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CAUTIONARY TALES: ADAPTATION AND THE GLOBAL POOR

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Abstract: Many who study global change, particularly from industrialized countries, are optimistic about the capacity of agriculture to successfully adapt to climate change. This optimism is based on historic trends in yield increases, on the spread of cropping systems far beyond their traditional agroecological boundaries, and the inherent flexibility of systems of international trade. Analysis of the success (or in rare cases, failure) of adaptation is by analogy—either to analogous socioeconomic or technological change or to short term environmental change. Such studies have been limited to industrialized countries.

This paper uses five analogs from developing countries to examine potential adaptation to global climate change by poor people. Two are studies of comparative developing country responses to drought, flood, and tropical cyclone and to the Sahelian droughts of the 1970s and 80s that illustrate adaptations to climate and weather events:. Two address food production and rapid population growth in South Asia and Africa. Three types of adaptive social costs are considered: the direct costs of adaptation, the costs of adapting to the adaptations, and the costs of failing to adapt. A final analog reviews 30 village-level studies for the role that these social costs of adaptation play in perpetuating poverty and environmental degradation.

1. Introduction

As environments change, all life adjusts, adapts, and evolves. Human life responds in conscious and unconscious ways to such environmental change and even in anticipation of that change. These actions are variously termed human responses, coping actions, mitigating actions, adjustments, and adaptations. Depending on context, both substantive and disciplinary, the terms have various shades of meaning. We geographers generally employ the long-established distinctions used in hazard assessment, and distinguish between short-term purposive or incidental adjustment and long-term biological or cultural adaptation. Over time, the distinction fades as the adjustments of yesteryear become incorporated into the cultural repertoire of adaptations. In this paper the various terms are used interchangeably because of the widespread and official use of adaptation when referring to adjustment to climate change, but. also because with a longterm perspective—tomorrow's adjustments may well be 2060's adaptations.

To date, almost all efforts to address global climate change focus on preventive action to limit greenhouse gasses rather than adaptation. The subtitle of volume II of the IPCC report: Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses (Watson et al., 1996) is a misnomer, where adaptation is concerned. Of the 728 pages of substantive text, about two thirds are devoted to impacts, one third to mitigation and only 32 pages to adaptation. That so little work is done on adaptation is a function of both

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"limitationist" and "adaptationist" biases. The "limitationists" fear that such work may weaken the social will to undertake greenhouse gas reduction and thus play into the hands of those that argue that any action is premature. Many "adaptationists" see no need to study adaptation in any special way, simply trusting the invisible hand of either natural selection or market forces to encourage adaptation. Many also think of adaptation as providing little or no burden and ignore, for example, the often high social costs of adaptation. Finally, both sides are rooted in studies from the industrialized world and tend to ignore the lack of capacity to both prevent and adapt in developing countries.

Where adaptation has been considered, as in modeling of agriculture, the effects of using various adjustments are simulated. In the state-of-the art regional study of a four-state area in the U.S.: Missouri, Iowa, Nebraska, and Kansas (MINK), "low-cost" on-farm adjustments were considered for a climate scenario that uses as a climate analog the decade of the 1930s (Rosenberg, 1993). In this study, economic costs of adaptation were considered and where they exceeded benefits, the adjustments were assumed not to have been adopted. Adaptations were also simulated in the major global study of climate change and world food supply, Fischer, Frohberg, Parry, and Rosenzweig (1994) found that on average, climate changes resulting from a doubling of CO_2, would have only a small impact overall on global agricultural productivity, assuming a modest level of adjustment and the enrichment benefits for plant growth of increased CO_2 in the atmosphere. In their modeling, they employed two levels of adaptation: adjustments to be undertaken at the farm level without major changes in the agricultural system and those requiring a transformation of the agricultural system itself. The costs of adaptation or the availability of future water supplies were not modeled.

The possibilities for adaptation as well as its impacts are surely different in rich and poor countries and for different groups and places within countries (Bohle, Downing, and Watts, 1994; Downing et al., 1997). For example, in the world food supply study, cereal production with adaptation was reduced by less than 3% on average and even increased in one of the climate scenarios with a high level of adaptation. This global average was sharply differentiated however, between developed and developing countries, with net declines in cereal production in the developing world, and net gains in the industrialized countries. Even assuming high levels of adaptation in developing countries, losses were reduced but not eliminated.

Within countries, one of the early findings of hazard research was that the ability to adjust and people's access to adjustments reflect existing divisions between rich and poor, powerful and powerless, ethnic or gender-favored and ethnic or gender-denied. Wisner (1977), for example, identified such differences in drought adjustment in Kenya and subsequent studies have led to a generalized model of differential resource access (Blaikie, Cannon, Davis, and Wisner, 1994).

We need to understand much more about the social costs of adaptation and differential access to it because adaptation, even by the invisible hand of the market, is not cost-free and does not yield the same benefits everywhere. The costs of adaptation include not only economic and social costs of the efforts to adapt, but also the social costs of adapting to the secondary effects of the adaptations themselves, and the losses suffered by groups and the locations bypassed or marginalized by the ensuing changes. Serious study of the true costs of adaptation and the differential ability to undertake it should be a major focus in contemplating response to global climate change. However, designing good studies is difficult.

Thus, much of the reasoning as to the success (or in rare cases, failure) of adjustment is by analogy, observing how people have adjusted to instances of socioeconomic or technological change or to short term environmental change (Glantz 1988; Easterling; 1996; Burton, 1997). These analog studies are from industrialized countries and include the use of climate analogs as in the MINK study (Rosenberg, 1993) or changes in resource use as in the case of the declining Ogallala Aquifer in the American high plains (Glantz and Ausubel, 1988). Easterling (1996) has recently reviewed these and other North American studies, using as analogs the translocation of crops (winter wheat; maize); introduction of new crops (soybeans and canola); and substitution of resources in response to scarcity (energy; groundwater). In another North American context, using today's weather and climate as an analog, Burton (1997) cites a Canadian study that estimates the annual costs of adapting to their cold climate are $11.6 billion while the average annual losses from "atmospheric disturbances" of storm, hail, tornado, and flood (1983-1994) were around $110 million.

This study, initiated with Robert S. Chen, sought to use five analogs from developing countries to see what can be learned about the adjustment to global change that can be made by poor people. Two of these involved adjustments to natural hazards directly related to climate: a comparative cross-national study of flood, drought, and cyclone and of the Sahelian drought.. Two others considered how agriculture was adapted in response to population growth in Africa and South Asia and addresses the process and problems of adaptation, not climate per se. The fifth examines a series of case studies that incorporate interactive effects of changes in population, economy, and environment including in some cases, climate events. In all of these, three types of social costs were considered: the direct costs of adjustment, the costs of adjusting to the adjustments or responding to the secondary effects, and the costs of failing to adjust. Not all situations provided information on all sets of costs, but what they did provide is instructive.

2. Adaptation to Extreme Weather and Climate in Developing Countries

The best-studied analogs of adapting to environmental change in developing countries comes from natural hazard research which studies human adjustments

Table 1.
The comparative annual social costs of associated adaptation with various hazards (≈ 1975).*

HAZARD	COUNTRY	DEATHS/ 10^6 POP.	DAMAGE	ADJUST –MENT	TOTAL COSTS	COSTS % GNP
Drought	Tanzania	40	.70	.80	1.50	1.84
	Australia	0	24.00	19.00	43.00	0.10
Flood	Sri Lanka	5	13.40	1.60	15.00	2.13
	United States	2	40.00	8.00	48.00	0.11
Tropical	Bangladesh	3000	3.00	.40	3.40	0.73
Cyclone	United States	2	13.30	1.20	14.50	0.04

*Total costs, damage costs, and adjustment costs are in 1970s dollars per person at risk. (Burton, Kates, and White, 1993, 68-74).

to extreme weather and climate events, such as droughts, floods, and tropical cyclones. The most comprehensive cross-cultural study of adjustments, The Environment as Hazard, is now more than 20 years old but is available in a second edition (Burton, Kates, and White, 1993). Its central findings appear still relevant today.

In a series of national studies, agricultural drought in Australia and Tanzania, floods in Sri Lanka and the U.S., and tropical cyclones in Bangladesh and the U.S. were compared. In each case, the annual social cost of each hazard was estimated using two basic measures: the annual average number of deaths (per million at risk) due to the hazard and the estimated economic value of damages sustained and of adjustment effort expended to prevent losses. For purposes of comparison, these are shown as costs per person at risk (in 1970s dollars) and as percentages of gross national product as of the time that the study was carried out.

To illustrate, in Tanzania deaths due to agricultural drought were low and estimated to average annually 40 per million of the then 12 million at risk. Total costs of agricultural drought was estimated as equivalent to 1.8% of GNP or a $1.50 per person at risk. Adjustments at $0.80 per person at risk were slightly more costly than damages at $0.70 for farm households. A reasonable approximation for labor invested in reducing possible drought losses was 10 days per year. The balance of the costs of adjustment were government expenditures

($0.21 per person at risk) for meteorological, climatological, and crop varietal research; weather modification, irrigation, and rural water-supply development; famine relief, food import and storage; and provision for migrants. For historical context, the period under study (prior to 1970) was generally favored with ample precipitation. More recent costs would be considerably higher.

The economic costs of floods in Sri Lanka were much higher than for drought in Tanzania (about the same as a percentage of GNP). Damage losses far outweigh the costs of adjustment, despite significant investment in channels, dams, and levees to avert flood damage. The most important social costs of tropical cyclones in Bangladesh were the enormous death toll (average 3,000 per million for the 10 million at risk), with at least 225,000 having died in the storm of 1970 and over a hundred thousand in 1991.

Global warming will almost surely bring more drought to some areas, more floods to others, and possibly more and greater cyclones. Adjustments to such extreme events in developing countries are ancient, widely implemented, primarily household based, and costly in effort expended. As a proportion of GNP, the social costs of adjustment are already high in developing countries and are relatively more costly than in industrialized countries, not absolutely, but in the proportion of available resources expended. And with economic and social change, many traditional adjustments become less relevant while at the same time government-organized adjustments, characteristic of industrialized countries, are as yet poorly developed. Under conditions found in much of the developing world, vulnerability to extreme events is actually growing because reasonably successful traditional adjustments are no longer being implemented and societal-organized adjustments are not yet available. Therefore the ability of developing countries to make cost-effective adjustments to climate extremes caused by global warming is by no means assured.

3. Adapting to Drought: Sahel 1968-1990

The Sahelian-Sudanic Zone of Africa marks the border between the desert and the forest and crosses a dozen African countries mostly between 10 and 20 degrees latitude. Rainfall below the previous 30 year norm has been experienced in most of the years between 1968 and 1990. Adjusting to this two decade-long drought period has been extraordinarily difficult for the peoples of the region and might be a harbinger of what increased warming without compensating moisture increases might bring. While there has been extensive writing on the drought, its impacts, and some analysis of the responses to it (Dalby, Harrison Church, and Bezzaz, 1977; Somerville, 1986; Downing, et al., 1987; Glantz, 1987), there has been no overall study of the cumulative impacts of the drought and of the adjustments to it. An early study of the Sahelian drought (Kates, 1980, 1981) and subsequent events since then suggest the following observations regarding adjustments.

Despite slow starts, over two decades the international community acquired an increasing capability to prevent famine, except in situations of armed conflict. This capability includes: improved early warning of potential crop and animal loss, coordinated donor and food-aid mobilization; and the logistics to move and distribute large amounts of food and to do so with some consideration of its effect on local markets. This capability is reflected in successful efforts to provide food where people live rather than in distant relief camps to which they have been forced to migrate. And in a few countries, this international capability is matched locally with improved crisis planning and governmental coordinating mechanisms.

Some attention has also been focused on adjustments to reduce vulnerability to persistent drought and its stresses on ecosystems. Proposed adjustments have been often quite contradictory, reflecting the professional and ideological differences of their advocates. One group of proposed adjustments focuses on improved production technologies, such as higher-yielding drought-resistant plants and animals, irrigation, or improved ranching and grazing schemes. Another group of proposed adjustments focuses on the human and drought-induced stress on natural ecosystems and proposed ways of scaling down production to a more appropriate carrying capacity or of encouraging tree-planting and agroforestry. On the consumption side, there are also some efforts to improve transportation and marketing and diminish the urban bias that moves food from the hungry rural areas to relatively well-fed cities.

It is also recognized that any successful adjustment is difficult without solving the problems that make the region so vulnerable to drought impacts. The list of such problems is long and advocates strongly differ among themselves as to which problems to emphasize but they include: poverty, global economics, neocolonialism, ethnic conflict, or rapid population growth. Recurrent droughts exacerbate the many existing problems of the region. Thus it is difficult to separate out adjustments designed to cope with these long-term problems and those responsive to the extraordinary conditions of the drought. Indeed, it might be argued that the drought, when it received popular attention, helped initiate some longer-term externally-aided projects that might not otherwise have been supported, such as major dam construction in West Africa.

Thus, over time, there is an improving capability to respond to drought as an extreme event, to prevent famine, and to save lives. There is little success however in adjusting livelihood systems to the persistent drought and the stress placed on the ecological systems supporting agriculture and pastoralism. In fact, serious differences emerged in expert views as to which adaptations to pursue. Moreover, persistent drought is but one of a set of overwhelming problems affecting some of the poorest nations in the world and in most countries there is little internal capacity to cope even with the most pressing impacts of the drought, let alone the more subtle ones.

4. The Green Revolution: Food Production Adaptation to Population Growth

Between 1960 and today, population in Asia more than doubled. During that same period, a green revolution in rice and wheat production in Asia enabled that region to become essentially self-sufficient in cereal grains despite the enormous increase in population. At the core of the revolution were internationally developed rice and wheat varieties that were able to respond to high inputs of nutrients and water and by growing grain rather than straw. An extensive system was developed for producing and distributing seeds, providing credit, fertilizer, pesticides, and water, and marketing the surplus.

If the green revolution is viewed as a massive adjustment to rapid population growth, the immediate direct costs of that adjustment are the costs of creating and maintaining that system. Over time the value of the increased production has clearly exceeded these costs. But over the last 20 years an extensive literature (Karim, 1986) has emerged that has documented a wide range of other costs of adjustment, adjusting to the adjustments, and of failure to adjust. These studies must be cautiously interpreted however as they tend to be highly polemical and polarized on the one hand and dated on the other.

Early studies trumpet achievements in increasing yields and output and improving incomes for the early innovators adopting the new technology (Borlaug, 1971). Later writings are primarily revisionist, faulting the revolution for the inequalities engendered between small and large, rich and poor farmers, between well watered and dry regions, and even between developing and industrialized countries (Griffin, 1974). Still later writings fault the technology itself on environmental and ecological grounds, for its large and unsustainable input requirements of energy, chemicals, and water; for its vulnerability to pests and less than optimal growth conditions, for its displacement through the monoculture of rice and wheat of needed dietary complements of protein and oil rich crops, and for related impacts on forests, soils, and waters (Glaeser, 1987; Shiva, 1991).

Most recently, revisions of the revisions, purport to demonstrate that problems identified earlier did not actually occur, or were overcome over time. They demonstrate that over time small farmers benefited from the technology equally with large farmers, that wages and employment opportunities for landless laborers actually increased, and that improvements in the seeds and accompanying technologies have coped with many of the earlier problems (Lipton, 1989; Hazel and Ramsamy, 1991).

A judicious review of this literature suggests the following important observations with respect to adaptation costs. Adjustment can be rapid and in appropriate situations very favorable—social benefits exceeding social costs. Where irrigation and fertilizers were available and affordable, over the space of two decades both large and small farmers adopted the new technologies. More

food, at lower prices were made available to the much larger population. Adapting to these adaptations however requires considerable and sustained effort.

The extensive monoculture, has increased the numbers and varieties of pests (Jirström, 1996). New pest-resistant varieties are needed every few years as well as new pest control regimes to cope with pesticide resistance and the threats to humans and other organisms from massive pesticide use. Intensive cropping with chemical nutrients have depleted soil micronutrients requiring these to be added as well. Intensive water use has required new water works with their social and environmental problems and has led to increased waterlogging and salinity. The very bounty itself has lowered market prices for grains, squeezing farmers between decreasing real prices and increasing costs for manufactured inputs, narrowing margins of profitability, and increasing indebtedness. And there is ample evidence that the productivity gains have slowed or stopped altogether and thus a new technological fix, perhaps from biotechnology, is required. There are also large, but poorly defined social costs in failing to adjust. Inequality between regions has increased, the numbers of farms and farmers has decreased, and little is known of the fate of the poor, impoverished, and dispossessed.

For adaptation to climate change, many features of the green revolution are most encouraging. With international aid, traditional biotechnology was effectively harnessed in a relatively short space of time to address a high profile problem—in this case the inability to feed a rapidly growing population. But success was limited to favored regions and the adaptations themselves have created a set of secondary effects that require new remedies. The costs of adapting to the adaptations continue to be high.

5. Adapting to Population Pressure in African High Density Areas

Unlike Asia, in Africa there has not been a green revolution. While population growth rates in Africa are the highest in the world, per capita food availability has declined since 1977. While Sub-Saharan Africa overall is still sparsely populated (27 people/km2), high density areas (>200/ km2) are scattered throughout the continent. These create a "natural experiment" for examining the relationship between population growth, increased density, agricultural intensification, and the well-being of people. How did the inhabitants of these areas adapt to population growth and increased density over five decades?

Five case studies from densely settled areas of East Africa (Kenya, Rwanda, Tanzania, and Uganda) and five from West Africa (central, eastern, and northern Nigeria) were prepared by researchers with extensive knowledge of the study areas, many of whom had conducted field research in the areas over a period of decades (Turner, Hyden and Kates, 1993). Each case study, using a common protocol, examined agricultural and other societal changes over periods ranging from 10-50 years as adaptations in response to increasing population.

Overall, farmers have kept pace with population growth by intensifying agricultural productivity through increased labor (rather than modern technology), by dietary changes to higher-caloric yielding crops such as cassava, by finding new and diverse sources of income, and by outmigration. These adjustments have been sufficient to sustain a much larger population, but not to make the transition to the higher levels of productivity needed for improved well-being. There was also considerable differences between study sites. In 3, there was evidence of success, not merely maintaining subsistence but improving the quality of life. And in 3 of the 10 studies, there had been a clear deterioration in the quality of life with the ability to sustain the population only through substantial outmigration. Thus, this African experience with high-density populations does not support expectations of a Malthusian collapse of food supply in the face of rapid population growth. But it also indicates that technological changes sufficient to achieve the much higher levels of agricultural productivity required for an improvement in well-being will not occur spontaneously.

In contrast to the green revolution analog, the many adjustments evidenced in the case studies were unplanned, locally undertaken, and used primarily indigenous technology. As an analog, these case studies tell us of the considerable capacity of poor people to adapt to prolonged and extended change similar to what some expect with global warming. Adjustment can be local, spontaneous, and successful in maintaining subsistence under difficult conditions. At the same time, in the absence of external inputs, markets, or new technology, it is clearly limited in its capacity to move beyond subsistence. Also, the studies do not examine the social costs of some of the adjustments undertaken, for example the nutritional and gastronomic loss in dietary change to denser but less desirable foods or the impact of outmigration on cities or marginal rural areas.

6. Adapting to Interactive Stresses of Population, Economy, and Environment

Studies of adaptation are difficult to undertake due to many simultaneous changes—for example, population growth interacts with environmental change and with economic conditions. Several such important interactions are documented in case studies that link poverty and environment in developing countries. Such case studies are rare though, for despite the widespread view that poverty and environmental degradation are strongly linked, there are actually few studies that carefully describe the actual linkages. Through surveys of colleagues and searches of 40 journals, some 30 case studies (14 from Africa, 6 from Latin America, 9 from Asia, and 1 global) were located (Kates and Haarmann, 1991, 1992).

Despite the variety of locales, methods of study and reporting, the case studies have much in common. The rural inhabitants of these case study locales found it increasingly difficult to maintain access to their natural resources for agriculture, herding, or fishing in the face of growing population, increased competition for land, and "development" itself. Common threads run through these stories of poor people's displacement from their lands, division of their resources, and degradation of their environments

Poor people were displaced by activities intended for development or commercialization that deprive them of land or traditional access to common property resources of land or water. Lands and water were divided and reduced as they shared with children or sold off pieces as needed to cope with extreme losses (crop failure, illness, death), social requirements (marriages, celebrations), or simple subsistence. Resources were also degraded by excessive or inappropriate use (clearing, overgrazing, unsuitable cropping), by failure to maintain or restore protective works (canals, check dams, drainage, terraces) and by the loss of productive capacity from natural hazards.

Driving these processes were two forces external to the case study locales: development/commercialization and natural hazard events, and two internal to the communities studied: population growth and existing poverty (Fig. 1). These culminated in three major spirals of impoverishment and environmental decline—displacement, division, and degradation— in each of which two of the driving forces dominate. Poor people were displaced from their resources by richer claimants or by competition for existing land or employment, driven by development activities, commercialization, and by population growth. For these displaced people, division of the remaining resources followed, or else forced migration to other, usually more marginal, areas. Driven, by population growth and the existing poverty, meager resources were further divided to meet the needs of generations or the exigencies of poverty. Remaining resources were then degraded by excessive use of divided lands, or inappropriate use of environments unable to sustain the requisite resource use. Driven by poverty and natural hazard events, poor families were unable to maintain protective works or to restore damaged resources affected by natural hazards of disease, drought, flood, soil erosion, landslides, and pests.

The very development-commercialization activities that displace poor people are precisely those that would constitute adaptive strategies to climate change, other environmental change, and to population growth—large-scale agriculture, irrigation, hydroelectric development, forestry, and wildlife preservation. While these strategies may benefit some groups and larger national or regional purposes, they frequently harm local, indigenous, and poor populations. Poor households are increasingly unable to pay the costs of adaptation because they lack the labor to restore or to maintain protective works, the means to hire specialized skills or make needed inputs, or the access to public programs of resource improvement and renewal. The studies also tell of the high cost of trying to adjust to existing natural hazards and the pauperization and enforced

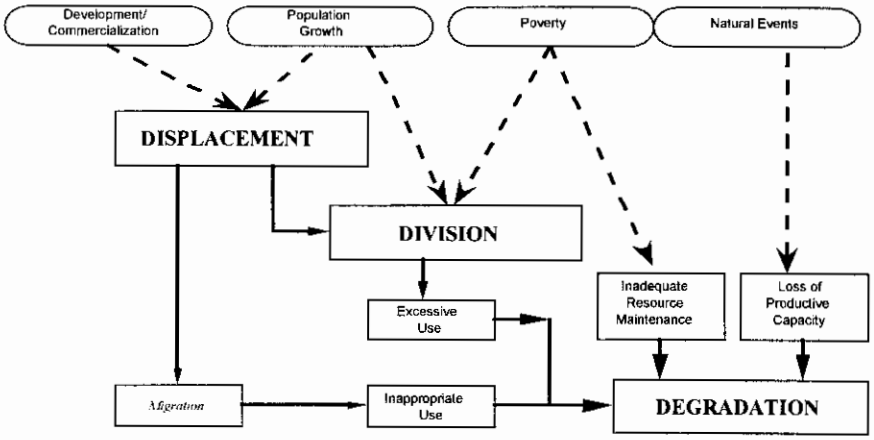

Figure 1. Impoverishment-degradation spirals.

migration that failure to adjust entails. Thus, they tell us that the social costs of adaptation includes the displacement of poor people from their lands, waters, and vegetation; that poor people are hard-pressed to maintain even existing adjustments; and that the failure to adjust is extraordinarily heavy on those least able to bear additional burdens.

7. Can the Global Poor Adapt to Global Climate Change?

The conclusion from these five studies must surely be yes, but with great difficulty and much pain. Poor people everywhere cope with drought, flood, and storm, and inhabitants of some of the poorest countries in the world have weathered two decades of severe drought. In the face of population growth unique in human history, food supplies kept up with population growth, not only in the lands favored by the green revolution, but in places in Africa where it was and is still unknown. But the social costs of adaptation have been enormous: in the tolls of lives lost or diminished and in the direct costs of adaptation, the costs of adapting to the adaptations, and the costs of failing to adapt.

In developing countries, coping with the climate extremes of drought, flood, and storm is the moral equivalent of war—requiring the equivalent effort in percentage of GNP that most countries expend on national defense. Despite this enormous effort, success is limited. The damage toll is very high from natural hazard or as in the case of responding to population growth, indigenous adaptation can maintain life but not much more. And the linked tales of poor people and environment tell of how one group's adaptation is another group's hazard.

Thus, if the global poor are to adapt to global change, it will be critical to focus on poor people, and not on poor countries as does the prevailing North-South dialog. The interests of poor people are not always the same as the interests of poor countries, since in the interest of "development," the poor may grow poorer. In adapting to global environmental change, we need to break the impoverishment-degradation spiral by addressing the underlying causes of population growth, poverty, hazards, and development and commercialization and by interrupting the cycles of displacement, division, and degradation. For it is in these cycles that the true social costs of adaptation appear.

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