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DEPARTMENT FOR RESEARCH COOPERATION

Environmental Research Challenges
in Developing Countries
– some reflections

Future Environ- mental Research



Foreword

The Foundation for Strategic Environmental Research, MISTRA, is now nine years old and subject to a major external evaluation. Work on the evaluation started in the autumn of 2002 and a final report is expected by September 2003.

The leader of the evaluation team approached Sida and requested a contribution to the evaluation in the form of a paper on major environmental challenges in the developing countries in the Third World and Eastern Europe. The paper was intended as a guide for a discussion on the future strategy of MISTRA. It should include an outline of major environmental issues in development countries with a brief analysis of underlying causes and conclusions in the form of suggested research priorities for MISTRA to consider. It should preferably be a short document.

Work on this paper was carried out during February – April 2003 by Johan Holmberg who had been retained for this purpose as a consultant. Mats Segnestam and Sten-Åke Elming coordinated the process within Sida.

A total of 26 senior scientists were contacted to explore their views on earlier drafts of the paper and on the research priorities to propose to MISTRA. Some of them attended “mini-seminars” at Sida with about six participants each time, the others were approached individually by Johan Holmberg. They represented the universities in Stockholm, Uppsala, Lund, Linköping and Gothenburg as well as the colleges of technology in Gothenburg and Lund and the agricultural university in Uppsala. A contribution was also requested from the International Institute for Environment and Development (IIED) in London.

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Executive Summary

The paper has been written within the delimitations of the mandates of MISTRA ("support research of strategic importance for a good living environment") and of Sida ("eradication of poverty"). The focus is on the developing countries and no effort is made to explore issues in industrialized countries that may directly or indirectly affect the environment in developing countries.

Economic incentive structures play a major role in driving environmental change, as individuals (and nations) act in their self-interest with little regard for others or for future generations. Inefficient institutions and poor governance in developing countries often render well-intended policies ineffective. There is also insufficient knowledge of the economic consequences with regard to the environment of a particular set of policies.

With climate change a major threat against development in the poorest and most vulnerable countries actions at global as well as national levels to reduce emissions of greenhouse gases become important for development. The technological progress made in recent years towards small-scale generation of renewable energy must be explored. Provision of electricity to the two billion people worldwide who today lack such services is important for several reasons, particularly the health risks of traditional fuels for home cooking.

A substantial and increasing area of the world's farmland is degraded and the shortage of water is becoming acute in large parts of the developing world. To satisfy future demand for food then becomes a major challenge, taking account of the unmet needs of the 1,2 billion poor today as well as the rapidly increasing urban populations. This will require major improvements of agricultural productivity to which both biotechnology applications and so-called sustainable agriculture will have to contribute.

Both terrestrial and marine biodiversity is under threat in the developing countries. Much biodiversity is lost because of changes in land use as more land is converted to farmland and forests are depleted. The destruction of coral reefs and mangroves are major threats to marine biodiversity and will have consequences for the fish stocks that are not yet well understood.

There is a complex and mutually reinforcing, two-way relationship between poverty and the environment, sometimes referred to as the poverty-environment nexus. Population growth, also driven by poverty, is usually the proximate cause of many of the common environmental issues found in developing countries. In future years the vast majority of population growth in these countries will occur in urban centres where the environmental issues to date have largely been neglected.

There is a variety of issues of a cross-cutting nature that relate to the environment and give rise to specific problems that need attention by researchers and practitioners. These include environment on the one hand and health, conflicts, humanitarian emergencies and refugees, law and international governance, gender, awareness and knowledge, and institutions and governance on the other hand.

The overriding criteria for the research priorities proposed is that they should be relevant to poverty eradication, “researchable” and of interest to the academic community, of a broad interdisciplinary nature, yield practically applicable findings, and be of “strategic” importance. All research on sustainable development will need to take interdisciplinarity into account, since sustainability by definition has economic, social and environmental dimensions. Research should help practitioners detect “avoidable” environmental destruction while minimising the effects of what is “unavoidable”. Cross-cutting themes, such as economics or gender or governance, can be applied to most environmental research programmes and no attempt is made to provide an exhaustive listing of such linkages, yet many of them may provide interesting and relevant topics for research. It is essential that research conducted in developing countries be carried out in collaboration with local scientists and include an element of local capacity-building.

Against that background the following eight research programmes are suggested as examples, many others could also be conceived: (i) human development needs and ecological system survival, (ii) satisfying future food demand, (iii) sustainable livelihoods in degraded areas, (iv) sustainable management of coastal habitats, (v) energy for sustainable development, (vi) climate change adaptation, (vii) atmospheric haze and development, and (viii) sustainable urbanization.

Environmental Research Challenges in Developing Countries

1. Introduction

Purpose. The Foundation for Strategic Environmental Research, MISTRA, was founded on 1 January 1994 and will thus soon celebrate its tenth anniversary. The MISTRA Board of Trustees felt that it would now be an opportune time to carry out an external evaluation of the achievements of the foundation during its first decade.

This evaluation was launched in the autumn of 2002 and a final report is expected by 30 September 2003. The coordinator of the evaluation team approached Sida and requested a contribution to the evaluation in the form of a paper dealing with the major environmental challenges facing developing countries in the Third World and Eastern Europe. This would be an important input since the principal purpose of the evaluation is to provide a basis for a discussion of the future strategy for MISTRA. The paper was intended to be no more than 20 pages and include a summary description of major issues, a brief analysis of underlying causes, and Sida's proposals for research priorities to be tackled by MISTRA. It should be ready by mid-May 2003.

Outline. The paper is divided into two chapters. The first is a summary of major environmental challenges or issues affecting developing countries, the second a listing of research priorities for MISTRA to consider.

Chapter 2 starts with a brief summary of what drives environmental change in developing countries, emphasizing the role of incentives, institutions and governance. Related environmental issues are grouped in four topic clusters in sections 2.2 – 2.5. The first deals with climate change, energy and transportation, including emissions of greenhouse-gases, renewable energy, transportation, and non-renewable natural resources. A second cluster deals with land, water and food, stressing the availability of cropland and water and consequences for food supplies. A third covers terrestrial and marine biodiversity, including deforestation and coral reef destruction, the services of biodiversity and overfishing of the seas. A fourth cluster discusses some demographic and social factors closely related to environmental change: poverty, population growth and urbanization. Section 2.6 highlights a selection of cross-cutting issues having a complex and often two-way relationship with the environment.

Chapter 3 suggests eight examples of research priorities for MISTRA's future work that derive from the preceding discussion. Under each of the eight headings several subjects for research projects are proposed.

Delimitations. It is not possible to provide an exhaustive coverage of these complex issues in this short paper. While there may be general agreement about the issues, there will be differing views about how broad a coverage to give to the analysis and what to emphasize most. It is therefore necessary to be explicit about two delimitations to this paper. The *first* relates to the mandate of MISTRA which, according to its statutes, is “to support research of strategic importance for a good living environment”. Research funded by MISTRA “shall play a significant role in solving major environmental problems and contribute to the development of sustainable society”. The *second* deals with the mandate of Sida to reduce poverty in the countries in the Third World and in Eastern Europe, which below collectively are referred to as “developing”. First World environmental issues and problems are therefore not the primary focus of this paper. Since causal analysis of environmental issues affecting developing countries necessarily becomes complex and far-reaching and soon touches on lifestyle issues in the rich countries, the focus here is not on those causal chains per se but on their impact in the developing country context.

2. Major Environmental Challenges in Developing Countries

2.1 Factors Driving Environmental Change

Much of the environmental change taking place in the world, notably the consequences of climate change, seems destined to affect all mankind in the long term, albeit in different ways and not necessarily always negatively. There would seem to be broad consensus that the poorest countries that are constrained by a general lack of resource endowment would also be the most vulnerable to environmental change. There would also seem to be general agreement that it is within the power of man to alter or at least mitigate the ongoing environmental change. The question then is what drives this change process and why it seems to be so difficult to modify it, particularly in the poor countries.

At one level it is clear that in developing countries environmental change is driven by poverty¹. Poor people, and equally poor countries, have no margins, no buffers against economic downturn, are largely unable to consider the needs of future generations, have to attend to their immediate survival needs, and hence are forced to disregard long term environmental considerations. Traditional communities have long been known to live in ostensible harmony with nature and to treat nature with respect and even reverence. But it is the combination of poverty on the one hand and modern technology on the other together with poor governance that can prove to be truly deadly for the conservation of sensitive ecosystems.

But neither people nor countries remain poor of their own volition. Their poverty and hence their behavior is influenced by a number of factors beyond their control in their local, national or global environ-

¹ There is a line of argument that the poor must not be blamed for environmental destruction, that they are poor because of the inequalities in the world caused by the rich, and that therefore the rich (and the First World) carry the blame for the global environmental problems. There is no intent here to pursue this debate.

ment, many of which are inexorably interlinked in a manner that often makes causality difficult to define. Economic incentive structures play a major role, individuals (and nations) act in their own self-interest with little regard for others or for future generations: farmers in India (and elsewhere) use groundwater to irrigate their crops unsustainably causing groundwater tables to fall, because water pumps are subsidized by the government and the real cost of water is not reflected in crop prices. But economic incentives can be influenced by policy which is shaped by political power structures and by the quality of governance. Inefficient or even corrupt institutions may render well-intended policies ineffective and powerful lobbies can dilute political attempts to address problems.

Ultimately policy is a function of prevailing power structures, norms, values and knowledge. There is often insufficient knowledge of the economic consequences with regard to the environment of a particular set of policies. Frequently there is little understanding of the value of the resilience of biodiversity to human life and processes. There is a common belief that the biosphere is endless, that nature has its own healing mechanisms, and that environmental destruction is not irreversible because science can always fix whatever change is occurring. The phase of development is one of the determinants of environmental change, since history suggests that industrializing countries pollute their environment more than countries which are yet in the pre-industrial phase, and that the nature of pollution changes with the level of development.

Environmental change in developing countries is also influenced by external factors wholly or partially beyond the control of these countries. Lifestyles in the rich countries that contribute to climate change, such as drought, in developing countries would be one example. Trade patterns and the influence of multinational corporations would be another, armed conflicts and social upheavals would be a third.

In an increasingly globalized world it is not possible to separate the local from the global, all are intertwined and combine in a complex mesh of causes that underlie environmental change in general and in developing countries in particular. It does not necessarily follow that every eroded hillside in a developing country is ultimately caused by globalization nor that a scientist always should adopt a global perspective. But it is necessary to have in mind the broad background of what drives environmental change before considering the more direct manifestations of such change in developing countries.

2.2 Energy, Climate and Transportation

There is strong scientific consensus that the two most important human-caused problems associated with environmental processes operating at the global scale are the disruption of climate as the result of energy-related emissions of heat-trapping so-called greenhouse gases (GHG) with long atmospheric residence times and the depletion of atmospheric ozone as a result of emissions of chlorofluorocarbons and related compounds from refrigeration equipment and other sources. Only the first of these is discussed here.²

² Stratospheric ozone is not covered since it is not primarily an energy issue and since it does not, at least not yet, affect a large number of developing countries.

While more knowledge is needed on the sensitivity of human systems to *climate change*, there is broad agreement that projected adverse impacts include

- a reduction in potential crop yields in tropical and subtropical regions subject to the highest temperature increases;
- decreased water availability for populations in many water-scarce regions, notably in the subtropics;
- an increase in the number of people exposed to vector-borne and water-borne diseases (such as malaria and cholera) and an increase in heat stress mortality; and
- a widespread increase in the risk of flooding for tens of millions of people, due both to increased heavy precipitation events and sea level rise.

Projected changes due to climate extremes – droughts, floods, heat waves, and windstorms – could have major consequences, as the frequency of these events is expected to increase. It is already evident that these consequences are hitting hardest in developing countries and particularly in the poorest among them, not only because they are ill equipped to cope but also because they are already struggling with the combined effects of economic deregulation, poverty, population growth and resource depletion with effects from climate change an added burden.

Carbon dioxide (CO₂) is the most important GHG, and its share in global warming is expected to rise from slightly more than half today to around three quarters by 2100. It results mostly from the burning of fossil fuels by man, i.e. the use of coal, oil and natural gas as sources of energy for heating, cooling and transport. Global carbon emissions from fossil fuel combustion rose by 9.1 percent between 1990 and 2000. The US accounted for 24 percent of the total in 2000, by far the largest share, but developing countries are rapidly increasing their emissions with e.g. China increasing by 7.7 percent during 1990 – 2000.

Against this background the development and application of non-fossil fuel based or *renewable energy* sources that can contribute to reducing the rate of increase of carbon emissions becomes a high priority for the world at large and for the developing countries in particular. Promising steps are being taken in that direction in both rich and poor countries, but much still remains to be done.

The most important source of renewable energy has been hydropower³. While most of the existing potential for hydropower has already been exploited in developed countries (in Sweden 80 percent), much such potential still remains in developing countries. However, with the increasing criticism in recent years of dams the exploitation of hydropower will in future years likely be done on a more selective basis than in the past.

The “new” renewable energy sources hold promises for the future. Globally they still account for only a small fraction of total energy supply, but their share is increasing rapidly. Wind power grew during the 1990s at an annual rate of 24 percent and is now a significant source of energy

³ While hydropower is usually regarded as a clean, renewable energy source, it is often overlooked that dams may cause emissions of methane, a much more persistent GHG than CO₂.

in several European countries. Solar photovoltaics, which convert sunlight into electricity, have also witnessed significant cost declines and a market growth rate of 17 percent during the 1990s. While these technologies are still too expensive for broad application in developing countries, they will be important in specific situations, e.g. to drive water pumps or cooling facilities for health stations in remote locations.

Biomass energy is the most common traditional source of energy in developing countries. Worldwide, two billion people are without access to electricity and use traditional, biomass-based fuels – fuelwood, charcoal, agricultural residues, dung – for cooking and heating. Over 100 million women spend hours every day gathering fuel (and water) and then spend additional hours cooking in poorly vented spaces. The stoves used often lead to significant health impacts through the generation of pollutants that expose women and children to air pollution corresponding to smoking two packs of cigarettes a day: in India the health effects from household solid fuel use have been estimated at 5-6 percent of the national burden of ill health and 6–9 percent of the burden for women and children. Providing the poor with access to clean sources of energy is therefore a major social priority.

Technological innovations are fuelling a trend toward more and smaller energy generators closer to users, changing electricity systems away from the traditional centralised configuration to a more decentralised one facilitating access for large numbers of poor users. Small-scale generating technologies, including combined heat and power, fuel cells, and renewables such as wind and solar power will become increasingly important. Gasification of biomass even at household level holds promise and has several advantages over the traditional burning of solid fuels. The production of ethanol from biomass has attracted considerable interest as an alternative automotive fuel, particularly in Brasil where at one time this industry based on sugarcane generated 700,000 jobs.

For these changes to occur specific policies to foster energy efficiency improvements are warranted. Electricity market liberalisation coupled with stimuli of technological innovation provides new opportunities to accelerate access to electricity. However, the electricity crisis in California in 2000 illustrates the dangers of reckless liberalisation and the need to ensure values that a short-term market will tend to ignore, such as reliability, price predictability and environmental impact. There is also the social need to subsidize the provision of electricity to the poor, e.g. because of the aforementioned health hazards with traditional fuels, as illustrated by public programmes for rural electrification in South Africa and electrification of the *favelas* of São Paulo. Getting the right mix of market liberalisation, subsidies and control over energy markets is therefore a challenge for many governments.

The *transportation sector* is the fastest growing source of the carbon emissions that are affecting the climate. Worldwide, the share of carbon dioxide from transportation climbed from 17 percent in 1971 to 23 percent in 1997. In most developing countries the demand for freight and passenger transport is growing 1.5–2 times faster than GDP; in e.g. the three Baltic states the number of passenger cars increased by an average of 62 percent during 1990 – 1996. Air pollution from vehicle emissions in urban centers in developing countries, particularly from the

highly polluting two- and three-wheeled vehicles so common in many Asian cities, is the single largest contributor to illness and death in many large cities, particularly among the poor living in shanty towns near major traffic arteries.

Just as the case with renewable energy environmental issues arising from transportation affect developing countries at two levels: at the global level where reduced GHG emissions from all sorts of transport would help reduce global warming and hence its effects on poor and vulnerable countries, and at the national level where improved means of transportation would improve urban environments with benign side effects in health and other areas.

World consumption of the *non-renewable natural resources* coal, oil and natural gas has increased more than fourfold since 1950, and the increase is set to continue. There are more than enough reserves of fossil fuels to meet the projected growth in energy demand through 2020. The growth of renewable energy sources as well as conservation measures adopted under the climate change convention will stretch available reserves still further. But as the most conveniently located deposits are being depleted the exploitation of new reserves will require massive investments in infrastructure and a risk of increasingly negative environmental effects. The main problem affects resources that lack clear and reliable ownership and hence incentives for sustainable management.

A similar situation obtains with regard to metals. Expenditure by mining companies to explore untapped lodes of metal around the world have dropped sharply and were in 2001 less than half of what they were in 1997. At the same time the production of metals is increasing. Because of the increased use of recycled materials and a falling metals intensity in the global economy there is little reason to fear depletion of metals reserves. However, in those developing countries where mining operations are significant – primarily western Latin America, southern Africa, China and southeast Asia and western Pacific – there are serious problems of tropical habitat destruction, groundwater pollution and soil erosion. Some mining companies have been so destructive that work has been initiated to introduce an environmental (and ethical) code of behavior in the industry.

2.3 Land, Water and Food

The essentials for producing food are land and water. Both are under increasing threat as a consequence of climate change, population growth and poverty. There have so far been no difficulties at the global level to meet the demand for food, and real prices for cereals have fallen in the world market during the last century. However, this hides the facts that some 800 million people, mostly in Africa and South Asia, have a daily diet in terms of calorie intake that is below the minimum for a healthy human life, and that 1.2 billion people are defined as absolutely poor. These people lack purchasing power and do not influence world market food prices. It is they who are primarily affected by deteriorating arable land and water shortages.

A substantial area of the world's *farmland* is degraded and getting more so, particularly in the developing world. It is estimated that 10–20 percent

of the world's 1.5 billion hectares of farmland suffers from some level of degradation, in developing countries one quarter of all farmland may be thus affected. The pace of decline has accelerated in the past 50 years.

Compared with the industrial world's soils, the tropical soils of the developing countries are older (they were not rejuvenated by the last glaciation), exposed to more severe weather, more often in hilly or mountainous areas, and require more careful management to avoid degradation. Farmland in arid areas – both rangeland and cropland – is particularly susceptible to degradation, because the low rainfall means that soils and plants recover more slowly.

Perhaps the most common cause of farmland degradation is excessive tillage and removal of vegetation, leaving the soil exposed to rain and wind. Too many animals feeding on an area of land can strip it of vegetation and expose it to erosion and other degradation. Cultivation of land not suited to agriculture, because it is too dry or steeply sloping, can also lead to degradation. In the poorest developing countries, farmland suffers from the depletion of nutrients as farmers continuously harvest crops without fertilizing or fallowing the land. Salinization is the most common form of degradation of irrigated cropland, some 20 percent of the world's total irrigated land is degraded, mostly in developing countries where knowledge of irrigation management often is inadequate.

The underlying reason behind most causes of farmland degradation is population growth in combination with poverty. Population growth causes farm holdings to be subdivided into unsustainably small plots and forces farmers to cultivate steep slopes and drylands unsuitable to farming. Poverty prevents farmers from using fertilizers and hence from resupplying nutrients to the soil, leading to low yields and continued poverty. This vicious cycle characterizes many countries in Africa and South Asia. The situation is often exacerbated by the droughts and increasing temperatures that may be a consequence of climate change.

As in the case with use of the motor vehicle *water use* increases rapidly with economic development, and water withdrawals have increased at 2.5 times the rate of population growth during the last 50 years. In developing countries about 70 percent of all water use is for agricultural purposes. Many aquifers are now being depleted as farmers are pumping groundwater faster than nature can replenish it. During the last several decades, as the number of groundwater wells skyrocketed, often as local governments subsidized pumping costs, aquifer depletion has spread from isolated pockets to large areas of irrigated cropland. The problem is now widespread in central and northern China, northwest and southern India, parts of Pakistan, much of the western US, North Africa, the Middle East and the Arabian Peninsula. Most of this overpumped groundwater is used to irrigate grain, the staple of the human diet. It takes about 1,000 tons of water to produce one ton of grain and some 180 million tons of grain – roughly 10 percent of the global harvest – is being produced unsustainably by depleting water supplies in the regions mentioned.

When a country's renewable water supplies drop below about 1,700 cubic metres per capita it becomes difficult for that country to mobilize enough water to satisfy the needs for water of its population, industry and agriculture; the country is then defined as water stressed. Today

there are some 34 countries in this category, mostly in Africa, Asia and the Middle East, with a total population of 470 million. By 2025 the number of people living in water stressed countries is expected to have reached about 3 billion. Competition for water between many of the same countries is also increasing as countries share precious water resources, e.g. the Nile, the Jordan, the Ganges and the Tigris-Euphrates. Again, water shortages are being exacerbated by droughts and rising temperatures caused by climate change.

With cropland and water resources under stress it becomes important to raise *agricultural productivity*, i.e. yield per land unit, lest world food supplies run short of demand. As mentioned, this has not happened to date simply because the poor, perhaps 20 percent of mankind, eat less than they should and do not affect world market prices. However, world cereal production was down significantly in 2002, and the crop in that year was the smallest since 1995.

The world as a whole has nearly tripled land productivity since 1950 and some countries have done even better: the US has quadrupled its maize yield per hectare, India has nearly done the same with wheat. For several decades scientists generated a steady flow of new technologies designed to raise land productivity, but that now appears to be slowing down. In countries where yields have already tripled or quadrupled, it is difficult for farmers to continue raising yields. But even some developing countries are now experiencing a plateauing of grain yields. For example, wheat yields in Mexico climbed from 1.7 tons per hectare in 1961 to 4.4 tons in 1982, a rise of 160 percent, but since then there has been little change. World grain yield increased by 2.1 percent per year during 1950–90 but only by 1.2 percent during 1990–2000.

While the big gains in agricultural productivity were made during the second half of the last century in some of the most fertile regions of the world, much remains to be done in the less well endowed regions. These include in particular the countries in Africa and South Asia dominated by peasant farming and subject to recurring droughts, land degradation and water shortages. In these countries use of imported farm inputs such as fertilizer is generally limited and yields have not changed much over the past several years. Whatever gains many of these countries may have made in agricultural productivity have tended to be outweighed by population growth, rendering them more food insecure. Some countries in this group, such as Ethiopia and Mozambique, are now chronically dependent on humanitarian food aid.

Two complementary approaches have been cited to address the problem of stagnant yields under peasant farming conditions. The first relates to the application of biotechnology to specific issues affecting peasant agriculture, e.g. the development of more drought tolerant crop varieties. The second is the concept of sustainable agriculture, a production system that incorporates natural processes such as nutrient recycling, nitrogen fixation and pest-predator relationships and minimizes the use of external, off-farm inputs while building on local knowledge and practices. There is no quick fix, no “silver bullet”, to the problem of stagnating agricultural yields in poor countries, and a variety of different approaches will therefore be required. What is vexing is that this problem

is hidden behind the seemingly abundant world supply of cereals, as witnessed by falling world market prices, which has bred complacency among decision-makers causing development aid for agriculture and agricultural research to fall.

2.4 Terrestrial and Marine Biodiversity

Biological diversity or *biodiversity* is about the diversity of life in all its forms: from genes, to species, to ecosystems. Biodiversity is not just a measure of sustainable development or a concern of environmentalists, it is essential to human life. A diverse natural environment includes a range of species that provide services essential for the survival of ecosystems, e.g. pollination, soil conservation, pest control and break-down of waste and pollutants. Such an environment supplies the necessary resilience to changes or disturbances in the interaction between man and nature which often is necessary for sustainable development. But like products that are gathered from the wild, nature's services are often regarded as free and therefore undervalued.

Poor people are the most dependent on these services and the most vulnerable to loss of biodiversity. But biodiversity loss is ongoing at a seemingly accelerating pace making the permanent loss of species a major concern to governments, scientists, farmers and fishermen: for example, by one estimate some 20 percent of the world's freshwater fish species are now threatened with extinction or have already gone extinct.

The reasons are complex. One factor is the failure of traditional economic analysis to take into account the true value of biodiversity. Until an economic value can be attributed to biodiversity the cost of its destruction will continue to be neglected by governments and individuals alike.

Much biodiversity is lost because of changes in land use, primarily for increased agricultural production. The forces driving these changes include excessive consumption by the rich as well as the pressing needs of the poor. There are cases in e.g. Latin America where people see biodiverse areas, such as tropical forests, as barriers to development since the services provided by a diverse environment are not properly understood.

Deforestation is therefore one of the most acute environmental issues in developing countries. FAO reported in 2001 that during the 1990s "the world's natural forests continued to be converted to other land uses at a very high rate" and went on to estimate that 4.2 percent of the forest cover that stood in 1990 was gone by the end of the decade. According to another estimate about half of the Earth's original forest cover is now gone with another 30 percent degraded or fragmented. Forest loss results largely from conversion to agriculture by small, medium and large farmers, though logging often plays a catalytic role by opening up forested areas. The underlying reason is usually policy failure and weak supervisory institutions of the governments concerned.

Of the 161 million hectares of natural forest that were lost during the decade 152 million hectares of the loss occurred in the tropics. Most of that took place in just eight countries: China, Brazil, Indonesia, Sudan, Zambia, Mexico, DRC and Myanmar. Many nations lost a high proportion of their forests during the last decade: 18 nations lost 20 percent or

more of their forest cover, another 16 lost 10–19 percent. Most of the highest losses were recorded in Africa: Rwanda and Burundi, two countries plagued by civil war and poverty, each lost 39 percent. The tropical forests are the world's richest depositories of biodiversity, and the destruction of these forests is one of the principal reasons behind the aforementioned biodiversity loss.

Deforestation is somewhat compensated by regrowth, estimated at 36 million hectares during the 1990s, and by tree plantations, some 31 million hectares during the last decade. Most tree plantations are found in Asia where they now account for 21 percent of all forest cover. Planted forests meet needs for construction timber and fuelwood but can sustain only a small fraction of the biodiversity services of natural forests.

The *coastal areas* are home to about two-thirds of the world's population, a figure that is estimated to rise to three-fourths within 30 years (the coastal area being defined by the UN as up to 60 km from the waterline)⁴. Environmental conditions in the coastal areas throughout the world are deteriorating rapidly as this environment is under increasing pressure from unsustainable human activities, particularly uncontrolled urbanization. Pollution, destruction of natural habitats and over-fishing are posing an increasing threat to the life and well-being of billions of people. The situation is particularly serious because such a large portion of the dietary protein intake comes from the fisheries in coastal shallow waters that are under increasing threat.

The environmental situation in coastal areas in the tropics can be assessed through study of two important ecosystems: coral reefs and mangrove forests. Coral reefs provide nature's second richest ecosystems after tropical rainforests in terms of biodiversity and host huge numbers of plants and animals: one out of every four ocean species is a reef-dweller, including at least 65 percent of marine fish species. But coral is extremely vulnerable to heat stress. Unusually high sea surface temperatures of the past two decades, probably a consequence of climate change, have damaged the reefs just as badly as fire has damaged tropical forests. Over a vast tract of the Indian Ocean, from the African coast to southern India, 70 percent of the coral appears to have died. In addition, coral reefs have been destroyed in some areas, e.g. Southeast Asia, by more direct actions by man, such as fishing using dynamite or poison. The long-term consequences of the destruction of coral for marine biodiversity and for fish stocks are yet poorly understood.

The mangrove ecosystem is equally productive, providing nurseries for a rich array of marine life as well as terrestrial animals. The mangrove forests grow in tidal zones along most tropical coasts. This environment is also being quickly destroyed, as large areas are being cut down and the land is used for shrimp farms, settlements and roads.

Global *catches of fish* have declined ever since the mid-1990s. In 2000 it stood at 95 million tons and FAO forecasts world fishery production to range between 80 and 105 million tons in 2010. Some species are now under threat and may not recover unless politicians succeed to regulate the fishing industry, apparently a tall order. Particularly serious is the situation in the rich fishing waters along the coast of tropical countries

⁴ Scientists prefer to use the less mechanical term seascape to denote the coastal zone.

where demographic pressure from the coastal zones combines with the failure of the countries involved to contain the activities of fishermen from as far away as Spain or South Korea to accelerate the depletion of fish stocks.

As a result, fish farming, or *aquaculture*, is expanding rapidly, at present the fastest-growing segment of world food production. Total production from aquaculture was in 2000 36 million tons, up from only 13 million tons ten years earlier (this is in addition to the production from capture fisheries mentioned in the preceding paragraph). However, the rapid growth of fish farming carries with it high ecological costs in rich and developing countries alike. Fish farming causes pollution, as mentioned it contributes to the destruction of mangrove forests, it can lead to fish disease outbreaks and it carries with it a high demand for fishmeal that contributes to overfishing.

2.5 Demographic and Social Factors

Even though average incomes more than doubled in developing countries between 1965 and 1998, 1.2 billion people – almost one in five in the world – lived on less than USD1 per day in 1998, a level often used to denote “extreme poverty” or lack of income to meet basic food needs. Almost 70 percent of the absolutely poor live in Sub-Saharan Africa and South Asia. Sub-Saharan Africa has the largest share of extremely poor people, although there are large differences within and between countries. Rural areas house the bulk of the extremely poor, but with massive migration toward the cities and stagnating economies the rural-urban income gap has been shrinking in many countries.

Not only has *poverty* persisted in the 1990s but the chasm between rich and poor has widened. While 60 percent of the world’s people earn just 6 percent of the world’s income, 17 percent of the people receive 78 percent of the income. In many countries the gap between rich and poor narrowed between the 1950s and the mid-1970s, but since then the reverse has happened. Also between countries income differentials have widened in recent years, as countries poorly endowed with resources and plagued by conflict, such as in Africa, continue to fall behind the rest of the world.

There is a close but complex relationship between poverty, depletion of natural resources and degradation of the environment. The poor are often forced to live in marginal areas where ecosystems are vulnerable to overexploitation. This, in turn, leads to deeper poverty in a vicious circle. But poverty interacts intimately with degradation of the environment and depletion of resources in a variety of ways. Often poverty is a result of environmental degradation, just as it can be one of the causes of such degradation. When grazing lands, coastal zones, wetlands or forests are overexploited, the people who usually collect wood, water or fish in these areas are those directly affected. Certain types of environmental degradation are particularly caused by poverty, such as soil erosion, overgrazing and depletion of vegetation. The poor do not have the resources necessary to protect the environment and lack the means and the knowledge to find new ways of living, being forced to think in terms of short-term survival. Since there is a complex and mutually reinforcing,

two-way relationship between poverty and the environment, this relationship is sometimes referred to as the *poverty-environment nexus*.

At the same time it should be intuitively obvious that wealth, including the consumption patterns of the rich world and the rich in the poor world⁵, and economic growth contribute more than poverty, in fact much more, to the global environmental problems such as climate change. As mentioned, the US alone accounts for almost one-fourth of global carbon emissions, deforestation in e.g. the Amazon is commonly caused by the road construction, logging and ranching of the relatively rich. At different income levels there are different types of impact on the environment, and overall environmental degradation increases rapidly with rising incomes.

The world's population swelled to 6.2 billion in 2001 – more than double the number in 1950. This represented an increase of 77 million over the preceding year. More than 95 percent of this growth is occurring in the developing world. Most of the people are added in just a handful of countries, with China and India alone accounting for over one-third of the growth. The global rate of *population growth* has actually decreased over the past three decades to under 1.3 percent today, but the number of people added to the planet each year has remained almost constant for the last several years.

Africa has the highest growth rate of any region, increasing by 2.4 percent each year. Population there is expected to almost triple – from 800 million to 2.3 billion – by 2050. Growth rates in Asia are lower but apply to a much larger base. In the regions of the world where population continues to grow the increase is largely fueled by a combination of factors, in particular poverty, discrimination of women and unmet needs for reproductive health care. Population growth rate in industrialized countries is just 0.3 percent, while it is 2.5 percent in the least developed countries.

Population growth is usually the proximate cause of many of the environmental issues discussed above: soil erosion, deforestation, overgrazing, depletion of water supplies, destruction of coastal zones and coral reefs can in large measure be traced back to the increasing need for food and sustenance by an expanding population. And population growth is driven by poverty which becomes an underlying cause⁶.

Urbanization is increasing rapidly as people migrate from rural to urban areas in search of work and new opportunities. Since 1950 the number of people living in urban areas has jumped from 750 million to nearly 3 billion. Over 60 million people are added to cities each year through rural to urban migration, natural increase within cities and the transformation of villages into urban areas. In future years the vast majority of population growth in developing countries will occur in urban centres. By 2025 the total urban population is projected to reach 5 billion people and 90 per cent of this increase is expected to take place in developing countries.

Urban sprawl creates new needs and aspirations, as people work, live,

⁵ The latter are today more numerous than the former, i.e. there are more people in developing countries enjoying a lifestyle and consumption patterns typical of the industrialized countries than there are in the latter. The distinction between rich and poor countries is therefore increasingly losing some of its meaning, just as the distinction between First World and Third World lost its meaning after the end of the Cold War. Yet these terms continue to be used for want of better alternatives.

⁶ Cf footnote # 1.

move and socialize differently than they did in rural areas therefore demanding different products and services. Urban environmental impacts and demands are also different. With a large and rapidly increasing number of people concentrated to a limited area urgent and growing demands are placed on the provision of housing, power and water. A whole set of so-called “brown” environmental issues relates to waste disposal, recycling of materials, and pollution of air and water. The need for transport provides another set of issues with environmental implications. In many of the poor countries the environmental issues arising out of urbanization have to date been largely neglected as cities have grown incrementally and without proper attention to infrastructure and basic services. The result is that large cities in these countries have become increasingly unliveable with horrible slums, accumulating waste, congested streets, air pollution and resultant ill health among residents. As urbanization proceeds apace it is becoming increasingly necessary to address these issues, lest human life and economic progress in these cities be seriously impaired.

2.6 Selected Cross Cutting Issues

As concern for the environment has permeated society in industrialized countries and, increasingly, developing countries, there is a growing awareness of linkages between the environment and a number of other societal issues. These issues are often of a cross-cutting nature in the sense that they impact on a variety of sectors, countries and regions. Often the linkages are of a complex two-way nature, just as the relationship between poverty and the environment discussed above. What follows is a somewhat arbitrary selection of such linkages listed in no specific order.

2.6.1 Environment and Health

It is intuitively clear that a poor environment will affect human health, that polluted air and water will contribute to the spread of disease, and that the poor will be worst affected. The issues involved can be grouped into home, work and the broader environment. In the home environment the health risks arising out of poor water, sanitation and hygiene are prominent, contributing to the spread of diarrhoeal diseases. Poor and crowded housing and indoor air pollution also produce ill health, as said in section 2.2. The work environment in most developing countries is often totally unregulated exposing workers to occupational hazards such as poisoning, air pollution, unshielded machinery and biological agents.

But it is the broader environment that affects most people and in a systemic fashion. Climate change affects human health and disease patterns in direct and indirect ways. Rising temperatures increase the geographic range and incidence of some of the major tropical diseases. It is estimated that the proportion of the world’s population affected by malaria could increase from the current 45 percent to about 60 percent in the second half of this century. Dengue fever may undergo a latitudinal and altitudinal expansion similar to malaria, and schistosomiasis is likely to spread beyond its current distribution limits (although it may well also decrease in some areas). Climate change may also have extreme

weather-related health effects, and with rising temperatures the respiratory infections resulting from air pollution in congested cities would be more severe.

2.6.2 Environment and Conflict

It is difficult to demonstrate empirically that either poverty or the environment, in and by themselves, are strong determinants of conflict. However, there is strong evidence that the loss of livelihoods resulting from poverty in combination with population growth and growing lack of resources, arable land in particular, is an explanatory factor underlying many conflicts and social upheavals in poor countries. As rural populations grow and already small farm holdings are subdivided further, young men, and to a lesser extent young women, lose their livelihoods and migrate, often to the cities, in search of work. Many of them become susceptible not only to crime and prostitution but also to political agitation and tend to become the foot soldiers in local conflicts and civil wars. This was what occurred in Rwanda in the 1990s and seems to be what is happening today in e.g. Algeria and Somalia. The poverty-environment nexus can therefore be said to be an underlying factor behind those and other conflicts in ways that still need to be better understood.

2.6.3 Environment, Humanitarian Emergencies and Refugees

A similar relationship pertains to environment, humanitarian emergencies and refugee flows. It is evident that affected people flee from acute environmental disasters whether they be sudden and acute, such as the flooding in Mozambique in 2000, or more gradual over time such as the destruction of the Aral Sea or the badly eroded highlands of Ethiopia, Nepal and El Salvador. Again, it is the poverty-environment nexus at work: if these areas were not so poor people would have coping strategies that would allow them to remain even in the face of environmental disaster.

Humanitarian emergencies and refugee flows are usually triggered by an event, which may be a war but more often drought or flood, that suddenly renders untenable a situation that over time has been worsened by a gradual process of environmental degradation. The state of the environment will then only be one of many interacting physical and social variables that ultimately force people from their homelands. Linkages among climate change, environmental degradation, security and refugee flows need to be much better established to allow vulnerabilities and risk to be better specified.

2.6.4 Environment, Law and International Governance

Since the 1960s environmental law has evolved as an increasingly important discipline for the use of legal instruments and frameworks to advance conservation of nature and natural resources. Over the past two decades environmental law has become universal with the volume of environmental legislation growing almost exponentially. This has paved the way for treaties, such as the multitude of international conventions now in force, and “soft law” such as the UN World Charter for Nature as well as many national or regional laws. In developing countries environ-

mental law generally remains little known and poorly applied. However, there are exceptions: the South African water law is regarded as one of the most progressive and insightful in the world, China has recently legislated integrated management of water resources.

The number of international environmental treaties has soared over the last few decades. UNEP estimates that there are now over 500 international treaties and other agreements related to the environment, more than 300 of which have been agreed to since the first UN conference on the environment in Stockholm in 1972 and 41 of which UNEP considers “core international conventions”. But international environmental governance has to some degree become a victim of its own success as problems of duplication, fragmentation, and excessive bureaucracy have arisen in the wake of many conventions and their accompanying secretariats. The need to reinvigorate international environmental governance is illustrated by calls made in the context of international trade negotiations for the creation of a World Environmental Organization to be the institutional and legal counterpart of the WTO. In this age of globalization there is a perceived need for some environmental rules of the road for the global economy that existing institutions seem unable to provide.

Developing countries feel that their environment is being degraded not only by the consumption patterns but also the trade rules of the industrialized world and therefore have a keen interest in improved international environmental governance. They are often the intended beneficiaries of the major international environmental conventions, but they tend to lack the requisite expertise to benefit adequately from them.

2.6.5 Environment and Gender

Women’s relationship with the environment in rural areas in poor developing countries has dual dimensions. On the one hand, women are users of natural resources, in poor developing countries relying heavily on them for household sustenance. Natural resource degradation, including what is induced by development itself, can undermine women’s ability to perform their traditional tasks with regard to food production and collection of water and fuelwood. On the other hand, women are active and knowledgeable environmental managers and caretakers and are said to have a more caring relationship to the environment than men. They play an important part in conserving natural resources, e.g. by planting trees and engaging in soil conservation. Environmental policies frequently fail to take into account women’s roles and circumstances and make full use of their skills and knowledge.

Women’s close relationship to natural resources has often been translated into an image of women as powerless victims of environmental degradation, struggling to scrape food, water and fuelwood from increasingly depleted land. This image fails to account for the accumulative or asset creating activities which women engage in, such as trade involving products derived from natural resources. There is also an asymmetry between women’s resource-related responsibilities within the household and their weak rights or entitlements which reduce their access to the very resources they need most, e.g. laws preventing women from inheriting or owning land. Women’s relative lack of access to essential resources

is a universal issue that is often simplified as property rights but in fact is more far-reaching in many societies, as exemplified by the poor education of young women and girls often cited as one of the main factors underlying high population growth.

2.6.6 Environment, Awareness and Knowledge

The world remains unconvinced about acting on climate change which is of concern to all mankind but arguably more so to the developing countries which, as said above, are those disproportionately affected. Despite more than 20 years of increasingly intensive scientific work and exhaustive follow-up discussions by governments, the international community has made little real progress on actually reducing the growing global emissions of GHG, particularly CO₂. The economic damage from global warming seems to be doubling every decade, and adaptation costs are set to increase exponentially. The dangers to human survival that climate change will bring are, by now, well documented and overwhelmingly accepted by those working in the area. Yet the general public appears to have become bored with the issue, and governments, possibly as a direct consequence, have proven themselves unable to act nearly forcefully enough. Commitments made under the existing Kyoto protocol can only be characterized as totally inadequate.

Knowledge, awareness and motivation are key to requisite changes of the human behavior that degrades the environment. A consumer in an industrialized country needs to know about climate change and how it is caused by emissions from motor vehicles in order to be motivated to use collective transport instead of a private car. A peasant in a poor country needs to understand the effects of soil erosion and what measures can be taken to husband the soil on arable land in order to be motivated to undertake such measures. In rich and poor countries alike environmental care is now commonly taught in schools, and environmental education is a growing discipline. But much more needs to be done to raise awareness of environmental issues among politicians, administrators and the common man, particularly in the poorest countries.

2.6.7 Environment, Institutions and Governance

Environmental law is an expanding discipline, as said above. But laws are only useful to the extent that the institutions of government exist to monitor their implementation and bring sanctions to bear in cases on non-compliance. With regard to the environment (and a host of other fields) it is common in developing countries that the laws existing on the books are adequate, while the institutional machinery to implement them is weak or non-existent. Weak governance is an explanatory factor underlying many or most of the aforementioned issues of environmental degradation in developing countries. It includes a wide range of issues from corruption, poor political leadership, weak institutions to poorly trained public servants and insufficient financial resources

Ministries of environment and similar institutions in developing countries are typically weak and toothless lacking both analytical capacity and authority to take legal action against blatant offenders of ordinances intended to protect the environment. They tend to be preoccu-

pied with donor-driven environmental action plans that are routinely ignored when hard decisions about financial resource allocation are made elsewhere in government. Field personnel assigned to monitor environmental performance of individual enterprises in industry or agriculture tend to be poorly trained, remunerated and motivated, often lacking requisite equipment such as adequate transport and sometimes susceptible to corruption. It is unlikely that institutional performance will change significantly in the absence of more understanding of the economic and financial costs of environmental degradation, an argument for introducing these issues in the work of ministries of finance and similar entities.

3. Priorities for Research

3.1 Overriding Criteria

This paper will conclude by suggesting research priorities for MISTRA to address in its future work. These priorities should meet the following criteria, most of which derive from MISTRA's present statutes:

- (a) their relevance to poverty eradication in developing countries should be high,
- (b) they should be “researchable” and of interest to the academic community,
- (c) they should be of a broad, interdisciplinary nature,
- (d) their findings should be practically applicable, and
- (e) the research should be of “strategic” importance.

Using these criteria eight research priorities have been proposed as a basis for discussion in section 3.6 below. However, they need to be accompanied by caveats regarding interdisciplinarity and overriding cross-cutting themes as well as attention to the underlying factors driving environmental change and to their relevant time setting in the development process.

3.2 Interdisciplinarity

A new field of sustainability science is emerging that seeks to understand the fundamental character of interactions between nature and society. Such an understanding must encompass the interaction of global processes with the ecological and social characteristics of particular places, sectors and socio-economic contexts.

This involves two different dimensions. First, relevant research will have to integrate the effects of key processes across the full range of scales from local to global. There is increasing understanding that seemingly local environmental issues must be approached also from a global perspective and that both perspectives are necessary for a complete causal analysis.

Second, sustainable development combines economic, social and environmental dimensions, and research in this area therefore tends towards interdisciplinarity and holistic approaches. This means that it is sometimes difficult to place an area of research squarely in one sector or

discipline, and that some of the priority programmes shown below will necessarily overlap. It will be somewhat arbitrary under which heading to place a particular topic, indeed a given topic could appear under different headings. What will be important is to merge several topics into a coherent programme including multiple research projects in a variety of disciplines.

3.3 The Time Dimension of Environmental Challenges

There is an essential time dimension to the perceived environmental challenges in developing countries that should be taken into account when future research priorities are considered. Research should arguably be forward looking and help minimise avoidable future problems. It is possible to classify the environmental challenges discussed in chapter 2 above as follows:⁷

1. *Past and ongoing environmental degradation.* This includes what *has already occurred* and cannot be stopped but possibly repaired or mitigated (climate change, land degradation, deforestation, water pollution, groundwater depletion).

2. *Problematic environmental preconditions complicating poverty alleviation and socio-economic development.* This is what *complicates development* and has held back developing countries with unfavourable agro-climatic conditions, e.g. in parts of Sub-saharan Africa. This includes areas with harsh hydroclimate and vulnerable soils where multiple water scarcity obtains (short growing seasons with frequent dry spells, droughts related to El Niño, soils that develop crusts and prevent water infiltration leading to desertification, high evaporation after rains causing water courses to run dry quickly).

3. *Future more or less unavoidable environmental change.* This includes *what must happen* if poverty and hunger is to be sustainably reduced. Here it is essential to separate the avoidable from the unavoidable. It will not be possible to increase food production unless at least some landscape modifications are undertaken (terracing sloping land, digging irrigation ditches, building rural roads, breaking new land for cultivation), and some of them will have unavoidable environmental effects. Other environmental effects will be entirely avoidable as they are caused by mismanagement in the broadest sense (salinisation of irrigated land, excessive pesticide use, insensitive clearing of forests, soil erosion caused by road construction).

Research supported by MISTRA within the context of Sida's mandate (reducing poverty) should therefore aim

- to reduce the impact of problems under category 1 above,
- to facilitate the fight against poverty by tackling the challenges under category 2, and
- to minimise the avoidable problems of category 3 while taking into account the trade-offs between man's development needs and the survival of ecological systems.

⁷ This section is based on comments provided by Professor em. Malin Falkenmark.

Research should help practitioners detect what is “avoidable” while minimising the effects of what is “unavoidable”. It is unavoidable to clear more forests for cropland and to use more groundwater, if food demand by 2050 is to be satisfied, it is equally unavoidable that the cities will continue to expand. If research on the environment in developing countries adopts this perspective it will be of more use in assisting the fight against poverty.

3.4 Overriding Cross-cutting Themes

Cross-cutting themes, such as economics or gender or governance, may be applied to all or most of the subjects listed below, e.g. economic costs of biodiversity loss or governance and water savings in agriculture or gender aspects of buildings for improved home environment. Many such linkages may in themselves be interesting areas of research, but an exhaustive list would be voluminous and is not attempted here.

But it is also necessary to place the entire discussion about environmental change in the broader context of causality at a still higher level of abstraction, perhaps the most important cross-cutting theme. Conventional natural resource management has tended to take for granted the capacity of ecosystems to sustain production as well as the flow of ecosystem services, many pious declarations by governments to the contrary. If research findings are to be of practical applicability, it is necessary to address the underlying driving forces that, as said above, in a globalized world combine the global with the local. The question needs to be asked what systems of incentive structures - be they markets, rules, norms, and scientific information – can most effectively improve social capacity to guide interactions between nature and society towards more sustainable patterns of activity. Another important question relates to governance structures at global, national, regional and local levels and how they can explain policy failures that affect environmental change.

It is obvious that research can be highly relevant, even if it does not always allow for exploration all underlying causal chains. Further, such chains may soon lead to the lifestyles issues in the rich countries which above (page 2) have been said to be beyond one of the delimitations set for this paper. Those lifestyles issues should not in and by themselves be the focus of the kind of research proposed here. Nevertheless, any research programme to be funded by MISTRA should be set in the proper context of underlying causal factors.

3.5 Capacity-building for Research

It is obviously for MISTRA to decide what type of research, if any, to support in the area of developing countries and the environment. To date MISTRA has funded research carried out mostly by Swedish scientists. But if MISTRA is to devote attention also to issues in developing countries a case may be made that such research should involve also scientists from those countries and include an element of capacity-building for research.

The reasons should be obvious and rest both on the need to ensure the quality of the research and on a moral argument. Without a strong involvement from scientists who understand the local ecological, social, cultural or political contexts, there is the obvious risk that the scientific

approach will be badly conceived. Also, Swedish scientists have access to financial resources that most scientists in developing countries can only dream of. At a typical Third World research institution everything is in short supply, scientific staff at universities usually only have resources to do basic teaching and very little discretionary funds for research. Their research abilities are often blunted after a few years of teaching in dilapidated and underfunded universities. They will need all the support they can get to help them continue their research and indeed to keep them motivated to remain at universities.

In the early stages of development assistance it was not uncommon for western or Swedish scientists to come in and do their research in developing countries with minimal involvement of local scientific staff, and then to take all of the original raw data with them back to their home country for analysis. This is no longer acceptable. Research on issues in the developing countries by Swedish scientists is certainly legitimate but provided that it is carried out in cooperation with scientists from those countries. This means that a typical research project would consist of a small network of scientists from developing countries as well as from Sweden and, perhaps, also other First World countries.⁸

At the same time it is clearly in Sida's interest that more research on issues in developing countries and of relevance to development is carried out at Swedish universities and research institutions. This is a Swedish dimension of capacity-building that Sida is already supporting through its programme of support to Swedish research. Continued priority to Swedish participation in projects supported by MISTRA would therefore be important for Sida in order to enhance interest in development in the Swedish academic community.

3.6 Proposed Research Priorities

Eight research programme priorities are suggested below. They should be considered as *examples* of broad, multi-disciplinary research programmes derived from the previous discussion. They should also be considered in the overall context of the preceding sections on interdisciplinarity, the time dimension, overriding cross-cutting themes, and the need for capacity-building.

Suggestions are given for research projects to be included under each heading. As mentioned under section 3.2, titles of some research projects may overlap under different programme headings. It is also possible to merge all or part of some programmes with others. The number of priority research programmes is by no means exhaustive, others could be provided as well. The final selection of these, and perhaps other, programmes would be a management consideration for MISTRA.

1. Human development needs and ecological system survival.

Ecological resilience and development. Impact and cost of biodiversity loss. Trade-offs in water use between human and ecological needs. Impact of water shortage and shrinking availability. The role of biodiversity in sustaining local livelihoods. Tourism and sustainable natural resource management.

⁸ Research projects on development funded by the European Commission have to be designed in this manner.

2. Satisfying future food demand.

Agricultural research for the poor. Water savings in agriculture. Institutional reform for agricultural development. Strategies for raising agricultural productivity based on natural processes and traditional knowledge. Biotechnology and biosafety for food security in developing countries.

3. Sustainable livelihoods in degraded areas.

Evaluation of traditional knowledge of natural resource management. Governance and incentive structures for sustainable resource management. Devolved management of common property resources. Livelihood conflicts caused by degradation of the environment. Poverty and environment linkages. Causes and effects of environmental refugee flows.

4. Sustainable management of coastal habitats.

Optimization of fish harvests from aquaculture and fisheries. Sustainable management of marine reserves. Impact on marine biodiversity and fish stocks of coral reef bleaching and mangrove destruction. Sustainable livelihoods for poor coastal communities.

5. Energy for sustainable development.

Making energy markets work better. Energy technologies and rural development. Household energy use for better health. Sustainable use of biomass for energy generation. Widening access to electricity services. Promotion of ethanol as a substitute for gasoline and diesel in developing countries.

6. Climate change adaptation.

Carbon dioxide absorption strategies with a focus on land use. Climate change adaptation scenarios for specific regions/countries. Impact of climate change on vulnerable countries. Agricultural research priorities arising out of climate change. Health effects of climate change.

7. Atmospheric Haze and Development.

The Asian Brown Cloud: mitigation and adaptation strategies. Impact on water and agricultural productivity from atmospheric haze. Consequences for the hydrological cycle, climate and the global ozone budget. Health effects of air pollution and haze.

8. Sustainable urbanization.

Transportation and mass transit in large cities. Chemicals and heavy metals in the urban environment and their impact on vulnerable groups. Local governance for urban development. Clean production technologies for large- and small-scale industry. Sustainable ecological management in and of cities.

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Halving poverty by 2015 is one of the greatest challenges of our time, requiring cooperation and sustainability. The partner countries are responsible for their own development. Sida provides resources and develops knowledge and expertise, making the world a richer place.



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