.

Decreasing the use of chemical pesticides is another area receiving the Bank's attention. We are encouraged by the progress made in countries like Indonesia and Sri Lanka, which are adopting the technique of integrated pest management in their agricultural loans, thereby diminishing heavy reliance on these products. On urban environmental issues, the daunting problems of sanitation, waste disposal and air pollution will require a concerted international effort. We deeply appreciate the strong support the United Nations Development Programme and many bilateral agencies have given to the Bank's initiatives in the area of energy conservation.

In addition to these collaborative studies on critical global issues, there is a need to learn more about the effect of agricultural pricing policies and other economic

incentives on natural resource depletion. We will be reviewing subsidies for fertilizers, pesticides and irrigation water to see whether they are economically and environmentally appropriate.

The relationship between women, resource management and development is a special area of concern. Many of our past projects have neglected women, generally the group most concerned with daily decisions on natural resource use and management. While it is women who gather fuelwood, till the soil and harvest the crops, they rarely are consulted about the design of agricultural and rural development programmes.

Finally, of course, we are continuing to step up our activities in support of programmes to reduce population pressure that would have imposed still larger demands on ecosystems.

The financial implications of a significant shift towards sustainable development are daunting and call for a massive global response. It would be unrealistic and unfair to expect the developing countries to bear the full cost of protecting tropical rain forests and other biological diverse habitats that benefit all mankind. The Bank is actively pursuing the possibility of securing increased concessional aid flows to tackle these global ecological issues.

The call for sustainable development thus urges the borrowing and donor nations to act in concert. It is a call for closer cooperation, for concerted decisions, for sustained generosity and for mutual compassion and understanding of the dilemma the developing countries face as they struggle to balance the pressure of immediate needs and the priority aim of longer-term sustainability. This critical call must be answered. Only then will Third World nations be encouraged to undertake development activities that do not endanger their natural resource base. Only then will the whole world be able to call its future safe.

Environmental aspects of agricultural and rural development

Edouard Saouma
Director-General, Food and Agriculture Organization, Rome, Italy

'As people search for the means to eat today,
they are taking away tomorrow's food.'

Progress in agriculture

Perhaps the best single indicator of the extraordinary achievements in food and agriculture over the past 25 years is the successful response to the challenge of providing food for a population that has increased by 1800 million people. World agricultural production expanded by an average of 2.5% a year from 1961 to 1985, well in excess of the annual 1.9% increase in world population.

The developing countries, where the percentage increase in population was higher by a large margin, managed to increase agricultural output even faster, enough to realize an increase in per capita terms of 0.8% a year. In the early 1960s, average daily per capita food supplies were just under 2000 calories in the developing countries; by the mid-1980s the average had reached 2420. The massive increase in the quantity of food was accompanied by substantial improvements in quality.

Unfortunately, global food production surpluses, a common characteristic of the 1950s and again observed in the 1980s, have often masked the dilemma which many developing countries face in attempting to feed their people and develop their economies while at the same time conserving the natural resources upon which production depends. Food crises and famines, particularly severe in Asia during the period 1963–68, and in the Sahel and sub-Saharan Africa during 1973–75 and 1983–85, are clear indicators that sustainable food production and minimum nutritional standards have not yet been achieved for millions of people.

The impressive food and agriculture achievements for the world as a whole have been unevenly distributed and the impact on the environment has varied greatly. Improvements in food supplies, arising from either increased production or increased imports, or both, occurred mainly in the middle-income countries and China. Gains in the low-income countries, apart from China, were small. The sharpest per capita increase was in the Near East/North Africa region, followed by Asia and Latin America. In contrast, per capita food supplies in the sub-Saharan Africa region during 1983–85 were at the 1961–63 level.

Growth in agricultural output was highest in Asia, followed by Latin America and Near East/ North Africa, and lowest in sub-Saharan Africa. Output rose faster in the middle-income countries. Among the low-income countries, China managed to increase production rapidly, and the 1980s gains in India have also been impressive, but the others as a group were hard pressed to maintain per capita production.

Nearly three-quarters of the increase in world crop production, and about 70% of the increase in the developing countries came from higher yields. Expansion of harvested areas accounted for a smaller share of the increase in crop production in developing as well as developed countries.

The crises faced in Asia during the 1960s, when rapid population growth and low agricultural production threatened the capacity of countries to produce food, were addressed by action on a number of fronts. Often referred to as the 'Green Revolution', this term does not fully reflect the wide range of actions undertaken to bring many Asian countries towards self-sufficiency in food production.

Technological advances offered high-yielding varieties of rice and wheat. These, in turn, depended on significant increases in inputs of fertilizers, irrigation and pesticides. But the real challenge, successfully met by many Asian countries, was the adjustment of policies and practices related to agricultural investment and production. Provision of incentives to farmers, access to credit, establishment of market mechanisms, income generation schemes, training, information dissemination and strengthening of extension services were essential contributions to making the Green Revolution successful.

Today, high-yielding varieties are used on more than 50% of Asia's cropped land, bringing in an additional estimated US$500 million annually in production. More important, perhaps, is the fact that countries are able to manage successfully these complex production systems.

Although dramatic gains in production have been achieved, many countries and international organizations, such as FAO, continue to face the same paradox – chronic malnutrition, poverty and unemployment still plague millions of people even in countries able to produce 'food surpluses'. During the 1970s, the global percentage of undernourished persons in developing countries, with the exception of China and other centrally-planned Asian economies, declined from 19% to 15%, the first decrease in more than 40 years. Nevertheless, due to rapid population growth, the total number of undernourished persons increased to approximately 335 million during 1979–81.

Emerging environmental concerns

The Stockholm Conference on the Human Environment, held in 1972, was the first major effort to focus international attention on the management and maintenance of our natural resources base and the prevention of pollution. Agricultural and rural development was of deep concern to the participants and was reflected in the conference recommendations. Of the 106 substantive recommendations for action, 36 were related specifically to agricultural and rural development.

The Conference was largely an initiative of the developed countries who were concerned about the air and water pollution and resource problems characteristic of industrialized economies. Initially, developing countries considered that the recommendations of the Conference might slow down their economic growth. However, it eventually became clear that sustainable economic growth and environmental protection were deeply intertwined. At a follow-up conference, ten years after Stockholm, the developing countries were in the forefront in calling for greater attention to environmental problems affecting economic development. As most have agrarian economies and derive a large portion of their gross national

products from agriculture, their most serious environmental problem is often natural resource degradation in rural areas.

Soil erosion, mismanagement of water resources, inappropriate use of pesticides, overgrazing, desertification and deforestation were seen at the Stockholm Conference as important problems that were poorly understood. The direct link between the maintenance of environmental quality and sustainable economic development, today universally accepted, was then viewed primarily as an important issue in need of more attention.

During the decade following Stockholm, developed and developing countries, international agencies and others, dedicated millions of dollars to improving our understanding of environmental problems and identifying specific, practical steps to avoid or solve them. Information on the condition and extent of natural resources, gathered by FAO since the late 1940s, has been synthesized, case studies have been conducted and guidelines prepared. The United Nations Environment Programme (UNEP) has played an important role in catalysing this action within an environmental context. Although sophisticated techniques exist for the productive management of natural resource systems, their successful implementation can be limited by a phalanx of institutional, cultural and physical constraints.

Environmental problems in developing countries

The environmental problems associated with agricultural and rural development are numerous. Although they cannot all be discussed here, it is important to review some of the main problems to understand their breadth and complexity.

Foremost is soil degradation, which pervades virtually every region of the world, encompassing different cultures, climates and ecosystems. Water erosion is the most common form, accounting for about 25 000 million tonnes of soil lost each year, which accumulates in dams, reservoirs, rivers and eventually the oceans. Wind erosion, particularly severe in the Near East and North Africa (35% and 23% respectively), is often found in association with other desertification processes, such as overgrazing or deforestation. Drifting sand, in addition to causing loss in soil fertility, can adversely affect roads, buildings and fences.

Good water management practices are a prerequisite to maintaining fertile, productive soils. In many warm climates, soil becomes saline or alkaline due to improper irrigation practices and poorly-drained irrigation land. As a result, water tables rise, bringing saline water into contact with plant roots. In the mid-1970s, it was estimated that at least 50 million hectares of irrigated land were affected by salt, and many millions more were potentially salty; the amount of land being abandoned each year roughly equalling the amount of land being reclaimed.

Soil structure can be physically affected when it is repeatedly or improperly worked with heavy equipment or when it is compacted around water holes in pastureland. Biological damage occurs when soils are deprived of essential nutrients and organic matter. The former can be replaced by mineral fertilizer, the latter cannot. The only solutions are sound management and good farming practices.

The loss of biological diversity is one of the most critical environmental problems today. Relatively undeveloped areas of the world contain important wild gene pools of plants, trees and animal species. These resources are particularly well adapted to the local climate and topography, and resist pests and disease.

However, they are threatened by land conversion and deforestation. Such practices lead to permanent loss of local genetic pools which form the basis for improved crop varieties and higher-producing animals, as well as for the supply of pharmaceutical and industrial materials. Unfortunately, only a small proportion of plant species have been classified or screened for possible economic importance. In the case of domestic animals, although the breeds are recognizable by appearance and local name, little has been done to classify their economic characteristics in an orderly and accessible way for users in other locations.

Closely related to the loss of genetic resources is the problem of tropical deforestation. As the demand for fuelwood, pasture and cropland grows, forested areas are increasingly used by default as the land base for this expansion. It is estimated that more than 11 million hectares (or 0.6%) of forest cover in tropical countries are being cleared annually. The consequences of uncontrolled deforestation can be disastrous since many areas are on fragile soils and contain high species diversity. Without careful management, not only does the physical state of the natural resource decline, but the wide array of indirect or secondary forest products are lost.

The utilization of natural resources can often result in the long-term interests of local people being sacrificed for short-term economic gains. For example, some countries have extensive tropical hardwoods which can generate much needed foreign exchange. However, foreign exchange is of little benefit unless local people are able to develop parallel industries to generate income when the trees have gone. First and foremost, this means that not all the trees of economic value should be harvested. Significant reserves should be maintained as sources of seed, fibre, building material and wildlife. Such secondary forest industries, while perhaps yielding fewer short-term economic returns, can be sustained indefinitely with proper management and ultimately return far more sustained benefits to the local people.

In 1985, the Pacific Ocean provided about half of the world's fish catch, but stocks of demersal fish and large tunas have been fully exploited. Pelagic shoaling fish are very much dependent on environmental conditions. For example, anchoveta depend on the cold water Humboldt current and are seriously affected by alterations resulting from El Niño, a warm current. The North Atlantic Ocean is the most heavily fished and most of its stocks have been fully or overexploited. The Indian Ocean offers some opportunities for increased catches, but high value species, like shrimp, have been fully exploited. With better management, most exploited stocks could give sustainable yields which would even allow for increased catches in a number of areas.

In dryland areas, the process of desertification is becoming progressively worse. The results of activities, such as overgrazing, unsuitable cropping systems and deforestation can be observed in shifting dunes, blowing sands and desert-like conditions. Although data are poor, the rate of desertification is believed to be accelerating in Sahelian Africa and in parts of the Near East. In 1980, desertification was estimated to be affecting a global area of 27 million hectares of irrigated land, 173 million hectares of rainfed cropland and 3071 million hectares of rangeland. A major constraint of lands subject to desertification is the sensitivity of their ecosystems. Inappropriate technologies, such as deep ploughing or pulverization of topsoils, frequently contribute to the problem.

In Africa, the breakdown in traditional communal grazing practices, due in part to the encroachment of dryland farmers, and cultural norms identifying cattle with

wealth, have served to strip vegetation and expose the soil. In the early 1970s, attempts to relieve the effects of drought by establishing boreholes to provide water for people and cattle, only exacerbated the degradation and intensified land use around the boreholes.

For the past three decades, pesticides and fertilizers have been among the most important tools available for improving agricultural yields. But, without careful and selective use, these tools can become potent weapons working against sustainable, high levels of production. Resistance of pests to pesticides is already a serious problem throughout the world, but especially in tropical regions where their numbers and diversity are greater. Nearly 500 arthropod species have been identified as having significant resistance to commonly-used pesticides.

Improper use of pesticide can expand the number of economically important pests, as broad spectrum pesticides eliminate pest predators. For example, in the cotton-growing regions of Nicaragua, where pesticides have been intensively used for nearly two decades, the number of economically important pests increased from five to nine over a ten-year period, and aerial applications of pesticides rose to as many as 28 per growing season. Eventually, this system collapsed from its own weight. Now integrated pest control, which includes selective use of pesticides, is being promoted.

Pesticide use is growing at a relatively slow 4.5% annually worldwide. However, growth in developed countries is almost stationary and has been so for about five years. Most of the current growth is taking place in developing countries, with some showing an annual increase of nearly 20%. This has resulted in both chronic and acute poisonings in rural as well as in urban areas. Pesticide formulations at excessively high concentrations, application without minimum safety measures, and the use of empty pesticide containers to hold drinking water, are a few of the problems.

Mineral fertilizers, if improperly used, can also pose problems of environmental pollution, although in a manner considerably less obvious than pesticides. There may be excess uptake of nitrates in plant tissues, soil contamination by heavy metal impurities, nutrient loading of rivers and lakes due to run-off and leaching into groundwater (primarily nitrogen-related).

Human health is affected by badly stored food, particularly cereal and grains. Liver cancer, which can be caused by exposure to mycotoxins, is common in Asia and is the most widespread of all cancers in Africa. While not all liver cancers can be attributed to mycotoxin exposure, the limited amount of monitoring conducted has shown food contamination to be prevalent throughout the continent.

Maintaining adequate water quality is a major problem for inland fisheries. The contamination of fresh waters, estuaries and lagoons by pesticide residues and other wastes reduces the value of the products harvested and may harm the aquatic species themselves. Further, the world's rivers are being affected by the construction of dams, channelling of river beds and increased consumption of water by agriculture and industry.

Annual flooding of rivers is an essential feature of some of the world's most productive inland fisheries. However, it is generally agreed that the floods causing most damage are not those due to natural disasters, but rather those resulting from man's misuse of the land. They are best avoided by maintaining forested areas on the watersheds and by employing better land management practices.

The problems described above are some of the important environmental problems facing agricultural and rural development. Most of these are much better

understood today than at the time of the Stockholm Conference in 1972, due to interdisciplinary studies undertaken by countries and international organizations.

Apart from yielding useful technical and resource management information, these investigations have revealed that, although the technical knowledge on how to manage agricultural production systems in an environmentally-sound manner is quite comprehensive, policies and institutional structures are often weak and not organized to develop and implement such complex systems. Despite the availability of technical solutions, the lack of means to implement them results in problems that are not resolved.

Some responses to environmental problems

Over the last two decades, a number of important initiatives have been taken to address these broader problems in agriculture and rural development. The World Food Programme was formed in 1961 to improve the distribution of surplus food in periods of famine.

The establishment in 1962 of the Joint FAO/WHO Food Standards Programme and the intergovernmental Codex Alimentarius Commission provide the means by which governments can control the contamination of food by pesticide residues, mycotoxins and other environmental contaminants. Codex limits for contaminants and maximum residue limits for pesticides are based on the safety evaluations prepared by scientists working under the auspices of FAO and WHO. The application of national food control programmes and the Joint FAO/WHO Food Contamination Monitoring Programme enable countries to be aware of the problems associated with the environmental contamination of food and the means available to control it.

International Agricultural Adjustment, a framework to facilitate the harmonization of national agricultural policies and programmes in order to effect changes in world production and distribution, was introduced in 1969. The concept of World Food Security, introduced in 1973, was revised in 1983 to focus on ensuring production of adequate food supplies, maximizing stability in the flow of food supplies and security of access to supplies by those who need them.

The 'food shock' of the early 1970s, when strong food demand collided with a decrease in global food production and increased producer and consumer prices, led to the organization of the World Food Conference in 1974 and the establishment of the International Fertilizer Supply Scheme to provide farmers with access to an essential input for production.

The early 1970s also witnessed the emergence of concern about environmental issues, such as the Stockholm Conference in 1972.

In 1980, the International Union for the Conservation of Nature and Natural Resources (IUCN) introduced the World Conservation Strategy, representing a consolidated effort by countries and international organizations to define a framework and action plan to deal with environmental problems. It is based on the premise that the maintenance of essential ecological processes and the prevention of pollution are among the primary challenges facing sustainable development. But, practically speaking, how can the concept of developing resources while also conserving them be translated into meaningful actions?

The World Conservation Strategy provides for action at the national level to identify environment/development priorities, establish interministerial coordina-

tion mechanisms and action at the level necessary to implement the priority action plan.

In 1981, FAO's member countries adopted the World Soil Charter which identifies environmental priorities and approaches to the problem of maintaining soil resources. The Charter calls for the commitment of governments and international organizations to improve soil conservation and reclamation activities through national policy adjustment, training and awareness building.

In 1983, the International Undertaking on Plant Genetic Resources addressed the issue of proper conservation and providing better access to plant genetic material of agricultural interest. It requests participating governments to pay greater attention to their genetic resources and to allow access for the purpose of scientific research and plant breeding. Action is proposed to improve the capability of countries to conserve and use their plant genetic resources.

The International Code of Conduct on the Distribution and Use of Pesticides was adopted by FAO member countries in 1985 after long negotiations. The Code recognizes that individual governments have responsibility for regulating the introduction, distribution and use of pesticides in their countries. The Code also assigns responsibilities to manufacturers, distributors and users, and set standards of conduct for public and private entities engaged in, or affecting, the distribution and use of pesticides.

The Strategy for Fisheries Management and Development, adopted by the 1984 FAO World Fisheries Conference, recognizes that fishery resources, although renewable, are subject to over-exploitation, depletion and to the influence of environmental factors. It therefore calls on governments and international organizations to take steps to prevent or abate pollution and any form of environmental degradation which may result from various aspects of economic development. These steps are necessary to maintain sustainable levels of fish resources and to protect critical coastal ecosystems, such as mangroves.

The Tropical Forestry Action Plan, a major initiative in response to the problems of deforestation, was formulated and launched in 1985 in an effort to coordinate donor and country activities in combating deforestation. The Plan aims at reducing and ultimately reversing deforestation, which is reaching alarming rates in many tropical countries, by harmonizing and strengthening international cooperation. It has received wide acceptance among tropical countries and major multilateral and bilateral donors, and is being implemented in various parts of the tropical world.

Such efforts are the beginning of action and serve as benchmarks in setting standards and assigning responsibilities for environmentally-sound development.

Challenges for the future

Meeting the projected food requirements of a world population estimated to reach more than six billion by the year 2000, will require increases in production of approximately 40%. An even larger increase will be required to eliminate hunger. Two main approaches will be used – increasing the productivity of each unit of land and increasing the total area under production.

While seeking to eliminate hunger and improve nutritional status, our common goal is to promote conservation-based agriculture, forestry and fisheries production. The characteristics of such an approach are: human equity, stability of production, maintenance of ecological processes and balances, and integration of

ecological, social, institutional and technical considerations. To achieve this objective, action is required on a number of fronts. Some of the activities will have a direct bearing on environment; others can have substantial indirect effects by influencing how farmers and fishermen manage their resources and production. These include pricing policies, subsidies, market infrastructure, export markets, cost of energy, level of investment in agriculture and political stability.

Lest we become hopelessly enmeshed in the economic and political constraints, the environmental challenges to agriculture can be limited to six main areas:

(1) Strengthening policies and institutions
(2) Expanding technical training
(3) Improving information dissemination and awareness building at local levels
(4) Integrating traditional production systems with advanced technologies
(5) Research and development
(6) Technical assistance which meets the needs of the farmer

Many countries have inadequate policies and institutions to address their environmental problems related to agriculture. In others, there is a lack of communication and coordination between natural resource management and agricultural production. This can be manifested in the form of farmers unwilling to produce crops beyond their immediate needs due to the low market prices set by the government, or of one government agency planting trees on a site that another agency intends to use for agricultural production. There are also instances of development in the upper part of a watershed adversely affecting activities in the lower reaches.

Coordination mechanisms, both inter- and intra-ministerial, are necessary to ensure that crop production, livestock, forestry or fisheries programmes are supportive and enhance the quality of the environment in the region. Meeting the needs of local people requires participatory, smaller scale, mixed land-use development. This implies knowledge of the needs and priorities, which must be achieved through consultation from policy to village levels.

Environmental Impact Assessment (EIA) of agricultural and rural development activities is essential to identify, understand and resolve potential conflicts, and the impacts themselves, before development take place. Although a number of countries have such mechanisms, only a few are able to implement and enforce them. More emphasis is needed on the positive use of EIA in development activities likely to cause significant impact. The capacity to implement EIA must be further developed.

The investment countries make in agriculture as a percentage of their GNP is a reflection of the importance they attach to this sector. Low levels of investment in African agriculture are due, in part, to heavy debt and a perception of low returns. Yet governments, if their goal is to sustain production in the long term, must be willing to provide incentives for farmers to undertake conservation-based agricultural practices, such as integrated pest control, soil conservation and water management.

Expanded technical training is a primary requisite for policy and institutional development. Technically-trained people working in the field are well placed to identify and prevent environmental problems. But this requires support for salaries and basic equipment which, in turn, depends on the availability of funds for agriculture. Mechanisms for information flow from farmers to technical experts, to policy makers, and vice versa are required.

Sometimes when national governments do encourage rural people to focus on conservation-based development, the arguments go unheeded unless the farmers see direct links between economic returns, conservation and their own well-being. For example, the planting of trees can be perceived as taking cropland out of production in pursuit of a supply of wood in the distant future. However, planting such trees in clearly defined agroforestry or mixed-cropping systems can be perceived as beneficial.

A better understanding of the relationships between conservation and development would benefit rural people by providing information they understand and can use. As a rule, rural people with limited resources are particularly averse to taking risks. As they must meet today's and tomorrow's food needs, they cannot afford to try a new technique which has not been proved to be effective beforehand or which does not bring quick results. Thus, to be successful, conservation measures must be practical and of direct benefit to these people.

In many developing countries, particularly in Africa, the quantity of inputs, such as fertilizers and pesticides, and the application of irrigation are still quite low. On average, only 10 kg of plant nutrients in the form of mineral fertilizers are applied per hectare of arable land and permanent crop. In the Far East and Latin America the figures are 66 kg/ha and 32 kg/ha respectively. Developed countries range beyond 120 kg/ha. The total irrigated area in Africa is nearly 10 million hectares, of a potential area of at least 30 million hectares. Therefore an immediate challenge is to increase the flow of such inputs while protecting the environment.

Significant production achievements have been made in Asia and Latin America but at a cost of increased dependency on inputs such as agrochemicals and irrigation. For the environment, this has meant a greater risk of resource degradation and pollution of soil and water. Because the use of external inputs was relatively low prior to the Green Revolution, the system was initially able to absorb such inputs without short-term repercussions. Now, after two decades, it is clear that, to maintain production in developing countries, there will have to be a more rational utilization of inputs to avoid adverse environmental impacts. Greater emphasis will need to be placed on production methods such as composting, diversified cropping systems and integrated pest control.

Some traditional agriculture systems are ecologically and socioculturally adapted and offer a wealth of untapped knowledge and experience, When the use of pesticides and fertilizers reaches its limit, the next logical step is to obtain additional production from those farming systems that use the best aspects of traditional and technological methods.

Lessons learned from Asia and Latin America point to the need to undertake such efforts in a balanced manner. Although the challenges in Africa are similar in some respect to those of two decades ago in Asia, the tempting notion that technology alone can push Africa significantly ahead in food production over the long term must be avoided.

To keep food production ahead of population growth will require taking a middle road. Traditional systems, although often environmentally neutral, are not sufficiently productive to meet the food challenge. Technology-based systems, while highly productive, sometimes create negative environmental and social impacts as a result of being poorly adapted to the conditions under which they are applied.

The middle road consists of building from traditional systems and integrating them with technologies which enhance the positive features of being environmen-

tally neutral, culturally adapted, supportable by existing institutional mechanisms and highly productive. Despite some efforts, smaller farms remain a largely unexploited frontier. In fact they are viable, economic units. Seventy-five percent of farms in tropical Asia are smaller than two hectares. Technologies addressed to small-scale, labour-intensive, and capital and resource-sparing crop production systems could yield enormous increases in production, provide employment and income, and slow down rural–urban migration.

During the past 20 years, there has been a steady decrease in the amount of new land coming into crop production. On a global basis, most land with high production potential is already in use. These lands often have moderate to good soil fertility and climates that provide adequate rainfall and temperatures for production. Although this situation varies greatly from country to country, there is still substantial room for expanding cropland in some countries. However, national and international research efforts have not been adequately focused on sustainable land-use practices.

For the foreseeable future, the greatest contribution to crop production is likely to come from increased yields on existing cultivated land. In the fisheries sector, the major share in production will continue to come from capture fisheries, supplemented by the steadily increasing contribution from aquaculture. With the increasing world population, there is a high risk of damaging the fishery resources unless proper management is adequately enforced.

It can be reasonably concluded from present trends that natural resources will be used much more intensively in the future and expansion of arable land will focus progressively on lands with constraints such as low soil fertility, unfavourable climate or specific management problems. There is not sufficient scientific knowledge available on how to use these lands for more productive purposes. For example, the relationship between soil erosion and loss of productivity is poorly quantified. This being the case, it is hard to imagine how farmers can be convinced that soil conservation is in their best interests.

The Green Revolution of the 1960s and 1970s benefited the high-potential lands where irrigation was possible. However, it also left some areas untouched, primarily in Africa. The convergence of relatively unsophisticated agriculture, low inputs and extensive lands with production constraints in a food deficient continent, requires a major effort by the countries themselves, by development assistance organizations and by international research centres.

Asia and Latin America will need to match their institutional capabilities, which are comparatively advanced, with ecologically and socially-adapted technologies. For Africa, such systems have yet to be introduced.

International development assistance organizations, such as FAO, carry a special responsibility in the implementation of conservation-based agriculture. They must ensure that their assistance penetrates to the farmers and helps them maintain or improve the condition of resources, while increasing productivity. This aspect has perhaps not received sufficient priority in the past. As one talks about the need for better policies and stronger institutions, it is sometimes forgotten that it is the farmers who sow the seed, nourish it and ultimately reap the harvest. If farmers benefit by our effort, the challenges we face in the coming years can be undertake with confidence.

Bibliography

FAO (1981) *Agriculture: toward 2000*
FAO (1983) *Protect and produce: soil conservation for development*
FAO (1984) *Land, food and people.* Based on the FAO/UNFPA/IIASA report 'Potential population-supporting capacities of lands in the developing world'.
FAO (1986) *African agriculture: the next 25 years*
FAO (1986) *World food report*
FAO (1986) *The state of food and agriculture 1985*
FAO (1986) *FAO and the environment*
FAO (1986) *Natural resources and the human environment for food and agriculture in Africa.* FAO Environment and Energy Paper No. 6
FAO (1987) *Report on natural resources for food and agriculture in Asia and the Pacific.* FAO Environment and Energy Paper No. 7
FAO (1987) *Report on natural resources for food and agriculture in Latin America and the Caribbean*

The population problem

Robert S. McNamara
former US Secretary of Defense, and former President, The World Bank, Washington DC, USA

The thesis which I present here is this:

- Population growth rates in most developing countries fell significantly in the 1970s. This has led many to believe that the world in general, and most countries in particular, no longer face serious population problems and that efforts to deal with such problems can therefore be relaxed.
- Such a view is totally in error. Unless action is taken to accelerate the reductions, in the rates of growth, the population of the world (now approximately five billion) will not stabilize below 11 billion, and certain regions and countries will grow far beyond the limits consistent with political stability and acceptable social and economic conditions. Africa, for example, now with less than half a billion people, will expand sixfold to almost three billion; India will have a larger population than China; and El Salvador will grow from five million to 15 million.
- Rates of population growth of this magnitude are so far out of balance with rates of social and economic advance that they will impose heavy penalties on both individual nations and individual families. Nations facing political instability of the kind already experienced in Kenya, Nigeria and El Salvador – instability in part a result of high population growth rates – will more and more be tempted to impose coercive measures of fertility regulation. Individual families will move to higher levels of abortion, particularly of female fetuses, and higher rates of female infanticide.
- Developed and developing countries have a common interest in avoiding the consequences of current population trends. There is much they can do to change them, both through action to encourage couples to want smaller families, and by moves to increase the knowledge and availability of contraceptive practices to families giving birth to more children than desired.
- Unless such action is initiated, the penalties to the poor of the world, individuals and nations alike, will be enormous. And the ripple effects – political, economic, and moral – will inevitably extend to the rich as well.

In developing this thesis, recent and prospective population growth trends will first be examined. This will be followed by an assessment of the consequences of rapid population growth for families and societies, and for the world community as a whole. It will be concluded by discussing policies that nations can pursue to deal effectively with rapid population growth, and examining the ways in which international assistance and cooperation can contribute to the success of those policies.

I

The long stretch of early human history was characterized by a near balance of births and deaths. This was not a matter of choice: it was imposed on mankind by precarious existence. High mortality mandated high fertility to assure survival. With the advent of agriculture – about 8000 BC, when the best rough historical estimate is that the world's population approximated eight million – the food supply became more dependable and periods when births exceeded deaths by at least a modest margin became more frequent. Still, slowly expanding populations were frequently decimated by recurring crises and average rates of growth remained very low. At the dawn of the modern era – by about the mid-eighteenth century – the world's population had reached 800 million.

Increasing mastery over nature, associated in part with the Industrial Revolution, then led to a spectacular acceleration of the growth in human numbers. Mortality was gradually reduced and the gap between global birth rates and death rates widened. The differences between these two rates, the rate of population growth, increased steadily over the course of the next 200 years. The earth's population tripled, reaching 2.5 billion by the middle of the twentieth century – and grew by an additional 80%, adding two billion more, in the next 30 years. Whereas it had taken mankind more than a million years to reach a population of one billion, the second billion required only 120 years; the third billion, 32 years; and the fourth billion, 15 years.

These global totals obscure wide differences between what are known today as the 'developed' countries – the industrial nations of Japan, Europe, and North America – and the 'developing' countries of Africa, Asia, and Latin America. During the period from 1750 to 1850, the two groups of countries grew at similar average annual rates: 0.6% for the developed and 0.4% for the developing. From 1850 to 1950, the rates were 0.9% and 0.6%. But, between 1950 and 1970 both rates changed dramatically, becoming respectively 1.1% and 2.2%. Those in the developing countries, by 1970, were not only twice as great as in the developed nations, but exceeded by a full percentage point the most rapid growth ever experienced by them.

The experience of the industrial nations during the last 200 years reveals a most important lesson of modern demographic history. Higher rates of survival need not lead to ever-expanding populations, hence to the dire consequences envisaged by Malthus: lowered living standards and eventual re-establishment of high death rates. Humankind can also control its fertility. Low rates of growth can be the outcome of an equilibrium achieved through low death rates and low birth rates.

In many of these more economically advanced societies, even before the end of the last century, a spontaneous decline of fertility set in. Millions of individual couples decided to opt for smaller families, and we have since seen that the demographic transition can run its full course to population stability with low mortality. We also know that the behavioural responses to the spread of industrialization and urbanization underlying that transition are not limited to western populations but are much the same the world over.

Yet contemporary patterns of demographic change also demonstrate that the response to 'modernization' is not automatic and may occur so closely as to prevent an orderly approach to the end-point of population stability. The process of transition initially generates greater population growth, with death rates falling faster than birth rates. The magnitude of that growth can affect the speed and

characteristics of the transition itself. If population growth is very rapid, the socioeconomic transformations that could be counted on eventually to lower birth rates may be retarded. Thus, in some cases the Malthusian scenario could, after all, prove to be relevant.

More typically, as will be argued in the next section, the scale of population growth generated by the transition may be such as to postpone or permanently foreclose desirable patterns of development that could have been attainable with less rapid demographic expansion.

Population trends that have become clearly visible in the second half of this century exhibit characteristics without historical precedent. The global increase in numbers during the past three decades was greater than the world's total population at the beginning of the century. More than 80% of this increase took place in the developing countries. The increase in the low-income countries alone – countries with per capita gross national product of less than US$400 – exceeded one billion.

The reasons for such explosive growth are well known and do not need repeating here. However, two facts merit attention. First, the speed at which death rates declined in the developing countries following the end of the Second World War was much faster than was the case in the equivalent phase of earlier demographic transitions. The massive application of imported medical and public health technology and improvement in food production largely explain this success. Second, in most developing countries the pre-transition levels of birth rates were higher than was typically the case in earlier western experience. The birth rate of the developing world as a whole in the early 1950s exceeded 45 per 1000 population. This compares with birth rates of 30–35 per 1000 in Western Europe in the nineteenth century, prior to the onset of the secular decline of fertility.

Thus, by the early 1950s many developing countries were experiencing annual growth rates of more than 2%, some even 3%. Between 1955 and 1975, for example, the average annual rate of population growth in the Central American republics was 3.2%. Such a rate, if sustained for a century, would increase the population more than 24-fold. The growth rate for the developing world as a whole in 1965–69 was 2.6%, a rate that would double the population in less than 27 years and increase it more than 13-fold in a century.

As in earlier demographic transitions, the beginning of an adjustment process eventually became visible. In the 1960s, in the developing world as a whole, the average number of children a woman would bear during her lifetime at prevailing

Table 1 Crude birth rates by regions: 1950–85 (annual number of births per 1000 population)

Region	*1950–55*	*1960–65*	*1970–75*	*1975–80*	*1980–85*
Africa	48.1	48.3	47.0	46.9	46.4
Latin America	42.5	41.0	35.4	33.3	31.8
East Asia*	45.0	37.3	33.9	22.3	18.8
South Asia	45.6	45.8	40.6	37.7	34.9
Developing countries	45.4	42.8	38.7	33.5	31.2
Developed countries	22.7	20.3	17.0	15.9	15.5
Total World	38.0	35.9	32.7	28.9	27.3

* Excluding Japan
Source: United Nations 1982 assessment

levels of fertility was nearly 6.5. By the late 1970s, that figure had declined by almost 30%, to 4.6 children. Birth rate trends between 1950 and 1980, summarized in Table 1 above, reflect that decline. Moreover, the decline, slow in the 1960s, accelerated in the 1970s. Estimated figures for 1980–85, shown in the last column of the table, indicate further decline, although at a more moderate pace.

During the 1950s and 1960s, with the decline of death rates on the whole faster than that of birth rates, rates of population growth continued to increase. But beginning with the early 1970s a slow deceleration of population growth has become evident. For the world as a whole, measured over five-year periods, the growth rate peaked at 2.1% in the second half of the 1960s. As Table 2 shows, the estimated annual rate for the early 1980s is 1.67%.

Table 2 Annual rates of population growth by regions: 1950–85 (%)

Region	*1950–55*	*1960–65*	*1970–75*	*1975–80*	*1980–85*
Africa	2.11	2.44	2.74	3.00	3.01
Latin America	2.72	2.80	2.51	2.37	2.30
East Asia*	2.08	1.81	2.36	1.47	1.20
South Asia	2.00	2.51	2.44	2.30	2.20
Developing countries	2.11	2.30	2.46	2.14	2.02
Developed countries	1.28	1.19	0.89	0.74	0.64
Total World	1.84	1.96	2.03	1.77	1.67

* Excluding Japan
Source: United Nations 1982 assessment

Thus a historic turnaround has occurred in world population growth: after centuries of steady acceleration, overall growth rates during the last decade and a half have turned downward.

This decline in the rate of population growth has led many observers to believe that the world in general, and most individual countries as well, no longer face serious population problems and, therefore, that efforts to deal with such problems can be relaxed. Editorial writers and commentators in the mass media have been quick to take up this theme, announcing the end of the population explosion or declaring rapid population growth to be 'another non-crisis'.

But this assessment is simply wrong.

The fertility change which has occurred during the last decade or two has been very uneventful. In particular, the statistical decline for the developing countries as a whole, and indeed for the world, is heavily skewed by the special experience of China. In many other parts of the developing world, including much of Africa, a large part of South Asia, and some countries of Latin America, no measurable or significant drop in fertility has occurred. The combined current population size of countries and regions that have experienced no appreciable reduction of fertility exceeds 1.1 billion. And as we shall see in the next section, in many of the countries where growth rates have slowed the situation remains perilous.

II

What are population growth prospects for the next few decades and for the longer term?

Uncertainties affecting the future argue for some caution in answering. Demographic processes have a built-in momentum that permits relatively accurate forecasts for 15–20 years ahead. Beyond that time span, the possibility of error becomes much greater. The question, however, remains highly appropriate, and is answerable in part with a fair degree of accuracy. We know, for example, that a large majority of the children born in the 1980s will be still alive past the midpoint of the next century.

To answer the question for the longer term, we can spell out plausible assumptions as to the future course of fertility and mortality, and calculate the implications of these assumptions for future population size and other demographic characteristics. Those who wish to challenge the orders of magnitude resulting from such calculations can best do so by challenging the underlying assumptions, and by proposing and defending alternative assumptions that they consider more plausible.

The results of such a projection exercise covering the time span from 1980 to 2100, undertaken by the World Bank, are presented in Table 3 below. The

Table 3 Population projections: 1980–2100 (population in millions)

							Total fertility rate – 1980	*Year in which NRR = 1*
Selected countries								
China	547	980	1198	1397	1414	1426	2.3	2005
India	350	675	1001	1361	1605	1778	4.7	2020
Indonesia	80	146	216	297	351	388	4.4	2020
Brazil	53	118	177	239	274	297	3.9	2015
Bangladesh	42	89	156	259	342	412	6.3	2035
Nigeria	32	85	169	329	472	600	6.9	2040
Pakistan	40	82	148	249	329	394	6.4	2035
Mexico	27	69	115	166	197	214	4.8	2015
Egypt	20	42	64	88	104	115	4.6	2020
Kenya	6	17	40	84	122	153	8.0	2030
Regions								
Developing countries								
Africa	223	479	903	1646	2297	2873	6.4	2050
East Asia	587	1061	1312	1542	1573	1596	2.3	2020
South Asia	695	1387	2164	3125	3810	4328	4.9	2045
Latin America	165	357	543	748	868	944	4.1	2035
Sub-total	1670	3284	4922	7061	8548	9741	4.2	2050
Developed countries:	834	1140	1284	1393	1425	1454	1.9	2005
Total World	2504	4424	6206	8454	9973	11 195	3.6	

Source: 1950, UN estimates; other years, World Bank estimates and projections

projections are based on the estimated population size in 1980 and its sex and age distribution. They incorporate the assumption that mortality improvements in the future will trace the historical experience of the more advanced countries in moving towards higher levels of life expectancy.

The nature of the more crucial fertility assumptions is summarized in the last two columns of the table. Starting with the estimated level of fertility in 1980 (expressed

in terms of the total fertility rate, that is, the number of children an average woman would have during her lifetime), the projections stipulate a decline to replacement level fertility – when the net reproduction rate (NRR) equals 1 – by a date that is specified for each country separately. Replacement level fertility means a level of childbearing in which each couple on average replaces itself in the next generation.

But when replacement level fertility is reached in a society, it does not mean that the population immediately ceases to grow. It may continue increasing for decades, depending on the society's age structure.

In the typical developing country, the high birth rates of the past have produced a broad-based pyramid of age distribution with a relatively high proportion of persons currently in, or yet to enter, the reproductive ages. When replacement level fertility is first reached in such a country, the population will still possess a strong growth momentum. It will continue to grow until the very large numbers of females at the bottom of the age pyramid have passed through their reproductive years – indeed until the pyramid has narrowed to resemble a rectangle with a small cone on top. Such a nation will not reach a stable population level until 50 or 70 years after it has achieved replacement level fertility; during that period its population will have increased by an additional 50 or 60%.

The assumptions concerning the future tempo of fertility decline in the developing countries, incorporated in the projections, reflect the judgement – or the hope – that recent declines will not only continue at a rapid pace in the near future but will do so until replacement fertility is achieved. Where fertility is still high – for example in Africa and parts of South Asia – it is assumed that it will start to decline well before the century's end and then the downward trend will be precipitous and sustained.

These are, in fact, heroic assumptions. They require that the move from high fertility to replacement level fertility – which took about a century and a half in the United States – be completed within a drastically shorter time span in today's developing countries. The assumptions envisage no possibility of temporary reversals or pauses on the downward course of fertility. They allow for no 'baby booms', such as the West experienced, once replacement fertility has been attained. Yet the populations that must conform to these demanding stipulations are largely poor and rural. They are populations where security in old age is still derived primarily from the support of one's children. Many are populations with religious and cultural values that place a high premium on fertility.

But let us take the assumptions at face value, despite their implicit optimistic bias. The projections in Table 3 are sobering. For the reasons referred to earlier, rates of growth in the developing countries, although declining, will remain high for decades to come.

India will more than double in the next 45 years, becoming almost 40% larger than China is today. Bangladesh in the same time will have nearly tripled and will have 259 million people jammed into an area, alternatively swept by flood and drought, the size of the state of Wisconsin. Mexico, which today has the most rapidly growing labour force of any large country in the world, will more than double in size. And Kenya, in which 17 million people are already putting heavy pressure on the limited supply of arable land, will have quintupled.

The total population of the developing countries as a group, 3.3 billion in 1980, will rise to over seven billion by 2025, and to over 8.5 billion by 2050. Of this total, Africa's population will be 2.3 billion, representing a tenfold increase during the course of the preceding 100 years. A century from now the world's population will

total about 11 billion. So much, then, for the supposed end of the population explosion.

III

Now what do these projections mean for human society over the coming decades – say, over the lifetime of children born in the 1980s? To what extent will this expansion in numbers absorb the resources that could have improved the quality of life in impoverished nations? What human values are likely to be curtailed in order to sustain that expansion? And how will international relations, both political and economic, be affected in a world with two or three times its present population? Answers to such questions must, of course, involve speculation, but enough is known today about demographic effects to provide some general outlines.

One can begin by grouping the consequences of population growth into two broad categories. First are the effects that bear on the pace of national economic development and on political stability and human rights in the developing countries. These effects, seriously detrimental on both counts, loom increasingly large to the governments of many poor countries. And second are the effects on the international system: principally, the perpetuation of the gap between rich and poor countries and all that implies for international economic and political relationships[1].

At the national level, rapid population growth translates into a steadily worsening employment future, massive city growth, pressure on food supplies, degradation of the environment, an increase in the number of the 'absolute poor', and a stimulus to authoritarian government. Each of these will be discussed in turn.

Over the 20 years from 1960 to 1980, the working-age population (15–64 years) of the world's developing countries increased by 730 million, to reach a total size of 1860 million. Over the 20 years, 1980–2000, this total will increase by 1150 million. These are people already born. Their numbers up to the end of this century are not subject to the vagaries of forecasting trends in reproductive behaviour. How will they secure economic support?

One way or another, most of them will find at least a foothold in the economy. Unemployment is an option few can afford in poor countries. It is equally apparent that even with optimistic assumptions of renewed vigour in the world economy, modern-sector jobs with high productivity will not be available in remotely sufficient numbers. Indeed, the proportion of the labour force in such jobs, a sensitive indicator of development success, may well decline in some countries, reinforcing the dualistic nature of their economies.

Agriculture too cannot indefinitely expand its employment. The ratio between land area and population is already at very low levels. In India between 1953 and 1971, a 66% increase in the number of rural households was accompanied by only a 2% increase in the cultivated area. The number of holdings of one acre or less more than doubled to 35 million, and the average size fell to 0.14 acres. Land subdivision eventually yields plots too small for subsistence. The trend, therefore, over recent years has been for agricultural employment to decline in relative terms even in the poorest and economically most stagnant countries.

Under optimal conditions labour-intensive manufacturing would take up the slack, producing both for the domestic market and for export. But the reasons that in practice make for much slower than optimal employment growth in manufacturing are all too familiar.

What labour-absorption possibilities are left? The short answer is the service sector. Once regarded as a manifestation of post-industrial affluence, the service economy is now increasingly evident even among the poorest nations of the Third World. Government itself, on both its civil and military sides, is a major employer: in Kenya, in the 1972–80 period, for example, the public sector accounted for two-thirds of the growth of wage employment. Small-scale trade and unorganized services of all kinds serve as a reservoir for the underemployed, yielding marginal private subsistence, but in many situations effectively zero productivity.

Much of this low-grade employment growth goes into urban areas, swelling cities far beyond their real economic base.

Up until the present decade the absolute increases of population in the developing countries have been greater in rural areas: in the decade 1970–80, for example, 340 million persons were added to rural areas, 321 million to urban areas. In the future, the balance is projected to shift. In 1980–90, UN forecasts show 320 million added in rural areas, 481 million in urban; in 1990–2000, the corresponding figures are 219 million and 662 million[2].

Thus, despite the fact that the rural population of the developing countries will continue to grow into the twenty-first century, the bulk of future population increases will be channelled into the cities. For several decades these cities have been growing at rates of 4 or 5% per year, rates that double their sizes in less than 20 years.

Over the last quarter of this century the number of Third World cities with populations above ten million is projected to increase from three to 21. Huge urban agglomerations are, of course, known in the West: the New York–northeastern New Jersey metropolitan area, or Tokyo–Yokohama, both with populations close to 20 million, or Los Angeles and London. These are now, however, growing slowly if at all. They have built up housing stocks, physical infrastructure, and public amenities over many decades of heavy investment – yet their maintenance problems are acute. The giant Third World cities – Mexico City (31 million by 2000), São Paulo (26 million), Shanghai (23 million), Bombay and Jakarta (each 17 million), and so on – will have doubled or more in the last quarter of this century. These sizes are such that any economies of location are dwarfed by costs of congestion. The rapid population growth that has produced them will have far outpaced the growth of infrastructure needed for even moderately efficient economic life, let alone amenity for their residents.

These massive urban populations, however impoverished, must be fed. But food production in many parts of the world has not kept up with population growth.

It is not technically difficult to increase food production at rates sufficient to maintain per capita consumption, or even to keep up with rising demand as consumer incomes edge upwards. Even in extreme cases such as Bangladesh or the countries of the African Sahel, agronomists can identify ways to raise crop yields. Yet post-war experience has been one of recurrent food crises.

World Bank estimates of trends in per capita food output in the 1960s and 1970s are as follows (% per year):

	1960–70	*1970–80*
Low-income countries	0.2	−0.3
Middle-income countries	0.7	0.9
All developing countries	0.4	0.4

Regionally, the worst performers were Africa, where the 1970s saw per capita output decline by 1.1% annually, and South Asia, where there was zero growth. For the low-income countries as a whole – with a population of 2.25 billion – production over the 20-year period failed to keep up with population[3].

Part of the reason for this poor performance lies in the social organization of agriculture: regressive tenancy arrangements; inadequate credit, storage, and marketing systems; inordinate government regulations; and so on. In addition, however, and underlying many of these constraints, there is the basic conflict between pricing policies designed to enhance agricultural productivity and policies designed to cater to the immediately pressing demands of urban consumers. In this conflict, blunted farm-level incentives are the typical outcome.

Agronomy tends to take for granted the stability of ecological systems. Yet good agricultural practices are very evidently threatened by the inexorable build-up of rural populations. As agricultural land is expanded to its geographical limits, but still at bare subsistence levels of production, ecological vulnerabilities are exposed.

In particular, high rates of population growth have been a major factor increasing the demand for firewood, which has led to widespread deforestation in many developing countries. In these countries the estimated 1.3 billion people who depend on firewood for fuel are cutting it faster than it is being replaced, with resultant damage to flood control, arable lands, power production, and household economics. Silting up of dams, caused by clearing of watersheds, is reducing their useful life by 50%. In Tanzania, firewood has become so scarce that each household spends 250–300 working days per year simply gathering its wood supply. In China, 70 million of 170 million households – 300 million people – suffer serious fuel shortages for up to six months a year. In much of West Africa, families that traditionally cooked two meals a day can now cook only one a day or one every other day.

During my tenure as president of the World Bank I coined the term 'absolute poverty' to refer to a condition of life so characterized by malnutrition, illiteracy, and disease as to be beneath any reasonable definition of human decency. It is a term that can be applied across countries, irrespective of differences in country-specific definitions of the poverty level. In 1980 the Bank estimated that 780 million persons in the developing countries (excluding China) lived in absolute poverty. As a proportion of the total population this was estimated to have decreased over the preceding two decades (except in sub-Saharan Africa), but the absolute numbers had increased.

High population growth rates severely limit the progress that can be made in reducing the number of absolute poor. In sub-Saharan Africa, expected population growth would increase the absolute poor by two-thirds between now and 2000. But with a more rapid fertility decline the increase could be held to 20%.

IV

Rapid population growth, in sum, translates into rising numbers of labour-force entrants, faster-expanding urban populations, pressure on food supplies, ecological degradation, and increasing numbers of 'absolute poor'. All are rightly viewed by governments as threats to social stability and orderly change. Even under vigorous economic growth, managing this demographic expansion is difficult; with a faltering economy it is all but impossible. Perceived political threats, actual or

anticipated, elicit a strengthening of administrative control over the population. I am not asserting that population growth is the dominant force behind the trend towards authoritarian govenment in the contemporary world, but I do see it as a major contributor.

This contribution is especially evident where population growth is associated with ethnic or communal differences. Many communal tensions are rooted in expectations of adjustment in political representation as demographic change occurs. The politicization of census-taking in Nigeria is a relatively benign example. The recent killings of Bengali migrants in Assam show the problem in its extreme form. In such cases an authoritarian response by government is to be expected.

In addition to the administrative consequences of rapid population growth, the absolute size of a population also has administrative implications. Today's most populous developing countries are ten times or more the size of the larger of the now-developed countries at the beginning of their industrialization. France had a population of some 30 million around 1800; Japan was about the same size in 1850; Britain in 1800 had fewer than ten million people; the United States in 1850 about 24 million. The legacy of administrative technology left by such countries may have little to offer even medium-size developing countries in the contemporary world. Simon Kuznets in his 1971 Nobel Prize acceptance speech pointed out that Third World countries face 'a long period of experimentation and struggle toward a viable political framework', and that economic advance for them was contingent not only on adapting to their own needs the available stock of material technology but also, and even more, on 'innovations in political and social structure'[4]. The political formats emerging from contemporary efforts to mobilize and govern vast national populations have long-range implications not only for the course of economic growth but also for the kinds of societies that result.

Authoritarian responses can be addressed to the causes of rapid population growth – continued high fertility – as well as to its consequences. China is the pre-eminent example here. Since 1970 it has devoted a part of its considerable administrative capacities to promoting a drastic decline in family size. It is currently endeavouring to institute one-child families. Such policies represent the outcome of the deliberate assessment of the urgency of dealing with rapid population growth. In effect, China's leaders have concluded that the political difficulties of undertaking those actions were outweighed by the anticipated adverse consequences of delay or adoption of more gradualist, voluntary measures.

There is accumulating evidence that rapid population growth is leading toward more pervasive regulation of social life in many societies. Curtailed freedom of movement within countries is one such constraint that may well be more widely practised in the future, as governments gradually acquire the means to impose it[5]. Restraints on reproductive freedom may similarly become more common in cases where governments through incapacity or unawareness have allowed demographic pressures to build to extremes. I am not speaking here of government measures aimed at creating greater social responsibility in the reproductive decisions made by families, but of coercive government intrusions into the decisions themselves – forced sterilization for example.

There will almost certainly lead to or be accompanied by increasingly harsh actions by families themselves: higher rates of abortion following the birth of the third or fourth child; use of pregnancy tests to determine the sex of an unborn child, followed by abortion of female fetuses; and rising rates of female infanticide. In November 1982, for example, the *China Youth News*, alluding to reports that under

pressure from the government's birth control programme parents were once again killing their girl babies, stated: 'Some of these unfortunate children are left by the roadside or abandoned on street corners while others are even drowned. . . . If this phenomenon is not stopped quickly, then in twenty years a serious social problem may arise; namely that a large number of men will not be able to find wives.' The paper went on to note that in certain rural areas three out of every five surviving babies were male[6]. If such reports are correct, they would indicate that one-third of the female infants had been killed.

If present growth trends continue, I expect such coercive measures by governments and such brutal actions by families to be common by the end of the century.

V

The greater part of the adverse consequences of rapid population growth are the effects I have described, those felt by individuals, families, and national governments. These effects, of course, may be reason enough for concern by the broader international community, simply on humanitarian grounds. But the international order is also affected in more tangible ways. The continuing shift in the world's demographic centre of gravity towards developing countries, and towards the poorer among them, has important implications for economic relations between states. Political instability within nations not infrequently spills over into the wider international arena. Just as certain desirable development options that once were open to particular countries are ruled out as population numbers mount, so a similar narrowing of possibilities may confront the international system.

At the level of the international economy, differential demographic growth contributes significantly to maintaining and even widening the income gap between rich and poor countries. Between 1955 and 1980, for example, per capita income in the United States, in constant 1980 dollars, grew from $7000 to $11 500. In the same period in India, it grew from $170 to $260. What had been a gap of $6830 in 1955 almost doubled in a quarter-century to $11 240 in 1980. In 1980 the developed countries, with 25% if the world's people, produced 77% of the world's output. Eighteen percent of the output was earned by the 28% of the people living in the middle-income developing countries (Brazil, Turkey, etc.). And only 5% of the world's output was shared by the 47% of the people living in the low-income countries (India, China, sub-Saharan Africa, etc.).

To maintain income, capital per person must be maintained; a lesser rate of population growth releases resources for increasing capital per person. Here again the contrasts between developed and developing countries are large. If all investment in Bangladesh, during 1980, had been allocated to new workers, each person would have had less than $1700 invested on his behalf. The comparable figure for the United States was $190 000.

The prospective growth patterns I have described make virtually certain that the existing economic differentials will continue well into the next century.

Contrasting growth trends in the population of labour-force age accentuate the differences in employment opportunities and in the relative prices of the factors of production between developing and developed countries. During the rest of this century, the population in the critical young-adult age group (20–40 years) in the developing countries will be expanding at the rate of 2.6% per year, while the

corresponding figure in the developed world will be one-tenth of that rate. The contrasts in absolute numbers are even more telling. Between 1980 and 2000, the developing countries will see the number of young adults increase by more that 630 million; the developed countries, by merely 20 million. The corresponding figures during the preceding two decades were 350 and 60 million.

These demographic trends in developing countries will exert a powerful force toward keeping real wages down. If political stability is maintained, they will tend to keep the labour force docile and pliable. In countries that succeed in combining such conditions with effective educational and health systems, the resultant abundant supply of labour will constitute a formidable asset in competing with the industrialized countries in international markets for mass-produced goods. Under conditions of relatively free trade and international mobility of capital and entrepreneurship, industry would tend to shift production to low-cost areas. The result could be massive and rapid structural change in the world economy through the relocation of entire branches of industry from the developed to the developing countries, with far-reaching employment consequences.

The developed countries obviously would not permit such an outcome, however compelling the global economic logic that supports it. Instead it is likely that the principles of free trade and capital mobility, principles which have served the world economy well in the postwar years, would increasingly be called into question.

I discussed earlier the strains put on national development efforts by rapid population growth. Amplified by the rising expectations that result from increased exposure to the outside world, dissatisfaction of significant segments of the population with their status is now growing in many countries. The weakening and eventual breakdown of social institutions that have accommodated poverty, and mediated between conflicting interests in the traditional society, lead to sharpened class conflicts and regional antagonisms. The political turbulence that results is exacerbated by the demands on government made by the steadily growing numbers of those seeking access to the modern economy. Not infrequently this turbulence spills over into the international area.

In any proper accounting of the forces making for international strife in the contemporary world there are always interwoven layers of causality: domestic political forces, economic interests, the intrusion of great power rivalries, and so on. Changing demographic configurations must similarly be a factor here. The current conflict in Central America is a prime example in which demographic pressures have played such a role – one explicitly recognized, for example, in the Kissinger Commission's report[7].

One highly visible international outcome of political instability is migration. I do not refer here to the international movement of labour or of permanent settlers, regulated by governments. Rather, I mean the large but sporadic refugee movements that have punctuated modern history, and that may well occur on an even larger scale in the future. Sheer numbers here can overwhelm national borders and administrative capacities. As a striking case in point, approximately ten million Bangladeshi refugees entered India in 1971 at the time of Bangladesh's war of independence.

A final point on the international consequences of rapid population growth follows from these considerations. Popular writings often foresee a world future of general affluence, with modern communications joining all into a 'global village'. But the persistence of wide differences in national economic and social development, caused in turn partly by differential population growth, works

strongly against any such trend. Convergence towards an integrated human society is not a realistic option in such circumstances. Development paths that would have been open to a world of, say, three billion persons – the world's total in 1960 – will not be open to a population four times that size.

VI

If the preceding analysis is anywhere near the mark, policies capable of reducing rapid population growth – effectively yet humanely – deserve the highest priority in the governments of those countries now confronted with that problem. Such policies largely come down to those aimed at reducing fertility.

What can a government do if it wishes to reduce fertility? Ten years ago, in an address at the Massachusetts Institute of Technology, I sought to answer that question[8]. I pointed out that the range of possible interventions divides into two broad categories:

(1) Those designed to encourage couples to desire smaller families;
(2) Those designed to provide parents with the means to implement that desire.

Both approaches are necessary. The first sets out to alter the economic and social environment that promotes high fertility, and by altering it to create among parents a new and smaller norm of family size. This generates a demand for birth control. The second endeavours to meet that demand, helping to make the new norm attainable. Family planning services are important, but in the end can be effective only to the extent that a demand for lower fertility exists.

I proceeded in my address to spell out a number of policy actions that governments can take to help stimulate demand for fertility control. My list, I believe, remains as valid today as it was seven years ago. Among other possible measures, I emphasized the reduction of infant and child mortality; the expansion of basic education; the more equitable distribution of income; and above all else, the raising of the status of women socially, economically and politically.

Such measures, I argued, should be complemented by programmes to promote a social consensus favouring small families; by the introduction of, or at least experimentation with, incentives and disincentives encouraging low fertility; and, last but not least, by vigorous government efforts aimed at improving access to modern means of fertility control.

My MIT address discussed in detail the rationale and the essential components of such a programme. I need not repeat them here. Much of what I said was beginning to be reflected, even then, in the policy directions pursued by the leading international development agencies concerned with population matters. It had also been incorporated into the formal policy declarations of some of the major developing countries endeavouring to reduce population growth.

Has the policy worked? Can it be counted upon to deliver the result – the rapid and accelerated reduction of fertility, the urgency of which I have argued for in this article?

The questions have no simple answer. During the last decade or two the developing countries have exhibited a great diversity of development policy approaches and demographic patterns. There is diversity too in their historical backgrounds, cultural and ethnic characteristics, and attainable levels of development, all of which confound efforts to trace the causal relationship between

policy and outcome. On the basis of recent experience, however, one can distinguish at least four types of situations.

First, in a number of countries in the middle income group – epitomized by Brazil – rapid fertility decline has begun and is proceeding apace, even though the policies pursued by the government have little resemblance to the policy package outlined here. One might be tempted to conclude that in such countries the classic mechanisms of the developed nations' demographic transition are at work obviating the need for an activist population policy.

There are, on the other hand, a number of societies which have followed the policy prescriptions summarized above and in which fertility rates have fallen. South Korea, Taiwan and Sri Lanka are perhaps the best examples. There is an element of circularity in interpreting their record in reducing fertility as validating the policy package in question, since to a significant extent the policy itself was fashioned from analysing that record. Still, it can be persuasively argued that measures that worked there will yield similar success at least in those countries of the developing world that possess administrative capacities approaching those of Korea, Taiwan or Sri Lanka.

A third example is the special case of China, where fertility reduction has been achieved through active government intervention that goes well beyond the kind of policy package I proposed at MIT. Chinese policies have achieved notable progress in changing traditional social norms regarding large families, and in providing effective family planning services. Nevertheless, the spectacular reduction of fertility in China was greater than could reasonably be expected from the provision of family planning and the overall process of development. Such policies could hardly be expected to result in a spontaneous demand for and substantial achievement of the one-child family, the central objective of current Chinese policy. The compulsion and coercion added to the Chinese family planning programme demonstrates that in the judgement of the Chinese government the standard policy package was simply not enough. Strong sanctions, the government concluded, were absolutely necessary if the demographic objectives it had formulated in the name of the collective interest were to be achieved.

In the preceding section, it was mentioned that the felt necessity of intrusive interference by government with parental decisions on childbearing is one of the deleterious consequences of population pressures inherited from the past. Whether or not the Chinese government has correctly assessed the nation's demographic predicament, Chinese policies do in fact underscore the limitations of the policy package I have proposed. Thus current Chinese policies may be a prototype of what is likely to be attempted in the future by other governments that conclude that the 'normal' protracted process of stabilizing their population must be drastically shortened.

A fourth group of countries – and from the point of view of the world's demographic future the most important – is made up of those in which the onset of fertility decline has not yet occurred. These countries, which include most of the world's poorest populations, comprise some 1.1 billion people in Africa, South Asia, and Latin America. What are the prospects for the policies I advocated at MIT working in these nations?

The evidence of past performance seems discouraging. In some of the countries in this group – Pakistan, for example – the principal ingredients of the policy package have been avowed government policy for decades. Countless official declarations endorse the objectives of achieving an equitable income distribution,

the emancipation of women, child and maternal health, universal basic education, and free access to family planning services. Programmes are presumed to be in place to give meaning to such words. Elsewhere – as in Kenya or Zaire, for example – the endorsements and programmes are more recent but equally emphatic.

The words are in place, but on the evidence to date the programmes are not working. Fertility is unaffected. Why is that so?

It is important to get a grip on the correct answer to this question. Otherwise, policies that have failed to bring results in three decades, say, in Bangladesh, may be recommended to, say, Nigeria, only to find, 30 years from now, that the transplant, too, was unsuccessful.

Part of the answer lies in lack of political will by governments to accord population policy the priority it deserves on the national agenda. What amounts to virtually the same thing, sensitivity to the gravity of the adverse consequences enumerated above may simply not have penetrated to the top echelons of government. Anyone with experience at these levels is familiar with the difficulty of focusing on medium-term and long-term issues in the face of a host of more immediate problems clamouring for attention. The most tangible effects of this year's high fertility rate will not begin to show up for 15 or 20 years – a lifetime away in the time-scale of political life.

Political will alone, of course, is not enough. An effective fertility reduction programme clearly requires an appreciable degree of adminstrative capacity. Experience has shown that this can best be achieved by greater decentralization of responsibility for the management of the programme.

Effective results in the promotion of a social consensus favouring a smaller family norm, and in the provision to families of the modern means of fertility regulation to achieve it, almost require as a precondition the development of a more coherent community voice at the local level. This clearly has been an important element in the striking successes in family planning in recent years in such societies as Indonesia and Thailand.

The administrative burden on national government can also be eased by placing greater emphasis on nongovernmental efforts in distributing contraceptive supplies, both nonprofit and commercial. It is too readily taken for granted that governments must necessarily assume the major operational responsibility for distribution of family-planning services – even in those settings where they have obviously been unable to deliver a wide variety of other basic services.

These observations suggest ways in which the obstacles in the way of progress towards low fertility might be overcome in countries which have yet to experience significant reduction or where early successes have faded.

But the most important single step that any nation can take to reduce its rate of population growth is to establish a frame or a plan within which all of these measures can be formulated and against which progress can be periodically evaluated.

Each nation experiences a rapid rate of population growth should, therefore, examine past trends and future prospects and come to a judgement of whether projected population levels are optimal in terms of the social and economic welfare of its people. If they are not, what are acceptable quantitative goals and how can they be reached?

If nations had established such goals ten years ago, no major developing country, with the possible exception of China, would now be satisfied with its demographic progress during the past decade. Even China, which has set a target of stabilizing its

population at 1.2 billion people, would have to recognize that it is likely to grow to a total of at least 1.4 billion.

The problem today is not one of a failure of governments to agree that population growth must be limited if social and economic development is to be maximized. Instead, it is an unwillingness to recognize that insufficient progress is being made in reducing fertility and that if this failure is to be overcome, additional political and financial capital must be spent in pursuit of that objective.

As a foundation for such action, country fertility targets must be set for specific time periods. Realistic policies can then be introduced which will lead to desired family sizes consistent with those targets, and family planning services can be provided to permit couples to achieve them. Reports to the nation each year – analogous, in some ways, to the World Development Report published by the World Bank – on the degree to which the overall targets, and the necessary supporting actions, are being realized would provide an assessment of the progress achieved. Such reports would introduce a discipline that would lead, over a reasonable period – say five years – to an effective fertility reduction programme.

The reports would indicate where greater programme efforts were needed, and would identify those signal successes – and most countries have them – that could be mined for programme insights helpful elsewhere. The managerial value, at both local and national levels, of comparing accomplishments of local government units against each other and against absolute standards, is hard to exaggerate.

A special word should be added about formulating national population plans in sub-Saharan Africa. This area has a unique set of problems. It has the highest population growth rate of any region in the world, the lowest capability for absorbing such growth, and the weakest programmes for limiting it.

During the 1970s, population in the area increased at 2.7% per year, compared to 2.5% in the 1960s. Growth rates are likely to accelerate even faster in the 1980s. Excluding Nigeria, per capita income declined during the 1970s and has declined by 2% per year in the 1980s. Life expectancy at birth was only 49 years in 1979; fewer than four out of every ten adults are literate; and only one out of three children survive to adulthood in the poorest countries. Only 5% of married women of reproductive age are using modern contraception, and yet politicians have been reluctant to propose limiting family size because the demand for children is extremely high (desired family size is six to nine children).

Sub-Saharan Africa's population will double in the next 20 years. The important question is whether in the next half-century the population will merely triple, or whether it will swell to five or six times its present size. What the governments and people of these countries must face, in their consideration of national population goals, is that failure to act quickly to reduce fertility voluntarily is almost certain to lead to widespread coercive measures before the end of the century. And in the meantime, social and economic distress will increase and be widespread.

VII

These then are the critical components of the role of national governments in this issue. These governments bear a heavy responsibility, and rightly so, in fashioning any effective and humane solution to the world's population problem.

There is also, of course, an important role for the international community. The most important help that community can give is to increase its support for high

rates of economic and social advance throughout the developing world and, in particular, in the low-income countries.

This will require far stronger resistance to the increasing pressure for protectionist barriers to the exports of the developing countries, a longer-term approach to the debt crisis and to the future financial requirements of the middle-income countries, and a much greater recognition of the need of the low-income countries for larger flows of concessional aid.

All these issues have been addressed before. It is suggested that the role of the international community, with specific reference to the population problems, is a threefold one.

First, it is to help provide technical and material assistance to population programmes in high-fertility countries. The assistance must be on a scale adequate to ensure that these programmes, at least in their early years, are not constrained by lack of resources and can in fact operate with a reasonable degree of efficiency. Clearly, realism dictates that the limited volume of such assistance likely to be available for population issues should not be spread thinly on peripheral programmes that only indirectly influence fertility levels. Family planning and associated health and nutrition programmes should be the major beneficiaries.

Second, the international community should continue to work towards easing the inconvenience and enhancing the safety of fertility regulation, through continuing support of contraceptive research and development. Programmes relying on coercion need pay little attention to either. But, for the voluntary programmes we are concerned with here, a wider choice among safer and more effective methods will surely enhance programme results.

These two are the traditional areas of international assistance in population – the dominant concerns, for example, of the major donor agencies in the field such as the UN Fund for Population Activities, the US Agency for International Development, and the World Bank. However, there is also a third area, in its own way perhaps as important as these. It is the development and transmission of relevant research and analysis: interpretations of the accumulated lessons of historical and contemporary experience, proven techniques of demographic and policy analysis, and appreciations of the ways that particular institutional settings influence programme performance. It is at least arguable that this third area promises the highest returns for an international contribution to the resolution of the population problem in today's high-fertility countries.

VIII

Let me return, in closing, to the issue of urgency that was emphasized at the outset. The fuzziness of policy instruments and the delay in obtaining results have dulled the sense of urgency that the population problem generated 20, or even ten, years ago. Elsewhere, the evident signs of progress in many places have instilled a self-congratulatory mood. If permitted to prevail, both these unrealistic attitudes will weaken national population efforts and undercut international support for them.

The demographic penalties for procrastination and delay are inexorable. For example, if Nigeria were to begin to introduce now those policies which would permit it to achieve replacement level fertility by the year 2000 – instead of in the year 2040, as is projected in Table 3 – its population would level off at about 227

million instead of 600 million. Similarly, were Bangladesh and Kenya to reach replacement level fertility in 2000, these populations would ultimately stabilize at 200 million and 54 million, respectively, instead of the 412 million and 153 million projected in Table 3.

Thus, immediate and much more effective action to bring about declines in fertility levels – by encouraging the desire for smaller families and providing the means to implement that desire – would make an enormous and decisive difference. Policy decisions today must be seen in terms of a choice between a difficult but barely tolerable national and global population status and one that is intolerable in terms of human welfare and world peace.

In the end, population growth in most countries will surely be halted substantially below the levels shown in Table 3. That will happen either because of humane and voluntary measures taken now, or because of the old Malthusian checks. Or perhaps even more likely, in tomorrow's world, it will occur as a result of coercive government sanctions and the recourse by desperate parents to both frequent abortion and clandestine infanticide.

For the great majority of mankind still experiencing high rates of population growth, action now to initiate, or to accelerate, fertility decline is imperative.

Notes and References

1. Supporting data for this analysis are drawn for the most part from World Bank materials
2. *Patterns of urban and rural population growth* (1980), United Nations, New York
3. *World development report* (1982), World Bank, Washington DC
4. Kuznets, S. (1973) Modern economic growth: findings and reflections. *American Economic Review*, **63**, 256–257
5. China has employed direct mobility controls, restricting movement from rural to urban areas, since 1950
6. Schell, O. (1984) A reporter at large. *The New Yorker*, **January 23**, 81–82
7. *The Report of the President's National Bipartisan Commission on Central America* (1984), Macmillan, New York
8. *The McNamara Years at the World Bank: Major Policy Addresses of Robert S. McNamara 1968–1981* (1981), Johns Hopkins, Baltimore, pp. 377–435

Sustainable forestry development

Emil Salim
Minister of Environment, Indonesia

Introduction

In the past decade or so a new consciousness, increasingly shared globally, has arisen. Its rise was caused by shared experiences and observations which have forcefully entered our thinking and among which two are of particular significance.

(1) A growing conviction concerning the interdependence that links nations and their respective efforts and endeavours; national activities which, in their totality, can be referred to as the processes of development.
(2) A growing awareness of the intricate and inseparable linkages and interdependence between development, population and the environment; an interdependence clearly visible within nations as well as between nations in a global context. It is a web of interdependence that has a tremendous impact upon the wellbeing of nations but also upon the globe as a life-support system.

This new consciousness lies at the base of present worldwide efforts to reconsider the relations between nations and their development activities, and efforts to seek new patterns of global cooperation. More than just cooperation, we must find new configurations for sharing our global responsibilities if we are to ensure lasting improvements in human wellbeing worldwide and the continued viability of our world itself.

All of these considerations have found expression in a number of concerns that are shared not just by policy-makers but by the public at large throughout the world. The first is the concern about the disequilibrium between rates of change in populations and changes in resources, environment and development. To cite one aspect, the pressures created by this disequilibrium have resulted in the depletion of natural resources faster than they can be regenerated. Hence their productivity has become reduced and this, in turn, will undermine development.

The second concern pertains to the responsibility of present generations to provide for the wellbeing of generations still to come. Ways of development and of resource use have to be such as to meet this concern and this underlies our present efforts to develop and implement patterns of sustainable development.

Third is the concern for what is observed to be the widely divergent rates of resource use coupled with equally divergent capabilities to regenerate depleted resources. It is in this context that a reconsideration of global cooperation and responsibility sharing is of the greatest significance.

The need for such cooperation is particularly critical in the case of natural resources which, on the one hand, provide national exploitation and utilization options and, on the other hand, constitute a vital part of the global ecosystem. Moreover, such natural resources lie within the boundaries of sovereign nations but they possess transboundary functions that are essential to all throughout the world. Tropical forests constitute such a particular resource.

National asset and global function

Undeniably tropical forests form a prime, and often a primary, asset of nations possessing them. As such tropical forests constitute:

(1) a source of income; domestic, local, provincial or regional incomes;
(2) a source of employment;
(3) a foreign currency earner, often of primary or secondary importance (in the case of Indonesia, second only to oil);
(4) an energy source (in the form of fuelwood) and a source for building and construction materials;
(5) a potential source of land once forested lands have become converted to other uses such as agriculture and horticulture, plantations, new settlements (for transmigrants, for instance), and so on.

In a national context, therefore, tropical forests as an asset can be used to meet a broad range of subsistence and development needs. The use of that asset must now be managed in such a way that its sustainability can be safeguarded and that a balance can be maintained between development and environmental imperatives.

While this is a difficult enough problem, it is further compounded by the earlier mentioned global divergence in resource use and resource demand. The need to earn foreign currencies coupled with adverse global economic and marketing conditions and the demand for forest products from abroad might cause a nation to step up its forest-resource utilization rate. This might reach a pace beyond the present capability of such a nation to regenerate its forest resources.

In performing its global ecosystemic functions tropical forests constitute, among others:

(1) an atmospheric purifier, maintaining the quality of the air we breathe;
(2) a factor affecting global air temperatures;
(3) a factor affecting global weather, rainfall and other forms of precipitation and other climatic phenomena;
(4) a factor affecting erosion, leaching and other forms of soil-quality depletion, sedimentation and so on;
(5) a genetic repository, a natural bank of genes possessed of great potential to meet future food and medical needs. Though a lot has been claimed for genetic engineering, it cannot invent or create new genes. It rearranges the genes known to men and tropical forests contain a great wealth of genes that are still unknown to us. The advent of genetic engineering should increase rather than diminish the value of tropical forest as a genetic repository.

It is for the sake of the functions and of the potential possessed by tropical forests as much as for their ability to meet present human needs that tropical forests need wise, global management.

Bringing the issue down to its essential elements, the problem is how to reconcile the two aspects of tropical forests:

(1) the aspect of tropical forests as an asset of development which provides a range of utilization options in meeting needs and demands;
(2) the aspect of tropical forests as a vital national and global ecosystemic factor and also as a factor to ensure that the world remains viable for future generations.

Such a reconciliation should find expression in principles that form the base of what could be called sustainable forestry development. This will not be an easy assignment for, even in a national context, development and ecosystemic or environmental factors interact in different ways in different places. Environmental resources provide the basis for development and, conversely, the pace and objectives of development, its substance, location and the distribution of its benefits will determine the state of the environment.

In an international context there are a great many additional variables affecting the equation of development and environment, of development and tropical forests. To cite but a few, there is the uneven distribution of the use and demand for forest resources, the uneven distribution of those resources themselves, and the uneven distribution of capabilities to deal with resource depletion.

There has developed over the past few years an increasing awareness of the deforestation/degradation of tropical rain forests. The perception that these forests are being destroyed with the attendant biological, economic and social losses, particularly by developed countries outside the tropical region, comes at a critical time for governments of developing countries.

Given the fall in world oil prices (and commodities in general) and effective devaluation of local currencies, the pressures on the tropical forest will no doubt increase. However, there are also opportunities to ameliorate these pressures by reinforcing development strategies, specifically, increasing agricultural productivity, greater industrialization and population control. The relationship between population growth and land use practices has received extensive attention. The current performance does little to maintain a degree of optimism for future potential. The essence of conservation is increasing productivity. The alternative is a reduction in current consumption – a policy that few governments anywhere in the world could presently countenance.

The world needs to consider the concept of economic rent as a strategy or incentive for the conservation of tropical forests. Specifically, such a rent would be additional to the orthodox view of rent as a market-derived determination of resource values insofar as it would represent a transfer payment from developed countries in particular for the non-tradable (and often unmeasurable) values such as the diversity of plant and animal genetic resources and potential climatic influences. Currently, the conservation of the tropical forests benefits the developed countries, but the governments of developing countries do not receive any compensation. Further, these benefits are in addition to the opportunity costs of following less than the optimal rate of exploitation the governments of developing countries might pursue in the absence of other external benefits.

We should therefore perhaps view the exploitation of the tropical forest, in which technical and biological knowledge are seriously lacking, as a non-renewable resource. As such, the concept of user cost, i.e. the current value of future benefits

that may be foregone by reason of a greater than optimal rate of exploitation should be a fundamental criterion in resource-use planning.

This is essentially the focus of the Tropical Forest Action Plan (TFAP) and its five-point strategy as articulated by FAO.

The notion of some developed countries that there should be some 'irreversible minimum' of preservation of tropical forest ecosystems for environmental stability should be explored for quantification although it is almost exclusively based on biological criteria. Social and economic consequences (both positive and negative) must also be given equal attention. This is not to suggest that 'market' solutions are socially optimum but rather that the public use of private interest generally receives little attention. It appears that the public sector all too often prefers to resolve crucial issues through legislation and regulation even where such institutions are insufficient for the task. The people who live around and in the tropical forests must have tangible evidence that their individual or collective welfare will not be impaired by conservation efforts. Consequently, public programmes to promote conservation should explore the use of incentives of a market-like nature to influence private interest. Simply stated, we know why people cut down trees, but we know very little of what it would take to encourage the regeneration of trees. This needs to be studied within the pattern of sustainable forestry development.

In summary, we might well advance the proposition of rent compensation for values put on the tropical forests over and above those that could normally be appropriated in a convential market-type environment or within national boundaries. Such a form of compensation could be viewed as a kind of environmental rent.

The response to such a proposition by the developed countries will very probably be less than enthusiastic. It may be argued that their technical and financial aid projects are directed to raising productivity in natural resource use, particularly in agriculture, and hence make a significant contribution to the conservation of the tropical forests. More fundamentally, they would strongly argue that such a rent is impossible to quantify, and even if it were, it should properly be viewed as an international or global resource that should be shared on moral or humanistic grounds.

The rejoinder to these responses should simply be twofold:

(1) The strategy of greater industrialization by the developing countries is hampered by existing tariff structures, especially for semi-processed goods, that should be given particular concessionary treatment in the current GATT (General Agreement on Tariffs and Trades) round.
(2) The concept of a rent payment is practised to a limited extent in North America by private and semi-public agencies directed to the preservation of wetlands (marshlands) and other forms of wildlife habitat under private ownership that are felt to be threatened. The major failing of such an approach is that the amount of the rental payment was often too close to the opportunity cost associated with the current land use, at least initially, to elicit the desired changes.

In short, the notion of a special environmental rental payment should receive serious consideration and at the very least, should result in the reduction of other constraints in the developed world that hamper economic development in countries rich in tropical forests.

Role of forestry in Indonesia

The world's total heritage of tropical forest amounts to some 2970 million hectares, of which roughly 40% is tropical moist forest. More than half of such moist forests, constituting some 33% of the world's total forest wealth, is found in Brazil, 10% of the total is found in Zaire and another 10% in Indonesia.

In the developing countries such moist forests are being opened or destroyed at the rate of 11.4 million hectares per annum or 21.6 hectares per minute. Shifting cultivation, the establishment of new settlements, dairy farming and the forest industry are among the major reasons for opening forests.

In Indonesia, out of a total land area of 192 million hectares, roughly 143 million hectares is forest land. Around 113 million hectares are classified and designated as permanent forest land. The land allocated as permanent production forest cover 64 million hectares, in addition to 30 million hectares to be converted for other purposes. Each year, about 550 000 hectares are opened to accommodate shifting cultivation, new settlements, and the timber industry.

The demand of developed countries for tropical timber has risen steadily. For Indonesia as a developing country, there is an eagerness to earn foreign exchange as well as to use the competitive advantage provided by the forest to the fullest possible extent.

Although the natural forested area in Indonesia exceeds 143 million hectares, it is being depleted, for many purposes, at such a rate that it could lead to serious environmental disruption. Because the Indonesian tropical forest benefits people in so many ways, the alarming rate of forest depletion should be a matter of grave concern.

The favourable climatic and ecological conditions of the country also make it possible to establish fast growing tree plantations at less cost than in most consumer countries, many of which are situated in temperate regions. Unfortunately, Indonesia up to now has not been able to exploit this inherent advantage and there is an urgent need to bring about a change in this situation.

Despite the rather bleak picture, there is a reason for optimism based on the success stories of several countries. Deforestation can be arrested and the trends of forest depletion can even be reversed.

A recent development in the Indonesian economy is the rapidly growing rate of timber exports. Within the short period of about 6 years, from 1974 to 1980, the value of Indonesian timber exports had nearly tripled.

It was US$ 720 million (or 38% of total non-oil exports of US$ 1905 million) in 1973/74 and jumped to US$ 2125 million (or 34% of total non-oil exports of US$ 6171 million) in 1979/80. However, since then log exports have dropped as a result of the deliberate policy of the government to emphasize the export of processed woods rather than unprocessed logs.

In terms of logs, of a total production of 4.1 million cubic metres, 125 000 cubic metres were exported from 1961 to 1965. In the period 1976–79 total production rose to 25.7 million cubic metres of which 19 million cubic metres were exported. Major importers of Indonesian logs are Japan (50%), Europe (32%), South Korea (13%) and the US (5%).

The extraction of forest products is not only for the purpose of export. Indonesia's forests also supply the firewood needed as fuel by the population. About 74% of the total population relies on wood to meet cooking and other energy needs.

The forests are also a source of the raw material for local building construction and for wood-based handicrafts and manufacturing. Further, they provide food and material for traditional medicine and medicinal practices, and are needed to maintain the water balance which is of vital importance to irrigation on which rice production relies.

In terms of genetic resources as the world's heritage, Indonesia's forests form an important habitat for such resources. About 17% of the world's bird species are found in our tropical forests which also contain some 100 unique mammals. These include the banteng which is of potentially great significance to cattle-breeding. Plants which constitute a genetic resource include bananas, sugar cane, various legumes and others. With 10% of the world's tropical forests located in Indonesia, it is clear that Indonesia is a major genetic resource nation.

Two-thirds of all the world's species are found in the Third World and half of them in tropical moist forests, including those found in Indonesia. In addition, oceans and coastal zones are also extremely rich in genetic resources, and Indonesia has a long coastline and extensive coastal areas.

There is no doubt that Indonesia is one of the richest repositories of genetic resources in the world. What implication does this have for Indonesia and for the world?

Indonesia is prepared to assume the guardianship over the genetic resources found wihtin its boundaries to the best of its abilities. In so doing, however, a number of aspects must be considered, namely:

(1) Indonesia's development needs which must be supplied by the country's natural resources;
(2) cost calculation of genetic resource conservation and economic cost-benefit calculations;
(3) cost-sharing calculations based on shares of benefit derived from genetic resources.

These three aspects are interconnected and must furthermore be viewed in the light of existing conditions in Indonesia and in the relations between nations. Those relations are very much coloured by the unfortunate but, nevertheless, real distinctions that separate the developing countries from the developed countries, the countries of the South from those of the North.

Indonesia's development efforts are aimed at overcoming the poverty that continues to be the heavy burden of the majority of our people. To do so we need land on which to grow food and land for other economic purposes. This means that we have to open our forests in order to open plantations, to produce food, to accommodate transmigration programmes and new settlements and the construction of an infrastructure. This means that considerable genetic resources will have to be sacrificed.

Although 18 million hectares (or 10% of our land area) has been set aside as conservation forests, we are not at all sure whether these will be sufficient to conserve genetic resources. Another developmental approach is therefore necessary.

Such an approach would be industrialization which would lower the demand for opening up forests. Here we are faced with a number of serious problems.

First, to industrialize we need capital goods, equipment and capital. These are to be obtained mostly from the countries of the North and under the present terms of trade between North and South we have to export much more before we can

accumulate sufficient capital and can afford the purchase of equipment and industrial machinery.

Second, the domestic market is too limited for our industrial products because of generally low incomes. We must therefore export our products, but we are handicapped by the protectionist policies imposed by the North. Unless some restructuring of economic patterns takes place our industrializing efforts cannot succeed and several changes are required:

(1) a speeded-up transfer of skills and technology from the North so that the South can manufacture its own industrial machinery;
(2) transfer of capital to overcome the terms of trade that are now unfavourable to the South so that capital for industrial investment can be made available;
(3) restructuring of trade patterns, including minimizing protectionist measures to facilitate the South's trading activities.

These suggested changes will take a long time to implement. In the meantime we should find other ways of development that do not cause undue destruction of natural and genetic resources.

A possible approach is the establishment of buffer zones separating production areas from conservation areas. In those buffer zones new techniques are to be developed aimed at managing the environment so that it becomes sustainable. New techniques are also needed for the sustained utilization of the forests and for the prevention of the destruction of genetic resources. Indicators to signal the presence of rare fauna and flora must be developed to alert and halt land developers.

All these efforts must be complemented by serious efforts at changing global consumption patterns linked to new pricing policies for forest products. In this way the rate of forest destruction can be slowed down.

The costs of genetic resource conservation will be considerably higher than the costs of conserving species. To conserve the banteng as a species one or two herds are enough but to conserve it as a genetic resource would require as many herds as possible because of potentially large differences in the genetic make-up of each herd.

To the cost of conservation must be added the costs of other economic benefits foregone and the value of income not earned. In general, comprehensive valuation methods and cost calculation techniques still need to be developed, together with appropriate cost-benefit analyses of environmental efforts in general.

With most of the world's genetic resources found in impoverished Third World countries it is clear that conservation costs may be too high for such countries. For that reason cost-sharing formulas should be developed.

One base for such cost-sharing formulation would be the extent of benefits derived from genetic resources and their conservation. In this context it is clear that the countries of the North obtain much greater benefits than the developing countries, although the genetic resources are physically located in those countries. In a sense, we in the South are conserving our genetic resources for the North to exploit and enjoy.

For instance, Northern crops such as wheat rely heavily on genes from the South. Conversely, Southern crops do not rely on Northern genetic resources but, instead, on those found elsewhere in the South. The same applies to livestock genes and to aquatic biota.

Many resources for the improvement of vegetable strains are also found in the South, e.g. soy beans, the winged bean and so on. Plants that are the basic

materials for medicines and pharmaceuticals are also overwhelmingly found in the South. Though such plants are being utilized for traditional medicine in the South, commercial pharmaceutical exploitation is centred in the North at great profit.

In industry, the beneficiaries of the South's genetic resources are also mostly in the North. One might also anticipate that in the near future when oil runs out, phytochemicals will replace petrochemicals based, once again, on genetic resources found in the South.

To all this can be added that the future holds many new prospects for genetic resource utilization through the developing science of genetic engineering. Its potential to create new strains of grains, legumes, etc., is huge and equally huge is its potential value; a potential US$ 50–100 billion per annum by the end of the 1980s. Most of this value will be generated in the North and will stay there.

In order to accelerate the development of industrial tree plantation as well as forestry conservation and protection, there is justification for a change of approach by the producing countries and the consumer countries, together with ample support from lending institutions. This kind of change is important in order to take account of the reality that the major contribution of forest development will come from its impact on watershed afforestation, land reclamation and rehabilitation, shelter belts and availability of wood products for domestic as well as for the world market.

Indonesia has already implemented the necessary policies to enhance its efforts in forestry-related activities based on a sound environmental concern. It will provide the nation with a forest resource that will serve fully according to its intended uses and functions.

But it looks like the efforts need to be accelerated and supported with the full cooperation of the consumer nations, because the consumer nations must also share the blame for the plight of tropical forest in the developing countries.

In an effort to achieve a steady increase in the potential of the production forests, the Indonesian government adopted and carried out the following policies and actions related to forest resource development, i.e.

(1) productive tropical natural forest will be maintained;
(2) unproductive forest areas will be rehabilitated by establishing timber estate units of industrial forest plantations;
(3) private companies will be encouraged to invest in the timber estate establishment.

To ensure proper implementation of regeneration of areas logged over by concession holders, the government imposed in 1980 a US$ 4 performance bond for every cubic metre of wood the concession holders produced. The fees are deposited in a reforestation fund.

Since 1977, large-scale reforestation averaging 160 000 hectares has been carried out yearly. But by 1985 the total area of forest plantation covered only 1.8 million hectares. These reforestation efforts had not been able to keep pace with logging and deforestation activities, while the natural forest resources are not well managed, mainly because of lack of funds.

With the average annual production of 30 million cubic metres of round wood by the concession holders, the performance bond has generated US$ 120 million yearly. By treating this sum as an equity it is hoped that we can generate US$ 480 million that can be used for timber estate and forest management purposes.

A conservation estimate of plantation establishment put an average cost of US$

900 per hectare, while the assumption for annual management costs of natural forest gives an average of US$ 5 per hectare.

Therefore, the amount of US$ 480 million has potential to be used for the establishment of 500 000 hectares of industrial reforestation. The balance of US$ 30 million can be used to manage around six million hectares of natural forest. These efforts in increasing tree plantation for industrial purposes (with annual growth of 15 cubic metres per hectare) and the area of managed forest (annual growth of 1–2 cubic metres per hectare) provide the potential for significantly greater production to supply increasing needs in the future.

These accelerated actions will guarantee or perhaps could surpass our objective of being able to produce 150 million cubic metres round wood for industrial purposes, i.e. 60 million cubic metres from natural forest and the balance of 90 million cubic metres from industrial forest plantation.

It is our fervent hope to succeed in this endeavour, but we do have problems with the terms of trade of forest products.

One of the constraints on the development of the tropical forest as a renewable resource on a steady basis is the terms of trade and lack of preferential treatment. Securing more favourable terms of trade for the export of forest products from Indonesia and the other tropical timber producing countries is a key issue.

The prices paid for tropical timber are generally on the low side. When prices are too low to fully reflect the growing and replacement costs for forest, there is little incentive to manage the resource long term.

If this situation of price policy for tropical timber is not changed then the trend to utilize forest on an unsustainable basis will continue. In fact, a renewable resource is being treated by the consuming countries as a non-renewable resource.

None of these solutions and actions will be easy to put into practice. And planting, as well as planning and changing attitudes, takes time. But a joint effort on an international scale by the producing and consuming nations, together with the financial support of various lending institutions, can make it happen.

To obtain these solutions a necessary first step would be drawing up a comprehensive picture of the forest resources available to us. Next would be to determine the allocation of the uses of those resources, an exercise that could be termed forest classification – forests that are to serve as a repository of genes (conservation forests); forests that are to be maintained for hydrological purposes, erosion control and so on (protection forests); forests for exploitation and, after their utilization, for conversion into other uses (production forests).

Such an exercise would necessarily be a national effort because the ways to which national forest resources will be put to use would depend on a nation's development objectives and activities, the size, rate of growth and distribution patterns of its population, its economic conditions, level of capabilities and so on. Incidentally, those factors also determine the rate of resource utilization that a nation can afford without jeopardizing its future and the sustainability of its develpment processes.

Once the various nations have compiled such a classification there will be a more comprehensive picture of resource availability on a global scale. For such a purpose a number of preliminary steps would be required. International cooperation for a sustainable forestry development approach compatible with the different conditions in tropical forest-owning countries would include:

(1) Consensus or a common understanding regarding such terms as conservation forests, protection forests and production forests.

(2) Determination or estimation of size of actual or planned conservation forests, their present uses (e.g. as national parks) and their management.
(3) Determination or estimation of size of actual or planned protection forests.
(4) Determination or estimation of size of actual or planned production forests, taking into consideration: (a) acreage set aside for sustainable forest product exploitation, (b) acreage expected to be converted into other uses (i.e. for plantations, for food crop production, for new settlement, etc.).

The classification of presently existing tropical forests, together with an analysis of the various factors affecting such forests, will provide us with information concerning:

(1) the present rate of depletion and exploitation in order to meet direct domestic and foreign demands, as well as the need to meet indirect demands (the need to earn foreign currencies, to pay off foreign debts, etc.);
(2) the computation of exploitation thresholds, or the rate of sustainable exploitation which takes into consideration the rates of forest regeneration (including the capabilities of a country to carry out such regeneration);
(3) the magnitude of the task of conserving forests for national purposes as well as for the purpose of safeguarding the ecosystemic functions of forests globally. This is an aspect in which global responsibility sharing is essential.

There are some strategic areas where international cooperation could be of great significance. Such cooperation could pertain directly to the conservation of tropical forests but could also, in an indirect way, provide help in modulating or modifying the rates and ways of forest exploitation; ways that would insure their sustainability.

(1) Assistance for the establishment of buffer zones around conservation forests. In addition to being a demarcation area, such zones could be developed to provide for the immediate needs of the people surrounding it (fuelwood and material for traditional construction needs).
(2) Assistance to develop, maintain and safeguard particularly critical areas inside protection forests such as upper watershed areas.
(3) Incentives to deter the export of raw, unprocessed logs, compensating for earnings foregone by assisting local timber processing industries. The development of such industries would provide them with a vested interest in sustaining forests and in sustainable exploitation.
(4) Assistance to render arable or otherwise useable presently critical lands for conversion purposes (e.g. for transmigration settlements in the case of Indonesia which is faced with the problem of managing no less than 40 million hectares of such critical lands).
(5) Assistance and investments in non-forestry based development and industrial activities by providing preferential treatment to activities which have a positive impact upon the conservation of tropical forests. For this purpose, perhaps special banking facilities could be provided through: (a) opening a 'special forest conservation window' at various regional banks (Asian Development Bank, African Development Bank, Latin American Development Bank, etc.) and at the World Bank; (b) developing special arrangements with private banks to encourage investments in forestry conserving activities.
(6) The basic premise would be that whoever is getting present benefits should pay the equivalent of a premium to ensure continued future benefits. Payments

could be made in the form of: (a) a 1% tax on imports of wood products; a measure apparently under consideration by UNCTAD; (b) a 1% tax on pharmaceutical sales and it has been estimated that such a tax could raise US$ 200 million in the US alone; (c) a 1% tax on the commercial sales of seeds. An estimated US$ 100 million a year could be raised globally by this means.

Another approach could be based on FAO's call for 'a fair return' on genetic resources. This could be implemented through the payment of royalties on genes, in the same way several countries of the North have imposed such payments on improved and 'patented' of 'copyrighted' seeds.

Still another approach would be for the repository countries of genetic resources to levy a research tax, for instance on research conducted in tropical moist forests. Conceivably, a country could also lease research rights to pharmaceutical firms or genetic engineering companies. Heavy taxes should also be placed on the approved trade of wildlife species.

The foregoing is merely an indicative list of areas of possible international cooperation. Urgently needed now is political will for genuine cooperation among countries, producers as well as consumers of tropical products, to give substance in sustainable forestry development. Only through such an international cooperation can tropical forest be exploited for the benefit of the developing countries while maintaining its global functions for the benefits of mankind.

The case of orchids

Tropical forest provides us with a natural habitat to conserve orchids. There is no doubt that all of us are drawn by the intrinsic beauty of an orchid, one of God's most beautiful creations and one of nature's most generous gifts to us. We are also aware of the joy and uplift provided to us by the fragile flowers of the orchid; a joy we would like to share with others and which needs to be cherished forever.

Such enjoyment and such sharing will only be possible for as long as there are orchids. Also, the economic benefits derived from cultivating orchids can only be sustained for as long as the presence of orchids can be equally sustained.

Preserving orchids therefore makes economic sense. And not only from the viewpoint of supply and demand but also from the viewpoint that orchids represent a potential – a genetic potential – that has been only partially tapped. Orchids, as all other living species, constitute genetic resources, each unique, some very fragile, many with known and valuable qualities, others still unknown, but all worthy of preserving and conserving.

Conserving natural orchids requires conserving their natural habitat: the tropical forest. There are problems: conserving the genetics of natural orchids; related to the economics of orchid cultivation; and its implications for international cooperation.

There are four possible methods for conserving natural orchids:

(1) to keep them in their natural surroundings;
(2) to grow the species in surroundings which closely resemble the natural environment;
(3) to grow the species in manmade greenhouses;
(4) to grow them in individual private plots.

The best way of orchid conservation is to keep them in their natural surroundings where after ages of evolution they have obtained their particular and respective niches in the environment.

The orchid belongs to the family of epiphyte plants. Most of them require trees to grow. It is in the natural environment of forest that diverse species of orchids flourish.

Orchids grow in many environmental surroundings, lowland and highland, wetland and dryland. There are species that have the capability to adapt themselves to the surroundings. There are also species that are dependent only to the local environment. In general, it can be said that orchids are 'cosmopolitans', they can grow in many countries. Even in Indonesia various species of orchids can be found from Sabang, Sumatra, in the western part of Indonesia to Merauke Irian Jaya in the eastern part of Indonesia, spread over an equivalent distance from London to Teheran.

Although orchids have a cosmopolitan adaptability, the most diverse and richest variety of orchid species are grown in the tropical forest. The very nature of tropical forest gives the orchids a fertile environment in which to grow. It is in the tropical forest that thousands of species, known and many other unknown, are growing. The genes of orchids in the tropical forest are the basic capital on which other species are cultivated.

Tropical forests are mostly located in developing countries. Brazil, ASEAN (Association of South East Asian Nations) and Zaire have approximately 80% of the world's tropical forest area, and provide the major habitat for the growth of orchid species.

But the tropical forests of these developing countries are under severe pressure of being exploited for firewood as a source of energy, for foreign exchange earnings, as a source of labour absorption. Tropical forests are also cut to obtain the soil beneath the forest, for human settlement, industrial zones, and agricultural land.

During the next 14 years total world population will increase by 50% raising the population from four billion to six billion people by the year 2000.

Indonesia alone will have an additional 60 million people, from 163 million (1985) to 223 million (2000).

It is therefore fair to assume that the total area of tropical forests is bound to decrease. Unless ways and means are found that may substitute the need for tropical forest exploitation with a significant resource transfer from developed to the underdeveloped countries through trade, aid and investments. If such a substitution can take place, then tropical forests can be saved.

In the world today, however, protectionism by industrialized countries is hampering the free flow of trade between developing and developed countries. Backlog in debt repayments from developing countries to creditor countries makes the aid programme unpopular. Economic recession makes the increase in flow of investments from developed to developing countries very unlikely. All this makes saving tropical forests an uphill struggle.

In Indonesia, the drop in oil prices from US$ 28 a barrel last year to US$ 20 a barrel expected this year, has pushed the need to boost non-oil exports. This means an increasing role for forestry as Indonesia's number one non-oil export commodity.

Under these circumstances it becomes imperative to explore new venues for international cooperation to save the world's tropical forests.

Orchid lovers have a stake in exploring these new venues, because of their dependence on tropical forests as the major source of orchid species.

A second best solution for conserving natural orchid is the development of a natural environment with similar features to the forest. Arboretums, national parks and botanical gardens can serve the role of forest as habitats of natural orchids.

This system provides the facilities not only for conserving natural orchids *per se*, but it also opens up the possibility for other uses, such as recreation, research, etc.

Another solution for conserving natural orchids is the development of 'greenhouses' in which humidity and temperature are deliberately adjusted to the need of the orchids.

The results of conserving natural orchids could well be the same as in other systems. The differences lie in the role of technology and the degree of man's intervention in changing certain aspects of the environment. This will raise the cost of conserving natural orchids much higher than with the other options.

Finally, the other possible system for natural orchid conservation lies in the orchid growers' initiative to breed natural orchids.

This may be specifically valid for rare, vulnerable or endangered orchids to prevent the extinction of these species.

All four approaches of conserving natural orchids are feasible. The difference lies primarily in the total cost involved. The less intervention by man in conserving natural orchids, the less costly is the effort. On the other hand the more man interferes, the higher will be the cost.

Developing countries have less capital and skill but more natural environment. The most appropriate method of conserving natural orchids will then be by preserving its natural forests.

Developed countries have more funds and skill, but lack this natural environment. The tendency will then be to move into the direction of the greenhouse or individual plot developments.

This process requires capital, skill, science and knowhow that may well be more available in developed rather than in developing countries. And it shifts the burden of conservation to those who can afford it.

If this trend takes place and the costs of conservation increase, then the economics of orchid cultivation become more and more significant.

When we talk about the economics of orchid cultivation, we usually think in terms of the conservational benefits and costs contained in orchids and revealed in the flow of net income. This is normal and sound economics. But it is also sound economics to distinguish between internal and external benefits, internal and external costs. Benefits and costs should not only be treated as something internal to the orchid entrepreneur alone, but it should also consider factors affecting the society as well.

In generating economic benefits from the exploitation of natural resources we should not imperil our existing wealth and assets. By depleting our wealth we might enjoy additional income, but only for some time. And at one stage we might not be able to generate any income at all from the depleted and exploited wealth.

In the case of orchids, wealth is represented by those families of species of natural orchids. By depleting the stock of species we are in fact generating income through efforts that reduce the very base of the continued resource exploitation.

The depletion of the stock of species is not revealed as costs in the market economics of the developed as well as developing countries. The sustained capacity of the stock of species as sources for hybridization is also not revealed as benefits in

the market economics. Such an imperfection of market mechanisms has distorted the real benefit and real costs of conserving natural orchids. And as such it also distorts the real value of the natural habitat and its environment for sustained growth of natural orchids. To sustain that stock of natural orchid species in a conserved natural environment is a common responsibility of all those concerned with orchids.

It is a responsibility not just of those who dwell near the habitat of orchids, not only of those countries who own tropical forests as the natural habitat of orchids, but also the responsibility of all who derive an income or other material benefit from orchids as well, and it must become part of our overall responsibility to sustain this natural heritage.

All of this means that efforts and resources must be allocated in order to sustain the continued existence of orchids. The burden must be equally shared between:

(1) procedures and users;
(2) society and governments;
(3) different societies and governments on an international level.

Equality in sharing means considering capabilities on what nations can effect, but also the intensity and magnitude of demand. Undeniably, the higher the income level the higher the demand for orchids. The demand for and the consumption of orchids is highest in countries with higher levels of income and prosperity. This puts an increased share of responsibility for maintaining the sustained existence of natural orchids on the shoulders of the countries with higher income levels and prosperity.

It is worth considering the formulation of ways and means for such international responsibility sharing in an action plan with the following ingredients:

(1) The responsibility to sustain growth of natural orchids
(2) To conserve its environment as natural habitat
(3) To correct market imperfection and carry the burden of external costs of orchid exploitation, but also to take into account the joy derived from the external benefits of orchid cultivation.

An action plan should contain cooperation to increase and expand protective areas for orchid, for the *in situ* conservation of orchids. While host countries could set aside such areas, they require international support for the maintenance and management of those areas.

Further international cooperation would be required to stop and prevent theft and deprivation of orchid species. While within countries this would be the responsibility of the respective governments, transnational transfer and trade of orchid species would require close international cooperation, especially in the case of endangered species. Such cooperation is vital if we are to enforce existing international conventions as well as local restrictions on the trade of endangered species. To prevent waste and to increase overall efficiency, information exchange and technology transfer pertinent to orchid cultivation and preservation should be encouraged. International cooperation would also be desirable and essential for the establishment of genetic resource repositories for orchids.

In order to enhance international cooperation, assistance is required from vocal lobby groups or, even, pressure groups to voice the interest of the voiceless persons who suffer because of the destruction of nature and natural habitats of millions of natural species, including orchids; to represent the interests of future generations

whose survival and welfare is at stake by the actions of the current generations; to fight for the interests of all those creatures who have the capability to enrich and enhance our quality of life.

The interests of these groups are not against development or against the utilization of natural resources. The interest of these groups lies in correcting the process of development from exploiting and destroying the environment towards sustainable development, a development pattern in which natural resources maintain their capabilities to sustain long-term development.

Orchids provide the perfect indicator for sustainable development. It is an indicator to provide us with information regarding the extent to which the environment is preserved through the process of development. It is a kind of a thermometer measuring to what extent its habitat, the natural environment of orchids, is kept healthy.

Orchids required a healthy environment. Because of its special niche in the environment and because of its vulnerability and fragility, the orchid becomes a special indicator of the state of the environment and of the state of our wellbeing.

Conclusion

The foregoing suggested approaches require further development and consideration. Be that as it may, something along these lines is required if genetic resource conservation is to take place at all. It is also a step towards repairing the disequilibrium in benefit derivation.

Above all it is clear that the conservation of genetic resources is intimately linked to economics, to North–South relations and, ultimately, to the international economic order.

In conclusion the following points are worthy of consideration:

(1) The world's genetic resources are found in abundance in tropical moist forests which are mostly located in the developing Third World, in the South. Though the countries of the South are aware of their responsibility to safeguard such genetic resources, they face the more urgent problem of ending the misery of poverty and of hunger, providing their populations with a livelihood befitting human dignity. This requires the continuation of the development process which requires the utilization of natural resources and consequently the partial destruction of our forests which form the habitat of genetic resources. Thus, the South faces a dilemma. If the forests are exploited there will be the loss of genes to the detriment of both South and North in the future. If the forests are preserved there will be a loss of land resources needed for good production and other economic endeavours.

    The dilemma is aggravated by the fact that the South cannot enter into other development efforts without assistance from the outside.

(2) The tropical moist forests also have external economics. Genes from those forests have been obtained and exploited by the North without any payment. Nor has the South received an equitable share of the benefits derived from such exploitation. The same holds for the exploitation of natural resources in general, and the lopsided relations between North and South are also apparent in the terms of trade that continue to favour the North. The problem is particularly painful if looked upon from an environmental viewpoint. After all,

> the environment relies on interdependency while environmental problems transcend all manmade boundaries. We do not see such interdependency and such transcendence in the relations between nations.

From an environmental, economic and moral viewpoint we should strive for an equitable share in the benefits and in the costs of safeguarding our shared genetic resources. There is therefore a need to share the financial burdens, to share technical skills and technology.

There is also the need to share the burden of enabling the South to develop without undue destruction of the environment. This can be realized by redrawing economic patterns and restructuring the international economic order.

Also we need to develop a new ethical outlook; one which will lead to a lifestyle that is less consumptive and that is in harmony with the earth's carrying capacity. This ethical outlook should be the basis of a renewed global solidarity; of our caring together for this one and God-created earth, ensuring upon that earth a place for all men to live in human dignity and in fulfilment of their humanity.

Protecting the atmosphere and controlling global warming

B. Lalonde
Minister of Environment, Paris, France

Rising sea levels, encroaching deserts, increasing untillable land, shifting of the world's nutritional resources, radical changes in rural economies could be some of the major impacts of the climatic upheavel that may have been set in motion. The magnitude and extent of the changes that could occur defy our imagination. The international scientific community has now predicted that these will be some of the unavoidable consequences of alterations in the chemical composition of the atmosphere, owing to the progress and actions of mankind. At the same time, a real threat weighs upon the ozone layer of the stratosphere, which protects life on earth from receiving an excess of ultraviolet rays of the sun.

A warming of the earth by several degrees Celsius may seem insignificant, but it is not. The average temperature of the globe is currently four degrees higher than it used to be in the prehistoric glacial age. At that time, northern Europe and America were covered with ice, the sea level was more that 100 metres (109 yards) lower and no one could mistake Britain for an island. Men hunted reindeer, the Mediterranean, at least to the north, was bordered by a forest of fir trees comparable to those found at present in Scandinavia and in the Alps.

The wide climatic fluctuations of the past originated in long astronomical cycles, as was suggested in 1941 by Milutin Milankovitch a Yugoslavian astronomer. However, in studying the Antarctic glaciers, those genuine archives, Claude Lorius and his French and Soviet colleagues discovered disturbing variations in the amount of carbon dioxide and methane in the air. These modifications of the atmosphere are likely to have amplified the variations (of astronomical origin) in the quantity of solar energy reaching our planet.

Be that as it may, several facts may be considered to be certain at present:

(1) During the last century, tha amount of carbon dioxide in the atmosphere has increased by 25% after remaining virtually constant for some 150 000 years.
(2) Since it was first measured in 1958, this increase has consistently been of the order of 0.5% per year, clearly showing that the natural regulatory mechanism – plants, ocean – are overloaded. No longer can they absorb the billions of tons of carbon dioxide emitted by the combustion of oil, coal, gas and wood.
(3) Concentrations of other gases in the atmosphere are increasing even more dramatically. This could contribute, if it has not already, to accentuating the 'greenhouse effect' of carbon dioxide.
(4) Combined together, these developments are likely to produce worldwide climatic changes within the next several decades, resulting in a global warming in the order of 1–5°C.

The question is not so much how to *avoid* the warming completely, since not all of its consequences are likely to be negative, but rather how to *control* it, to spread the various resulting disturbances over a greater length of time, so as to allow human societies, even the most technologically needy and deprived, to prepare to cope with them effectively.

Life on earth and mankind itself are not threatened so much by global warming as by the potential disappearance of the ozone in the stratosphere. The reality and immediacy of this threat do not mean either giving up on industrial civilization or rushing headlong towards technologies that may be difficult to harness and extremely dangerous if they are uncontrolled. Furthermore, developing countries cannot possibly be asked to bear the brunt of the effort and cost to protect the atmosphere, since they are likely to be the most resourceless under such circumstances, and the primary increase in energy consumption will not be in their countries.

Yet, we can slow down the evolution and give ourselves time to react. This presupposes some significant alteration in our production and consumption habits. These changes will not be easy to negotiate, to determine, or to live with; but many of them will have rather favourable implications for the environment, to which, let us not forget, we owe our very own existence.

The task of scientists is to enlighten us as much as possible as to the implications of our actions and decisions, but it is up to statesmen and stateswomen to spread the word. Their foremost duty is to educate. Information must be provided regularly to citizens throughout the world, about the situation and the decisions necessary to minimize the constraints imposed by it.

What then is to be done? Four directions must be considered: confronting the use of greenhouse gases other than carbon dioxide; substituting other forms of energy for wood, oil, coal and gas combustion; reducing energy consumption; and finally, reinforcing 'regulatory mechanisms' of plants and oceans.

Rare gases

Three categories of rare gases have been identified: methane, nitrogen oxides, and certain chlorofluorocarbons (CFCs). The increase in the first two appears to follow directly from the rise in world population and its food production activities. Their increase seems to be unavoidable, except where linked with energy consumption, which accounts for 25%, according to some scientists. The same does not hold true for CFCs, the prime suspect for ozone layer depletion.

All current indications are that the Montreal Protocol, which calls for a 50% reduction in CFC production within ten years, will be insufficient both to protect the ozone and to slow the rate of global warming. In fact, some models forecast that even strict application of the Montreal Protocol would fail to keep the amount of chlorine in the stratosphere from becoming two to four times greater between now and the year 2030. The only practical goal would thus be a plan to eliminate the harmful CFCs by the year 2000.

At France's suggestion, the European Community recently adopted this position, in view of a renegotiation of the Montreal Protocol which was scheduled in Helsinki in May, 1989. Two days later, the United States publicly agreed. Two days later, at an international conference on the ozone layer organized in London

by the British Prime Minister, India and China, two major countries yet to sign the Montreal Protocol, suggested that the most industrialized countries should assist others in developing their own research and development programmes looking into substitutes for the harmful CFCs. France immediately supported this proposal.

It should be noted that CFCs are, in fact, very useful gases. They are used in the manufacture of aerosols, foams, packaging, and thermal insulation, in refrigeration cooling systems, and as solvents in the electronics industry. Aerosol substitutes already exist and, if necessary, we should be able to do without aerosols. This is why several countries, including France, will be on line in a year or two with the standards set for 1998 by the Montreal Protocol. However, industrial research has yet to discover alternative chemicals or techniques in the other sectors using CFCs.

Like industrialized countries, developing countries cannot be expected to surrender all claims to an electronics industry, to packaging, or to refrigeration. The challenge goes far beyond strictly financial concerns for the current producers of CFCs. For preserving food and drugs, for example, industrial cooling systems are absolutely indispensable, especially in tropical regions of the world. For this reason, the elimination of harmful CFCs will require a sizeable effort, which should be reasonably distributed over some 20 years. Directed chiefly at protecting the ozone in the stratosphere, this effort, according to models, should push back by ten or 15 years the time when we will cross the purely psychological threshold of a doubling in the amount of 'carbon dioxide equivalents' in the air since the pre-industrial era.

New forms of energy

It should be realized that new forms of energy can only make a marginal contribution if the increase in consumption is not first controlled. For example, replacing the predicted consumption of coal (in a moderate scenario of protracted consumption tendencies) with nuclear power by the year 2025 throughout the world would require building 5000 nuclear power plants, which means construction of one plant every two-and-a-half days, and half of them would be in developing countries. At the same time, it would be necessary to develop electrical networks and the corresponding consumer infrastructures, which are generally lacking since two billion people at present live without electricity.

Clearly, this is out of reach. Even in developed countries, the construction of one plant every five or six days for 30 years would represent a rather far-fetched technical and economic effort. In addition, the prospect of a massive nuclear response to climatic hazards would naturally give rise to the prospect of multiplied 'Chernobyl syndromes', and will awaken the hostility to nuclear power by a good proportion of the population of Europe and North America. In other words, in precisely the regions where such a move may be possible, it would find the least unfavourable technical and economic conditions.

Naturally these major decisions are the privilege of each country, depending upon the state of its technology and of its public opinion. France is not involved in this debate, since it already possesses a nuclear power capacity in excess of its needs. This allows us – and financially compels us – to sell some of the surplus energy to our neighbours. But no one can even think of building in our country, for our neighbours' use, power plants that they do not themselves want on their own soil. There is no point here in denying the risks of nuclear power plants.

On the other hand, the short-term effect of a sudden push to develop renewable energy, solar energy and energy derived from other sources (hydro-power and wind power) cannot easily be measured. On the whole, though, I prefer these forms of energy. First, because they can provide for the minimal energy requirements of people who need it most, those far from the large energy distribution networks. Second, because these forms of energy represent mankind's future and foreshadow the day when we will have ceased to squander our energy capital. The earth receives 10 000 times more energy from the sun than we draw from the earth itself.

Soon, I, along with other French ministers and several partners from the private sector, intend to launch 'Energies for the World', a large foundation whose mission will involve directing a portion of public and private development funds towards creating modern tools adapted for solar energy production.

In fact, the only significant alternatives lie within organic energy sources. For equal amounts of energy, if wood burning emits six units of carbon dioxide, then the combustion of coal emits five, that of oil four, and that of gas only three. The use of natural gas, however, seems to contribute to a rise in the amount of methane in the air, adding more to the greenhouse effect than carbon dioxide.

Control of energy consumption

An East European consumes 50% more energy than a West European. Who would say, however, that the former lives better than the latter since the standard of living is not directly related to energy consumption. Neither is it true that the energy savings would make up a fixed 'deposit' that would have been emptied by the West Europeans since the 1973 oil crisis. The 'deposit' of potential savings is being continually replenished, which is fortunate because consumption habits change, equipment wears out, and the rhythm of technical progress is sustained. We constantly learn how to produce more while consuming less energy. Given our progress, materials always give way to grey matter.

Then again, not everyone has made the same effort in improving energy efficiency. A North American consumes 7.7 TEP (tons of petrol equivalent) annually, compared with 3.7 TEP for an Australian or Japanese, 4.4 TEP for an East European, and 2.9 TEP for a West European. The first alternative to slow down global warming can be found in the above facts. That is we need to improve the energy efficiency of our systems of energy production and use, most of all in North America, which alone produces a quarter of the carbon dioxide injected into the atmosphere. During the gathering of the Group of the seven most industrialized nations of the world, in summer 1989, we discussed this subject. It provides new terms for relations between the two Europes.

In France itself, the effort made in the 1980s, thanks to the action of the French Agency for the Control of Energy, should be pursued and strengthened. It is particularly absurd that only one-third of the energy produced in our thermal stations is actually used, while European countries are successfully developing cogeneration, which effectively combines the use of heat and electricity.

Finally, one must underline the significance of the growing proportion of energy consumption by the transportation sector in the industrialized countries. This is already more than one-third of the total, and it may soon become half. The development of the 'three-litre' car is more than ever of current interest, and public

transportation, both urban and interurban, even more so. In this arena, France already possesses a major asset with her high speed trains.

If it is possible and necessary to reduce the energy consumption of the industrialized countries, the same does not hold true for developing countries. How can we ask someone who uses 11 times less energy than an American to stay that way, even in the name of the common interest of mankind?

On the other hand, what can be done, besides encouraging the use of renewable energy sources as previously mentioned, is to help developing countries to avoid, as much as possible, following the paths taken in the past by the industrialized countries. For decades, growth in the economy and in energy use have gone hand in hand. Only recently have such linkages been uncoupled, allowing confused OECD countries to record, from 1979 to 1986, an economic growth of 18% despite a 2% decrease in energy consumption during that period.

To reach our goals, we must imagine a kind of 'Marshall plan' of energy efficiency. To ensure that the necessary investments are able to cross the debt barrier, two solutions may be considered simultaneously:

(1) The extension of the system by which a specialized firm provides the technical and financial services required for the control of energy, and is paid out of the money saved on the energy bill.
(2) The creation of an international fund for modernizing energy production and consumption systems, which would be but one aspect of a worldwide taxation system based on the principle that those who pollute are those who pay.

This fund could be supplied by a worldwide energy tax. It remains to be seen whether it could be made available to everyone (a good portion of this money would then remain within industrialized countries), or if, by a process to be devised, it must be reserved for certain countries. Whatever the case, this fund could also be used as a financial tool for a global reforestation plan.

Reforestation

If certain researchers have imagined 'sowing' the oceans to increase their biological productivity and their capacity to absorb the excess carbon from the atmosphere, realism demands that we think first of the forests. From the time it is planted, a tree takes in carbon, to the extent of 10 tons per hectare per year for certain tropical species. To absorb enough carbon so that it will no longer accumulate each year, it would be necessary to plant some three million square kilometres, which is approximately equivalent to the area of a country like Zaire and six times the area of France.

This may seem to be an enormous area, and in some ways it is, even though 100 000 square kilometres of tropical forest disappear each year throughout the world. Yet, available land that is uncultivated or uninhabited by man and suitable to receive these billions of trees does exist.

Elimination of CFCs, reforestation, and harnessing energy

All that can be done in this direction will contribute significantly to protect the environment. Forests slow the process of erosion, regulate the water cycle, and in

short are related, at least locally, to the most noticeable effects of global warming. In the same way, numerous air, water and soil pollutants find their origin in the production and consumption of energy. Lastly, of course, the elimination of CFCs will protect the ozone in the stratosphere.

Elimination of CFCs, reforestation, and harnessing energy are the principal courses of action, given the scale of global warming. Eliminating CFCs would reduce carbon dioxide equivalents by 15% and delay the warming process by ten or 15 years. If all developed countries were using energy as efficiently as France currently does, the emission of carbon dioxide into the atmosphere would immediately be reduced by some 40%. If we could manage to reforest three million square kilometres, we would absorb all the carbon dioxide that would be added in the next few years to that which already exists in the atmosphere.

Perhaps all these steps cannot be taken at once. But if we are not afraid of the effort it will take, and we start taking immediate countermeasures, there is no doubt we will succeed in significantly slowing down the global warming process, and in giving societies throughout the world the time to confront the problem calmly, jointly and compassionately. We can act together, the rich helping the poor.

Then again, France is convinced that the world is not sufficiently prepared with political, judicial or financial tools capable of defining, implementing, evaluating and, if necessary, correcting a strategy to combat global warming. This is why France took the initiative at the meeting in The Hague, in March 1989. During this meeting, 24 nations from five continents called on everyone to join forces to protect the atmosphere, and to create or reinforce international institutions able to confront effectively the destruction of the ozone layer and the drastic changes in the world climates. Those participating in The Hague meeting further affirmed the particular responsibility of industrialized countries, with regard to developing countries, especially the poorest nations, which are apt to be hit the hardest by a global change of climate to which they have contributed very little.

I am certain that this worthy appeal will be heard.

Environmental protection and economic development: guidelines for sustainable growth

Saburo Okita
former Foreign Minister, Japan

Because the costs of preventing environmental pollution that accompanies economic development do not necessarily contribute directly to expanded production, it used to be thought that environmental protection and economic development were contradictory concerns. This feeling was especially strong among the developing countries at the time of the 1972 United Nations Conference on the Human Environment, these countries contending that poverty was the ultimate environmental problem and that they therefore had no choice but to give economic development priority over environmental protection. However, it has become increasingly obvious that environmental degradation in the developing countries imposes its own constraints, not only on these countries' own economic development but upon growth worldwide. For example, the destruction of tropical forests for agricultural, fuel, and timber uses not only deprives future generations of the use of these tropical forests but also means that we forever lose those genetic resources residing in the tropical forests. The loss of genetic diversity in turn means forfeiting the possibility of developing new strains and other products for agricultural, pharmaceutical and other uses. People are thus becoming increasingly aware of the grave consequences of environmental degradation.

Poverty has been a primary cause of environmental destruction in the developing countries in that development has been seen as essential to the effort to eradicate poverty. Accordingly, it is increasingly coming to be viewed as imperative that the developing countries see environmental protection and economic development as the two sides of the same coin and seek to attain both ends.

The industrialized countries have experienced many different varieties of environmental pollution in the course of their economic development. In Japan, for example, we have seen industrial effluent result in such terrible afflictions as the mercury poisoning in Minamata, and industrial air pollution in such debilitating conditions as the racking asthma of Yokkaichi. These are just two of the better-known and most-feared examples of the kind of pollution-induced illnesses that have accompanied industrial development. Learning from these bitter lessons, the leading industrialized countries have moved in the last 15 years to enact and enforce strict environmental regulations and to improve the quality of their environments. This improvement is symptomatic of some degree of success in reconciling the need for industrial development with the equally important need for environmental protection. Nevertheless, with the expansion in the scale of economic development, there is an increasing possibility that the failure to spend

on environmental protection may inflict costs on society well in excess of any savings gained by the negligent company.

The environment is basic to continued human survival, and long-term prosperity for mankind is inconceivable unless we ensure that future generations are also able to receive full benefit of the blessings of nature. Yet at the same time, development is also necessary in order to solve the problem of poverty in the developing countries and to enable all peoples everywhere to live civilized lives in a better environment. Environmental protection and economic development must thus be seen as mutually complementary concerns. Working from this perspective, the World Commission on Environment and Development, established in 1984, has emphasized the need for all peoples everywhere to join hands in an effort for sustainable development worldwide. In so doing, it has defined sustainable development as progress in human society to meet the needs of the present generation while not foreclosing the ability of future generations to meet their own needs.

Calling upon all institutions in all countries to work both on their own and in cooperation with each other for sustainable development, the World Commission on Enviroment and Development set forth the following eight basic principles in its 27 February 1987, Tokyo Declaration.

(1) Reviving growth
(2) Changing the quality of growth
(3) Conserving and enhancing the resource base
(4) Ensuring a sustainable level of population
(5) Reorienting technology and managing risks
(6) Integrating environment and economics in decision-making
(7) Reforming international economic relations
(8) Strengthening international cooperation

Because it is important to observe these principles in order to integrate environment and economics and to ensure sustainable development, it might be as well here to dwell a little on their meaning and significance.

Reviving growth

Countless numbers of people in the developing countries are in a state of absolute poverty, unable to meet even their basic human needs. This situation imposes an excessive burden on the environment, and is why poverty is a major source of environmental degradation. At the same time, this environmental degradation not only affects the many people living in the developing countries but also threatens the very survival of the entire community of nations, both developing and industrial.

It is thus imperative to promote economic growth, especially in the developing countries. Eradicating poverty in the developing countries will require at least 3% per capita annual GNP growth in the developing countries as a whole including the redistribution of wealth. Taking population growth into consideration, this means per annum GNP growth of at least 5% in Asia, 5.5% in Latin America and Africa, and 6% in West Asia.

Because the developing countries' economies are closely interdependent with those of the industrial countries, it is also important that there be economic growth

in the industrial countries to stimulate and revive growth worldwide. The medium-term outlook is for 3–4% per annum growth in the industrial countries. This is both the minimum level of growth needed for these industrial countries to fulfil their international economic responsibilities and an economically sustainable rate of growth assuming that it is resoure- and energy-conservative.

The developing countries need massive capital financing to pay for the imports needed to support rapid growth, and their growth is also crippled by these countries' debt accumulation. There must be international cooperation to sharply increase the flow of capital to the developing countries as well as to stabilize commodity prices so as to stabilize income levels in the low-income countries dependent upon commodity exports. At the same time, emergency international action is needed to resolve the debt crisis.

Changing the quality of growth

Even if growth is restored, this must be a different kind of growth than before. Just as it must be more energy- and resource-conservative, it must renew natural assets, improve income distributions, and reduce the susceptibility to economic crisis.

Economic growth must be sound growth compatible with the stock of natural resources. As such, economic development must pay full heed to the increase or decrease in the natural assets. Income distribution is another important component of the quality of growth, and there are times when it may be more desirable to have gradual growth with income redistribution advantageous to the impoverished classes than rapid growth that exacerbates income disparities. It is often better to promote small owner-tilled farms than to embark upon agribusinesses run by giant corporations. Likewise, the need to lessen the susceptibility to natural disaster, price collapses, and other crises may well imply an imperative to adopt low-risk technologies and to enter into contracts that are relatively immune to market fluctuation.

If growth is to be sustainable, it is not enough simply to increase the number of economic coefficients that are taken into consideration. Rather, there must also be a strong priority on education, health, clean air and water, natural beauty and other non-economic values intimately connected with human needs and welfare. Protecting the interests of disadvantaged minorities is also an important consideration.

Economic and social development can and must be mutually complementary. Improving education and health also contributes to enhancing human productivity. Social development to promote the spread of education and other opportunities among people who are at a disadvantage also contributes to further promoting economic development.

Conserving and enhancing the resource base

Sustainability requires the conservation and enhancement of such environmental resources as clean air and water, forests, soil, and genetic diversity. Major policy changes are needed if this is to be done while still maintaining the high levels of consumption in the industrial countries, ensuring that the developing countries are able to attain at least the minimum necessary levels of consumption, and

responding to the pressures of population increases. This is also part of our moral responsibility to future generations and to all manner of non-human life.

One of the most urgent issues is that of conserving and enhancing the resource base for the primary industries cultivating and harvesting agricultural, forestry, and maritime resources. Unless this is done, it will prove impossible to meet the needs of an expanding population. The expansion of farmlands has reached its limits in many parts of the world, and forestry and maritime resources have been exploited to the brink of depletion. While it is possible to raise farmland productivity with the development and use of new agricultural technologies, any technology that carries the danger of reduced genetic diversity, contaminated water tables, or residual toxicity on crops is liable to create serious long-run ecological problems even if it does lead to a short-term increase in productivity. It is imperative that ecologically sound means be employed. Likewise, care must be taken, in using forestry and maritime resources, that harvests do not exceed replenishment. Ambitious efforts must be made in reforestation and fishery cultivation.

We are likely to run up against the limits to our energy resources sooner than the limits to our other finite resources. The first issue with energy resources will be the limits to supply, and the second issue is the environmental problems arising from their use. In order to resolve these issues, it is important both to develop cleaner energy resources and to promote energy conservation in all aspects of modern life, including industrial technologies, agriculture and transport.

In considering the issue of conserving resources, it is important to prevent the fouling of air, water, and other resources. It is thus imperative that all countries rigorously enforce environmental regulations, promote low-waste technologies, and anticipate the environmental impact of new products, technologies, and wastes so as to prevent environmental pollution.

Ensuring a sustainable level of population

While the requirement of sustainable growth makes it imperative that populations be held to ecologically sustainable levels, the developing countries are experiencing rapid population growth and lowering their population growth rates has become an important issue.

In the industrial countries, income growth and an increased social role for women have resulted in lower birth rates. It is important to take a similar approach in the developing countries. In effect, population policy should be integrated with such other economic and social development policy concerns as women's education, health and medical care, and efforts to enhance the livelihood base of the poor. Because there is so little time for solving this problem, it is also imperative that the developing countries promote the spread of family planning policies as a more direct means of holding population growth to sustainable levels. In fact, such policies are one aspect of social development in that they recognize the right to self-determination of couples, and women especially.

Population growth in the developing countries has been particularly rapid in the urban areas, far outstripping the urban areas' ability to accommodate these people. As a result, much of the population increase finds itself living in slums and subjected to polluted air, contaminated water, dangerous exhaust fumes, and other environmental hazards. While it is obviously important to provide adequate amenities for urban populations, it is also necessary to prevent these urban

concentrations by seeking to expand employment and other opportunities in outlying areas.

Reorienting technology and managing risks

The developing countries' capacity for technological innovation must be vastly strengthened in order to execute sustainable development more effectively. In so doing, because the industrial countries' technologies are not necessarily those appropriate to the developing countries, there is a need to develop appropriate technologies suited to the developing countries' own requirements, and in all countries, technology must be reoriented so that it is fully compatible with environmental concerns. This means the public sector must provide incentives to ensure that private-sector technological development takes environmental concerns into consideration and that the public sector must itself take the initiative in developing environmentally sound technologies.

Just as technology creates risks, so does it offer the means for their management. Atomic power, electrical and telecommunications networks, high-speed mass transit systems, and other technologies exhibit considerable fragility above a certain point. It is thus imperative that legal, institutional, and organizational arrangements be made and systemic provisions be put into place for design safety, accident prevention, crisis management, damage containment, and other means of minimizing the risk that the use of such technologies entails.

As new technologies come into wider use, there is the danger that they may pose hazards to the environment in unexpected areas and unforeseen ways. It is therefore necessary that national and international mechanisms be instituted to assess the potential impact of new technologies in all phases of their production, use, and disposal before they become widespread. Similar mechanisms are needed for checking river diversion, forest clearance, and other major interventions in the natural ecosystem. Likewise, it is imperative that the kind of no-fault liability introduced in Japan to provide indemnification for the victims of air and water pollution be introduced on a global scale. It is also necessary to promote greater public participation and appropriate access to the relevant information in making public policy on environmental and development issues.

Integrating environment and economics in decision-making

Environmental and economic goals can and must be mutually reinforcing. Yet environmental and economic goals are generally seen as conflicting when individuals and groups pursue their own short-term interests heedless of the impact on others. Most of the environmental and developmental problems that we face today have their origins in personal decision-making that refuses to accept any responsibility for the decision's impact on others.

Sustainability requires the enforcement of wider responsibility for the impact of policy decisions. It is especially important that policy decision-makers be responsible for the impact of their decisions upon their national environmental resources. If this is to be done, it is imperative that legal, institutional, and organizational arrangements be reformed to pursue the common good. In effect, the pursuit of the common good demands not only legal reforms but also that the

general public has the information and ability to participate in decisions affecting the environment. It is especially indispensable that large numbers of informed and experienced people make their views felt on large-scale project decisions.

In taking environmental concerns into consideration in the decision-making process, the focus should be not on the symptoms but on the source of environmental degradation. Accordingly, it is imperative that environmental policy outgrow its traditional emphasis on emission regulation, effluent treatment, or industrial siting and that environmental concerns be an integral part of tax policy, investment and technology decisions, trade incentives, and the entire range of development policies. The need to prevent pollution demands that the decision's potential ecological impact be taken into consideration alongside the economic, trade, energy, agricultural, and other facets of policy-making. Moreover, this multifaceted consideration including ecological concerns must prevail not only at the local and national level but at the international level as well.

Reforming international economic relations

Long-term sustainable growth can only be attained in the developing countries with a combination of these countries' own bootstrap efforts and complementary support from the industrial countries. Sadly, however, many of the developing countries are resorting to ecologically destructive development and foreclosing the possibility of long-term sustainable growth in a desperate bid to pay off their external debts despite the deterioration in their terms of trade engendered by the collapsing prices for those primary commodities on which they are economically dependent. Likewise, many of the developing countries beset with burdensome external debts are finding it difficult to attract new capital and are forced to adopt austerity budgets in an effort to wring the money for debt repayment from their already-weak economies, a need that in turn results in increasing the pressure on natural resources, reducing the funding and personnel available for environmental protection, and slighting environmental considerations in the formulation and implementation of development policy. Broad-ranging reforms are thus needed in capital, trade, and technology flows to enable these countries to achieve growth consistent with environmental protection.

The flow of capital to the developing countries has to be enhanced, both quantitatively and qualitatively. Quantitatively, there has been a decline in the level of official development assistance and a sharp fall-off in commercial lending and export credit financing. As a result, there is a need to expand the amount of financing available to the developing countries through the World Bank, the International Development Agency, and other multilateral institutions as well as through bilateral agencies. At the same time, realizing that past development assistance has not always been sufficiently mindful of ecological concerns and has sometimes run contrary to the interests of sustainable development, it is imperative that there be a qualitative enhancement of development assistance for sustainable growth.

Responding to the deterioration of the developing countries' terms of trade that has resulted from the structural slump in commodity prices will mandate revising commodity agreements to provide the financial and funding resources for price supports and efforts to escape economic dependence on single commodities. Likewise, the governments of the developing countries must strive to curtail

resource exploitation and to encourage resource renewal so that the pace of development can be held within sustainable levels.

Sustainable development also demands the development and widespread use of new technologies for agricultural production, renewable energy resource systems, pollution prevention, and other ecologically compatible development means. When patent issues and other concerns pose impediments to promoting international technology exchange, international coordination is needed to resolve these constraints. Likewise, it is essential that the developing countries pursue ambitious research and development, on their own and in cooperation with other countries, so as to acquire an indigenous technological capability.

Strengthening international cooperation

With the poverty-induced environmental degradation in the developing countries and the affluence-induced conspicuous consumption in the industrial countries, environmental pollution and ecological devastation have become global concerns transcending national borders. Rising levels of carbon dioxide in the atmosphere, the depletion of the ozone layer, the clearing of tropical forests, the encroachments of desertification, the damage of acid rain, the endangerment and extinction of wild species, and the pollution of the world's oceans are just a few of the many examples of this global threat. Environmental problems on a global scale are thus forcing everyone to take an active part in seeing that the constant efforts for economic coordination in an increasingly interdependent world are supplemented and integrated with equally determined efforts to preserve the environment for the greater good of the entire global community. The addition of this new dimension of environmental considerations to the agenda of international issues means that these problems are even more important and even more urgent, and it should be clearly understood that the effort to resolve these environmental problems is in everyone's mutual interest.

If we are to resolve these environmental problems and achieve sustainable development, there must be a higher priority on environmental monitoring, assessment, research and development, and resource management in all fields of development that have an international impact potential. This in turn requires a high level of commitment by all countries to the satisfactory working of multilateral institutions and to the making and observing of international rules in such fields as investment, trade, and technology. At the same time, explicitly realizing that national interests may not always coincide but that cooperation for the effective preservation and utilization of shared environmental resources is imperative for sustainable growth in everyone's best interests, there must be constructive dialogue in these areas of short-term conflict. New dimensions of international cooperation for sustainable growth are essential to human progress.

The governance of production: the key to environmental quality

Barry Commoner
Center for the Biology of Natural Systems, Queens College, Columbus University, New York, USA

The Stockholm Conference in 1972 marked a worldwide awakening to the environmental crisis and the start of a massive effort to resolve it. Now, eighteen years later, it appears that the effort thus far has largely failed, or at best has made only minor improvements in the rising tide of pollution. In the United States, for example, annual surveys by the Environmental Protection Agency (EPA) show that in the last decade, the emissions of all but one of the standard air pollutants have declined by only an average of 14%; the Geological Survey reports that pollution levels have failed to decrease at nearly 90% of river sampling sites; in Lake Erie, shoreline eutrophication is now worse than it was in 1970; coastal waters have reached unprecedented levels of algal overgrowths; the body fat of the general US population now contains more than 20 toxic chemical pollutants including dioxins and furans. Nor have global problems – the depletion of the stratospheric ozone layer or the greenhouse effect – been solved; indeed, both continue to intensify.

While official pronouncements tend to overlook such pessimistic estimates, in at least one case in the United States there has been an official declaration of failure. In reporting the continued increase in a serious pollution problem – groundwater nitrate levels – the US Geological Survey has concluded: 'Current trends suggest that nitrate accumulations in groundwater of the United States will continue to increase in the future.'[1]

It is time, it would seem, to ask what has gone wrong; to ask why the hopes that the Stockholm Conference inspired have not been realized; to learn from the few successes and the far more numerous failures what should be done to restore the quality of the environment.

With the benefit of hindsight, it is clear that the failure was predictable at Stockholm. While the Conference generated a widespread commitment to action, it failed to even consider the *origin* of the environmental crisis – the understanding of which is, after all, an essential prerequisite to effective remedial action. Cures were proposed in the absence of a diagnosis.

The cause of the environmental crisis was at least debated at the semi-official Environment Forum that accompanied of official Conference. Two contradictory theories were put forward. One was the idea that pollution originates from the pressure of increased population and levels of consumption on the ecosystem's inherently limited resources. The contrary view reflected eveidence that the escalating levels of pollution in industrialized countries after the Second World War were due to the introduction of new, ecologically harmful technologies of

production rather than to increasing population or levels of consumption [2, 3]. Thus, according to one view, the environmental crisis can be resolved by controlling population and consumption; in contrast, the opposing view emphasized the need to choose technologies of production that are in harmony with the ecosystem. The debate at the Environment Forum failed to resolve this conflict, and it has persisted since then.

Now we have a new opportunity to test the validity of the opposing theories about the origin of environmental degradation. In Stockholm the debate was about the meaning of the *rising* levels of pollution in the decades following the Second World War, when relatively little was done to combat the environmental crisis. Now, with the introduction of corrective measures since the early 1970s, we have a new source of data. We can now ask: which ameliorative methods have effectively reduced pollution, and which have not? Such a comparison can help explain the failures, define the principles of success, and provide new insights into the origin of the environmental crisis.

In the United States, data are available that provide a moderately detailed picture of the trends in pollution levels since the enactment, in the 1970s, of extensive remedial legislation. For example, since 1975 the US EPA has published consistent sets of data regarding the annual emissions and ambient concentrations of a series of standard air pollutants: particulates, sulphur dioxide, nitrogen oxides, carbon monoxide, ozone, volatile organic compounds, and lead. Data on water pollution are less comprehensive, but nevertheless describe the time trends in the concentrations of basic water pollutants such as faecal coliform bacteria, phosphate and nitrate. From these and more scattered reports, it is possible to determine what changes in the levels of a number of environmental pollutants have been brought about by the considerable effort, in the United States, to reduce them[4].

Perhaps the most striking aspect of these data is their very wide range. At one extreme are a few clear-cut successes – the few pollutants that have decreased in environmental levels by 70% or more in the last 10–15 years. On the other hand, most pollutant levels have decreased by only 10–20% in that period, and some have actually increased. Given this range of effects, it is possible to relate the magnitude of changes in pollution levels to the types of corrective measure employed and thereby to identify the reasons for the successes and the failures.

Table 1 Changes in emissions of standard air pollutants, United States, 1975–85

Pollutant	*Emissions*		
	(million metric tons/year)		*Percent change*
	1975	*1985*	
Particulates	10.4	7.3	−29.8
Sulphur dioxide	25.6	20.7	−19.1
Carbon monoxide	81.2	67.5	−19.1
Nitrogen oxides	19.2	20.0	+4.2
Volatile organic compounds	22.8	21.3	−6.6
Average			−14.1
Lead	147.0	21.0	−85.7

Source: References 5, 6.

The changes in air pollution (Table 1) can be summed up fairly simply. For all the standard air pollutants except lead, the average annual rate of emission has declined only moderately – by 14.1% between 1975 (when consistent measurements began) and 1985. In that period, the annual emission of nitrogen oxides actually *increased* by about 4%. This is hardly the sort of accomplishment envisaged in the environmental legislation adopted in the early 1970s. On the other hand, lead emissions have decreased by 86% (and the level of lead in blood declined about 40%) in that period, an accomplishment that does approximate the goal of solving the environmental crisis[5].

There is a similar situation with water pollution. A survey of water pollution trends at some 300 sites in US rivers shows that between 1974 and 1981 there had been no improvement in water quality at nearly 90% of the test locations (see Table 2). Concentrations of faecal coliform bacteria, dissolved oxygen, suspended

Table 2 Water quality trends in US rivers, 1974–83

Pollutant	*Trends in concentration* (% of sites)		
	Improving	*Deteriorating*	*No change*
Faecal coliforms	14.8	5.2	80.0
Dissolved oxygen	17.1	11.1	71.8
Nitrate	7.0	30.3	62.7
Phosphorus	13.1	11.3	75.6
Suspended sediment	14.1	14.7	71.2
Average	13.2	14.7	72.1

Source: Reference 7

sediments, and phosphorus improved at only 13–17% of the test sites. The nitrate pollution problem has become progressively worse: nitrate concentration increased at 30% of the river sites and decreased at only 7% of them. For five standard water pollutants, sites with improving levels averaged 13.2% of the tested locations; sites with deteriorating levels averaged 14.7% of the total; 72.1% were unchanged.

If a reduction of 70% or more in national pollution levels is taken as evidence of a qualitative solution to the problem, a search through the available data reveals that only a very short list of pollutants can meet this criterion: lead, DDT (and related insecticides), PCB, mercury in fresh waters, radioactive fallout from nuclear bomb tests, and in some local situations, phosphate. Of course, in certain localities a river or a lake has been greatly improved by halting the dumping of specific pollutants into it. But as the trend data show, there has been little or no overall national improvement.

What can we learn from these observations? Table 3 lists the few environmental successes and the measures used to achieve them. There is a common theme in the successful remedial measures. In each case the pollutant was prevented from entering the environment not by recapturing it after it was produced, but by simply stopping its production or use. Thus, the sharp drop in lead emissions is the result of removng lead from gasoline; the environment is less polluted with lead because less of it is now being used. In the same way, the declining environmental levels of DDT have been achieved because the insecticide has been banned from US

Table 3 Significant improvements in US pollution levels

Pollutant	*Time period*	*Percentage change*	*Control measure*	*Reference*
Lead emissions*	1975–1985	−86	Removed from gasoline	6, 7
DDT in body fat†	1970–1983	−79	Agricultural use banned	8
PCB in body fat†	1970–1980	−75‡	Production banned	8
Mercury in lake sediments†	1970–1979	−80	Replaced in chlorine production	9
Strontium-90 in milk†	1964–1984	−92	Cessation of atmospheric nuclear tests	8
Phosphate in Detroit river water†	1971–1981	−70	Replaced in detergent formulation	9

* Measured as amount emitted per year
† Measured as concentration
‡ Change in percentage of people with PCB body fat levels greater than 3 ppm

agriculture; it is therefore no longer being disseminated into the environment. Similarly, the decline in environmental PCB followed legislation that banned its production and use. There has been a sharp decline in strontium-90 levels because atmospheric nuclear bomb tests, which produce it, have nearly ceased since 1963. In certain rivers, phosphate concentrations have been sharply reduced by banning the use of phosphate-containing detergents; as a result, that much less phosphate is sent down drains, into the aquatic ecosystem.

In contrast to these successes, control measures that are designed to recapture the pollutant after it is produced, rather than to halt its production or use, are ineffective. The control devices that are designed to recapture or destroy air pollutants – such as the power plant scrubbers that trap sulphur dioxide or the catalytic converters that destroy carbon monoxide in automobile exhaust gases – have had little impact on emissions. Such control devices are simply appended to the *existing* productive technology: the sulphur dioxide scrubber is attached to the power plant without changing the power-producing technology; the catalytic converter is attached to the gasoline engine's exhaust without significantly changing the engine itself.Thus, the decade or more of effort to improve the quality of the environment teaches us a fairly simple lesson: pollution levels can be reduced enough to at least approach the goal of elimination only if the production or use of the offending substance is halted; the control device strategy does not work very well.

The sharply reduced level of mercury in freshwater sediments is a particularly informative example. This improvement came about when it was discovered that the major sources of environmental mercury in the Great Lakes were plants that produce chlorine by electrolysing a brine solution (mercury is used to conduct the electric current). Required to give up this practice, the plant operators substituted a semipermeable diaphragm for mercury in the production process. The plants no longer dumped mercury into nearby rivers for the simple reason that they were no longer using it. The plant output, which is largely consumed by the chemical industry, is chlorine, and chlorine consumption has not decreased. On the contrary, as shown in Table 4, during the period 1970 to 1979, when mercury pollution declined sharply, the total national production of chlorine increased by 26%. The

Table 4 Changes in output of production processes with significantly reduced US pollution levels

Pollutant	*Relevant good produced*	*Time period*	*Change in amount of good produced (%)*	*Reference*
Lead emissions	Automobile passenger-miles	1975–85	+26	10
DDT in body fat	Cotton	1970–85	+31	10
PCB in body fat	Electrical transformers	1970–85	−12	10
Mercury in lake sediments	Chlorine	1970–79	+26	11

mercury pollution problem was solved by *changing the means of producing chlorine*, rather than by consuming less.

The same pattern is evident in lead pollution. In this case, the production process is automobile travel, and what is 'consumed' is passenger-miles travelled. As shown in Table 4, between 1975 and 1984, while vehicular lead emissions declined by 72%, passenger-miles travelled *increased* by 26%. Clearly, this considerable environmental improvement was not achieved by limiting consumption of the good, but, again, by changing the technological means of producing it.

DDT provides a similar example. Here the good produced for consumption is the crop that DDT protected from insects, in the United States largely cotton. Between 1970 and 1984, environmental levels of DDT decreased by 70–80%; yet the production of cotton increased by 31%. Again, what was changed was not the amount of good produced or consumed, but the technological means of producing it.

These examples help to define the meaning of the changes that have brought about the few sharp declines in environmental pollution. Clearly, what has been changed is not population pressure or the level of consumption, but the technology of production. It is evident from these examples that in the few instances in which pollution has been significantly decreased, the operative decision was directed towards the technology of production, not the level of production or the level of consumption which it engendered. In this regard it is of interest to look at a case in which it appears, at least at first glance, that the operative decision was directed at consumption rather than production. This example arises from the response to the sudden shortage and price increases that have affected energy supplies in recent years. A common response has been energy conservation – that is, a deliberate decision to use less energy. This has had significant effects on energy consumption in the United States. Thus, between 1980 and 1985 total energy consumption in the United States decreased by 3%. Consumption decreased by 17% in the industrial sector and by 8% in the residential and commercial sectors; but increased by 3% in transportation and by 8% in electricity generation[10].

However, energy consumption is not an end in itself, but an essential input into the production of goods and services, which are the actual end-products that are consumed. In the United States, energy conservation has not been achieved by reducing the production of goods and services, but by improving the efficiency with which energy is used – that is, the ratio of goods produced to energy consumed, has increased. For example, while the amount of energy consumed by the industrial sector between 1980 and 1985 decreased by 15%, industrial output *increased* by 15%[10].

These improvements in energy conservation result from changes in the technology of production, for example, in industry, by modifying production machinery so that previously wasted energy is recaptured for use. Thus, even though these remedial measures were motivated by the desire to reduce the consumption of energy, they have been achieved by altering the productive processes that use the energy, rather than by reducing the level of production or consumption. In sum, the successful energy conservation measures suggest that if we are concerned with reducing the consumption of resources (and thereby improving environmental quality), action should be directed not at the level of consumption *per se*, but at the nature of the means of production. This same conclusion can be derived from the numerous failures to achieve a significant reduction in environmental pollution. Nitrate pollution of surface and ground water is a striking example. By the early 1970s, nitrate concentrations in certain US rivers, especially in intensely farmed areas, frequently exceeded the public health standard of 10 ppm nitrate nitrogen per litre. Since then, as noted earlier, the frequency of excessive nitrate levels in surface waters and groundwater has steadily increased. The rising concentrations of nitrate in surface and groundwater have been traced to two major sources: chemical fertilizer and, especially in heavily urbanized, non-agricultural areas, airborne nitrogen oxides that precipitate in rain and snow as nitrate. As indicated earlier, nitrogen oxides are chiefly produced by vehicles and power plants. The source of fertilizer nitrogen is agricultural production, which has employed rising rates of application of inorganic nitrogen fertilizer since the early 1950s in order to increase yields.

The conventional means of regulating pollution – a control device that traps the pollutant before before it can enter the environment – cannot be used to reduce nitrate levels. Nitrate leaches from the entire area of a heavily fertilized field; it enters a river along every millimetre of its banks. Unlike a power plant or automobile, the fertilized field is not a 'point source', and it is mechanically impossible to apply a control device to it. Consequently, pollution of surface and groundwater cannot be reduced unless the agricultural production system is changed by eliminating or at least greatly limiting the amount of fertilizer nitrogen that leaches into aquatic ecosystems.

A proponent of reduced consumption might claim that this conclusion supports the view that nitrate pollution can be controlled only be reducing the amount of crops grown – either by cutting back on the acreage planted or by reducing the rate of fertilizer application. However, the relationship between crop production and the rate of fertilizer application is not linear. Above a certain rate of application the increment in crop production yielded by a given increment in fertilizer decreases considerably, eventually reaching a plateau at which the gain in yield approaches zero. Excessive nitrate levels occur when the rate of fertilizer application is so high that much of it is not taken up by the crop, and instead leaches into surface and ground water.

In these circumstances it is possible significantly to reduce fertilizer application – and the resulting levels of nitrate pollution – with little or no loss in crop production. Thus, a study of the relationship between fertilizer application and river nitrate levels in the State of Illinois (where most of the rivers usually exhibit nitrate concentrations that exceed public health standards) shows that a 15% decrease in the rate of fertilizer application – which reduces crop production by only 1.1% – would reduce the present, high frequency of unacceptable nitrate concentrations to 5%[12]. Another study shows that when chemical fertilizers (and

synthetic pesticides as well) are totally eliminated from crop production on typical Midwestern farms, corn and soybean yields were reduced by an average of only 8.5% over a five-year test period[13]. The average income per acre harvested of the two groups of farms was identical; reduced chemical expenditures compensated for the slightly reduced yields.

It seems evident from these results that a specific change in the technology of crop production – the substitution of organic sources of nitrogen for chemical fertilizer – could successfully control nitrate pollution with a relatively small reduction in crop output. In effect, this would reverse the change in agricultural technology that gave rise to the nitrate pollution problem in the first place: the rising rate of application of chemical fertilizer, beginning in the early 1950s, especially to Midwestern soils, greatly depleted in their content of organic matter. Much of the considerable increase in crop output in the United States engendered by inorganic fertilizers could be retained – and nitrate pollution significantly decreased – by restoring organic sources of soil nitrogen and reducing the use of chemical fertilizer. Once again, the critical operational decision is to change the technology of agricultural production[14].

The levels of two major air pollutants – ozone and carbon monoxide – which, after more than a decade of effort, are still in excess of health standards in most US urban areas – represent another striking environmental failure. According to a 1987 estimate by the US EPA, 80 million people in 70 urban areas breathe air that exceeds the ozone standard, and the carbon monoxide situation is not much better. Ozone and a noxious mixture of toxic organic compounds occur in the photochemical smog that forms when light-activated nitrogen oxides and hydrocarbons (for example, from waste fuel) react. In the United States a control device has been used in the effort to solve the smog problem, as well as carbon monoxide pollution. The device, a catalytic converter, is designed to destroy carbon monoxide and waste fuel in the exhaust, thereby reducing these emissions (but not the emission of nitrogen oxides). However, although the catalytic converter does accomplish an appreciable reduction in emissions, per vehicle-mile, the device is not 100% efficient and becomes less so with use. As a result, its potential impact on ambient air concentrations is countered by increased vehicular traffic – which as indicated earlier, has in fact occurred in the United States.

Here, too, it might appear that the only option is to reduce pollution by decreasing the output of the good – vehicular traffic. However, pollution can be sharply reduced without diminishing transportation service by changing the technological means of providing it. One way is to alter the design of the internal combustion engine in order to obtain adequate power without elevating the temperature enough to form nitrogen oxides – the trigger that sets off the smog reaction. The so-called 'charge stratification' engine is a means of achieving this goal. Alternatively, intra-urban transportation could be based on electric vehicles, thus removing fuel combustion and its attendant pollution from heavily polluted urban areas to more remote and disseminated power plants. And, ideally, electric power sources that use fuel very efficiently (for example, cogenerators) or that depend on non-polluting sunlight (photovoltaic cells) would be employed. Finally, in many cities vehicular traffic could be greatly reduced by rehabilitating and enlarging the generally inadequate mass-transportation facilities. And again, such improvements depend on introducing technologies that are appropriate to the task of reducing environmental impact without diminishing service.

These considerations suggest that the debate about the origin of the

environmental crisis can now be resolved. The data about both the onset of environmental pollution since the 1950s, and the effort to combat it since the 1970s, lead to the same conclusion. Environmental pollution originates in faulty systems of production, in industry, agriculture, and transportation, and can be rectified only by changing the relevant production technologies.

This conclusion has an important bearing on the link between environmental quality and economic development, also a subject of considerable disagreement. It has been argued, for example, that environmental quality requires severe controls on 'growth' – that is, on continuing economic development. This argument is logical only if it is assumed that production – which is the source of economic development – will continue to be based on existing, environmentally unsound technologies. However, as we have seen, environmental improvement itself requires sweeping changes in the present technologies of production. These changes will perforce break the present link between the expansion of production and environmental degradation. Indeed, examples can be cited to show that technological changes that reduce environmental impact can also *improve* economic productivity. For example, the adoption of decentralized systems of electric power production – based on local cogenerators or photovoltaic power sources and gauged to local demand – reduce fossil fuel consumption and the attendant pollution, and at the same time improve the economic efficiency of power production[15]. Similarly, reduced reliance on agricultural chemicals – which, as we have seen, does not reduce farm income – can reduce eutrophication of inland and coastal waters and thereby income from fisheries, yielding a net economic gain.

The conclusion that both economic development and environmental quality depend on the system of production is particularly relevant to developing countries. In industrialized countries, it is evident that environmental quality can be achieved only through a massive transformation of the present, ecologically harmful system of production. This is a formidable task, given the resistance of the operators of the present system to such a socially determined imperative. In a developing country, which often has the task of introducing wholly new productive activities – for example, a national electric power system – the difficulties of transforming an existing system can be avoided, or at least minimized. Thus, a country that lacks a national power-line network can more readily establish a power system based on decentralized cogenerators and photovoltaic cells, and avoid the expense and organizational difficulties involved in transforming an existing , highly centralized power system.

By recognizing the crucial relation between the nature of production technology and both environmental quality and economic development, a developing country can avoid some of the faulty decisions that have led to trouble, in both of these areas, in industrialized countries. The issue of liquid fuel, which is essential to many forms of transportation, is an illuminating example. Industrialized countries depend entirely on petroleum products for this purpose. But petroleum is a non-renewable energy source that is therefore subject to escalating price, and is also a major source of environmental pollution. Ethanol, which incorporates the renewable solar energy captured by photosynthesis, is a more advantageous source of liquid fuel. But this advantage cannot be realized without redesigning the existing system of agricultural production. In the United States, agricultural production is designed to yield a net crop output with a carbohydrate/protein ratio that is appropriate to animal nutrition. Ethanol production consumes carbohydrate

preferentially; hence, if the present crop output is fermented to produce ethanol, the residue, while protein rich, contains insufficient carbohydrate for efficient animal nutrition. Ethanol production is achieved at the cost of food. On the other hand, it is possible to change the system of crop production so that the carbohydrate/protein ratio is increased, thereby permitting ethanol production with no loss in food value[16]. This is a net gain in resources and economic output, but it can be realized only by appropriately changing the technology of agricultural production.

The conclusion that effective environmental improvement can be accomplished only by altering the present technologies of production has important implications for environmental policy. Beginning with the Stockholm Conference and continuing in the subsequent national regulatory programmes, there has been a common approach to environmental policy: it has been directed towards the effect of a pollutant rather than its origin. Thus, current environmental policies commonly call for monitoring to assess pollutant levels; the setting of standards to determine what levels are acceptable; the establishment of emission standards; and specification of the necessary emission control devices. Such a policy starts by granting that the pollutant will be produced by the source; it then establishes procedures that attempt to limit the pollutant's entry into the environment to some acceptable amount.

It is evident from the foregoing considerations that this type of policy has been ineffectual. The few environmental regulations that have been effective were directed towards the *origin* of the problem; they have simply required that the pollutant should no longer be used or produced. In sum, if it is to be effective, environmental policy should be designed to regulate the technology of production – what is produced and by what means.

Thus defined, environmental policy must, at least in part, govern the decisions that determine what technologies are employed in industry, agriculture and transportation. The almost exclusively economic considerations that now control such decisions must give way to a new factor – environment impact.

In sum, environmental quality, a social goal, requires social governance of the means of production. Yet, the exclusive power to govern productive decisions is jealously guarded by firmly entrenched ideologies that are often regarded as immune to debate. The lesson of the environmental experience – an experience of failure thus far – is that the time has come expose these ideologies to the enlightenment of open debate.

References

1. USGS (Geological Survey) (1985) *National Water Summary 1984*, Water-Supply Paper 2275, Superintendent of Documents, Washington, DC
2. Commoner, B. (1972a) The meaning of the environmental crisis. *Miljoforum/Environment Forum*. Presented at the Environmental Forum, UN Conference on the Human Environment, Stockholm, June 5
3. Commoner, B. (1972b) The environmental cost of economic growth. *Chemistry in Britain*, **8**, 52–65
4. Commoner, B (1987) A reporter at large: the environment. *New Yorker*, June 15
5. US EPA (1987) *National Air Quality and Emissions Trends Report 1985*. Office of Air Quality Planning and Standards, Research Triangle Park, NC
6. US EPA (1986) *National Air Quality and Emissions Trends Report 1984*. Office of Air Quality Planning and Standards, Research Triangle Park, NC
7. Smith, R.A. *et al.* (1987) Water-quality trends in the nation's rivers. *Science*, **235**, 1607–1615

8. US EPA (1984a) *Environmental Quality*. The 15th Annual Report of the Council on Environmental Quality, Washington, DC
9. US EPA (1984b) *Lake Erie Intensive Study 1978–1979*. Final Report, prepared by D.E. Rathke, Ohio State University, Columbus, OH, EPA-905/4–84–001, Jan
10. US Dept. of Commerce (1986) *Statistical Abstract of the United States, 1987*, 107th Edition, Bureau of the Census, Washington, DC
11. US Dept. of Commerce (1985) *Business Statistics 1984*, 24th Edition, Bureau of Economic Analysis, Washington, DC
12. Klepper, R. (1978) Nitrogen fertilizer and nitrate concentrations in tributaries of the Upper Sangamon River in Illinois. *Journal of Environmental Quality*, **7**, No. 1
13. Lockeretz, W. *et al.* (1981) Organic farming in the Corn Belt. *Science*, **211**, 540–547
14. Commoner, B. (1977) Cost-risk-benefit analysis of nitrogen fertilization: a case history. *Ambio*, **6**, 157–161
15. Commoner, B. (1985) Economic growth and environmental quality: how to have both. *Social Policy*, **16**, No. 1
16. Commoner, B. *et al.* (1981) Economic evaluation and conceptual design of optimal agricultural systems for production of food and energy. Final Report to US Dept. of Energy. NTIS No. DOE/ER/30000–1. Dec. 16

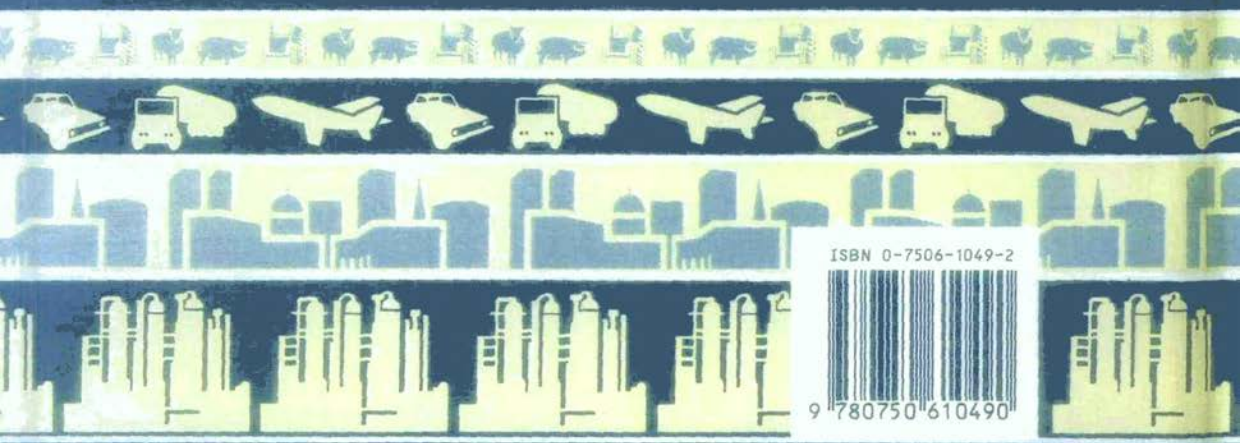
Index

Earth and Us

There are very close and intricate interrelationships between population, resources, environment and development. Changes in one affect the others, positively or adversely. Some of these changes are immediately visible, others may take a long time before they can be discerned.

In the past, in our pursuit of development, too much emphasis was placed on economic growth and not enough on the environmental impacts of such growth rates and patterns. To achieve this 'growth' the earth's resources were plundered, with little thought for the future. We can easily observe the extent and magnitude of numerous disturbances at global, regional, and national levels. For example, biological diversity is rapidly diminishing, and this will undoubtedly have a major impact on food availability and health for future generations. Ozone depletion, climatic changes, accelerated desertification, rapid deforestation in the tropics and sub-tropics, and extensive pollution of our air and water resources are all major environmental problems humankind is facing at present because of some of our past unsustainable actions and practices.

This book brings together the ideas and thoughts of some of the leading international statesmen, political leaders, economists and environmentalists, on the complex interlinkages between 'earth and us'. The various chapters examine aspects of the nexus between population, resources, environment and development, and outline their views on what can be done in the future. Thus, this book is designed to complement existing texts which deal with similar subjects, such as *Environmental Perspective to the Year 2000*, *Our Common Future*, and other important publications by the various United Nations Agencies, World Bank, World Resources Institute and Worldwatch Institute. The book will contribute to the overall debate for the further clarification of various complex environmental issues, and also enhance the environmental consciousness of the world.



ISBN 0-7506-1049-2

9 780750 610490

BUTTERWORTH HEINEMANN