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Stephen D. Mink

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## Foreword

The following report, which was written as a background paper for the 1992 World Development Report, Development and the Environment, presents a number of key arguments and some initial conclusions relating to the interactions of poverty, population, and the environment. The paper provides substantial backing for significant elements of the World Bank's evolving strategy to promote sustainable development in its borrower countries. In particular, by stressing the overlap between poverty alleviation and reduced environmental and demographic stresses, Mink points to the paramount importance of promoting broadly-based income growth strategies and increasing investments in human resource development.

The 1992 United Nations Conference on Development and the Environment showed clearly that the international community now regards development and environmental protection as complementary objectives. Taken as a whole, the Earth Summit accords -- and Agenda-21 in particular -- indicate that development policymakers have come to recognize that degradation of the environment and depletion of its valuable natural resources not only impedes economic development but threatens human survival. A new imperative of sustainable development demands that environmental considerations become fully integrated into the mainstream of economic decision-making.

Integration has several aspects. One of the most significant -- and one that provides a common theme running through many of Agenda-21's program areas -- is the identification of "win-win" sustainable development strategies that can realize economic and environmental benefits in a complementary manner. Stephen Mink's analysis shows clearly that poverty alleviation is one of the most important "win-win" strategies. By demonstrating the high economic costs that the poor suffer as a result of environmental degradation, and the high environmental cost they impose as a result of their poverty, the paper shows the need for, and desirability of, policies that can reverse the downward spiral of worsening poverty and natural resource degradation.

In addition, it argues that demographic factors can seriously exacerbate poverty, environmental degradation, and the negative linkages between both these factors. Examining the impact of population along three dimensions -- its rate of growth, its scale in relation to the natural resource base, and its redistribution across resources through migration -- it argues for a range of policies to increase the demand for, and supply of, family planning services.

Andrew D. Steer
Staff Director
World Development Report 1992

## Series Note:

## World Development Report Background Papers

The World Development Report 1992, "Development and the Environment," discusses the posssible effects of the expected dramatic growth in the world's population, industrial output, use of energy, and demand for food. Under current practices, the result could be appalling environmental conditions in both urban and rural areas. The World Development Report presents an alternative, albeit more difficult, path - one that, if taken, would allow future generations to witness improved environmental conditions accompanied by rapid economic development and the virtual eradication of widespread poverty. Choosing this path will require that both industrial and developing countries seize the current moment of opportunity to reform policies, institutions, and aid programs. A two-fold strategy is required.

- First, take advantage of the positive links between economic efficiency, income growth, and protection of the environment. This calls for accelerating programs for reducing poverty, removing distortions that encourage the economically inefficient and environmentally damaging use of natural resources, clarifying property rights, expanding programs for education (especially for girls), family planning services, sanitation and clean water, and agricultural extension, credit and research.
- Second, break the negative links between economic activity and the environment. Certain targeted measures, described in the Report, can bring dramatic improvements in environmental quality at modest cost in investment and economic efficiency. To implement them will require overcoming the power of vested interests, building strong institutions, improving knowledge, encouraging participatory decisionmaking, and building a partnership of cooperation between industrial and developing countries.

World Development Report background papers in the World Bank's Discussion Paper series include:

Shelton H. Davis, "Indigenous Views of Land and the Environment"
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Other (unpublished) papers in the series are available direct from the World Development Report Office, room T7-101, extension 31393. For a complete list of titles, consult pages 182-183 of the World Development Report. The World Development Report was prepared by a team led by Andrew Steer; the background papers were edited by Will Wade-Gery.

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## Introduction

The continued prevalence of poverty throughout the world keeps its alleviation as a central objective of economic development. Strategies for reducing poverty have begun to pay more attention to the relationship between environmental degradation and poverty. This two-way relationship is a significant one. Environmental degradation contributes to poverty through worsened health and by constraining the productivity of those resources upon which the poor rely, and poverty restricts the poor to acting in ways that are damaging to the environment. In addition, demographic factors can be involved in complex ways; high growth rates are associated with poverty, and directly exacerbate problems of environmental degradation.

This paper will address several of the links among poverty, population, and the environment. It first addresses the impact of environmental degradation on the poor's health and productivity. Next, it analyzes the proposition that the poor have "short horizons," the circumstances that contribute to this, and the consequences for the environment. The impact of population dynamics on the environment is considered in terms of three dimensions: scale, rate of growth, and migration. The final section turns to the broad policy implications of the preceding discussion.

The debate about whether poverty or high consumption levels contributes more to environmental problems is not addressed here. For the most part, this emotional question will remain unanswerable for as long as the income-environment relationship is only partially understood, and only some of the relevant links quantified in physical and value terms. Poverty and affluence both contribute to environmental degradation, but in different ways. Alleviating poverty does not eliminate environmental problems altogether; instead it alters the types of environmental problem confronting a society. However, if there is evidence of a downward spiral linking increased poverty and environmental degradation, then this is clearly an issue that needs to be addressed by affected countries.

## I. Environment's Impact on the Poor

The poor's exposure to environmental degradation is distinctive for two reasons. First, locations inhabited by the poor are often environmentally vulnerable or degraded. Whether erosion-prone hillsides in rural areas or urban neighborhoods with inadequate water and sanitation infrastructure, the areas to which the poor can gain access are often the riskiest for health and income generation. Second, being poor entails lacking the means to avoid the impacts of environmental degradation. A lack of resources makes it difficult for the poor to buy out of exposure to environmental risks, or to invest in alleviating the causes of environmental degradation.

### 1. Pollution Damages the Health of the Poor

Several types of pollution have the most pervasive and serious consequences for the

health of the poor. In order of severity, the most important is pollution of water by disease vectors that cause infectious and parasitic illnesses. Second is indoor air pollution from the use of biomass as a household energy source, principally in rural areas. Third is outdoor air pollution, which is mostly an urban problem.

*Water Pollution*

The poor are less protected from polluted waters than other income groups. Numerous country surveys demonstrate that there are significant differences in access to safe water and sanitation by income. Almost 60 percent of poor people in urban areas of Indonesia rely on unprotected wells for drinking water, compared with 34 percent of the non-poor (see Table 1). In rural areas of Indonesia, only an estimated 36 percent of households draw on water facilities that provide a clean supply.[1/] In Jamaica, 37 percent of households in the poorest income quintile rely on drinking water from water bodies or rainwater, about twice the level of higher income groups (see Table 2). Similarly, sanitation services are less adequate for poorer households. Poor urban households in Indonesia do not use developed sanitation facilities in 30 percent of cases (see Table 1).

Table 1 Drinking Water and Sanitation by Poor and Non-Poor Households in Urban Indonesia, 1988

| | Poor \a | Non-Poor | Total |
|---|---|---|---|
| Source of Drinking Water: | | | |
| Piped System | 1.1 | 1.1 | 1.1 |
| Pumped Wells | 16.0 | 24.4 | 22.2 |
| Other Wells | 59.4 | 34.0 | 40.7 |
| Peddlers | 10.1 | 11.1 | 10.8 |
| Other | 2.0 | 2.2 | 2.1 |
| | 100.0 | 100.0 | 100.0 |
| Sanitation Facility: | | | |
| Flush Water | 55.0 | 75.4 | 70.0 |
| Open Pit Latrine | 7.6 | 7.9 | 7.8 |
| Sanitation Block | 7.1 | 4.1 | 4.9 |
| None | 30.3 | 12.7 | 17.3 |
| | 100.0 | 100.0 | 100.0 |

Sources: Urban Institute and P.T. Hasfarm Dian Konsultan, "Data Book on Urban Housing in Indonesia," November 1989, Housing Policy Project.
\a The official poverty line in 1987 in terms of per capita monthly expenditure was Rp. 17,381 and Rp. 10,294 for urban and rural areas, respectively.

1/ Many households traditionally boil water for drinking, which reduces the risk of infectious diseases.

Table 2: Source of Drinking Water by Income Group in Jamaica, 1989

| | Poorest Quintile | Other Quintiles | Total |
|---|---|---|---|
| Source of Drinking Water: | | | |
| Piped System | 57.3 | 77.7 | 73.6 |
| River, Lake, or Spring | 14.1 | 6.5 | 8.0 |
| Rain Water | 22.6 | 13.1 | 15.0 |
| Other | 6.0 | 2.7 | 3.4 |
| | 100.0 | 100.0 | 100.0 |

Source: Statistical Institute of Jamaica, Jamaica Survey of Living Conditions, September, 1989.

This increases to 73 percent for all rural households, who use either waterways or fields for excreta disposal. In the Philippines, by contrast, some 62 percent of the rural population are estimated to have access to proper sanitation facilities. Where human density and economic activity are rising, people drawing on untreated and unprotected sources of water will be increasingly subjected to health risks.

During the 1980s, designated the International Drinking Water Supply and Sanitation Decade, substantial progress was made in bringing access to safe water (especially in rural areas) and sanitation (especially in urban areas) to greater shares of developing country populations. Overall, access to potable water in rural populations improved from 31 percent in 1980 to 46 percent in 1988, but only from 14 percent to 17 percent for sanitation over the same period (Table 3). In urban areas, access is generally much better, but -- with the exception of several Asian countries -- improvements in access to drinking water were smaller.

Despite the recent improvements in the share of population having access to sanitation, the absolute number of people without access has increased, by about 11 percent (200 million) between 1980 and 1988 alone. Even where access to sanitation is available, waste is often discharged entirely untreated. As a consequence, the environmental load is increasing in many areas, bringing additional health risks for those who use untreated water for their domestic needs, and higher treatment costs for systems whose intake is increasingly contaminated.

The water pollution problems to which the poor are exposed change as economies evolve from a predominantly agricultural and rural base to more industrial and urban activity. Earlier stages of economic development are dominated by problems of biological contamination of water, with fecal contamination being the most important from a health perspective. Over a dozen diseases related to microbiological contamination of water are prevalent in developing countries, including acute diarrhea, dysentery, cholera, and helminthiases. As industrial sectors develop, waterways become contaminated with hazardous and toxic wastes. In countries where

the pace of development has been rapid, both biological and chemical pollution of waterways can become significant.

Table 3: Trends in Access to Safe Drinking Water and Sanitation

| | Safe Drinking Water [a] | | | | Sanitation [b] | | | |
|---|---|---|---|---|---|---|---|---|
| | 1975 | 1980 | 1985 | 1988 | 1975 | 1980 | 1985 | 1988 |
| Access (% of population): | | | | | | | | |
| Developing Countries[c] | | | | | | | | |
| Urban | 74 | 76 | 75 | 78 | 50 | 56 | 59 | 66 |
| Rural | 20 | 31 | 42 | 46 | 11 | 14 | 16 | 17 |
| Total | n.a | 46 | 54 | 57 | n.a | 28 | 33 | 34 |
| Unserved (millions): | | | | | | | | |
| Developing Countries[c] | - | 1,251 | 1,204 | 1,210 | - | 1,668 | 1,753 | 1,858 |

Source: WHO Community Water Supply and Sanitation database.

[a] WHO definition of access to safe drinking water in urban areas is access to a piped water or a public standpipe within 200 meters of a dwelling. In rural areas access implies that a family member need not spend a disproportionate part of each day fetching water. Water considered safe includes treated surface water and untreated water from protected springs, boreholes, and sanitary wells.

[b] Urban and rural populations have access if they are connected to a public sewer, household system, or have adequate disposal including pit privies, septic tanks, communal toilets, and other such facilities.

[c] Excludes China.

Inadequate sanitation and impure water for domestic consumption are important pathways for the transmission of infectious and parasitic diseases in many developing countries. There are numerous pathways of infection, with environmental conditions contributing to several of these through lack of water for washing, contaminated water, lack of sewerage removal of solid human waste, absence of sewerage treatment, uncollected solid waste, and flooding. Relevant non-environmental factors include poor personal hygiene, poor nutrition and food preparation, lack or non-use of toilets, inadequate health care and education, and poor and overcrowded housing.

The extent to which an environmental problem is responsible for the incidence of such a disease can only be estimated subjectively. Satisfactory statistical evidence for dose-response functions is hard to obtain because factors such as nutrition, previous exposure, and the existence of different strains of a disease's agents confound the analysis. Even where a dose-response can be established, multiple pathways of infection may make it difficult to monitor exposure to the disease's causative agents. Consequently, the relative importance of environmental and non-environmental factors cannot be assessed in a rigorous quantitative sense. For any given

disease, a qualitative judgement needs to be made to determine which pathway is likely to predominate under local circumstances.

Nevertheless, it is increasingly accepted that water quality is very important in determining the incidence of diarrheal and bacterial diseases, while quantity is important in diarrheal and enteric fever prevalence. Inadequate excreta disposal plays a major role in worm diseases, with excreta treatment of moderate importance in these diseases. These interactions of water quality and quantity with adequate treatment of human waste are shown in Table 4, which summarizes the results of 55 studies covering diarrhoeal morbidity.

Table 4: Summary Findings of Studies on Reductions in Diarrheal Morbidity Rates Attributable to Water Supply or Sanitation Improvements

| Type of Improvement | Number of Studies | Morbidity reduction (percent) Median | Range over Studies |
|---|---|---|---|
| All interventions | 53 | 22 | 0-100 |
| Water quality | 9 | 16 | 0-90 |
| Water availability | 17 | 25 | 0-100 |
| Water quality and availability | 8 | 37 | 0-82 |
| Excreta disposal | 10 | 22 | 0-48 |

Source: Esrey et. al., 1985.

*Air Pollution*

Air pollution is typically thought of as an urban health problem because of the concentration of emissions sources -- vehicles, power plants, and industries -- in these areas. But in many countries, indoor air pollution, primarily in rural areas, is a more important health issue for the poor. The poor rely on biomass fuels such as wood, crop residues, and dung because these are the cheapest and most available option, but which produce many combustion pollutants. Household fuel consumption studies in India, Pakistan, Brazil and Indonesia have shown that as incomes grow, urban households switch to energy sources such as kerosene, LPG, and electricity, that are more expensive but provide energy more efficiently and cleanly. Poorer households, though, cannot afford these fuels, nor are they able to invest in housing improvements such as flued cooking areas or cooking and heating equipment, that permit biomass fuel to be used more safely.

Table 5: Summary Findings of Reports on Indoor Air Pollution from Biofuel Combustion in Developing Countries

| Location and Year | Measurement Conditions | Number of Measurements | Particulate Concentration (ug/m³) |
|---|---|---|---|
| **Note:** WHO 98th percentile standard[a] | | | 150-230 |
| **Kenya** | | | |
| 1972 | Overnight in highlands | 5 | 2,700-7,900 |
| | Overnight in lowlands | 3 | 300-1,500 |
| **India** | | | |
| 1982 | Cooking with wood | 22 | 15,800 |
| | Cooking with dung | 32 | 18,300 |
| | Cooking with charcoal | 10 | 5,500 |
| 1988 | Cooking, measured 0.7 meters from the ceiling | 390 | 4,000-21,000 |
| **Nepal** | | | |
| 1986 | Cooking with wood | 18 | 8,800 |
| **China** | | | |
| 1987 | All day in wood-burning kitchen | Unknown | 2,600 |
| **Kenya** | | | |
| 1987 | 24 hours | 64 | 1,200-1,900 |
| **Gambia** | | | |
| 1988 | 24 hours | 36 | 1,000-2,500 |
| **Papua New Guinea** | | | |
| 1975 | Overnight at sitting level | 6 | 200-9,000 |
| | Individual exposures during cooking for 2-5 hours each day | | |
| **India** | | | |
| 1983 | in 4 villages | 65 | 6,800 |
| 1987 | in 2 villages[b] | 44 | 3,600 |
| 1987 | in 8 villages[b] | 165 | 3,700 |
| 1988 | in 5 villages | 129 | 4,700 |
| **Nepal** | | | |
| 1986 | in 2 villages[b] | 49 | 2,000 |
| 1988 | in 1 village | | |
| | -traditional stoves | 20 | 8,200 |
| | -improved stoves | 20 | 3,000 |

Source: Smith, Kirk. 1988.

[a] The 98th percentile standard is a level which 98 percent of daily measurements should fall below, leaving 2 percent (7 days) above.

[b] Approximately half of the cooks used improved cookstoves.

Note: The studies are not completely comparable because of different measurement protocols and equipment, but the results are fairly consistent. Area concentrations were measured with stationary instruments placed indoors at breathing height. Individual exposures were measured with instruments worn by the cook during food preparation.

Indoor air pollution from biomass combustion varies widely with local cultural, climate, and social factors, but exposes hundreds of millions of poor people to significant health risks. Indoor cooking is common at higher altitudes in many areas of the Andes, Guatemala in Central America, in Zimbabwe and Kenya, and is widespread in such diverse countries as India, Yemen,

Nepal, and Indonesia. Since cooking in most cultures is done almost exclusively by women, they face higher health risks from indoor pollution, as do infants and children who accompany their mothers during cooking. The problem is not exclusively rural. For instance, in urban areas of Java, almost half of very poor households still rely on biomass for cooking, while in the five principal cities in Senegal wood and charcoal account for over 95 percent of household energy consumption. In contrast, firewood provides less than one percent of the energy used by households in New Delhi. Obviously, where cooking is traditionally done outdoors, as in parts of Africa and much of Latin America, biomass fuel use has fewer health consequences.

In several cities around the world, air quality monitoring indicate that a number of air pollutants have reached levels that can cause respiratory illnesses and premature mortality. Urban air pollution is often quite localized and urban land markets can therefore be expected to

Table 6: Indonesia - Shares of Urban Households by Cooking Fuel-Use and Expenditure Group[a]

| | Expenditure per household, '000 Rp/mo | | | | |
|---|---|---|---|---|---|
| | <75 | 75-120 | 120-185 | 185-295 | >295 |
| Biofuel | 46 | 26 | 11 | 8 | 7 |
| Electricity | 0 | 1 | 3 | 3 | 14 |
| Kerosene | 53 | 78 | 89 | 90 | 77 |
| LPG | 0 | 2 | 4 | 8 | 29 |
| Charcoal | 4 | 2 | 2 | 3 | 3 |
| Note: | | | | | |
| No. of households | 654 | 581 | 577 | 382 | 249 |
| People/household | 3.5 | 4.8 | 5.1 | 5.7 | 6.1 |

Source: Urban Household Energy Strategy Survey, Central Bureau of Statistics, Indonesia, as reported in Indonesia ESMAP UNESS Study, Report No. 107 A/90.
[a] Columns do not sum to 100 percent because some households cook with more than one fuel.

Table 7: Senegal - Per Capita Household Energy Consumption, 1986

| | Wood | Charcoal | Electricity | LPG | Kerosene |
|---|---|---|---|---|---|
| Urban (5 cities) | 10 | 225 | 23 | 6 | 1 |
| of which cooking | 9 | 203 | 0 | 5 | <1 |
| Semi-Urban | 44 | 79 | 9 | 2 | 3 |
| Rural | 100 | 9 | - | <1 | 1 |

Source: 1987 Household Energy Survey and 1986 SENELEC data, as reported in World/UNDP/Bilateral Aid ESMAP. 1989. Senegal: Urban Household Energy Strategy, Report No. 096/89, March.

concentrate poor urban dwellers in neighborhoods that are affordable only because they are less desirable -- for reasons that include higher levelsof air pollution. Low income neighborhoods and workplaces of the urban poor are indeed often found in close proximity to industrial zones, power plants, and their downwind plumes.

But attempts to demonstrate that the poor are more exposed to outdoor air pollution than higher income groups have revealed more complex and inconclusive patterns. Given further improvements to the coverage of pollution monitoring within cities and to information on poor group activities and consequent exposure levels, it may yet be shown that the poor face greater risk. In Tainjin, China, neighborhoods in the northwestern and eastern parts of the city, while subject to a much higher prevalence of diseases associated with air pollution, include areas characterized by more modern housing and the presence of non-poor income groups (Bertraud and Young, 1991). It appears that the high level of industrial, workplace and residential pollution, combined with malfunctioning land and housing markets, exposes households of *all* income groups to environmental hardship. Different pollutants can also have separate patterns in relation to residential neighborhoods in urban areas. In the southeast quadrant of Mexico City, an area of low to lower-middle income residential areas, total suspended particulates constitute the major air pollution risk. The higher income areas of the southwest quadrant of the city are not immune from air pollution hazards, however, as these neighborhoods are subjected to high ozone levels (Sebastian, 1990).]?

Despite these difficulties in demonstrating links between high air pollution concentrations and poor residential areas, the urban poor may still suffer disproportionately because of their greater *vulnerability* to such concentrations. Health effects from high levels of ambient air pollution are often concentrated among those who already have asthma or other chronic respiratory diseases, themselves partly the result of the poor's dependence on low-quality housing. Low nutritional status increases vulnerability to disease and the difficulties of recovery. Moreover, the poor have less access to health care and are less able to afford treatment.

## 2. Environmental Degradation Lowers the Poor's Productivity

In addition to affecting their health and capacity to work, environmental degradation depresses the poor's ability to generate income through two channels: first, it requires the poor to divert an increasing share of their labor to routine household tasks such as fuel wood collection; and second, it also decreases the productivity of those natural resources from which the poor wrest their livelihood.

### *Diverting Labor*

Environmental degradation can lower the labor productivity of the poor, even when they are healthy. For example, as fuelwood becomes scarce, poor households must spend an increasing amount of time in collecting it. Where family labor is not abundant, greater time spent on fuelwood collection takes away from other productive activities, and can result in lower incomes.

Conclusive demonstration of this link comes from a study of household time use in hill areas of Nepal (Kumar and Hotchkiss, 1988). In villages with severe deforestation, women collected fuelwood for over an hour longer than their counterparts in deforested areas. Considering collection time for other forest products, the total effect on labor available for agriculture was estimated to be one-and-a-half hours a day lost to collection activities. With labor relatively scarce, the potential loss of household labor from agricultural activities was 24 percent. Further, it was shown that families were not able to compensate for this diversion of labor, resulting in a reduction in household income from agriculture, and a deterioration in food consumption levels and nutritional status.

Different versions of this Nepalese story are told for many parts of the developing world, but since few are so fully documented, care must be taken in generalizing its conclusions. It is well established that fuelwood is usually gathered by women and children, and that the additional collection burden resulting from forest cover degradation falls most directly on them. Time devoted and distance travelled for collection vary widely, but in may places are already substantial, often ranging up to 4-5 hours/day and in exceptional cases as much as 10 kilometers (Agarwal, 1985; Barnes, 1990). Information is generally lacking on precisely *how* collection time and distance have changed with deforestation levels. Increasing woodfuel scarcity does not appear to lead to constantly growing time allocations for collection; once local scarcity constrains free collection by individuals, alternative collection strategies emerge. Local organization of transport for more distant collection may arise and foster informal markets, such that the impact on poor rural families comes through budget costs rather than labor requirements.

*Reducing Productivity of the Poor's Natural Resources*

Environmental degradation reduces the productivity of natural resources managed by the poor, thereby perpetuating impoverishment. Productivity declines of this kind are caused by a number of factors, some of which are beyond the control of the poor. Examples include the destruction of inland and coastal fisheries by industrial water pollution and municipal sewerage, and the degradation of wetlands and flood plain soils as a result of upstream dam construction. Deforestation by settlers, loggers, and ranchers destroys the livelihoods of indigenous forest dwellers, and exposes them to introduced diseases.

More frequently, productivity decline is more intricately related to the poverty-population-environment interaction. Where the poor depend on biomass fuel and confront increasing fuelwood scarcity, they often shift to using animal dung, fodder, and crop residues for fuel. Because reduced quantities of these materials are therefore returned to the soil, its fertility declines. Where rural population growth is putting pressure on land resources such that fallow periods are shortened, poverty may constrain farmers' ability to maintain soil productivity through more intense application of variable inputs.

The productivity of open access natural resources or of resources under deteriorating common property management, is often declining because of over-use. Pastures may be overgrazed and waters overfished such that aggregate as well as individual user incomes from

these resource decline.

## II. Poverty's Impact on Resource Management

### 1. Poverty Imposes Short Time Horizons

The very poor who are struggling at the edge of subsistence levels of consumption are preoccupied with survival on a day-to-day basis. The ability to plan ahead is often restricted to a critically short time horizon, measured in days or weeks. But these short time horizons should not be viewed as an innate characteristic of the poor, but rather the consequence of complex interactions among policy, institutional and social failures.

Simplifying the relationship of poverty and the environment to a single concept of short time horizons, while useful as a heuristic device, does not capture all important elements of the relationship. First, there are revealing examples of poor farmers or herders who demonstrate long time horizons, although they may be constrained in pursuing them. Such examples are usually of cohesive communities, with strong cultural or religious values that may define obligations of stewardship in managing natural resources in honor of ancestry. Communities often have social welfare arrangements that support families in times of crisis, thus reducing certain kinds of risks. Traditional cultivation of perennial crops, such as of cocoa in West Africa, demonstrates the existense of conditions that provide poor farmers with the incentives to make investments that may only begin to bear fruit in five-to-eight years. What these cases demonstrate is that the short horizons of those barely meeting subsistence needs can lengthen substantially with only modest rises in consumption above subsistence level, if accompanied by social institutions or policies that minimize the risk of failing to meet basic needs. As described previously, however, increasing land scarcity, the growth of commercial markets for rural products, and greater seasonal migration, all strain those social structures that have provided the rural poor with some security in times of dearth.

Poor farmers' horizons are short partly as a result of their having -- in economic terms -- a high rate of pure time preference. This lowers the ability to forego consumption today by using savings previosly put aside for later consumption purposes. In terms of natural resources, the implications of a high subjective discount rate are rapid resource extraction to meet present income or consumption needs, and low investment in natural resources to improve future returns. Given the greater value placed on present consumption, resources are "mined" at a more rapid rate. For example, with high discount rates, rural inhabitants with rights to tree resources are more likely to harvest them at a faster pace. Similarly, short-term production strategies that raise current income at the cost of future production -- overgrazing pasture or shortening fallow time -- may be pursued.

Similarly, poor farmers are less likely to make natural resource investments that only give positive returns after a number of years. Thus, efforts to introduce soil conservation and water harvesting techniques in the Yatenga area of Burkina Faso found that only those that

delivered an increase in yields within a year or two were likely to be adopted by farmers. Schemes designed to get rural communities and farmers to plant woodlots typically fail where no products are to be harvested until the trees have matured and can be harvested as logs, but succeed where products such as a building poles and fodder can be harvested more quickly.

It is generally accepted that as income grows rates of pure time preference decline, such that individuals discount the future less strongly. Evidence is limited on the magnitude of pure time preference in rural areas of developing countries, but is cause for considerable concern. Measurements made through experimental games with a small sample of poor farmers in India resulted in a mean estimated time preference of 35 percent (Walker and Pender, mimeo). This implies that benefits received four years hence are perceived to be only worth a third of the same benefits received today. The same study suggests that this high rate of time preference declines slowly as wealth increases. This suggests that stable, long-term economic growth will be necessary for poor farmers to gain the income and security that can generate a time perspective capable of encompassing many environmental concerns. Clearly it is important to verify whether these results will stand up if the same analysis is extended to other regions and conditions.

## 2. Risks Contribute to the Poor's Short-Term Focus

Under most circumstances, people tend to be risk averse, preferring to trade some of a potential outcome's value for a greater certainty of it happening. To the extent that outcomes become less certain the more distantly in the future they are, then risk aversion implies a preference for outcomes that will happen sooner. Studies on risk and farmers in India (Binswanger, 1980), Central America (Walker, 1981), Thailand (Grisley, 1980), and the Philippines (Sillers, 1980) have confirmed the predominance of risk aversion, albeit with a great deal of heterogeneity. The results also suggest that in their attitude to risk the poor are not distinguished from the non-poor by innate or acquired characteristics such as education. Rather, in this regard, poorer farmers are distinguished by their higher levels of risk and greater constraints to coping with that risk.

### *The Poor Face Higher Risks*

Poor rural households face higher levels of risk from various sources than better-off households do. Some of these risks are attributable to poorly conceived or implemented policies. Where governments are ineffectively intervening in input supply markets, inputs used in production may be unavailable when needed or available only at high prices. Better-off farmers may have connections that provide alternative sources of supply. Government policies may engender similar uncertainties about output prices and marketability. At a different level, poor farmers or pastoralists may perceive their access to land as tenuous because of conflicts with other claimants or overlap of customary land tenure and national land rights legislation. Better-off rural families are more likely to be able to establish firm claims to land where a transition is occurring from common property to private property systems, or where there are lengthy and costly administrative procedures for establishing legal title to land. Under such

circumstances, poor farmers' interest in longer term investments in the productive capacity of the land is likely to be severely diminished.

The degradation of agricultural land and pasture can itself bring increasing risks to poor farmers reliant on these resources. Deteriorating land quality can not only bring lower yields, but also more yield fluctuation. As soils become more shallow through erosion, and lose organic content, they have decreasing moisture retention properties and expose crops to more drought stress. Other environmental risks, such as susceptibility to erosion and flooding, are also more likely to characterize the land available to poor farmers.

The development of markets and spread of market incentives into rural decisions can introduce new risks for the poor. Jodha (1990) has documented how increasing land scarcity and commercialization of agricultural production in India has lead to privatization of land previously accessible as common property to poor villagers. Common property resources often serve as a form of insurance that poor rural residents can turn to if they face set-backs in their primary income-generating activities. As land-based products have become more valuable, private owners have managed their land more intensively -- to the detriment of patron-client relationships. Where previously land owners may have permitted collection of fuelwood on their property by designated clients, they may now manage this as a resource with commercial value and consequently prevent collection by others.

*Constraints to Managing Risk Contribute to Resource Degradation*

Poor households who risk falling below subsistence levels of consumption will treat available natural resources as an asset to be drawn down in times of emergency. Rarely will this be the preferred option, and rural households and communities often rely upon a rich array of mechanisms for reducing and coping with risk without resorting to natural resource mining. Households may first turn to selling stored produce or assets, migration of household members, increased wage labor, or borrowing for consumption. Where these do not suffice, rural communities often have strong traditions of mutual assistance and reciprocity. In some societies, patron-client relationships may be important and provide poorer families with access to resources in times of need. Further, to avoid risks in the first place, production practices are often adapted to minimize the risks involved in working marginal resources, such as mixed cropping and farming of multiple sites.

For poor households, such options for managing risk are often limited or unavailable. Their assets and agricultural stores are minimal and quickly depleted. Credit and insurance markets are frequently fragmented or non-existent. Formal credit markets may not serve poor farmers who are geographically isolated in marginal areas or who lack land title to offer as collateral. Informal credit markets may operate under such circumstances, but are characterized by rationing, high rates, and a predominance of short term lending. Empirical results from Thailand that compared squatters without title on state land to titled farmers showed that the latter had better access to credit, had higher investment levels, and were more likely to make land improvements, use more inputs, and achieve higher land productivity (Feder et al., 1988a,b).

This lack of access to markets that can help maintain consumption in the face of production risks can be particularly constraining for women who manage natural resources. In many rural areas, women are important decision-makers concerning the use of land and other natural resources. Time use surveys indicate that in Nepal, women may be responsible for 57 percent of subsistence agricultural activity (Acharya and Bennett, 1983). For Sub-Saharan Africa, Dixon (1983) has used ILO and FAO data to estimate that 46 percent of the agricultural labor force is made up of women, while for Latin and Central America, the figure drops to 18 percent. Despite such high levels of activity, women in many countries have no or limited tenure rights to land and cultivated trees, a situation that often limits their access to credit for agricultural investment. Innovative credit programs, such as those operated by the Grameen Bank in India and, in Indonesia, under the KUPEDES and Badan Kredit Kecamatan, are managing to reach women borrowers who lack land for collateral, but such programs remain the exception rather than the rule. Finally, women are frequently underserved by agricultural and forestry extension services. Extension services have either tended to focus on crops predominantly cultivated by men, or have not had the flexibility to deal with women's time and production constraints. They have thus had only a minimal impact on womens' ability to learn and adopt improved agricultural techniques that increase productivity.

### 3. A Caveat

Short horizons are not exclusive to the poor. There are circumstances under which relatively better-off farmers demonstrate short time horizons. Farmers in the United States in the early 1980s labored under heavy debt burdens exacerbated by high interest rates and declining prices, and frequently responded by expanding cultivation to soils susceptible to erosion, and reducing fertilizer and soil amendment costs. The threat of policy changes can also induce accelerated harvesting of natural resources by commercial managers. The prospect of new restrictions on logging and log exports has contributed to the acceleration of commercial logging on private land in locations as diverse as the northwest of the United States and Malaysia. Thus, short time horizons are not restricted to the poor; but the specific circumstances that lead to them are quite different, and imply different policy solutions.

## III. Population and the Environment

Population dynamics potentially exacerbate the impact of other factors such as poverty, inadequate property rights, consumption levels, and environmental deterioration. The impact of population intervenes along three main dimensions: its scale in relation to the resource base, its rate of growth, and its redistribution across resources through migration. Population's impact on the environment is critical in some countries or regions within countries, but is less important in others. Moreover, the three dimensions will not be equally important for the environment in different places and points in time. Thus, assessments of population's impact on the environment, and the appropriateness of addressing such impact through direct population interventions, need to take local circumstances into account.

Regardless of context, however, it is critically important to act upon the links between population dynamics and poverty. That poverty generates significant household incentives to raise large families is well understood, and poverty must therefore be alleviated if the demand for children is to be reduced. Much migration is motivated by the perception that other areas offer greater economic opportunity and hence better prospects for reducing poverty. Such links indicate that poverty alleviation, through both income growth and improved social services focused on the poor, is the linchpin to mitigating demographic impacts on the environment. Acting directly to reduce population growth can also play a role, particularly where parents want smaller families but lack access to family planning services. However, experience shows that by itself an improved supply of such services is unlikely to reduce population growth significantly if the underlying incentives for large families remain unchanged.

Environmental degradation appears to reinforce several links between poverty and high fertility. Degradation of land resources worked by women reduces their productivity and the opportunity costs of their labor time. Degradation of tree, range and drinking water resources can increase the time cost of fuelwood gathering, livestock pasturing and water fetching, activities that children can undertake, and that consequently increase their value to parents. Since these links are potentially strongest in areas where fertility is already high, they tend not to increase fertility rates outright, but to make reductions in those rates harder to acieve. Contrastingly, where environmental degradation is caused by demographic pressure on land, there may be negative impacts on fertility -- for example, in cases where social custom encourages acquiring access to land before marriage, or where spousal separation increases due to greater seasonal migration to supplement meager farm earnings. Such links remain conjecture, however. But if on balance the environmental impact on fertility is positive, it may also be sufficiently weak for interventions to break any downward spiral of environmental degradation and high population growth rates. Recent declines in fertility in Botswana, Kenya and Zimbabwe,in conjunction with ongoing environmental problems in rural areas, provide some evidence for this claim.

1. Population Growth

The second half of the twentieth century has been a demographic watershed. World population did not begin to rise steadily until the eighteenth century, and then only at a modest 0.5 percent per year. Prior to that, famine, disease and war ensured that life expectancy remained more or less unchanged. World population doubled between 1750 and 1900 when it reached 1.7 billion. During the first half of the twentieth century, population growth increased from about 0.5 to about 1 percent. But growth after 1950, particularly in developing countries, rose to over 2 percent as mortality declined and life expectancy extended. These gains were the result of improved living standards and medical progress -- in particular, the introduction of antibiotics, antimalarial mosquito spraying, and the increased use of vaccination. Because of these factors, the post World War II rate of population growth in developing countries rose to unprecedented levels. Growth rates of world population have slowed considerably from their late 1960s' levels, though, and now stand at 1.7 percent per year, as increasing numbers of countries have moved into the demographic transition towards lower fertility, mortality, and

growth rates.

However, despite the recent and anticipated further slowdown in the world population growth rate, population growth remains a key concern from an environmental perspective because it remains at levels which will lead to high absolute increases in the number of people. World Bank projections show that for base case scenario assumptions, the net increase in population will continue at about 92 million people per year through 2015, and only slowly decline thereafter. Future population growth is built in to the current demographic age structure, with many countries having over half their population in under-15 age groups, and only beginning to enter their childbearing years over the next two decades. As a consequence, the base scenario projects that, before stabilizing, world population will more than double from current levels to 12.5 billion, with over two thirds of this growth occurring by 2050.[1/]

These projections assume certain trends in fertility and mortality rates. Life expectancy at birth is assumed to continue increasing in all countries (faster in those countries where it is currently lowest), and, ultimately, to close the current 12.5 year gap in life expectancy between rich and poor countries. At present, the lowest life expectancies are in Sub-Saharan Africa, where the average is 52 years, while the highest level of 78 years is found in Japan. By 2010 the world average is expected to reach 70 years, up from the current 66, with the average in more developed countries about 10 years longer. For long-term projections, life expectancy of 86 years is assumed, somewhat higher for women, and less for men.

Country fertility levels are projected on the basis of whether a country has already gone through, is undergoing, or has yet to begin a transition from high to low total fertility rates. The critical assumption is that countries currently having high and non-declining fertility levels begin a transition shortly and undergo a substantial decline -- by more than half in many cases -- over the next forty years or so. All countries are projected to reach replacement levels of fertility no later than 2060.

The bulk of world population increases are projected to occur -- as previously -- in the developing world. Seventy-three percent of the 3.2 billion increase in world population through 2025 will take place in low income countries, which at present account for 55 percent of total world population. Over this period high income countries will add only about 150 million.

With China and India, two of the most populous countries in the world, Asia will contribute about half of total population growth through 2025, despite the successful lowering of total fertility and growth rates in many Asian countries. In contrast, Sub-Saharan Africa has high total fertility and growth rates that will remain above the world average through the next

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[1/] The Bank's long-range world population projections were revised upwards in 1990, with population in 2100 increasing from 11.3 to 12.0 billion, largely as a consequence of an upward adjustment of life expectancy.

century. By 2075 the region will account for a larger share of world population than Asia.[1/] Latin America is growing more slowly.

The economic and environmental implications of a more than doubled world population are substantial. Added concern arises from the uncertainty over possible population outcomes. In addition to the base scenario, two other scenarios were explored, based on faster and slower declines in total fertility (see Figure 1). The faster decline scenario differs from the base case in assuming: first, that countries yet to demonstrate fertility decline indicative of the early stages of demographic transition begin such a decline immediately; and second, that total fertility in countries firmly into their demographic transition decline twice as fast as in the base case. Conversely, the slow decline scenario assumes that the demographic transition is only triggered once life expectancy improves to 53 years, and total fertility decline in countries firmly into their demographic transition occurs at half the rate of the base case. The fast rate of decline is comparable to the historical experience in Mexico, Thailand, Jamaica, Hong Kong and Costa Rica, while the slow rate of decline is representative of demographic trends in such countries as Turkey, Paraguay, Sri Lanka and Suriname. These two additional scenarios focus on fertility, and do not incorporate expected fertility-mortality interactions; hence the results should not be interpreted as full blown population projections.

The scenarios indicate that the scope for reducing future population levels through further lowering fertility beyond the base case assumption is much less significant than the risk of demographic explosion triggered by slower than anticipated declines in fertility. Faster fertility decline results ultimately in a stable population of 10.1 billion, about 2.4 billion less than the base case stable population, but still almost a doubling from the present size. In stark contrast, the slow fertility decline projections result in more than a four-fold increase, to about 23 billion, with population levels only stabilizing towards the end of the twenty-second century.

This tremendous range of possible long-term population outcomes results largely from the demographic uncertainties of countries which have as yet shown little evidence of beginning demographic transition. These countries are mostly in Sub-Saharan and North Africa, and the Middle East. Together, countries in these regions account for 85-90 percent of the differences between the alternative scenarios and the base case. Sub-Saharan Africa alone contributes over two thirds of the difference under the slow fertility decline scenario. Future population trends in Asia, Latin America, and in the industrialized countries, are much less uncertain, although small changes in vital demographic trends in China would have a significant impact.

The projected decline in fertility rates will not be easily attained, even in the base case. By historical standards, they are relatively rapid; transition to lower fertility was slower in Europe and, more recently, in certain developing countries that have already made the transition. Achieving such rates of fertility decline will require substantially more couples having access

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[1/] These projections do not incorporate the uncertain impacts of AIDS. See Box 1, p.17, on the demographic impact of AIDS in Africa.

to -- and effectively using -- contraception. The substantial effort and resources put into expanding contraceptive use over the past decade has significantly increased the contraceptive prevalence rate in developing countries from 40 percent in 1980 to 49 percent in 1990. The rate would need to increase by another 7 percentage points by 2000 and by a further 5 points by 2010 for the standard population projections to be realized.

Effective programs to meet current contraception needs would go a long way towards reaching the standard projection's decline in total fertility. Unmet need is estimated using surveys that ask married women of reproductive age (15-49 years) whether they want to avoid or delay pregnancy and whether they are using contraception. Data from about 40 countries are

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Box 1 The impact of AIDS on population in Africa

Uncertainty over whether stable world population will reach two or four times its present size centers largely on the prospects for reducing growth rates in Africa. Unaccounted for in this range is the impact of AIDS.

A cautious consensus among researchers is that AIDS may reduce population growth rates by 0.5-1.0 percentage points by the end of several decades, with overall rates remaining comparatively high. Beyond this timeframe, there is great uncertainty. In the near term, impacts are mild because even in the most affected countries, the majority of the population will remain uninfected and thus unlikely to deviate from normal trends in fertility behavior. Also, with women in Africa beginning child-bearing at a young age and having high fertility rates, even infected women are likely to bear a number of children for whom the survival rate will be significant. But these conclusions are acknowledged to rest on critical assumptions for which there are very few data. Some analysts employ simple mathematical models to argue that absolute population declines are likely.

The demographic impact of AIDS will be through both mortality and fertility changes. Different predictions about changes in sexual behavior in response to the AIDS epidemic are what distinguish the two contrasting views. Although AIDS-related mortality might increase dramatically, increases would be less substantial given smaller numbers of sexual partners, greater prevalence of protection measures, and restricted sexual mixing among different risk groups. Greater awareness and treatment of other sexually-transmitted diseases, which facilitate AIDS infection, could also reduce mortality consequences. But in the absence of changes in behavior, the high infection rates present in some parts of Africa could become more generalized both vertically across age groups and horizontally across risk groups, leading to greater reductions in population growth rates.

Little is known about the impact of AIDS on individual behavior affecting fertility, and possible effects have generally not been incorporated into existing projection exercises. Factors both favoring and discouraging higher fertility can be expected to compete, with overall outcomes highly dependent on local social conditions. Couples may marry and start families earlier, thus avoiding higher risk sexual behavior. Or women, once aware they are infected, may forego further pregnancies to avoid passing the disease on to their newborn.

Even if AIDS does not result in substantial declines in population growth rates, other demographic consequences are anticipated that will contribute to individuals, families' and communities' difficulties in managing their environments. AIDS mortality will strike particularly at economically-active age groups, putting at greater risk of poverty many survivors such as orphans and the elderly. The loss of income, high costs of medical treatment, and family time involved in caring for the sick will lead to shorter-term horizons, more intensive extraction from natural resources, and likely sale of assets.

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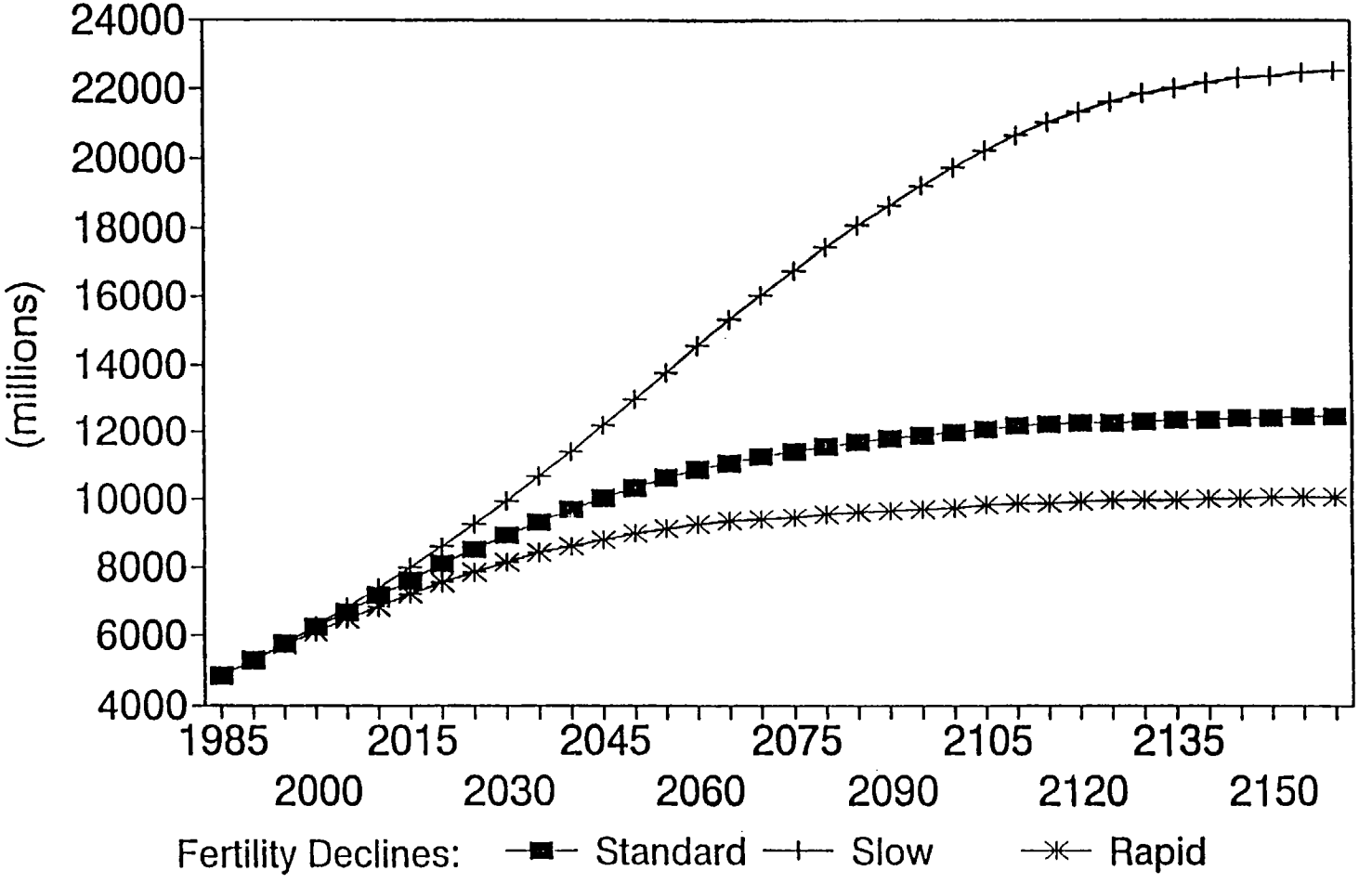
Figure 1 World Population Projection Under Different Fertility Trends



available; levels of unmet need in developing countries range from about 15 percent of couples in Brazil, Columbia, Sri Lanka and Indonesia to over 35 percent in Kenya, Ghana, Togo and Bolivia. In all, about one-fifth of current fertility in the developing world could be avoided if contraception was made available to -- and effectively used by -- all couples that want it. Higher rates of unmet need prevail where a fertility transition has begun but where family planning services have yet to become widely available. In the pre-transition stage, family planning coverage and contraception rates are low, as is unmet demand; increases in demand for, and supply of, services are both needed for lower fertility levels to be attained.

2. Natural Limits to Human Numbers?

The impact of human numbers on the environment is often discussed in terms of the *carrying capacity* of such resources as land, water and atmosphere. This biological concept holds that if nothing else changes, increasing populations will ultimately put demands on resources that can no longer be met without damaging the ability of these resources to support human life. Precise potential limits to carrying capacity are hard to establish since social and economic factors may change in ways that can alter the carrying capacity of resources. Principal among these factors are trade, technology, consumption preferences, and levels of inequality. Certain sound, if difficult, choices involving these factors may facilitate environmental adjustment to larger populations.

At the global level, substantially larger populations are inescapably dictated by current population size and structure, the probable pace of transitions to lower fertility and mortality, and population growth momentum. Even under highly optimistic projections that incorporate rapid fertility declines by assuming aggressive (but non-coercive) family programs even in areas where contraceptive use is currently minimal, world population will still increase to 7.6 billion by 2025. Such optimistic projections are lower by 0.9 billion compared with base case projections, and ultimately, a lower stationary population, but over the next generation, substantially larger populations are inevitable. Monitoring the contribution larger populations make to the evolution of environmental stress will help to identify needed economic and social adjustments; this approach is likely to be more productive than efforts to identifying specific physical carrying capacities.

Global carrying capacity can be estimated by measuring human use of net primary production (NPP). NPP is the global biomass production obtained through conversion of solar energy via photosynthetic processes. Rough estimates of annual NPP, and of the extent to which it is appropriated by humans through both direct consumption and alteration of ecosystems for human purposes, indicate that 5 percent of terrestrial NPP is used for food, biomass fuel, timber, and fibre. The figure rises to 41 percent once the NPP of lands appropriated for human activity is taken into account (Vitousek et al., 1986). Note that this latter figure includes the NPP of cropland and pasture even where this is not directly consumed. Extrapolating this latter figure suggest that given constant per capita NPP use, there would be barely sufficient NPP capacity in the world to absorb the doubling of today's population.

But since constant per capita NPP use is by no means certain, this conlusion is an alarmist one. Income growth could increase NNP use per capita, and technological change might well decrease it. Further, the difference between 41 and 5 percent is made up of NPP whose production, while certainly *altered* by human activity, is not sequestered from use by other species. However, its alteration will have important implications for species that cannot adapt to ecosystems changed by human activity, and is therefore more important for biodiversity than for human carrying capacity per se.

*Feeding Growing Populations*

Modern agricultural development has demonstrated tremendous capacity to meet the requirements of growing global population levels. The empirical record provides grounds for encouragement, but not complacency, about future prospects. World food production has outpaced the rapid population growth of the past quarter century. From 1965 to 1990, cereal production grew by 90 percent to 1.7 billion tons, while population rose by 60 percent to 5.3 billion people. The Green Revolution of high-yielding seeds, combined with chemical fertilizer and pesticides, and irrigation, greatly benefitted many developing countries, primarily those in Asia. The major exception during this period was Sub-Saharan Africa, where cereal production increased by 60 percent, but population by 105 percent. Shortages and famines that continue to occur are, for the most part, the result of social and economic policy failure, and of civil strife, rather than the land's productive incapacity (see Box 2. p.21).

Recent growth in agricultural production is historically unique in that yield increases have been unprecedentedly large; 93 percent of incremental cereal output has been due to intensification alone. Area expansion remains important in Africa and Latin America, accounting for 40 and 32 percent respectively of cereal production increases over the past thirty years (see Table 8). But these trends in agricultural output are now accompanied by growing doubts about their future direction. Declining productivity from soil erosion, waterlogging and salinization, depletion of ground and surface water for irrigation, lost habitat as land is converted to agricultural use, and fertilizer and pesticide pollution are among the sometimes hidden, but increasingly visible consequences of current agricultural practices. Additional output gains from agricultural area expansion will eat further into forests and wetlands, degrading the environmental services they provide, and placing tremendous pressure on biological diversity. Extensification will also be pursed by land-hungry rural populations who move further up erosion prone hill areas and into fragile semi-arid areas. In areas endowed with richer agricultural resources, intensification will almost certainly require greater use of chemical fertilizers and other inputs that carry risks for water quality and human health. Intensification of production that protects against environmental degradation will only be possible if farmers are able to master increasingly complex resource management techniques. Experience from the Green Revolution suggests that this will be difficult if farmers in many parts of the world remain poor, continue to receive little education, and are increasingly engaged in farming part-time as population pressure shrinks farm sizes. The consequences are serious not only because of the direct effect on the prospects for continued agricultural output, but also because of indirect costs both within and beyond the agricultural sector.

Box 2 Famine: Shortage, Distribution, or War?

The recurrence of famines is a paradox in a world of growing prosperity and increasing food availability. But the causes of famine often have little to do with aggregate wealth and food availability; rather famine often results from problems of distribution and poverty. The traditional explanation of famine is that sudden shortfalls in food supplies result in hunger; and, where such a shortfall occurs, prices of the little food that is available rise rapidly and the poor are often outbid by the more well-off. However, in several cases, such as the famines in Bengal (1943), Ethiopia (1973) and Bangladesh (1974), food prices did not rise and, in some cases, food supplies were unchanged or even increased. These famines were caused by the inability of poor people to command food in the marketplace because of their lack of income or "entitlements."

More recent famines in the Horn of Africa have had multiple causes including poverty, war and associated problems of distribution. Even before the current deterioration in Somalia, an estimated 23 million people were seriously affected by a combination of drought and armed conflict in eleven African countries, according to the World Food Program. Drought affected 1990 harvests throughout the Sahel, particularly in Chad, Mauritania, and Niger, as well as in Benin, Ghana, Liberia, Nigeria, and Togo. Countries in Southern Africa, including Lesotho, Madagascar, South Africa, Zambia and Zimbabwe, had below-average crops in 1991. Emergency food relief assistance is required in Angola, Burkina Faso, Cameroon, Chad, Ethiopia, Gambia, Mauritania, Niger, Rwanda, Sudan, and Uganda.

Ethiopia's regions are particularly vulnerable to fluctuations in rainfall and agricultural production because of weaknesses in the transportation and marketing infrastructure; local supply constraints cannot be readily met from neighboring surplus regions. Moreover, because of poverty and a shortage of foreign exchange, imported food cannot easily be brought in to supplant shortfalls in domestic production. The distribution of food aid has been hampered by the country's civil war and by the presence of almost one million refugees fleeing from conflicts in neighboring Somalia and southern Sudan. About 20 million people in Ethiopia face food insecurity.

Logistical bottlenecks, civil strife, refugees, and drought are also behind the food insecurity prevailing in parts of Sudan. Food grain production has been below normal in recent years because of low rainfall and poor production incentives. Despite the Sudan's enormous agricultural potential, 7.7 million people face starvation. Traditional systems for adjusting to drought, such as migration of people and livestock, have been undermined by civil war. The war in the southern part of Sudan has displaced about 1.5 million people and contributed to growing food insecurity. Refugees from Northern Ethiopia add about 5 percent to the Sudan's population. Although local food supply shortfalls have characterized both of the recent famines in Ethiopia and the Sudan, the availability of food has been a relatively minor cause of the crisis.

Because of the urbanization of their populations and the increasing efficiency of agriculture, some countries will be able to reduce pressure for agricultural land expansion as their economic structure evolves. The historical experience of many developed countries has been that the quantity of land devoted to agricultural has declined, but output has increased. Some countries such as Thailand appear poised to move into this phase in the next several decades. In an analysis by the Thailand Development Research Institute, the demand for agricultural land was projected using assumptions about the future evolution of agricultural prices, agricultural population, productivity, the level of crop diversification, and the extent of industrialization. The projections show a decrease in the demand for agricultural land by 2010 of 19 million rai from the current level of 88 million rai. The decrease in demand is in response to projected declining real agricultural prices, increasing productivity, growth in industrial and service sectors, diversification towards land-saving crops, and rural population that levels off and then begins to decline (Panayotou and Parasuk, 1990).

**Table 8** Yield and Area Expansion Effects, 1961-1987, Cereals

| | Production (P) (Million tons) | | | Yields (Y) (Tons/Hectare) | | | Harvested Areas (A) (Million Hectares) | | | Contribution to Growth Output | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1961 | 1987 | Percent Change | 1961 | 1987 | Percent Change | 1961 | 1987 | Percent Change | Area Expansion Percent | Yield Percent |
| Sub-Saharan Africa | 31.7 | 50.3 | 58.7% | 0.77 | 0.99 | 28.6% | 41.4 | 51.0 | 23.2% | 40% | 60% |
| South Asia | 118.8 | 218.0 | 83.5% | 1.03 | 1.69 | 64.1% | 115.0 | 128.8 | 12.0% | 14% | 86% |
| East Asia (excl. China) | 50.1 | 109.0 | 117.6% | 1.29 | 3.58 | 177.5% | 31.7 | 41.1 | 29.7% | 21% | 160% |
| China | 107.0 | 359.0 | 235.5% | 1.19 | 4.01 | 237.0% | 89.7 | 89.6 | -0.1% | 0% | 100% |
| Rest of East Asia | 50.1 | 109.0 | 117.6% | 1.58 | 2.65 | 67.7% | 31.8 | 41.1 | 29.2% | 25% | 75% |
| EMENA | 88.9 | 167.3 | 88.2% | 1.26 | 2.34 | 85.7% | 70.4 | 71.5 | 1.6% | 2% | 98% |
| Latin America | 46.8 | 110.7 | 136.5% | 1.27 | 2.08 | 63.8% | 36.9 | 53.2 | 44.2% | 32% | 67% |
| OECD | 294.4 | 532.3 | 80.8% | 2.22 | 3.96 | 78.4% | 132.5 | 134.3 | 1.4% | 2% | 98% |
| Low-income economies | 285.9 | 692.3 | 142.1% | 1.09 | 2.41 | 121.1% | 263.0 | 287.4 | 9.3% | 7% | 93% |
| Middle-income economies | 165.0 | 335.7 | 103.5% | 1.29 | 2.16 | 67.4% | 128.3 | 155.5 | 21.2% | 21% | 79% |
| LDCs | 450.9 | 1027.9 | 128.0% | 1.15 | 2.32 | 101.7% | 391.3 | 442.9 | 13.2% | 10% | 90% |
| World | 885.0 | 1792.2 | 102.5% | 1.37 | 2.59 | 89.1% | 647.6 | 692.7 | 7.0% | 7% | 93% |

**Note:**

Area Expansion Percent = $[Y_{1961}(A_{1987} - A_{1961}) + (P_{1987} - P_{1961})] * 100$

Yield Percent = $[A_{1987}(Y_{1987} - Y_{1961}) + (P_{1987} - P_{1961})] * 100$

Projected population and income growth over the next four decades will roughly double world grain demand from today's 1.9 billion tons, ninety percent of this growing demand coming from developing countries. Current average per capita consumption of grains in developing countries is 250 kilograms. Even assuming a robust 2.5 percent annual rate of agricultural output growth, consumption will rise to around 350 kilograms, about Japan's level today.

Satisfying this need appears possible, but will require improvements in environmental management at all levels of the agricultural sector, including: further land conversion; more intense use of fragile soils; an expansion of irrigation water withdrawals; and increased use of chemical inputs. The severity of these potential constraints to future output growth are not precisely known at present. Improvements in agricultural policy will clearly be needed.

3. Rapid Population Growth Complicates Adjustment

High population growth rates make it more difficult for countries to invest in social and physical infrastructure, for institutions such as property rights to evolve, and for induced innovation to provide solutions. All these conditions must be met for pressure on environmental resources to be prevented from resulting in deteriorating standards of living. The relevant question in this context, is not with whether increasing population eventually leads to social and economic adjustments that compensate for higher population/resource density, but whether transition costs -- in terms of environmental degradation -- are higher at faster rates of population growth.

Cross-country data suggest a relationship between rates of population growth and agricultural area expansion (see Figure 2). Over the last three decades, countries with population growth rates below 1-1.5 percent per annum have most often experienced a decline in agricultural area, and as growth rates have increased, the growth of agricultural land area has also generally increased. An econometric study of 23 Latin American countries in the 1980s found that agricultural area expansion was positively related to population growth, even controlling for other factors such as agricultural trade, yield increases, and a measure of the closing frontier (Southgate, 1990). An important implication is that countries with higher population growth rates are more likely to confront a faster conversion of land to agricultural uses, with the most obvious consequence being greater pressure on biodiversity through loss of habitat. It would appear evident that much of the conversion would take the form of continued deforestation, but it is proving difficult to establish an empirical link between deforestation and population growth.

At rapid rates of population growth, there is both less time and more pressure for adjustment to environmental stresses that arise. Historically, two types of response to population pressure have proven critical, namely induced technological innovation and improved security of property rights, but it is unclear whether these can be relied upon to keep pace with projected population increases.

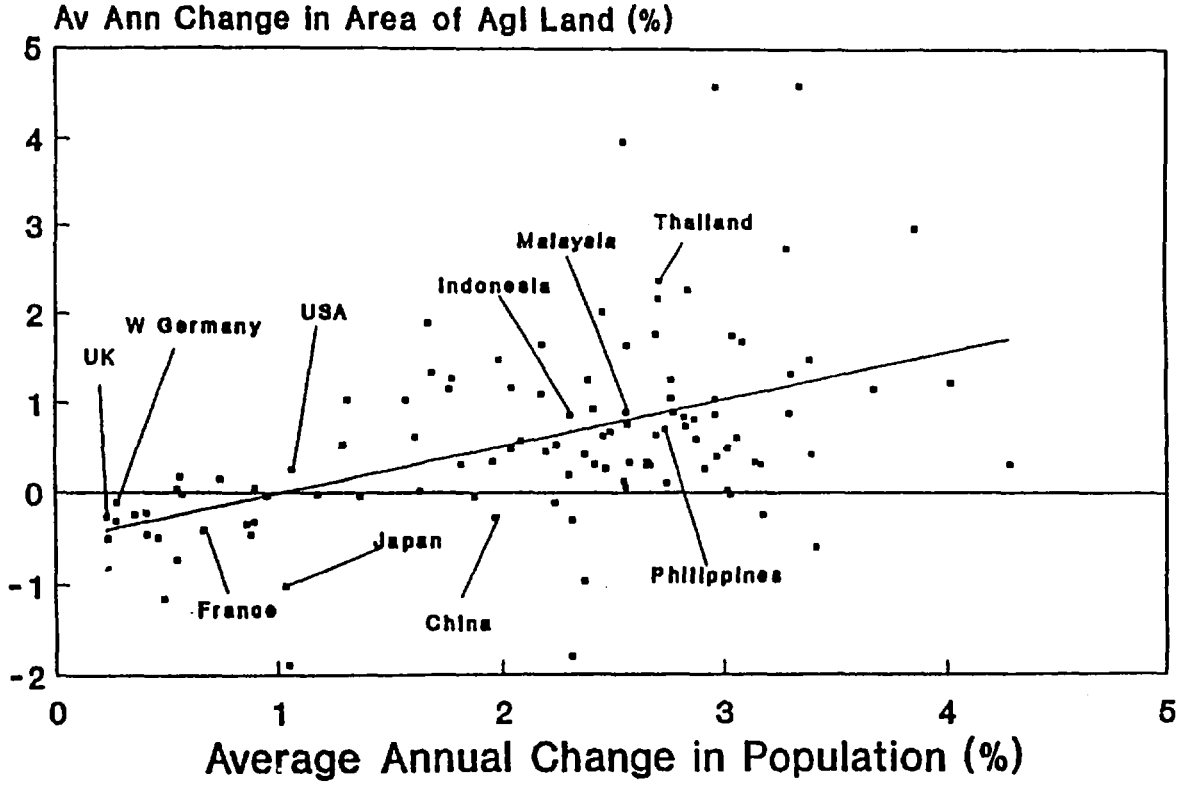
Technological innovation in response to growing population pressure on resources has proven a potent avenue for raising productivity and output. But this interaction appears to be weak in a number of agricultural regions where environmental resources are fragile and farmers poor, and at the very least involves long transition periods during which environmental damage can be severe. An investigation of six countries in Sub-Saharan Africa indicates that farmer-based innovations are not coping with the demands of rapidly rising rural populations. The consequence in many locations -- eastern Nigeria, Sierra Leone, southern Malawi, Ethiopia -- is that agricultural intensification is taking place only in the sense that fallow periods are shortening; there has been no additional use of better inputs or new techniques that would permit yields to be maintained or increased. Rapid population growth is resulting in mining of soil resources and stagnating or declining yields. The consequent reinforcement of poverty makes it even more difficult for those affected to undertake the investments and accept the associated risks that will be necessary to realize greater long-term productivity.

Declining yields resulting from shortened fallow periods are by no means inevitable, but these trends are appearing in quite diverse settings, particularly in Sub-Saharan Africa. An almost universal response to lower soil productivity is to increase labor inputs into cropping activities. But this response will reduce labor productivity unless farmers are able to improve management techniques, such as in soil preparation, or introduce new inputs such as improved seed or fertilizer.

But in many areas, shortened fallow time is not accompanied by the introduction of new techniques that would permit yields to be sustained under this greater intensity. In part, this is because the greater intensity of land use is not generating surpluses for reinvestment in land productivity or other activities. Rather, the rapid rate of population growth is resulting in the mining of natural resources, as indicated by expansion into marginal areas and by stagnating yields.

Traditional property rights systems in previously resource abundant areas are having mixed success in adapting to increasing population pressure on resources. In parts of Africa, traditional land tenure rules are changing to provide sufficient incentives for cultivators to take a longer-term perspective in land management. Studies of tenure in Ghana, Kenya and Rwanda found that customary land tenure rules were little impediment despite the absence of formal titling and land registration, and were evolving toward greater individual ownership and management control. Inheritance of family land is becoming more widespread, with security strengthened by continuous cultivation and occupation. Outright purchases of land are not yet common but are increasing, even where formal registration and titling, backed by a solid legal framework for defining and enforcing property rights and adjudicating disputes, are not yet in place.

Figure 2 Agricultural Land and Population (Average Annual Change: 1961-87)




However, if resource ownership, use rights and management responsibility do not coincide, property rights are not likely to evolve successfully. Thus, where cultivators are pushing into traditional pasture lands in semi-arid areas, where women are responsible for food production but have no independent rights to land, and where trees and the land they are on are regulated by different use and ownership rules, traditional property rights systems are proving less adaptive and less able to provide the secure access rights that are fundamental to generating incentives for good management practices. Common property rights systems are also adjusting poorly where resources are under pressure from increasing numbers of land-poor and landless rural people. Moreover, state-owned property such as forest reserves is often poorly managed and encroached upon by land-hungry squatters who clear it for farming.

Population pressure in semi-arid areas is pushing cultivators along river basins, and onto drier areas and sloped terrain, areas that have traditionally served pastoral groups and their

herds. Ethnic differences, unequal access to governmental authorities, and other factors regularly lead to conflicts over land-access that are difficult to resolve. Pastoralists now face reduced land-access and also less mobility since better pasture areas, to which pastoralists could previously move their herds in periods of drought, are now occupied by crop growers. Consequently, low-quality pasture is now being more intensively and degradedly used, and pastoralists' herds, forced to graze post-harvest crop residues, are not manuring agricultural land as much as before. Attempts like those in Maasiland, Kenya, to shift nomadic herders from open range practices to group ranching on defined land parcels have met with little success. Isolated cases of spontaneous range enclosure, such as in South Darfur, Sudan, have occurred when the right combination of declining range productivity, improved access to commercial markets, and the capacity to enforce exclusion come into play simultaneously.

The security of property rights for women managers of natural resources is frequently insufficient to mitigate demographic pressure on resource use. While this will clearly not be the case in matrilineal societies, in many areas of Africa, women are the primary producers of food, but are without any long-term rights to land. Access to land often comes only through one's husband, and is not inheritable, thus imposing substantial uncertainty on unmarried, separated or widowed rural women farmers. Women face the prospect of their plots being transfered to men's commercial farming activities if these latter expand. Such insecure tenure is an important impediment to women farmers' following continuous cultivation practices that can maintain soil quality over time.

Where tree resource ownership and use rights are not coincident with land rights, adequate resource security may not be realized. Conflicts can arise when these rights reside with different people or groups, and when demographics generate pressure to intensify land and tree resource use. Customary tenure has tended to evolve in favor of stronger rights to land than to trees, with has resulted in more rapid forest-clearing and reduced incentives for agro-forestry investment.

Often property rights systems have not evolved to the point where they can provide tenure security sufficient to generate soil management investment incentives that, if acted upon, could realize sustainable continuous cultivation. As population pressure grows and land becomes so scarce that shifting cultivation and natural regeneration of soils through fallowing are no longer viable, new practices of soil mulching, manuring, and new techniques of chemical amendment and erosion prevention must be used to maintain soil quality and prevent declining yields. Such practices and techniques often generate benefits only over a number of years, and consequently they are unlikely to be adopted by farmers who are unsure of continued land-access and unpersuaded of their benefits. Thus, a critical issue for countries where population growth is moving them quickly through the transition from land abundance to land scarcity, is the capacity to adopt secure property rights systems that provide appropriate incentives.

4. Migration Has Mixed Impacts on the Environment

Migration often represents a response to imbalances between population levels and the

capacity of local environmental resources to support them. There are also potent environmental impacts in areas receiving the migrants, which will differ according to the form the migration takes -- whether of individuals or households, seasonal or permanent, to frontiers or established communities -- and which can either mitigate or exacerbate the environmental impact of population growth. Some forms of episodic migration, such as flight from political strife, can expose environmentally fragile areas to massive population increases (see Box 3 on refugees).

Migration from rural to urban areas will continue to dominate shifts in population, despite a slowdown to some cities during the 1980s in response to slow economic growth and a lack of job opportunities. Most potential migrants are attracted to urban areas by better job prospects and greater access to social services. As urban population are further concentrated, they will increasingly overwhelm the natural ability of urban environments to absorb the wastes and emissions of urban populations and their activities. In turn, the unassimilated pollutants will expose the growing urban populations to environmental health hazards. From an environmental perspective therefore, the shift of populations towards urban areas indicates that urban environmental problems are set to become more important in developing countries, both physically and politically.

The rate at which developing countries' populations are becoming more urban is not all that different from the historical experience of developed countries. What distinguishes current urban growth is the absolute size of the cities involved, and the pace at which they are growing. City growth in developing countries peaked at a rate over 1.5 percentage points greater than the maximum rate realized for Europe (2.6 percent, in the late 1800s), although rates in most regions have begun to decline from their peak between 1960 and 1975. The natural rate of population growth in these cities is an important factor, but so too is migration from rural areas. As a result of rural-urban migration, estimates based on UN projections of urbanization indicate that between 1990 and 2020 about 90 percent of the total incremental population increase in developing countries will be in urban areas (Tables 9 and 10). While the population of rural areas in developing countries will grow by about 10 percent over this period, developing countries' cities will grow by almost 160 percent.[1/] Regional patterns of urban growth will differ substantially, with annual average rates over the next thirty years of 1.6 percent, 4.6 percent and 3 percent in Latin America, Sub-Saharan Africa and Asia, respectively. Possible impacts of changing economic trends on urbanization are not explicitly incorporated into these rough estimates. Among the factors known to affect the level of internal migration are imbalanced technical progress between urban and rural areas, and the impact of domestic policies and world market conditions on the urban-rural terms of trade and on factor markets (Williamson, 1991). Overall, however, the prospects for high but gradually declining rates of urban growth appear to be quite robust.

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[1/] The projections are derived from World Urbanization Prospects 1990, United Nations, by applying that document's projections of urban population as a share of a country's total population to World Bank projections of total population.

Policy attempts to influence the pace of urban migration directly have rarely proven successful, and there appears scant justification for revisiting them on environmental grounds. Little can be stated conclusively given present knowledge about whether population's impact on the environment is more manageable in urban or rural settings, nor has it proven feasible to determine "optimal" city size with respect to infrastructure, such as sewage treatment and potable water supply, that intermediates between population and the environment. It is more important to focus on those factors, common in many urban settings, which constrain flexible responses to environmental issues as they emerge. Such factors -- legal status of squatters, uncertain property rights, limited finance for infrastructure -- often parallel constraints on sound environmental management in rural areas.

Box 3 Refugees and the environment

Abrupt and massive movements of people in response to natural disasters or political instability can put tremendous pressure on natural resources. Such movements frequently spill over international boundaries. Refugee inflows have been large relative to natural population increase in a number of countries as seen in Box Table 1.3. Environmental impacts are probably greatest where refugees are dispersed, typically in rural areas, although areas around camps are also usually affected.

In Malawi, the local impact of refugee inflows from war-torn Mozambique is even greater than Box Table 1.3 indicates. Most of the nearly 1 million arrivals are settled in rural areas of border districts in the South and Central Provinces, where they outnumber the indigenous population. Although integrated into Malawian villages, refugees exert only limited pressure on land, since they are not permitted land-access for agricultural purposes. Major environmental problems are refugees' cutting trees for fuelwood and building materials, and using agricultural residues for fuel; both of these activities exacerbate the area's already serious rate of deforestation and land degradation. While reforestation and introduction of improved fuel-efficient cookstoves are alleviating some of this pressure, another option being explored is to supply surplus and waste timber from Government plantations in regions without fuelwood deficits.

Box Table 1.3 Flows of refugees as a % of natural population growth in selected countries, various periods

| Country | Period | Total refugee entrants | Refugee entrants, Percent of natural pop. growth, p.a. |
|---|---|---|---|
| Somalia | 78-81 | 1,540,000 | 421.9 |
| Dominican Republic | 69-71 | 295,000 | 118.5 |
| Malawi | 84-90 | 909,000 | 51.0 |
| Botswana | 77-80 | 37,300 | 41.0 |
| Gabon | 78-81 | 30,000 | 28.0 |
| Sudan | 77-85 | 1,003,000 | 23.0 |
| Iran | 78-88 | 2,771,980 | 18.7 |
| Pakistan | 79-87 | 3,545,400 | 15.7 |
| Zimbabwe | 83-89 | 185,500 | 10.9 |
| Ethiopia | 84-89 | 700,000 | 9.5 |
| Zambia | 81-86 | 107,500 | 9.2 |
| Nicaragua | 80-83 | 22,500 | 7.8 |

Notes: Number of refugees obtained from U.S. Committee for refugees. Refugees explicitly identified as living in camps are excluded.

## Table 9 Population, by Region (millions)

| Regions / Years | | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | ..... | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sub-Saharan Africa | | 530 | 617 | 717 | 831 | 955 | 1089 | 1231 | 1378 | ..... | 2062 |
| | Urban | 162 | 210 | 268 | 339 | 423 | 519 | 627 | 746 | | |
| | Rural | 368 | 407 | 448 | 491 | 532 | 570 | 604 | 632 | | |
| 2. Asia and Pacific | | 2921 | 3170 | 3409 | 3638 | 3856 | 4065 | 4270 | 4467 | ..... | 5192 |
| | Urban | 961 | 1177 | 1404 | 1635 | 1861 | 2100 | 2347 | 2599 | | |
| | Rural | 1939 | 1972 | 1983 | 1981 | 1971 | 1941 | 1897 | 1843 | | |
| 3. EMENA | | 1105 | 1168 | 1233 | 1301 | 1369 | 1436 | 1503 | 1570 | ..... | 1843 |
| | Urban | 728 | 788 | 854 | 924 | 998 | 1074 | 1151 | 1227 | | |
| | Rural | 377 | 380 | 380 | 377 | 371 | 362 | 353 | 342 | | |
| 4. Americas | | 722 | 777 | 828 | 877 | 924 | 971 | 1016 | 1057 | ..... | 1192 |
| | Urban | 527 | 582 | 635 | 688 | 740 | 792 | 844 | 892 | | |
| | Rural | 195 | 195 | 193 | 189 | 184 | 178 | 172 | 165 | | |
| World Total | | 5282 | 5736 | 6192 | 6652 | 7109 | 7567 | 8026 | 8472 | ..... | 10319 |
| | Urban | 2385 | 2761 | 3162 | 3584 | 4020 | 4486 | 4975 | 5464 | | |
| | Rural | 2897 | 2975 | 3030 | 3067 | 3089 | 3081 | 3052 | 2982 | | |

## Table 10 Shares of Urban and Rural Population, by Region

| Regions / Years | | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Sub-Saharan Africa | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Urban | 31 | 34 | 37 | 41 | 44 | 48 | 51 | 54 |
| | Rural | 69 | 66 | 63 | 59 | 56 | 52 | 49 | 46 |
| 2. Asia and Pacific | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Urban | 33 | 37 | 41 | 45 | 48 | 52 | 55 | 58 |
| | Rural | 66 | 62 | 58 | 54 | 51 | 48 | 44 | 41 |
| 3. EMENA | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Urban | 66 | 67 | 69 | 71 | 73 | 75 | 77 | 78 |
| | Rural | 34 | 33 | 31 | 29 | 27 | 25 | 23 | 22 |
| 4. Americas | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Urban | 73 | 75 | 77 | 78 | 80 | 82 | 83 | 84 |
| | Rural | 27 | 25 | 23 | 22 | 20 | 18 | 17 | 16 |
| World Total | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Urban | 45 | 48 | 51 | 54 | 57 | 59 | 62 | 64 |
| | Rural | 55 | 52 | 49 | 46 | 43 | 41 | 38 | 35 |

Urban migration can significantly alleviate the direct pressure of rural populations on natural resources. In most South American countries, such migration has already brought a decline in the number of people living in rural areas. While also true for China and the Republic of Korea, most other countries in East and South Asia are likely to experience further increases in rural population over the next two decades, before rural-urban migration and declining fertility rates effect an absolute decline in rural populations. With rural populations likely to increase by 50 percent over the next thirty years, Sub-Saharan Africa and several Central American countries face a significantly different future.

With the prospect of relatively little absolute growth in rural population for many parts of South America and Asia, the environmental management issues in rural areas rural will shift from dealing with the direct consequences of rural population pressure on the environment. Increasingly, rural environmental concerns will center on the effects of urban demand for food, energy, and water, and on the influence of urban markets on the resource management incentives of increasingly commercial rural producers. But in much of Africa, the Middle East and Central America, there will continue to be substantial direct pressure on natural resources as a result of growing rural populations and household subsistence needs.

*Migration Will Not Always Benefit the Rural Environment*

Rural areas experiencing net out-migration have generally benefitted in terms of reduced environmental pressure. Often degradation is merely slowed rather than halted or reversed since in general rural area populations in developing countries are not declining in absolute terms. Scattered cases of rural out-migration having negative environmental consequences do occur: certain investments in resource conservation infrastructure, such as terraces, may realize lower rates of return as a result of labor scarcity or disrupted mechanisms for community decision-making. Of greater concern is in-migration to rural areas, which can cause rapid environmental degradation, particularly in frontier areas where affected resources may be forests, wetlands or uplands. Migrants to these areas often attempt to transplant familiar but inappropriate agricultural practices; need to clear land of trees to establish property rights; are beyond the effective reach of extension and credit programs; and are cut off from community mutual assistance traditions that aid in pursuing more long-sighted strategies.

Migration in search of agricultural land can result in rapid loss of forest cover and rapid degradation of newly opened soils. These problems are most visible in countries with frontier land resources, where the migrants often attempt to transplant familiar but inappropriate agricultural practices. While earlier inhabitants may have subsisted on the areas' resources using low intensity harvesting and gathering, cultural, linguistic or other barriers can prevent the transfer of their resource management knowledge to the migrants.

Under these circumstances, risks are particularly high for migrants. Most of their savings have gone into migration. Their knowledge of managing their new natural assets is weak, and the potential for failure high. Social cohesion may be low, with few arrangements in place to provide community assistance to families that fall on hard times. Contested or

unclear property rights are the norm in frontier areas; as a consequence, migrants to the frontier face a clear set of incentives to convert the natural assets of the land into income and physical assets that are not tied to the location. These all contribute to heavy reliance on the natural resource asset base, which is often the only "savings bank" available to comepsate the migrants for their precarious incomes.

Significant damage can result from a comparatively small influx of migrants to a frontier area. A common pattern in forest areas is that several years after planting crops on a cleared site, output begins to fail, and the migrants pick up and start over on the receding frontier. Such has been the experience in the Brazilian Amazon, where migrants from rural areas in the northeast and south have followed the falling forest, leaving behind areas of low crop productivity for cattle ranchers and land speculators.

Frontier areas are often beyond the effective reach of extension programs. For some of these areas, access to extension is not the issue, since few technical approaches exist for sustaining profitable yields on their soils. But even where stable forming systems are possible, geographic remoteness, a lack of training, and understaffed extension networks handicap counseling farmers on practices that can provide a regular return over the longer term.

*Migration Benefits the Environment Where it Mitigates Risks*

Migration can be used by rural households as a strategy to cope with risk, especially where insurance and credit markets are too poorly developed to provide alternatives. Risk can be reduced through the diversification of household income sources that results from the migration of family members. Migratory and sedentary household members can in effect co-insure against changes in either of their incomes. This provides families with options for maintaining consumption above subsistence levels without having to draw excessively upon natural resource "savings" to survive drought or other calamities. Thus in Botswana, survey analysis revealed that families that relied on crops for their sustenance received greater remittances during the drought of 1978-79 (Stark, 1991).

Remittances sent by the migrant to the family are not important only in that they can be invested in increasing the productivity of rural resources. In fact, studies have found that remittances are largely used to increase consumption. Further, where this substitutes for consumption financed by the mining of natural resources, the environmental impact can be positive. Additional channels whereby migration can smooth consumption levels and consequently maintaion environmental quality, include transfers in kind and the temporary residence of family members with the migrant.

## IV. Policy Choices on Poverty, Population and the Environment: Congruence or Trade-offs?

A five-fold policy strategy is needed to break out of the poverty-population-environment

interaction that reinforces poverty and degrades natural resources. First, an appropriate macroeconomic stance should be adopted to enable growth in poor people's incomes. Such income growth will be gradual and will only benefit the environment over the longer term. Second, it should therefore be supplemented with targeted interventions that directly alleviate the risks faced by the poor and that secure their rights to natural resources. Third, the maldistribution of services and resource ownership need to be addressed since it contributes to environmental degradation. Fourth, social programs in education and health will be required for families to be provided with options that will allow them to manage their natural resources with a longer-term perspective. Finally, improved access to family planning will reduce existing unmet demands for contraception and smaller family size, and therefore contribute to slower population growth. In each of these policy areas, adding an environmental perspective is more likely to reinforce, rather than conflict with, strategies best suited to poverty alleviation and economic development.

1. Promote Poverty Alleviation

Macroeconomic policies that promote stable and broad-based income growth are a longer-term but essential component of improving the use of natural resources by the poor. In the framework used earlier, higher incomes will result in lower pure time preference. They will also provide the poor with improved incentives and a cushion above subsistence consumption that will allow them to consider longer-term resource use options that provide better returns. better returns.

Macroeconomic growth strategies best suited to poverty alleviation are only briefly surveyed here since in-depth reviews are available elsewhere.[1/] The essence of these strategies is to make the best use of that resource which is most available to the poor -- their own labor. Policies should therefore not discriminate against agriculture, which is the principal labor-intensive sector, and should provide strong support for agriculture development through the provision of rural infrastructure. Malaysia in the 1970s accomplished this through relatively low total taxation of agricultural commodities at 19 percent of value, while public expenditure in the sector was 10 percent of agricultural value added. Thailand pursued a somewhat different path, with resource outflows from agriculture due to high total taxation on agricultural goods -- 43 percent of their value -- being offset by strong government spending on infrastructure and services in rural areas.

Within this general emphasis on agricultural development, governments need to evaluate local circumstances to determine the appropriate balance between agricultural intensification in more robust agro-ecological systems and development in more marginal resource areas. Some countries may have sufficient land resources to pursue extensification of agriculture in marginal areas for some time, or have substantial scope for introducing techniques that enable less

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1/ This section draws on the 1990 World Development Report on poverty.

environmentally degrading agricultural activity. But other countries have essentially exhausted the extensification option and have few technological solutions in resource-poor areas. They must therefore focus on intensification in more established agricultural areas for income generation and labor absorption.

Many countries will also need to pursue policies that promote income growth, labor absorption in non-agricultural sectors, and consequently migration in order to relieve population pressure on land and other natural resources. Important policies that affect the urban demand for labor include incentives targeted at capital and goods markets: industrial protection, credit and exchange rate policies that reduce the cost of capital relative to labor; and labor market regulations that fragment urban job markets and raise labor costs in the formal sector. Public spending on infrastructure will also be critical, not just for the provision of potable water and sanitation to poor residential areas, but also of roads, electricity and other services to areas where small-scale and informal sector businesses are concentrated.

Macroeconomic policy focused on broad-based income growth and labor absorption will need -- even under the best of circumstances -- several generations to make appreciable progress in alleviating poverty. Because of the potential for poverty-population interactions to result in extensive environmental damage over a much shorter time-frame, there is a need to identify more targeted policies that, in a shorter period of time, are able to address the pressure that poverty places on natural resources in marginal areas. Policies that are most likely to have such an impact will address the consumption and production risks confronting poor rural households.

2. Reduce Rural Risks and Tenure Insecurity

Targeted government intervention can have an immediate impact in minimizing the extent to which poor rural households are forced to mine natural resources during crises that threaten to push them below subsistence levels of consumption. In times of flooding or drought, targeted interventions such as food-for-work programs can enable poor households to maintain minimum consumption levels without overexploiting the few natural resource assets to which they continue to have access. Temporary programs of this kind can be combined with natural resource management projects that will benefit the rural environment: up-grading rural road drainage to minimize erosion; planting windbreaks; and improving soil conservation and water harvesting techniques on common property or public lands.

Production risks will often be heightened by inadequate definition of tenure rights to natural resources managed by the rural poor, which causes the potential benefits of longer-term investments to be uncertain. State intervention in several areas can have beneficial results. Provision of an adequate legal framework and judicial institutions can help resolve conflicts in land title claims. Misguided legislation that requires settlers to clear land of forests in order to establish rights to title should be rewritten, as has happened recently in a number of countries, to permit alternative and less damaging economic uses of the property. It should be recognized that squatters remaining on public land under dubious legal status are likely to have negative environmental consequences, and that granting them tenure rights will often be the best option.

Finally, where common property management has deteriorated into open-access exploitation of natural resources, the government may be able to work with local communities in identifying and helping to enforce workable access rules.

However, not all cases of tenure uncertainty will be amenable to short-term resolutions through targeted state intervention. This will be particularly true where tenure uncertainty is caused by conflicting state land legislation and customary tenure arrangements, since the resolution of authority and rights issues is likely to be complex and time-consuming. In other cases, traditional tenure practices may be intact and provide sufficient security without conferring physical title to the resource.

Governments have some scope for reducing the impact of risk on the poor's use of natural resources where missing or fragmented credit markets predominate. Some governments have mistakenly attempted to suppress informal credit markets, on the grounds that such markets are exploitative. While rates in informal markets are predominantly high, evidence suggests that this is simply an accurate reflection of relevant risk premia and transaction costs. Even at high rates, informal credit provides the poor with some potential for consumption smoothing that mitigates mining of natural resources. Indeed, informal market lenders often provide credit for consumption in contrast to formal market lenders who typically focus on lending for production.

Formal credit programs need to be made more flexible in addressing environmental degradation. Instruments to provide credit directly for conservation investments should be developed. In cases where food deficit farmers would otherwise have to hire themselves out, such credit could cover these farmers' own labor costs for conservation activities on their own plots. A second measure wold be to encourage lending to groups as a means of reducing transaction costs and decreasing the risk of default, thereby permitting the extension of formal credit to poorer farmers. In addition, lending to groups can facilitate those conservation investments that, to be effective, have to be undertaken on a scale larger than the individual holding. Finally, there will be instances where establishing formal land titles for poor farmers will provide them with the collateral needed to gain access to credit.

There is only limited scope for using insurance to reduce the environmental consequences of production risks facing poor farmers. Although crop insurance is the most likely instrument, it faces a number of constraints and has not spread much beyond limited pilot projects in certain developing countries. As noted by the Asia Productivity Organization, there are some exceptions. Sri Lanka has had paddy insurance for several decades on a nation-wide basis, with administrative costs paid by the government. Beginning in 1978, Thailand has experimented with cotton insurance in cooperation with local insurance companies; these experiments have expanded to cover several provinces and include maize and soybeans. In the Philippines, a public sector insurance agency administers a crop insurance program covering maize and paddy that is obligatory for farmers participating in government supervised credit programs.

Public sector crop insurers rarely operate without substantial financial losses. Most programs attempt to insure risks where hazards are high and often spread over the entirity of the

insured pool, such that the premiums necessary for financial solvency cannot be afforded by targeted farmers. Administrative costs increase as coverage extends from medium-scale to smaller farmers. Incentive problems arise when governments are pulled into maintaining the financial viability of insurance agencies. Although crop insurance provided by the private sector is now expanding beyond developed countries, it is concentrated on commercial farmers and is unlikely to be extended to poor and small-scale farmers. Thus, it is probably more effective for governments to help poor rural households cope with income loss crises through targeted, direct assistance programs such as the relief employment and food ration programs discussed above.

3. Address Maldistribution

A lack of access to services, to infrastructure, and to resources are important determinants of how the poor interact with the environment. Improvement in service, infrastructure and resource distribution can reduce environmental problems confronting the poor.

Agricultural extension and research services often fail to benefit poor farmers. The reasons for failure vary by group: squatters, women, and farmers in remote frontier areas. But the outcome is an insufficient two-way flow of information on environmental problems and on beneficial management techniques. It may be more costly to reach poor farmers, but this may be offset if there are higher external environmental benefits to be achieved from improved resource management by the poor, as will be the case where they are marginalized on fragile resources.

Women farmers often face additional constraints to their management of natural resources. Where social norms are for husbands and wives to have autonomous responsibilities in agriculture, women are less able to compensate through their husbands for inadequate access to land, inputs and credit. Access can be limited by the inability to join cooperatives or hold legal title to land.

Improving the distribution of access to infrastructure also addresses poverty alleviation and environmental objectives simultaneously. Extending rural road networks into areas with more resilient nature resources is essential to foster agricultural intensification, but needs to be avoided if it increases access to areas with fragile resources and uncertain agricultural potential. In urban areas, water and sanitation services are often publically subsidized and available mostly to non-poor households, with the poor unserved or in the case of water, paying higher prices to water vendors. Reducing these subsidies will generate some of the financial resources needed for expanding water and sewage system coverage.

Redistribution of unequally owned natural resources is frequently suggested as a means to reducing the environmental damage that attends the poor's search for land. Land redistribution in practice, however, can generate both positive and negative incentives for effective resources management. Redistribution of larger holdings to smaller-scale owners is beneficial in that it typically involves a shift to labor-intensive practices, and this absorption of labor reduces demographic pressure on marginal areas. Providing previously landless or land-

short farmers with secure rights to property can help create a longer term perspective in their use of resources. However, land distribution often implies a protracted transition period of social upheaval and uncertainty over implementation. Owners who anticipate losing property or recipients uncertain about the durability of their new rights are apt to overexploit natural resources and convert them into other assets. While land redistribution is therefore not a panacea, it may be environmentally beneficial where property rights are already a widespread problem, or where redistribution can successfully avoid a long transitional period.

4. Strengthen Education and Public Health Programs

An environmental perspective reinforces the emphasis on developing human capital through education, family planning, and health programs that came out of past decades' focus on poverty alleviation and economic growth. More access to quality education can improve families' ability to use natural resources more productively and to diversify their income sources away from dependence on natural resources alone. Further, education can increase the opportunities and productivity of off-farm employment, which, as average farm-size shrinks in many parts of the world, will become an increasingly important source of income. Education of girls and young women is particularly important because of the extensive range of women's resource management. Improving their income earning possibilities increases the opportunity costs of raising children and the incentives to have smaller families, while providing the means to improve the health and education prospects of children they do have; both developments have clear environmental benefits.

Public health programs need to incorporate preventive measures capable of reducing environmental health risks faced by the poor. Such measures include hygiene education and monitoring of children's nutritional and growth status. Access to low cost treatment -- such as oral rehydration therapy for diarrhoea -- will remain important in situations where the poor are likely to confront the environmental risks of inadequate water and sanitation infrastructure for some time to come. The poor also need access to health clinics for treatment of respiratory diseases and cardiac problems, both od which increase their vulnerability to the health risks of air pollution.

4. Expand Family Planning

Progress on income growth, female education, and child health is critical in fostering demand for smaller family sizes. It can expand the scope for family planning interventions to lower fertility rates, although it should be noted that, where there is currently unmet demand for such services, such scope already exists. Inadequate funding and numbers of family health clinics have kept family planning options unavailable to many who want them. Remedying this shortage is a clear priority in areas where population growth is exacerbating environmental degradation.

The financial resources needed to achieve substantial declines in fertility involve

significant increases, but are achievable. Current expenditure on family planning by governments, individuals and donors, is difficult to measure but several recent studies indicate that the world aggregate probably lies between $4 and 5 billion (1988 dollars) annually. Donors and individual users each account for 10-15 percent of the expenditure, leaving the greater share to government budgets. Information available through 1988 on donor contributions to family planning programs, mostly grants with some loans, show that despite a 7 percent real increase over 1980 to $653 million, contributions did not kept pace with the increased numbers of married couples in their reproductive years. Moreover, financing family planning through fees charged to individual users has only a limited potential. In the absence of publicly subsidized provision of contraceptive methods, individuals in many countries would have to pay 5 percent or more of their annual average income to meet increased unmet demand. These countries include: Laos, Myanmar and the Philippines, in Asia; between 15 and 24 Sub-Saharan nations; and, with respect to contraceptive pills, Bolivia, Ecuador and the Dominican Republic, in Latin America. Reducing public subsidies on contraception would also reduce effective demand, whether measured in terms of couples actually using contraception or as unmet need.

Estimated financial requirements to achieve the fertility decline of the standard projection for 2000 will be about $8 billion. Over the next decade this will require an annual increase in expenditure of about 4.5 percent, or roughly a 60 percent real increase in total over current spending. This financial target, and the underlying assumptions on fertility decline, remain basically unchanged from recommendations made by the Bank in the 1984 World Development Report on population. At the half-way point of this period, expenditure is about $500 million below target needs, and 1990 world population about 100 million greater than the 1984 projections. Increases in the number of contraceptive users have been impressive, but must continue. From over 200 million married couples in 1980 practicing contraception, the number has reached an estimated 323 million in 1990, but needs to increase by roughly 135 million in each of the next two decades to achieve the fertility declines of the standard projection. These figures understate the actual effort needed, since the number of new users must compensate for couples that stop using contraception for reasons such as becoming infertile with older age.

Achieving rapid fertility decline will be much more difficult and financially costly. The additional costs are partly due to having to expand family planning services and contraceptive use more rapidly, to achieve a 72 percent prevalence rate by 2000 compared with the present 49 percent. Estimates put the additional costs some 36 percent, or $2.9 billion higher than the resources needed to achieve the standard fertility decline, for a total that is double the upper range of current expenditure estimates.

## References

Acharya, M. and L. Bennett. 1983. "Women and the Subsistence Sector; Economic Participation and Household Decision-Making in Nepal", World Bank Staff Working Paper No. 526.

Agarwal, Bina. 1985. Cold Hearths and Barren Slopes: The Woodfuel Crisis in the Third World. Maryland: Riverdale Company, Inc.

Asian Productivity Organization. 1987. Crop Insurance in Asia. Tokyo.

Barnes, Douglas F. 1990. "Population Growth, Wood Fuels, and Resource Problems in Sub-Saharan Africa," World Bank Industry and Energy Department Working Paper, Energy Series No. 26.

Bertaud, Alain, and Mary Young. 1991. "Geographical Pattern of Environmental Health in Tianjin, China," World Bank, Urban Development Division, INURD Working Paper No. 13, February.

Binswanger, Hans. 1980. "Attitudes toward Risk: Experimental Measurement in Rural India," American Journal of Agricultural Economics, Vol. 62(3):395-407.

Binswanger, Hans and Prabhu Pingali. 1988. "Technological Priorities for Farming in Sub-Saharan Africa," World Bank Research Observer, Vol. 3(1), January.

Burgess, Joanne C. 1991. "Economic Analysis of Frontier Agriculture Expansion and Tropical Forestation," Masters thesis, University College, London, June.

Dixon, R. 1982. "Women in Agriculture: Counting the Labor Force in Developing Countries," Population and Development Review, Vol. 8.

Energy Sector Management Assistance Program (ESMAP). 1990. "Indonesia: Urban Household Energy Strategy Study," World Bank/UNDP Report No. 107A/90, February.

Esrey, S.A.,R.G. Feachem, and J.M. Hughes. 1985. "Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities," Bulletin of the World Health Organization, Vol 63(4): 757-772.

Feder, Gershon, Tongrojj Onchan, Yongyuth Chalamwong, and Chira Hongladarom. 1988a. Land Policies and Farm Productivity in Thailand. Baltimore, Md.: Johns Hopkins University Press.

Grisley, W. 1980. Effect of Risk and Risk Aversion on Farm Decision-Making: Farmers in Northern Thailand. Ph.D. dissertation, University of Ilinois, Champagne-Urbana.

Hazell, Peter. 1990. "Appropriate Function of Agricultural Insurance in Developing Countries," paper presented to the Asian Productivity Organization Seminar on Agricultural Insurance, August 21-31.

Jodha, N.S.. 1990. "Rural Common Property Resources: Contributions and Crisis", Economic and Political Weekly, June 30.

Kumar, Shubh K. and David Hotchkiss. 1988. "Consequences of Deforestation for Women's Time Allocation, Agricultural Production, and Nutrition in Hill Areas of Nepal, IFPRI Research Report No. 69, October.

Leitmann, J. 1991. "Energy-Environment Linkages in the Urban Sector," UNDP/World Bank/UNCHS Urban Management and the Environment Project INT/89/052, Working Paper, March.

Lele, Uma and Steven W. Stone. 1989. "Population Pressure, the Environment and Agricultural Intensification: Variations on the Boserup Hypothesis," World Bank, MADIA Discussion Paper No. 4.

Panayotou, Theodore, and Chartchai Parasuk. 1990. "Land and Forest: Projecting Demand and Managing Encroachment," Thailand Development Research Institute, Research Report No. 1, 1990 TDRI Year-End.

John L. Pender, and T.S. Walker. 1990. "Experimental Measurement of Time Preference in Rural India," ICRISAT, Economics Group Progress Report, Number 97.

Riddell, James C. and David J. Campbell. 1986. "Agricultural Intensification and Rural Development: The Mandara Mountains of North Cameroon," African Studies Review, Vol. 29(3): 89-106.

Sebastian, Iona. (Forthcoming). "Issues in Urban Air Pollution: Mexico City Diagnostic Case Study," World Bank, Environment Department.

Sillers, D.A. 1980. Measuring Risk Preferences of Rice Farmers in Nueva Ecija, Philippines: An Experimental Approach. Ph.D. dissertation, Yale University, New Haven.

Smith, Kirk. 1988. "Air Pollution: Assessing Total Exposure in Developing Countries," Environment, Vol. 30(10): 16-35.

Southgate, Douglas. 1990. "Tropical Deforestation and Agricultural Development in Latin America," World Bank, Environment Department, Divisional Working Paper No. 1991-20, March.

Stark, Oded. 1991. The Migration of Labor. Oxford: Basil Blackwell.

Tyler, Stephen. 1991. "Household Energy Use in Thai Cities: The Influence of Value of Women's Time and Commercial Activity," paper presented at the 1991 International Conference of the International Association for Energy Economics, East-West Center, Honolulu, July 8-10, 1991.

Vitousek, Peter M., Paul R. Ehrlich, Anne H. Ehrlich, and Pamela A. Matson. 1986. "Human Appropriation of the Products of Photosynthesis," Science, Vol. 36(6).

Walker, T.S. 1981. "Risk and Adoption of Hybrid Maize in El Salvador," Food Research Institute Studies, Vol. 18, pp. 59-88.

Williamson, Jeffrey G. 1991. "Macro Dimensions of Third World City Growth: Past, Present and Future," World Bank, paper presented at the Annual Conference on Development Economics, April 25-26.

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