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Rural Poverty, Migration, and the Environment in Developing Countries

Three Case Studies

Richard E. Bilsborrow

Case studies — of the links between highlands and lowlands in Latin America; of transmigration in Indonesia; and of migration and desertification in the Sudan — illustrate the relationship between poverty, internal migration, and environmental change in rural areas of developing countries.

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This paper — a product of the Office of the Vice President, Development Economics — is one in a series of background papers prepared for the *World Development Report 1992*. The *Report*, on development and the environment, discusses the possible effects of the expected dramatic growth in the world's population, industrial output, use of energy, and demand for food. Copies of this and other *World Development Report* background papers are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact the *World Development Report* office, room T7-101, extension 31393 (November 1992, 75 pages).

Bilsborrow presents three case studies (of the links between highlands and lowlands in Latin America; transmigration in Indonesia; and migration and desertification in the Sudan) to illustrate the relationship between poverty, internal migration, and environmental change in rural areas of developing countries. Policies to deal with the problems of environmental degradation in areas that are destinations for migrants would usually include:

- Preparation of a detailed national inventory of land and water resources, and a land-use plan to protect biologically important or fragile areas and direct new agricultural settlements elsewhere.

- Coordination of this plan with the construction of roads.

- Better coordination across government agencies in the development and implementation of policies related to land use.

- Reduction of population growth, a driving force behind decisions to migrate.

- Improving land use in traditional areas of settlement, to reduce both overuse and underuse of land.

- Development of a system of land tenure that provides land users with incentives to maintain productivity.

- Environmental education programs (in schools and for farmers) to create a national environmental consciousness and more appreciation for the country's natural assets and beauty.

- New, appropriate systems of data collection and analysis, to help clarify underlying processes and develop more refined, appropriate policies.

- Broad-based macroeconomic policies aimed at improving incomes in rural areas, relative to urban areas — aimed at reducing poverty, environmental degradation, and rural outmigration.

Rural Poverty, Migration and the Environment in Developing Countries: Three Case Studies

Richard E. Bilsborrow

Carolina Population Center
123 W. Franklin St.
University of North Carolina
Chapel Hill, NC, 27516-3997
Tel.: 919-966-2157
Fax: 919-966-6638

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I. Introduction

This paper investigates the interrelationships between poverty, internal migration movements and environmental change in rural areas of developing countries. Increasingly, environmental problems are being recognized as developmental problems also. Natural resource deterioration in rural areas of developing countries, for example, affects the productive capacity of the land, which, in turn, threatens food production and the livelihoods of both rural and urban populations. Moreover, since the poor reside primarily in rural areas of developing countries and are dependent on the land for their livelihood, rural poverty and land degradation in rural areas are, at a minimum, closely related.[1] To the extent that the rural poor tend to live in and depend upon the most degraded rural environments, the linkages are very close indeed. Despite significant economic growth in most developing countries since 1965, substantial poverty continues to exist.[2] Despite continuing increases in per-capita incomes, the total number of poor, estimated at over 1 billion persons, may well be continuing to rise, especially in rural areas.[3]

Throughout human history populations have migrated in search of better livelihoods or to escape environments which, for any number of reasons (natural disaster, a decline in game to hunt, etc.), could no longer support them. In many parts of the world, sedentary agriculture has over time exhausted the limited natural fertility of the soil, and populations have consequently needed to move to new areas. However, as nation-states and borders have been created, historical migration movements, especially if long-distance, have become less feasible; and as populations have increased greatly in recent decades, there are now fewer unoccupied areas into which to move.

As demographic pressure on resources has increased in recent years, rising incomes and aspirations, coupled with vast improvements in transportation and communications systems, have stimulated substantial internal migration movements in low-income countries. While much of this has been to urban areas (with their relatively higher incomes, growing employment opportunities, and greater infrastructure and amenities), migration flows between rural areas continue to be important. Depending on the nature and destination of this rural-rural migration, and the land-use practices engaged in, even small numbers of such migrants can cause enormous environmental damage. Some countries, such as Indonesia and Malaysia, have actually directed large-scale movements of population from rural areas thought to be overcrowded to less-densely-populated areas. Other countries, such as those in Latin America with densely-populated highlands regions and expansive areas of lowland forests, have facilitated and sometimes encouraged population movements from the former to the latter; Guatemala and Ecuador will be examined in this context. Populations in still other countries, where the primary limiting resource is water rather than land, have experienced increasing threats to the land from high

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[1] World Bank, 1990a: Table 2.2; Todaro, 1989.

[2] Income per capita in developing countries has grown by 70 percent since 1965 (World Bank, 1990a: 1).

[3] Ibid, p1.

human and animal population growth leading to overuse of semi-arid areas; Sudan will be studied as an example of this situation. These countries are selected as case studies because of their different environmental/ecological contexts; because of the important role internal migration has played in land degradation; because of the different ways in which governments have encouraged population redistribution; and because of the author's familiarity with each.

The three case studies will examine the linkages between rural poverty, environmental degradation and migration, primarily internal. The key questions addressed are:

(1) to what extent is rural out-migration due to environmental degradation in areas of origin?

(2) what are the environmental and other consequences for the migrants and their communities in the areas of destination, and what should be done to ameliorate the negative consequences?

(3) what are the environmental and related consequences in areas of origin, and what policies should be considered to maximize the positive and minimize the negative aspects?

The next section briefly reviews migration theory and provides a simple conceptual model focusing on the consequences of rural-rural migration in areas of destination. Section III looks briefly at migration flows in developing countries, particularly rural-rural flows, and presents comparative economic and environmental data for the case-study countries. Section IV presents the Latin America case, a kind of synthesis (for reasons made clear therein) of Guatemala and Ecuador. This case clearly indicates the need to examine changes in land area and land use in order to understand the linkages between rural poverty, migration and the environment. Section V assesses migration and environmental interrelationships in Indonesia, with a particular focus on the transmigration program. Section VI examines so-called "desertification" and population movements in the Sudan. Finally, section VII attempts to derive some general conclusions about poverty, migration and the environment.

II. Conceptual Interrelationships

Since migration is the key decision variable linking environmental factors in the place of origin with those in the place of destination, we begin by recalling the factors that influence migration decisions, and how those may in turn be affected by environmental conditions. We also review the environmental effects of practices engaged in by migrants in the place of destination; these depend on land use and technology decisions.

The starting point in discussing the determinants of migration is the human capital theory of Sjaastad (1962) and its subsequent modification by Todaro, summarized in Todaro (1976). According to the theory, people make decisions about where to live based on where they can maximize the present value of their discounted stream of expected future earnings, given their human resources or human capital (i.e. education). This is a strictly micro-theory based on individual income maximization, with account taken of individual characteristics. Todaro adjusts

the basic theory for the probability of being employed, and Brown and other geographers (see DeJong and Gardiner, 1981) point out the relevance for migration decisions of other, non-economic aspects of potential destinations, or their "place utility." Sociologists such as Lee (1966) use the terminology of "push" and "pull" factors to refer to, respectively, the negative aspects of the place of origin on impelling migration and the positive aspects of the place(s) of destination on attracting migration. In any case, the prevailing theory of migration now considers migration decisions to be influenced both by individual/household and by contextual or structural factors (DeJong and Gardiner, 1981; Bilsborrow et al, 1984, 1987; Massey, 1990).

The relevance of environmental factors in influencing out-migration decisions of rural populations can be readily seen as a contextual factor which operates either through reductions in income-earning opportunities (resulting, for example, from land degradation) or through the place of origin becoming a less attractive place to live (i.e., declining "place utility"). Given that the populations being examined here are generally of very low income, it is mainly the former economic effects that are relevant. Any form of environmental degradation in the place of residence which affects the productivity of the land through reduced soil fertility or increased soil erosion, will tend to reduce incomes and stimulate out-migration.[4] Some causal factors are at the level of the farm (e.g., improper practices), while others affect the whole community as a result of either natural forces (e.g., drought) or collective human decisions (e.g., depletion of the available water supply through overuse).[5] In extreme cases, such as drought or natural disaster, the role of environmental factors in impelling out-migration becomes dramatically evident, and those forced to move are labeled, "environmental refugees." This situation is considered common across the Sudano-Sahelian belt of Africa (see VI below).

Migration may also be viewed as part of a household survival strategy that each year allocates family labor over space and time (including seasonal out-migration) in order to ensure the family's survival. Labor time is thus spread across diverse income-earning activities: farming the family's own land; and long-term or seasonal off-farm agricultural and non-agricultural employment -- part- or full-time -- in the vicinity or elsewhere. Diversifying income

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[4] This is true whether degradation is caused by natural factors such as drought, recurrent floods or wind erosion, or by human factors such as reduced fallow times that do not allow for natural replenishment of soil fertility, insufficient (or excessive) fertilizer/pesticide use, or a failure to use proper crop rotation or terracing.

[5] This author, however, is not aware of any migration survey that has seriously examined the effect of environmental factors on out-migration decisions. This is partly because interest in the environment, particularly on the part of migration experts, is so recent. Moreover, when farmers are asked in surveys about their reasons for migration, they may not recognize the underlying primacy of environmental factors. They will usually answer instead that they migrated because of low yields, insufficient income or land, etc., without making a further causal connection to the environment. Special efforts and probing questions are needed to investigate the effect of environmental degradation on out-migration decisions.

sources in this manner reduces the risk to the household of any one source (such as the family's main crop) failing.[6] Factors may be seen as inducing out-migration via income effects (caused, for example, by a gradual decline in soil fertility), increased risk (the consequence of, for example, increasing income instability resulting from greater severity or frequency of drought or flooding), or through the environment becoming less pleasant or healthful (the product of, for example, increased air pollution).

To examine the consequences of migration, it is desirable to consider environmental effects not only on the migrants themselves but also on both origin and destination populations and areas (Bilsborrow et al, 1984, Ch. 4). Environmental effects refer to effects on the migrants' own land and indirect or spillover effects on non-migrants' land in the area. In destination areas, the main effects of migration are the result of land extensification -- the expansion of the agricultural frontier by rural-rural migrants (Bilsborrow, 1987; Bilsborrow and Geores, 1990). Extensification has significant deforestation and desertification implications.[7] Environmental effects can also be important in areas of origin; they may, for example, relieve demographic pressure by easing employment problems or reducing demands on local food and water resources. In particular, out-migration can relieve pressure on common property resources such as fuelwood and water. Moreover, wage rates may rise, poverty decline, and the quality of life generally improve. On the other hand, in a community which does not have excessive population pressures relative to its carrying capacity (Higgins et al., 1982), out-migration can create serious labor shortages, loss of scarce human capital, and declining total and per capita output. Where labor needed to maintain the productive character of the land is lost, environmental implications may also be negative.[8]

Figure 1 below illustrates the linkages between rural poverty, internal migration and environmental degradation. As illustrated, an initiating factor may be population growth, in conjunction with traditional, pre-existing systems of land tenure and land use (technology). The initial implications in areas of origin are increased fragmentation of landholdings and increasing agricultural intensification (Boserup, 1965), eventually leading to excessively intensive land use, with reduced fallow times that are too small for soil fertility replenishment.[9] Other autonomous causes of deterioration in the origin environment (such as drought or floods) could

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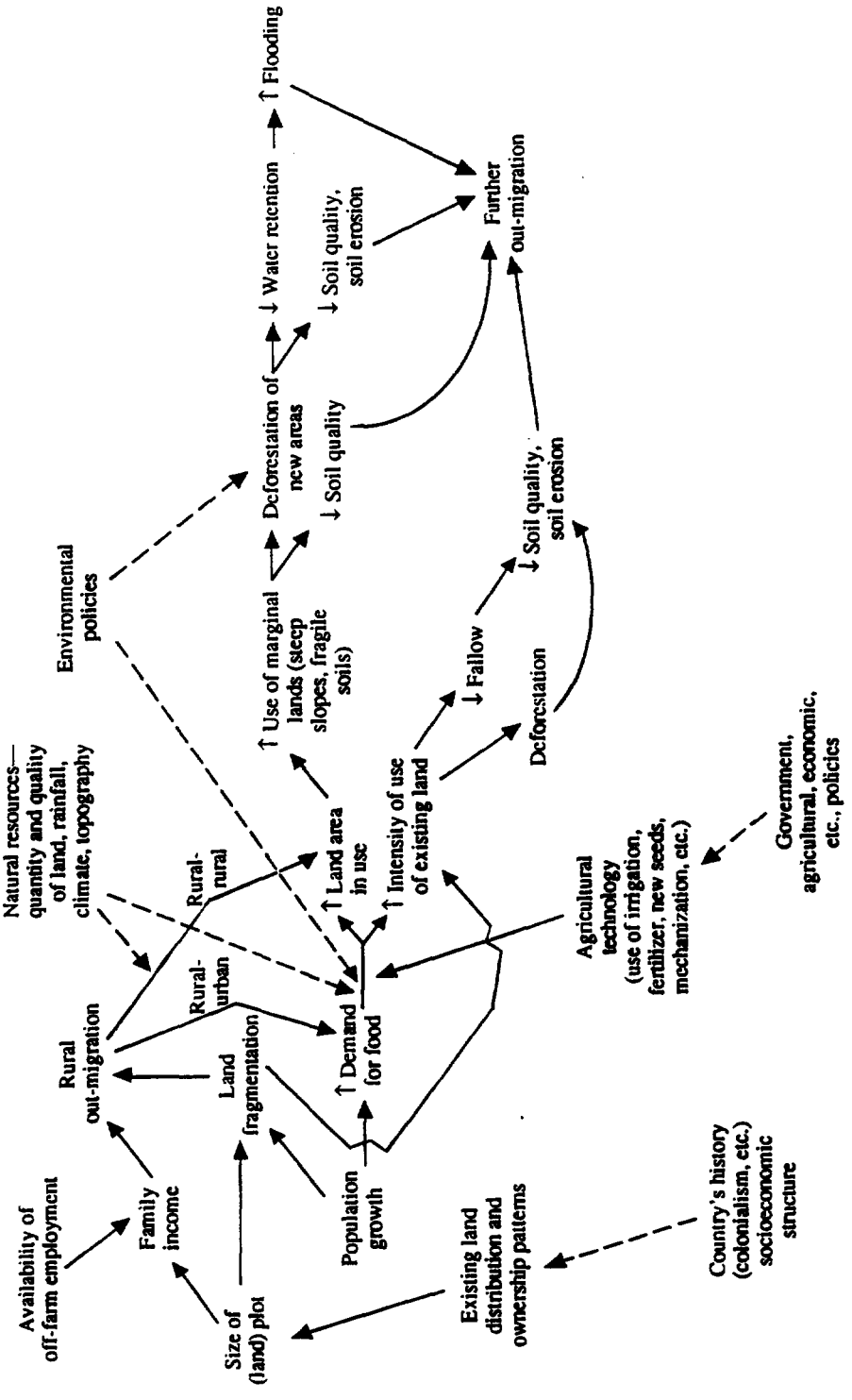
[6] The peasant household survival strategy literature growing out of rural sociology in Latin America is relevant here: see, e.g., Arguellos. Regarding migration of household labor to reduce risk, see Stark and Levhari (1982); see also Katz and Stark, (1984).

[7] Serious non-economic effects may also be generated in places of origin and destination, particularly if the volume of migrants is large relative to origin or destination population, or otherwise significantly different (in race, education, customs, etc.).

[8] Collins (1986) provides the example of a Peruvian highland village where labor out-migration resulted in a shortage of labor to maintain terraces for farming on steep slopes. Bilsborrow and Stupp (1987) cite cases in southern Africa where male out-migration created a shortage of labor for maintaining fences and weeding, with the result that food production declined.

[9] Direct links between rural poverty and land degradation in highlands Nepal are seen by DeBoer (1989) and Bajracharya (1988). See also Jagannathan (1989) on Indonesia, discussed below.

Figure 1 Illustration of Linkages between Rural Poverty, Migration, and Environmental Degradation in Developing Countries



also be incorporated as initiating processes. The figure shows the fundamental importance of initial land endowments as well as a number of contextual factors which condition responses to population increase (Bilsborrow, 1987; Cain and McNicoll, 1991). These latter include land quality, the availability of untapped land resources in the nearby area, water, technology (and therefore government policies, such as extension services), agricultural prices, availability of nearby off-farm employment (which can allow a family with decreasing land per capita to sustain itself without migrating away), and so on. Such factors influence the extent to which the family intensifies production on its existing plot or otherwise adapts without out-migration. Once these possibilities are exhausted, are no longer feasible (when fallow time is reduced to zero, for example) or are insufficient, then out-migration must occur.

To the extent that out-migration is to urban areas, it has indirect effects on resource use through changes in demand levels and patterns. Income and therefore consumption levels are generally higher in urban areas, and tastes are more oriented toward imported foods, durable goods, etc. To generate resources to satisfy these higher and altered demands, a developing country must produce more food and/or generate more foreign exchange by increasing agricultural cash-crop exports; both increase demand pressures on land resources. To the extent that out-migration is to other rural areas,[10] involving the extensification of agriculture, it will tend to be to relatively unproductive, marginal lands. As these are cleared, yields decline, watersheds are damaged, and soil erosion and flooding increase, all of which can lead to further environmentally destructive cycles. In general, effects on areas of destination depend on the size of migration flows; on the origins, characteristics, previous agricultural experience and attitudes toward the new area of the in-migrants (usually rural-rural); on its ecological conditions and absorptive (or carrying) capacity, given available technology; and on national government and local community policies regarding plot sizes, tenurial arrangements, access roads and other infrastructure, prices of agricultural commodities and inputs, etc.

Finally, there may be "feedback" on origin areas resulting from: (a) remittances submitted by out-migrants (their effects depending on whether they are used for consumption or investment);[11] (b) return migration, which is part of virtually every migration movement, and which can affect tastes, technological change, etc.;[12] and (c) changes in women's labor-force activity, to the extent out-migration is predominantly individual and male, or seasonal.

The case studies below illustrate many of these processes. They also consider the relevance of environmental factors in initial migration decisions.

III. Migration Movements from Rural Areas and the Environment

For present purposes, it is useful to distinguish the different types of migration: rural-

[10] Few countries still have unoccupied areas available which come without serious constraints such as low soil fertility, too much or too little water, or prohibitive topography (steep slopes).

[11] However, it is rare for remittances from rural areas to be significant.

[12] Again, this is not likely to be important in rural-rural-rural origin return migration.

rural, rural-urban, urban-urban, and urban-rural.[13] Most research, and virtually all migration data, such as that contained in United Nations Demographic Yearbooks and other publications on population distribution over time and space, has been on rural-urban migration. This reflects both the relative ease of generating such data on the part of government census offices around the world and the preoccupation of governments with the presumed negative effects of migrants on rapidly-growing cities.[14] Annual rates of growth of urban and rural areas in developing countries as a whole in 1985-90 were 3.6 and 1.4 percent (by continent: 5.2 and 2.0 in Africa; 3.0 and 0 in Latin America; and 3.2 and 1.3 in Asia).[15] The rates of urbanization were 1.5 percent per year overall, and 1.5, 0.9 and 1.2, respectively, for the three continents; in Latin America and Africa rates have (just) passed their peak, but they are still rising in Asia.[16]

Of particular interest for the purposes of this paper is the magnitude of migration flows to rural areas, including both rural-rural and urban-rural flows. The latter may contain a large amount of return migration. To the extent that this is the case, it will have very different (and presumably less serious) environmental effects on the rural areas of origin; however, to the extent it is not, and is also an outflow from urban areas to new rural areas, it would seem likely that it is mostly a flow of previous rural-urban migrants who were not successful or satisfied in the urban areas, and wanted to try rural work again in new rural areas. Both these and rural-rural migrants will tend to move to available unoccupied areas, many of which have limited agricultural potential and/or are isolated from existing principal urban areas and transportation networks.

While it is possible for census offices in developing countries to tabulate rural-rural migration flows for geographic units and the country as a whole, this is usually not done for the reasons indicated above. However, if countries wish to investigate the effects of migration

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[13] Migration is complicated to measure and characterize because of its many types and dimensions; because it involves simultaneously taking into account space and time; because a person can move many times; because it involves human attitudes which can themselves change (thus, for example, a move intended to be temporary evolves into a change of residence); and because it involves movement between places, whose definition can change over time within countries (creation of new borders for provinces or districts, annexations of rural areas by urban areas, etc.). A typology of migration reflecting some of these dimensions would include (so-called) permanent or long-term migration (defined as that involving a change of residence) versus temporary or seasonal migration (virtually always for work), individual versus family or household migration, and migration for economic reasons versus marriage or education. (See Standing in Bilsborrow et al., 1984, Ch. 3.) Some commentators -- though not this author -- even consider "migration" to include daily or weekly circulation or commuting for work, involving sleeping temporarily in area of the place of employment.

[14] See the various government policy statements in UN (1989).

[15] See Table 3, UN (1988).

[16] The rate of urbanization is the rate of change in the percentage urban of the population in the country.

processes on the rural environment, these tabulations will have to be made.[17] These flows, of course, "net out" for rural areas in the country as a whole.

The principle source of currently-existing data on rural-rural migration flows is therefore scattered data from household surveys and special tabulations from censuses in some countries.

Table 1 Distribution of Migrants by Type of Migration Flow According to Origin and Destination

Country/Year	Percentage Distribution			
	Rural-urban	Urban-urban	Rural-rural	Urban-rural
Botswana (1985)*	60.0	8.0	29.0	3.0
Brazil (1970) *	18.0	50.4	25.7	6.0
Cote d'Ivoire (1986)	14.8	44.2	20.3	20.7
Ecuador (1982)	16.0	46.0	18.0	21.0
Egypt (1976)	26.0	55.2	12.0	6.8
Ghana (1988)	4.6	48.5	9.5	37.3
Honduras (1983)	25.9	31.7	28.6	14.1
India (1981) *	16.7	11.9	65.4	6.1
Korea, Rep. of (1975)	43.5	28.7	14.0	13.8
Malaysia (1970)	8.8	20.0	38.8	32.4
Pakistan (1973)	17.2	38.7	33.0	11.1
Peru (1986)	11.6	51.6	13.6	23.2
Philippines (1973)	39.0	25.3	19.9	15.8
Thailand (1980)	15.4	18.5	55.9	10.1

Notes: Columns may not sum to 100 because of rounding. Data refer to previous place of residence except for those designated by *, which are by place of birth. Most data, except as noted below, are from population censuses carried out in the year noted.

Sources: Cote d'Ivoire, Ghana, Peru: LSMS Survey data, processed by Lara Akinbami, World Bank (1991); Ecuador (Palacios, 1990: 96-97) and Botswana (Cobbe, 1990) in Nam et. al. (1990); U.N. 1991. "Types of Female Migration," UN Expert Group Meeting on the Feminization of Internal Migration, Aguascelientes, Mexico, 22-25 October.

[17] The author intends to formally request the UN Statistical Office and the UN Population Division to encourage countries to do this in the future, and to provide them with the data, starting with the 1990 round of censuses of population, which are currently in process.

The data in Table 1 show perhaps surprisingly high levels of both rural-rural and urban-rural migration for all countries, based on comparing the place of interview with the place of previous residence or place of birth. Indeed for the 14 available countries, rural-urban migration constitutes the largest flow in only two cases. Rural-rural migration is the largest in three, and is larger than rural urban in 11 of the 14, yet is almost universally neglected in the literature.[18] Data for several countries suggest an increase in both urban-rural and rural-rural flows in more recent years (e.g., in the period 1974-82 compared to pre-1974 in Ecuador: c.f. Palacios, 1990: 96-97). However, the statistics presented in Table 1 are not unproblematic, since they vary according to reference (place of birth or of previous residence), type of data source (census or survey), sex, time period, and so on.[19] In any event, the data above indicate that: (a) in contrast to what one might infer from the media and the literature, rural-rural migration is quite substantial in most developing countries; and (b) relative to urban-urban, rural-rural migration declines as a proportion of total migration as countries urbanize (a mathematical necessity) -- contrast Brazil, Ecuador, Egypt, and Peru with Botswana, India and Thailand.

Migrants to rural areas may clear lands to establish new farms and settlements; such extensification is associated with severe environmental degradation. In fact, land clearing has long been actively encouraged by most developing country governments for various reasons, including easing demographic and economic pressure on land in areas of origin, "regional development" to exploit more fully the country's resources, and improving national security through settling -- and thus controlling -- areas near international borders.

The case studies below examine the environmental aspects of various types of rural-rural migration, whether spontaneous or stimulated by public policy. Before proceeding, however, it is useful to compare case-study countries with respect to various socioeconomic, demographic, land use, and environmental indicators. Table 2 below provides data on per capita income (over time as high in Ecuador and Guatemala as in Indonesia and Sudan), total fertility rates (which have fallen the most in Indonesia, and then Ecuador, while remaining high in the Sudan and Guatemala), and corresponding current rates of population growth. The countries differ even more in relative land endowments, with the average size of agricultural plots in Indonesia (where the soil is better, however) tiny compared to the other countries, and the overall proportion of the land turned over to agricultural use highest in Guatemala and Indonesia, but rising over time in all four countries, especially in Guatemala and Indonesia.[20] Table 2 also presents data on forest cover and rates of deforestation as indicators of environmental degradation. While all such data are to some extent unreliable, they suggest that deforestation has proceeded farthest

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[18] Urban-rural is greater than rural-urban in five of the 14 countries.

[19] The data presented by Palacios support the statements in the text, although he interprets them to in the opposite fashion (p96). In any event, they are extremely unreliable, as only about half of the migrant population reported in the 1982 census has a place of previous residence recorded (INEC, 1982 Population Census, Final Results, Table 16, p121).

[20] Such changes are occurring all over the developing world: see Bilsborrow and Geores, 1990.

Table 2. Basic Data for the Case-Study Countries (1985-90)

	Per Capita Income, 1988	Total Fertility Rate	Rate of Population Growth	Hectares A&P Land per EAP in Agriculture, 1980	A&P Land as % Total Land 1965	A&P Land as % Total Land 1987	% Original Forests Lost	Annual Rate of Deforestation	% Area Remaining in Forests
Ecuador	1110	4.3	2.5	2.7	9.1	9.6	42[a]	2.3	44[a]
Guatemala	900	5.6	2.8	1.5	14.2	17.2	60	2.0	38
Indonesia	440	3.4	2.0	0.25	9.5	11.5	34	0.8	58[b]
Sudan	480	5.0	2.9	2.8	4.9	5.2	74	1.1	20[c]

Sources: World Bank, FAO, WCMC (1992 draft), Bilsborrow and Geores, 1990.

A&P Land = Arable land plus land in Permanent crops (including pasture land and fallow farm land).

EAP = Economically-Active Population.

Forests includes woodlands.

[a]Estimated from data in World Bank (1989) on Ecuador.

[b]World Bank, 1990b:2.

[c]Estimated from WRI (1990). There are no reliable data.

in Guatemala and the Sudan, but is currently highest in Ecuador, followed by Guatemala.[21] In sum, the broad cross-country differences that Table 2 reveal, suggest, on the one hand, the generality of any common conclusions, and, on the other, the need to bear such differences in mind when reading the case studies.

IV. Case Study: Highlands-Lowlands Linkages in Latin America

In most of Latin America populations have grown rapidly since the 1950s. This population growth, along with considerable economic growth up until the 1980s, has vastly changed the continent's landscape. In considering this landscape, account should be taken of two particular characteristics. First, most of the population (outside of Brazil, the southern cone and the Caribbean) has traditionally lived and continues to live in the highlands areas, in the inter-mountain valleys from Mexico through Central America and down along the Andes to Chile and Bolivia; the climate has always been more pleasant and healthful in these areas. But the Spanish conquerors, the Incas, the Mayas and other native populations all had hierarchical societies, characterized by considerable inequality in access to economic resources and political power. This has evolved over time into the extremely concentrated landholding patterns that typify the region today, especially in the highlands. In recent decades, these areas have come under increasing economic and demographic stress, leading to high rates of out-migration from many rural areas. Much of this goes to the burgeoning cities of Latin America, but some is increasingly going to the lowland rainforests. These latter, the largest in the world by far, are the second dominant characteristic of Latin America relevant to this paper. This case study concerns the growing human threat to these ecosystems and its relationship to land distribution and population growth in the highlands.

The case study is unusual in that it deals with two countries. The reason is the availability of relevant macro-level information on the factors impelling migrants to move to forest areas in one country (Guatemala), together with some emerging, very recent micro-level information for another country (Ecuador) on environmental consequences in the area of destination. Considering the two in sequence seems justifiable because they are, in most relevant respects, quite similar. It can also be contended that what is happening at the macro-level in Guatemala is also occurring in Ecuador, and that the lessons learnt from the micro data in Ecuador also help in understanding what is happening in the lowland forests of Guatemala.

Both countries have about the same population size and growth rate; Guatemala grew from 5.0 million in 1968 to 9.1 by 1990, Ecuador from 5.7 to about 10.5. Both have extensive lowland forests, populations concentrated in the highlands with high indigenous components, and virtually identical levels of per capita income (see Table 2). Both experienced substantial growth in per capita income over the period from the 1960s up to 1981 and declines since, including in agriculture. Per capita income rose from 330 to 1200 in Guatemala between 1968 and 1981, and then declined, stabilizing at 900 in 1988; in Ecuador it rose from 260 to 1490, then slipped to 1100 in 1988. The somewhat higher growth in Ecuador was due to the discovery and

[21] Of course, deforestation is not the only serious environmental problem faced by these (and other) countries' rural areas.

substantial export of petroleum starting in 1973 (revenues peaked in 1980, and then again in 1984/85 before declining to half these levels in 1986-88). The percentage of the labor force dependent on agriculture declined from 56 to 39 in Ecuador but only from 62 to 57 in Guatemala.

Additionally, both have extensive lowland forests and densely populated highlands characterized by extremely concentrated land holdings, rural poverty and out-migration flows. In Guatemala since 1950 there has been substantial migration from the rural highlands to the capital city, the low-lands immediately to the east of the highlands, and the Pacific Coast. In-migration to the northern-most department, the Petén, which is completely covered by forests, accelerated from the late 1960s onwards: the proportion of its population born outside the province more than doubled between 1950 and 1973 to over half, with the absolute number of these (lifetime) in-migrants rising seven times between 1964 and 1973, and doubling again by 1981, the date of the most recent census. The net intercensal migration rate to the Petén was only 17 percent in 1950-64, 47 percent in 1964-73, and 49 percent in 1973-81 (SEGEPLAN, 1987:36). Its annual rates of population growth varied from 4.3 to 18.7 percent during 1973-81, and in all probability continue to be high. In Ecuador, the population of the provinces in the eastern tropical forest Amazon region has also grown rapidly in recent decades, facilitated by the discovery of oil and, starting in the early 1970s, the construction of access roads from the Sierra to the Amazon. The population of the Amazon grew at a rate of 4.9 percent per year in the intercensal period 1974-1982 and is thought to have grown at a faster rate since.[22]

The remaining sections of this case-study first address linkages between demographic processes, rural development and environmental degradation in rural Guatemala. To appreciate the significance of high population growth over an extended period of time, two population projection scenarios, based on high and low future growth rates, are considered and possible results contrasted. Neither scenario is intended as a prediction, or is even likely, but the two scenarios almost certainly provide upper and lower bounds on the future population of Guatemala. The major potential effects of population growth on rural areas considered here are: land fragmentation, rural employment problems, rural out-migration, and environmental deterioration.[23] After examining the linkages at the macro level for Guatemala, and the gaps

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[22] There are, of course, important differences between the two countries. In contrast to Ecuador, Guatemala has had a violent political history over the past four decades. This difference undoubtedly contributes to the different degrees of socioeconomic progress. Education systems differ significantly, with primary school enrollment ratios in Ecuador being over 100 since 1975 (and 117 in 1987, including over-age students), while in Guatemala they continue to be among the lowest in Latin America, 57 in 1970 and still only 77 in 1987. The comparison for secondary enrollments is similar: in Guatemala, they were 8 in 1970 and 21 in 1987, compared to 40 in 1970 and 60 now in Ecuador. Moreover, Ecuador is twice as large as Guatemala, so population pressures on the land are not quite as omnipresent. A further difference is the relative constancy of fertility in Guatemala, where total fertility rates have fallen from 6.6 in the late 1960s to 5.6 in 1987 (INCAP, 1987); in Ecuador, by contrast, they have fallen from the same initial level to 4.3.

[23] Discussion of rural employment problems is omitted here because of space limitations. Detailed references and supporting documentation are not provided. See Bilsborrow and Stupp

in knowledge that remain, the study looks at recent data for the Ecuadorian Amazon that begin to address some of these gaps.

Population Growth Effects on Land Fragmentation and Poverty Perpetuation

In this subsection we consider the problem of rapid growth in the number of farms with less than two manzana; these are considered (by SEGEPLAN) too small to provide sufficient production and income to support an average rural family.[24] A closely-related problem is landlessness, for which there are no reliable data in Guatemala.

Out of a total national territory of 10.8 million hectares, only 5.2 million or 48 percent is classified as suitable for agriculture. Of this, some 4.4 million (85 percent) was already in farms at the time of the last agricultural census (1979), but only half was actually in use (which includes pasture as well as land in crops). Table 3 shows the highly-skewed distribution of land in farms by size of farm in both 1964 and 1979, including the regional breakdown. Land distribution in Guatemala is among the most inegalitarian in the world. In 1964, 44 percent of all farmers (with farms of less than 2 mz., or minifundia) possessed together only 3.4 percent of the land, while at the other extreme, 2 percent of the farmers (with large farms, or latifundia) had exactly two-thirds of all the land. By 1979, the number of minifundia had risen to comprise 60 percent of all farms (although this still amounted to only 3.7 percent of total farm area), while the latifundia numbers remained the same.[25]

Under the pressures of high rural population growth, the total number of sub-subsistence farms grew from 419,000 to 606,000, or by 45 percent, between 1964 and 1979. While the number of very small farms doubled, the number of other farms hardly changed. The total land area of farms grew by over a million mz., or 13.5 percent; as noted below, this increase was probably mostly at the expense of forested areas. This kind of expansion in agricultural land area is a common response to increasing population pressure whenever land is available (Bilsborrow, 1987). Nevertheless, there is also evidence of increasing intensification, with increases in labor per land area, use of fertilizers, insecticides and other chemicals, and irrigation, though these technological changes are modest in Guatemala compared, for example, to Costa Rica (Bilsborrow and Stupp, 1988; Bilsborrow and Geores, 1990).[26]

(1988, 1991).

[24] One manzana equals 0.7 hectares or 0.7(2.5) = 1.7 acres. Farms with 2-5 mz. are considered family farms and can, on average, support a rural family with no net labor hiring nor need for off-farm employment.

[25]Land distribution is almost as skewed in Ecuador, with 65% of the farms (with less than 5 ha.) having only 7% of all the farmland, while the 2.4% of the farms with over 100 ha. had 48% of the land.

[26] It is instructive to examine trends in agricultural yields in Guatemala. While data are not available on yields by region, they are by crop. Since corn and beans are the region's traditional crop, their yields provide good indicators of the extent to which intensification has been successful in raising land (if not labor) productivity in the altiplano. Yield data across a significant time period up

Table 3. Guatemala: Land in Farms and Number of Farms by Farm Size and Region, 1964-79

Land Area (thousands of manzanas)

	<2 mz.		2-5 mz.		5-64 mz.		64+ mz.	
	1964	1979	1964	1979	1964	1979	1964	1979
Central	30.8	39.6	58.5	55.8	193.9	193.5	833.5	837.4
Oriental Sur	26.3	30.3	68.1	70.9	225.0	244.1	684.0	699.7
Costera	25.4	25.2	23.9	27.0	111.0	110.9	649.6	740.7
Altiplano	73.2	112.6	147.6	158.2	480.2	479.2	399.5	365.9
Oriental Norte	11.5	16.0	34.1	36.5	121.2	199.6	454.0	471.0
Norte	5.3	25.1	61.8	64.3	171.3	331.9	744.2	1406.5
Total	192.5	248.7	394.0	412.7	1302.7	1559.2	3764.8	4521.3

Number of Farms (thousands)

	<2 mz.		2-5 mz.		5-64 mz.		64+ mz.	
	1964	1979	1964	1979	1964	1979	1964	1979
Central	28.8	66.0	20.2	15.6	12.9	20.3	1.6	1.8
Oriental Sur	21.0	41.1	21.6	24.1	14.4	16.6	2.3	2.2
Costera	30.3	46.9	7.8	8.7	6.1	6.9	1.5	1.5
Altiplano	76.1	144.3	47.1	47.4	39.7	32.8	1.3	0.9
Oriental Norte	10.4	27.1	11.9	12.0	8.3	11.9	1.0	1.4
Norte	7.1	36.2	20.5	20.9	14.3	22.7	1.1	5.9
Total	183.7	361.5	129.7	128.6	95.7	101.3	8.8	13.7

Source: Bilsborrow and Stupp (1988)

to the present can be put together for the three basic crops, corn, beans and rice. Data for 1973 and 1983 are from USAID (1987), and those for 1986 and 1988 from Sparks Commodities (1991). Yields in kg/ha were as follows:

	1973	1983	1986	1988
corn	1180	1636	1772	1595
beans	636	986	698	501
rice	1600	2850	3195	2526

These data show a considerable increase in yields between 1973 and 1983, but declines or stagnation since. The 1986-88 decline cannot be attributed to an increase in land area (involving increasing use of lower productivity marginal lands), since the total land area in basic grains was estimated to be lower in the latter year (802 thousand ha in 1980; 1063 in 1987, and 980 in 1989: Sharp Commodities: 29). This stagnation in yields may indicate declining soil fertility and/or the effects of insufficient use by minifundistas of fertilizer and other needed inputs during the 1980s economic crisis and consequent lower foreign exchange availability in Guatemala.

Comparing the data for 1964 and 1979, we see that in all regions, most new farmland was in the largest (64+ mz.) size category, particularly in the northern region (Petén), which accounted for 76 percent of all new land in farms. Contrastingly, in the very densely populated northwestern highlands region (the altiplano), farmland area grew by 25 percent. In 1979, the altiplano contained 40 percent of all farms in the <2 mz. category and 37 percent of those in the 2-5 mz. category. Between 1964 and 1979, the number of farms in the 5-64 mz. category actually declined in both the northwest and central regions, while the number of small farms virtually doubled between 1964 and 1979, not only in the altiplano but generally (Table 3, lower-left columns). Although inconclusive, this evidence suggests that land is being increasingly fragmented by subdivision among heirs, despite considerable out-migration. Indeed, between 1964 and 1979, the average size of the <2 mz. holding declined from 1.0 to 0.7 mz.

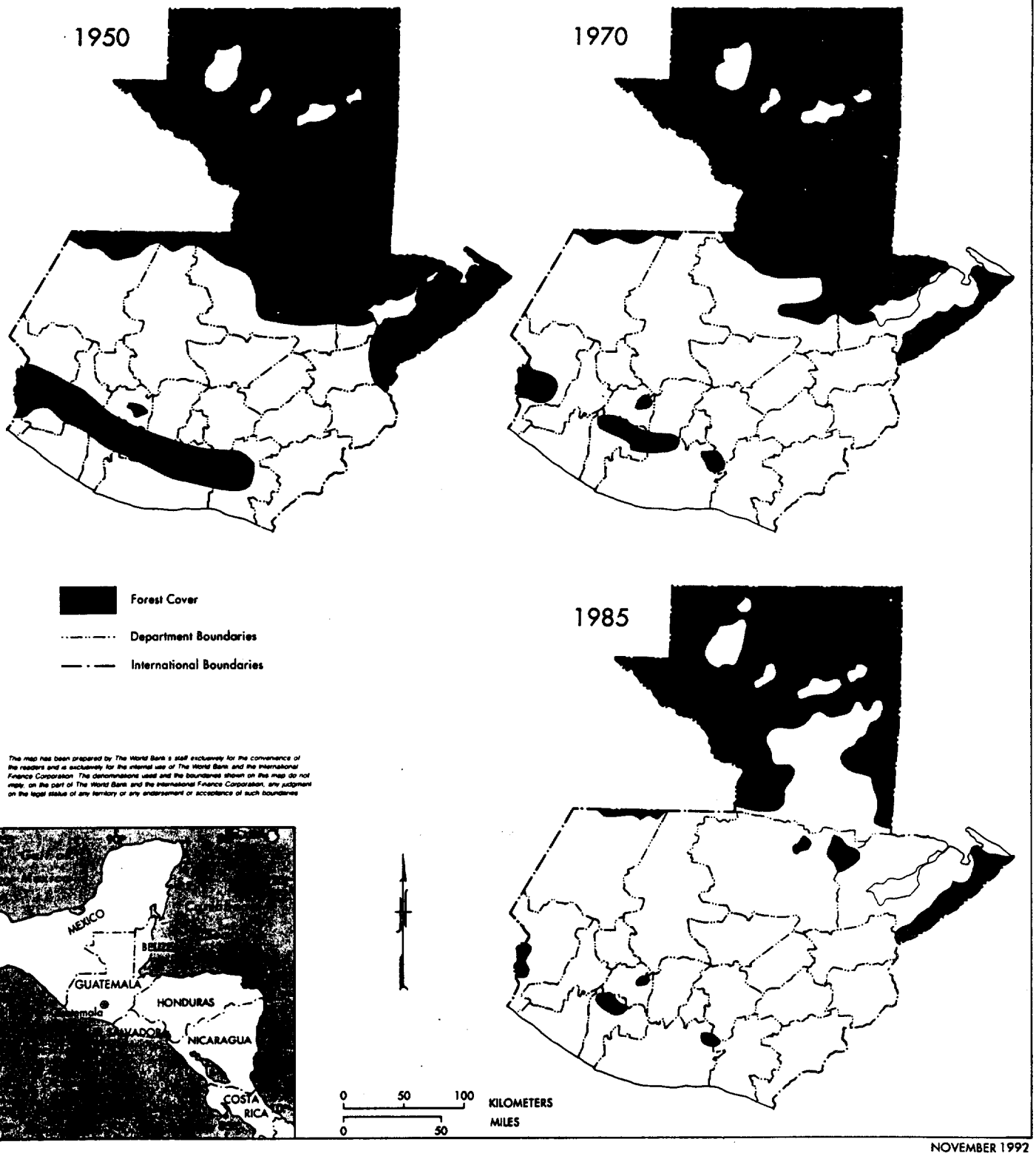
It appears likely that, in lieu of substantial land redistribution, future growth in the number of farms will continue to be predominantly in the smallest size class, and that landlessness will also grow for as long as the rural population continues to grow. The process of land subdivision is leading to greater impoverishment of the rural population, thus contributing to out-migration flows to the capital and other urban areas, as well as to other rural areas. Increasing rural under-employment (see Bilsborrow and Stupp, 1988) further contributes to these flows.

Implications for the Environment

Major forms of environmental deterioration in Guatemala associated with population growth and related effects on agricultural change and rural out-migration include: deforestation, soil degradation, watershed destruction and flooding, and urban encroachment on agricultural land. Others include excessive pesticide use (particularly on cotton, resulting in severe environmental degradation in most of the Pacific river basins), destruction of mangroves and fish populations, and groundwater depletion (Leonard, 1987; ICATA, 1984). We consider the four major forms briefly in order.

Figure 2 shows areas of Guatemala with heavy forest coverage in 1950 and 1985 (based on Leonard, 1987). Roughly half of the area covered by dense forests in 1950 had already been depleted by the mid-1980s. The annual rate of deforestation, perhaps 1100-1600 km^2/year, has been variously estimated as 1 percent (Rodriguez, 1984), 1-1.5 percent (Wing, 1988), and 2 percent (FAO and WCMC, 1992 draft). Even at an annual rate of 1 percent, the lowland forests of Guatemala, rich in archeology as well as biodiversity, will disappear completely by 2010-2025 under present trends. Reforestation during the period 1975-84 was only 500 km^2 for all 10 years combined (Rodriguez, 1984). Practically no real forests exist now in Guatemala except in the northern region of the Petén, where the agricultural frontier moves further into the forests every year. As recently as 1968, 97 percent of the Petén was covered by forests. By 1979, this figure had declined to 66 percent (Rodriguez, 1984), and by 1990 was probably less than 50 percent. The main causes of deforestation in the Petén are, in order of significance: the clearing of land for agriculture; the expansion of cattle-ranching; and fuelwood usage. In other parts of the country, it is thought that deforestation results from: excessive intensification on small plots that includes the felling of all trees; expansion of agricultural land up steep slopes; and excessive

GUATEMALA
REDUCTION IN FOREST COVER



This map has been prepared by The World Bank's staff exclusively for the convenience of the readers and is exclusively for the internal use of The World Bank and the International Finance Corporation. The denominations used and the boundaries shown on this map do not imply, on the part of The World Bank and the International Finance Corporation, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.

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fuelwood use, wood being the principal source of energy for 97 percent of the rural households and 55 percent of the urban households (Rodriguez, 1984).

There are now large regions of the country where it appears that marginal land is being used for agriculture, with consequent environmental destruction (USAID, 1987). For each department, if the percentage of land classified in 1979 as "appropriate for agriculture" is compared to the percentage of land already in farms at that time, it is clear that in the drier eastern region, the altiplano, and the Pacific coast, additional and inappropriate marginal lands had already been absorbed into farms. All these areas are experiencing environmental problems.

In addition, much of the country has experienced environmental problems other than deforestation per se. First, widespread soil erosion is linked to deforestation, which causes lack of moisture retention, especially in upland areas. The search for land in the altiplano may increasingly have led families to exploit lower-quality areas, characterized by steep slopes or lowland forests with shallow, lateritic soils that cannot sustain agriculture beyond a few years. After a few crops, the land is thought to be abandoned as the settlers move further into the rainforest (as in the Brazilian Amazon), or used for cattle-grazing. The erosion problem is greatest on the Pacific slopes, where the soil is thin, the land sloping, and the rainfall heavy. But there is also extensive erosion in the altiplano, with topsoil losses of 5 to 35 tons per hectare per year in many places, and most evident in the area around Lake Atitlan (Leonard, 1987). Another cause of soil loss is the abandonment of Mayan practices of terracing and contour planting.

Watershed destruction and consequent flooding occur widely on the Pacific slopes, in large areas toward the Caribbean basin (along the Motagua River) and even in the south of the Petén (where the rivers flow west into Mexico) -- all areas where colonization has only recently occurred. Every watershed on the Pacific coast has been denuded of vegetation and now suffers from erosion, flooding and sedimentation.

Gaps in the Guatemala Case

The analysis above is based on an assessment of relationships derived from macro data. But alternative explanations of environmental degradation are possible. Relevant gaps in knowledge include the following:

(1) Exactly how (and when) does rural population growth lead to increased fragmentation of landholdings, and what are its consequences, under various cultural and ecological circumstances, in terms of excessive soil use and land degradation?

(2) How can very small farms in the highlands increase production and productivity? What factors restrict the adoption of better technology -- low education, lack of land titles, credit, agricultural extension?

(3) Are there ways of surviving on very small farms? Under what circumstances does out-migration occur?

(4) Why do migrants choose to migrate to the lowland rain forests, such as the

Petén and neighboring provinces? What factors impinge on the choice of destination?

(5) Where do the migrants to the Petén come from? Are these areas of origin experiencing environmental stress? Was that stress a factor in the decision to migrate?

(6) What are the characteristics of the in-migrants, in terms of their previous land ownership, occupation, and attitude toward the forests? How are these related to their land-use decisions in the areas of destination?

(7) What are the underlying socioeconomic, political, and physical causes of large-scale deforestation? What can or should be done?

(8) How can farm settlers achieve long-run sustainable production? What role do land titles play? How can forest assets be managed sustainably? What policies are needed in this regard?

Micro level information -- from migrants and non-migrants, from the settlers in the forests, and from the decision-makers themselves -- is required in order to understand the relationships between farm practices and land degradation (e.g., from "excessive" intensification), between environmental problems in rural areas and out-migration, and between land extensification and deforestation. In this Guatemala case, it is not known whether the in-migrants to the Petén actually come primarily from the highlands region, nor, if this is the case, whether they were farmers with tiny plots or landless. The environmental conditions in the areas they came from, and on their own plots (if any), are similarly unknown.

Thus, although the Guatemala case can provide a plausible explanation for the phenomena addressed in this study, that explanation has important gaps. The next sub-section will indicate how information from appropriately designed household surveys can shed light on some of these issues. While based on Ecuador because of data availability, it has relevance for Guatemala as well, given the similarities of the two countries.

Extension to Ecuador at the Micro Level

As the population has grown in the densely-populated Sierra of Ecuador, landholdings have become increasingly fragmented, as in Guatemala. Although there has unfortunately been no agricultural census in Ecuador since 1974, it is estimated that there was a 35 percent increase in the number of minifundia in the Sierra between 1974 and 1984 (World Bank, 1989: 19). Moreover, during the past 25 years some 70 percent of the highlands forest stock has been destroyed. Relatedly, soil erosion has increased, as has the sedimentation and flooding of rivers flowing west to the Pacific and east to the Amazon. With land productivity increasing only slowly over the past three decades but natural population growth exceeding 3 percent per year in the Sierra, small farmers have experienced worsening economic problems and increasing fragmentation of landholdings.

During the last intercensal period (1974-82), the rural Sierra experienced a net out-migration of about 7 percent of its population. While most migration was to cities in the Sierra and Guayaquil, around 10 percent (some 19,000 people) was to rural areas of the Amazon or Oriente.[27] Although these numbers appear small relative to a total population of 10 million, they are associated with devastating deforestation in the Amazon, estimated at 80-150,000 ha. per year (World Bank, 1989). While some deforestation is due to logging and the infrastructural demands of the oil industry, the vast majority is caused by settlers migrating into the region along the access roads constructed by oil companies (Hicks et al, 1990; Kimmerling, 1991). Do these migrants come mostly from the Sierra? Did land fragmentation and/or environmental factors in the area of origin play a significant role in their out-migration decisions? Why did they choose the Amazon as their destination? What have been the effects on their own lives and on the ecology of the region? Should changes be made to macroeconomic and agricultural policies, in either the origin areas or the Amazon? These questions obviously parallel some of those posed in the preceding sub-section.

To add to the knowledge base necessary to address such questions, the author (together with F. Pichon) designed and carried out a unique survey of settler households in the Ecuadorian Amazon in 1990. The survey covered farm settlers (all spontaneous migrants) in an area of intense colonization in the northern two Amazon provinces of Napo and Sucumbios, where the Ecuadorian Amazon is experiencing its most rapid population growth and deforestation. The survey was unusual in that it was based on a scientific probability sample of settler households (rare in the Amazon basin); involved direct interviews on settler plots (no matter how far from the closest road); and collected detailed information on topics not usually covered in previous (small-scale) anthropological and agricultural surveys.

A number of characteristics of the 420 settler households are worth noting, as they provide useful information regarding some of the questions not answered by the Guatemala case.[28] Although most respondents came from rural areas and had agricultural occupations in their previous place of residence, three-fourths had no land of their own before migrating. (Around 15 percent had held 20 ha. or more). Two-thirds gave having access to their own land as their major reason for migrating to the Amazon region (see question 4 above). The median level of education was 2-3 years. Household sizes were varied (from 1 to 26 people) but predominantly large, as one would expect on the frontier, with the mode around 6-8 persons (versus a national mean of 5.4 in 1982). The vast majority of the settlers arrived, as expected, in the 1970s and 1980s, with few before 1972, the peak years being 1979-81, and fewer in the 1980s than the 1970s. Five-sixths have only one land plot in the region, and almost nobody rents or sharecrops (2 percent), in contrast with, for example, Rondonia, Brazil (c.f., Henriques, 1985 and 1988). Nearly two-thirds have at least one head of cattle, and the main cash crop is coffee, with plátano (plantain), corn and yucca (manioc) the main subsistence crops.

Cross-tabulations were used for initial examinations of the relationships between deforestation and a number of factors thought to be associated with it, specifically: duration of

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[27] These figures may well be too low. Our own survey data show that in just one part of the rural Amazon, there are over 40,000 rural people, almost all of them in-migrants since 1972.

[28] Most of the following is from Pichón and Bilsborrow (1991).

residence in the plot, distance from nearest road, land tenure status, size of plot, and household size. A strong positive relationship was expected between land clearing and duration of residence at the plot (most plots are 40-50 ha), since clearing jungle is both arduous and time-consuming. Such a relationship was observed, but was not as strong as expected. One probable explanation is that many of the recent settlers have purchased small plots (5-10 ha.) from older settlers, and these are predominantly more than 40 percent cleared. Some 55 percent of settlers who have lived over 15 years on the same plot have cleared over 40 percent. The overall mean percentage of land cleared is 35.

Plot location was expected to be a significant factor also, since residents of plots close to a road are able to market their produce relatively easily and therefore have an incentive to clear a larger proportion of their land. But to the extent that the first plots settled tended to be closest to the roads, simple cross-tabulation cannot distinguish the duration from the location effect.

A relationship between land-tenure status and land clearing is commonly postulated: a more secure title is thought to provide more incentive for sustainable practices. The first of two common types of title in the Ecuadorian Oriente is the *certificado de posesión*, which is a provisional title allocated to settlers who have begun to occupy the land, formed a *cooperativa* with their neighbors, and got IERAC to conduct a physical survey of the plots and to register the plot boundaries with the local (Amazon area) office of IERAC. To obtain a definitive legal title to the land (*escritura*), settlers also have to pay IERAC for the land, the price per ha. depending on its location and assessed quality. This usually takes many years. Such a title is necessary to obtain credit from the formal sector (the *Banco de Fomento*) and, presumably, to sell the land. The hypothesis here is that having a legal title eliminates the need to establish a usufruct claim to the land by means of excessive clearing.[29] No support is found here for the hypothesis that legalizing land titles reduces pressure on settlers to over-exploit their land. However, because the process of acquiring title is so lengthy, those with titles will generally have been resident longer in the region, and thus the effects of land tenure cannot yet be disentangled from those of duration of residence and location of plot. But it should be borne in mind that in Ecuador there is little enforcement of land titles, or punishment for illegal land sales (such as by someone with only a provisional land title), and there is therefore little incentive to acquire a legal title. Other countries, of course, may be characterized by stronger land title allocation and enforcement regimes, in which case titles are likely to be of greater significance.

The short-run Malthusian relationship between clearing and household size was also explored and a substantial relationship between the number of people in the household and the extent of land clearing was established. However, it is not known whether this is due more to a consumption effect (more mouths to feed implies the need to clear a larger area to produce more) or a production effect (more persons implies the availability of more *brazos* to help clear more land). Finally, a fairly consistent relationship between land clearing and plot size was found.

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[29] IERAC nation-wide regulations up to 1987 required that, to establish a usufruct claim and apply for a definitive legal title, 80% of the land be cleared. These regulations were never enforced in the Amazon, although their existence may still have led to excessive land clearing.

Conclusions

Agricultural settlement of fragile frontier regions such as the humid tropical rain forests remains extraordinarily difficult to analyze; it involves conflicts between the legitimate human (survival) needs of the colonists and the need to protect rich and diverse ecosystems, as well as the habitats of the forests' indigenous populations that for centuries have lived in harmony with nature. In Ecuador there are no longer any lands, even in the Amazon, that are entirely uninhabited. Moreover, the Amazon is usually viewed by Ecuador's leaders as the area that will have to absorb an increasing proportion of the country's future population growth. The Guatemala case study suggests that to reduce future population influxes policies must address population growth and issues of land distribution, poverty and agricultural technology elsewhere in the country. At the same time, policies -- including the development and dissemination of agricultural technologies appropriate for those already settled -- are needed to increase settlers' standards of living and to reduce their incentive to deforest plots still further. Direct policies that would encourage them to maintain large proportions of their plots in forest should also be considered.

The preliminary empirical results above suggest relationships between deforestation and duration and location of residence, land size, household size, and (possibly) land titles. It is evident that these relationships need to be investigated in a multivariate context, and that other factors also need to be taken into account. But the survey also provides other data that sheds light on the questions raised at the end of the Guatemala discussion. Most of the in-migrants to the Amazon have poor, agricultural backgrounds, and migrate in order to control their own land. They endure great sacrifice to do this. Most have their origins in provinces where rural poverty is severe (Loja in the Sierra; Manabi on the coast; and Bolívar, which straddles the Sierra and the coast), although these provinces are not necessarily the poorest nor those with the most intense land concentration (fragmentation). However, the two provinces of Loja and Manabi are characterized by environmental problems -- drought in Loja and recurrent drought and floods (from deforestation of the upper watersheds) in Manabi. It thus seems likely that wherever push factors were significant in the out-migration decisions of the Amazon migrants, environmental factors often played a role. Although further analysis is necessary before clear policy recommendations can be inferred, one obvious measure (that would also directly prevent further deforestation) would be to restrict in-migration by not building any more access roads into the Amazon (cf. also Kimmerling, 1991).

An issue not touched upon above is whether the spontaneous, undirected out-migration from the high-density highlands in both Guatemala and Ecuador has had any positive effects on areas of origin. Briefly, out-migration appear unlikely to alleviate significantly demographic pressure on land resources, since overall rural population growth in areas of origin remains positive in Guatemala and near zero in Ecuador. Moreover, in the case of the latter, the fact that three-fourths of the in-migrants to the Amazon had previously been landless indicates that major origin benefits are associated with reduced pressure on common property resources (see also the discussion of Java in section V below).

V.Case Study: Transmigration in Indonesia

The Context

Following the break-up of the Soviet Union in 1991, Indonesia, with a 1990 population of over 180 million people, became the fourth-most populous country in the world and third-most among the developing countries. Its geographic area of 1.8 million km^2 also makes it Asia's third-largest country. Comprised of some 13,000 islands, Indonesia contains some of the most unique ecosystems on earth, and the richest biodiversity in Asia (World Bank, 1990). It has the largest tropical rain forests in Asia, and the third-largest in the world (some 7 percent of the world's stock, with only Brazil, with 29 percent, and Zaire, with 9 percent, having more). Second to Brazil in its annual loss of rain forest cover, Indonesia is said to have lost 32 percent of its original forests (WCMC draft, 1992:67).[30] A third fundamental characteristic of the country, for the purposes of this study, is the fact that Indonesia is a poor country, with a per capita income of U.S. $440 (in 1988 U.S. dollars) and, consequently, an overwhelming need to achieve economic development and improve the living standards of its population. AS a result of its considerable petroleum and other natural resources, and the commitment of its post-colonial governments to promoting economic growth, it has achieved one of the highest sustained rates of economic growth in the Third World from the mid-1960s to 1982 (7.7 percent real growth per capita per annum), reaching a per capita income level of $610. The price of petroleum then fell, reducing both imported and domestic (government investment) resources and thereby economic expansion, with implications for government migration programs and the environment.

This case study is concerned with the linkages between demographic factors, economic development, and the environment in Indonesia over the past two decades. The analysis focuses first on the nature and size of internal migration movements, and second, on their environmental and related effects on areas of destination and origin. In addition, the study asks whether the effects of government-sponsored and spontaneous migrants have been significantly different and, if so, why this may have been the case.

The discussion here does not pretend to answer any of these questions definitively but summarizes the state of knowledge, based on documents available in the U.S. Moreover, an effort is made to indicate where data are inadequate and what might be done to rectify these deficiencies.

Population and Poverty in Indonesia

The classic modern study on the problems resulting from a growing population and a fixed amount of natural resources is that of Geertz (1963), dealing specifically with Java. He

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[30] Indonesia also has the largest wetlands in Asia by a factor of two (even with 39% being lost by the 1980s), the most butterfly species, and untold other biodiversity not yet accounted for; it is also third among all developing countries, and sixth in the world, in carbon emissions and contribution to global warming (Choucri, 1991). Ecuador is one of the other leaders in carbon emissions among the developing countries.

postulated that the pressures of a population growing over a long period of time could lead only to limited technological adaptations of the Boserup sort (land and labor intensification) such that, in the absence of sufficient out-migration, the population would have to accept a steadily declining standard of living, which he referred to as "agricultural involution" and which might also be described as "shared poverty." However, with the discovery and large-scale export of oil after 1963, and the large-scale transmigration program it made possible, there is now no way of knowing whether and how far the process observed by Geertz would have continued.

Java together with the small, nearby islands of Bali, Madura and Lombok, have long had about three-fourths of the country's population living on some eight percent of its land. Population densities on Java approach 800/km^2, or about the same as that of Bangladesh.[31] This density contrasts with that of the large, so-called Outer Islands, which average only 34 persons/km^2 (see Table 4). Some 80 percent of the population on Java and Bali live in rural areas. Moreover, "virtually all land in Java is used (...75 percent under agriculture and 87 percent under productive use)," and average plot size (see Table 6) -- only 0.25 ha. -- is rarely enough to support a family. Pressures of human habitation on land have left almost no forests of consequence on Java, with widespread damage to watersheds and serious levels of soil erosion; average annual soil losses on agricultural land in Java are estimated at 6-60 tons/ha., thus costing the economy some $400 million each year (ibid.:59,62).

All such data on soil erosion are highly suspect and are usually based on indirect estimates computed from downstream sediment flows. Abernethy (1987: Fig. 8), for instance, confirms the problem for a major river system in Java for which there are data spanning 1910-65, finding the level of sediment rising at an average annual rate of 4.5 percent for the Cilatung River. In examining the relationships between population pressure and soil erosion in the highlands areas of Java, Repetto (1986) cites evidence of a six-fold increase in sedimentation from a West Java watershed since 1911, and adds that "erosion rates from steeply-sloped land under annual corn production ... are over 10 times the average rate of soil formation" (p. 14). This is important because, as the population of rural Java has grown, it has historically moved in two principal directions -- further up the slopes or to urban areas. The most severe erosion is said to occur on the smallest, subsistence holdings in upland areas, those with under 0.4 ha, according to Repetto.[32]

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[31] The latter has the advantage of being almost all arable. Nor does it contain anything analogous to the range of volcanoes that span the length of Java.

[32] This is plausible and consistent with the widespread presumption that excessively intensive land use is induced by poverty, with resulting increases in soil erosion threatening the long-run sustainability of agricultural production (see sections II and IV above). But the author knows of no study on Indonesia (or elsewhere) which actually measures differential losses in topsoil over time by size of farm. Evidently, many factors influence soil erosion, and it can be mitigated by appropriate methods, even on steep slopes, such as terracing/contour farming, using permanent vegetation barriers to retain soil, and the choice of crops, especially tree crops.

Table 4 Basic Data on Indonesia

Island	Estimated Population 1988 (millions)	Population Density (per km²)	Annual Rate of Population Growth (%)	Percent Land in Forest Department Boundaries	Estimated Area Covered by Forests[a]
Inner islands					
Java	106	788	1.7	22	--
Bali	3	503	1.3	22	--
Outer Islands					
Sumatra	36	74	3.1	65	32
Sulawesi	12	63	2.2	68	--
Kalimantan	9	15	3.0	82	61
Irian Jaya	1	3	2.9	99	58
other	9	37	3.0	69	--
Total	176	90	2.1	75	--

[a]Not all land in Forest Department boundaries is forested. In fact, from World Bank (1990:xx), the proportion for the country as a whole can be estimated to be 76 percent; but on p. 157, it is 69 percent, with estimates provided by island and province for the Outer Islands (except Sulawesi). Using these figures, the estimates shown are obtained.

Source: World Bank, 1990b:xiii.

In rural Java, family incomes, until very recently, were so low that Repetto (1986) stated that over half the families were below the poverty line. The 1984 survey of the Central Bureau of Statistics reported 40 percent of families living below the poverty line. The main reason is lack of land, with some 40 percent of families in Java having none and half of the rest having under 0.5 ha. (In the Outer Islands, only 19-27 percent of families held less than 0.5 ha.: World Bank, 1988). Therefore, in terms of the ownership of assets (Sen's major claim to "entitlements"), some 80 percent of Java's rural population can be classified as poor. However, Jagannathan (1989:3-4) notes that most of these people consume sufficient rice and other commodities, so the lower bound estimate may be closer to 20 percent. Pursuing the land-size argument further, the major factor behind the lack of land is the simple mathematics of multiplication of human numbers on a fixed area with inheritance customs requiring regular sub-division of the land (but legally not beyond a plot size of 1/4 rau, or about 0.18 ha). According to this view, which follows both Geertz and Malthus, population growth has inexorably and directly contributed to rural poverty over time.

Despite its persistence in Java and elsewhere in Indonesia, rural poverty has been dramatically reduced in recent decades. In 1967 Indonesia's GNP per capita was estimated at U.S. $50, or half that of India and Bangladesh. But beginning in the 1960s the government

initiated a broad-based development strategy that focused on rural areas and promoted rice production, rural infrastructure (roads and schools especially), and rural health and family planning services. The proportion of the total population below the (moving, World Bank) poverty line fell from 40 percent in 1976 to 22 percent by 1984 and 17 percent by 1987. Income distribution also improved. The decrease in poverty was greatest in rural Java, where contributing factors included: price supports, credit and agricultural extension for rice (Jagannathan, 1989);[33] diversification into more profitable crops; and the expansion of non-agricultural employment opportunities, especially in the informal sector -- most farm families in Java obtain over half of their family income from non-agricultural activities, which often involve regular commuting to, or seasonal work in, nearby urban areas.[34] As a result of these changes, rural poverty in Java and Bali fell from 24 percent in 1984 to 18 percent in 1987, while it declined in the Outer Islands from 17 to 14 percent (World Bank, 1990d:15). Yet despite these dramatic reductions, Java still has two-thirds of Indonesia's rural poor; average rural household income in Java is $450, compared to $600 in Sumatra and Kaliman (World Bank, 1990b:xiii). Thus, further reductions in rural poverty remain a major policy focus of the government (e.g., in Repelita V, the current Five Year Development Plan, covering 1989-94:see ibid.).

There is still some potential for increasing agricultural incomes in Java (e.g., from more terracing of upland plots and greater use of tree crops), although far less than 20 years ago. Virtually all of Java that can be irrigated, is; virtually all rice grown is of the modern hybrid varieties (94 percent of wet rice: World Bank, 1990b:28); and there is little potentially arable land left for expansion (Repetto, 1986; World Bank, 1990b). This makes continuing population growth in Java and Bali more threatening than previously. The fragmentation of landholdings resulting from continuing population growth and subdivision among heirs (recall also the Guatemala-Ecuador case study in section IV) perpetuates rural poverty in Java and extends agriculture up the steeper slopes, with resultant disruptions to ecosystems. We now examine the major policy response of the Government of Indonesia (GOI), the famous (or infamous, in some environmental circles) Transmigration Program, and its ecological and related consequences, first in areas of origin, then in areas of destination.

The Transmigration Program

The Transmigration Program in Indonesia is probably the largest directed, voluntary, internal migration operation in modern times, if not in human history. Understanding its consequences for the environment requires a look at its historical roots and its overall project goals, which are primarily non-environmental.

Transmigration, in the sense of government-directed migration, has a hoary history in Indonesia, a consequence of Java's population density having long exceeded that of the other

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[33] "Rice output more than doubled between 1968 and 1983, mostly from improved yields, which rose from 2.8 to 5.1 tons/ha," (Repetto, 1986:312) on both highlands and lowlands.

[34] See World Bank (1988), Benoit et al. (1989), and Jagannathan (1989:10). This topic has been extensively investigated by Hugo (e.g., 1981).

islands by some considerable margin. The Dutch colonial government first initiated a program as early as 1905; by 1930, about 100,000 people had been moved. Following independence in 1945, various Indonesian governments have consistently encouraged migration from the crowded Inner Islands to the Outer Islands, directly supporting the resettlement of about 1 million people by 1979, half of this migration occurring in the 1970s during the first two five-year development plans (Repelita I and Repelita II). The scale of transmigration then accelerated in the Repelita III quinquennium (1979-84) by a factor of about seven (see Tables 5 and 6). Some 366,000 families, or about 1.5 million people, were moved in this short period: 62 percent to Sumatra, 19 percent to Kalimantan, 14 percent to Sulawasi and 5 percent to Irian Jaya (World Bank, 1988).

Following the large-scale and (in the GOI's view) successful transmigration program in Repelita III, even more ambitious plans were made for Repelitas IV and V (covering, respectively, 1984-89 and 1989-94). Some 500,000 families were to be moved to the Outer Islands in Repelita IV, and another 250,000 in Repelita V. But environmentalist opposition and a drastic decline in resources available to the government (because of falling petroleum prices and consequently export earnings) forced a major retreat. Though some 179,000 families were still moved in 1984-87, before the program was said to have come to a halt (Table 5), the focus since 1987 has been on improving and consolidating existing settlements.[35] The principal goals of the transmigration program are economic, namely the alleviation of rural poverty and unemployment/underemployment problems in Java (together with Bali, Madura and Lombok, the other much smaller, densely-populated Inner Islands). Reducing pressure on Java's land resources is no more than a secondary goal. The principal aims of transmigration with respect to the Outer Islands are not as prominently stated as the economic goals *vis a vis* Java. They include: increased exploitation of the natural resource base, on the one hand; and, on the other, the promotion of national security and the integration of distant and often distinct lands and peoples into Indonesian society.

As in other countries where the government has tried to play a role in directing colonization programs, transmigrants in Indonesia are selected using certain criteria:[36] they should be currently married, young, have had farm experience, and be "of good character." While the vast majority of those selected have been from rural areas, some previously worked in the urban informal sector, having earlier migrated there from rural areas. In practice, most of the transmigrants have been landless, rural laborers (World Bank, 1988:4), which has significant implications for assessing their environmental impacts in Java (see below). While in the early years of transmigration, in the 1970s, concerns were expressed that not all the transmigrants were voluntary (some were said to have been "nominated" by their village heads to fill village quotas assigned by the central government: village heads have considerable power in Indonesia and are appointed by the government party), it appears that this has not been

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[35] However, the World Bank (1990b) states that a total of 264,000 families were moved in Repelita IV, thus implying that nearly 90,000 more families were moved in the two years from mid-1987 to mid-1989.

[36] For Rondonia, for instance, see Martine, 1981, 1983; and Henriques, 1985.

Table 5 Sponsored Transmigrant Families Settled since 1950

	Sumatra	Kalimantan	Sulawesi[a]	Irian Jaya	Total
1950/54	20,400	1,400	500	--	22,300
1955/59	28,900	2,600	700	--	32,200
1960/64	21,000	4,500	1,000	--	26,500
1965/69	16,500	2,100	2,700	300	21,600
1970/74	22,000	6,000	11,400	100	39,500
1975/79	33,000	11,000	9,000	2,000	55,000
1980/84	227,100	70,600	51,700	16,600	366,000
Total	368,900	99,200	77,000	19,000	563,100
Percent	65%	18%	14%	3%	100%

[a]Includes the Moluccas and other small eastern islands.
Source: World Bank, 1988:xxiii.

Table 6 Settlement from April 1, 1984 through June 30, 1987 by Type of Migrant Family and Island

Island	Sponsored	Partially Assisted	Spontaneous	Total
Sumatra	99,100	8,600	183,800	291,500
Kalimantan	44,900	5,800	73,500	124,200
Sulawesi[b]	25,500	2,400	18,700	46,600
Irian Jaya	9,400	50	5,100	14,550
Total	178,900	16,850	281,100	476,850

[a]Partial enumeration based on government records.
[b]Includes the Moluccas and other small eastern islands.
Source: World Bank, 1988:15.

a serious problem since 1979 despite the huge numbers moved: "in recent years, the number registering ... has exceeded the number that could be moved" (World Bank, 1988:xviii). The program should therefore be considered a voluntary program, although it should be noted that the transmigrants have little control where they are sent. The families are provided free transportation to the site, a small house already built on a 0.25 ha plot, 0.75 to 1.00 ha of cleared land for farming (with an additional 1-2 ha cleared at a "second stage"), subsistence food for one year (along with seeds, small trees, and chickens or goats), and basic community infrastructure comprising a primary school, health clinic, mosque, etc. It was expected that for several years the migrants would mostly grow subsistence crops, and then expand their production and cash incomes during stage 2, when additional lands would be cleared for them. It is also important to note that groups from villages are moved together, thereby facilitating social adaptation to the new area of residence, which, in terms of its physical characteristics, is alien to the transmigrants.

In practice, the second stage has been delayed and, in many instances, remains unimplemented. In consequence, farmers have continued to eke out little more than a subsistence living, and generally have lower incomes than those of rural natives in the places of destination (see Table 7).[37] Nevertheless, two-thirds report higher incomes than in their previous residence in Java or Bali (Table 8), and return migration from major areas in the first 12-18 months after arrival varied from 9 to 15 percent (although in certain specific sites with poor soils, the rate was over 20 percent: World Bank, 1988:34). In virtually all cases of return migration, the plots of those who leave are quickly occupied by spontaneous migrants already living in the same area. The limited extent of return migration provides strong evidence that transmigration has generally improved the transmigrants' welfare[38]; since people vote with their feet, their staying generally implies that they consider themselves better-off (although some who

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[37] Figures showing destination incomes to be below the average in rural origin areas of Java should not be interpreted to mean that their incomes fell as a consequence of migration -- most of the transmigrants had origin area incomes well below the average. However, the most appropriate data for comparison, namely their own (price-adjusted) incomes in their previous residence (see Bilsborrow et al., 1984, Ch. 4), do not appear to have been collected in the 1985 Transmigration Income Survey. Such data would permit a better assessment of the change in the transmigrants' economic status than is possible from the subjective opinions contained in the table. In addition, income levels in the "rural sending areas" (for 1985) reflect whatever changes may have occurred in those areas since the time the migrants left (i.e., any time during the five years previous to the 1985 survey). Finally, "rural sending areas" probably do not refer to exactly the same areas as those the transmigrants left. (Identifying these latter would have required special tabulations from either the 1984 SUSENAS national socioeconomic survey -- in the unlikely event that it obtained specific information on transmigrants from the origin villages in Java -- or from the 1985 survey). "Rural sending areas" more likely refer to all rural areas of Java, which presumably have a higher mean income than the areas (villages) of out-migration. Although in analyses of migration data it is important that these details be absolutely correct, they rarely are.

[38] However, an assessment of return rates after 5 or 10 years would provide a far more definitive conclusion; such an assessment is badly needed.

Table 7 Comparison of Transmigrant and Nontransmigrant Incomes

	Survey Date	Monthly Household Income (Rp)[a]	% with Monthly Incomes Below Rp 30,000[b]	% with Monthly Incomes Below Rp 50,000[c]	Annual Household Income (US$)[a]
Transmigration sites	1985	58,300	20	50	636
Rural sending areas	1984	67,200	15	43	733
Rural receiving areas	1984	90,750	4	24	990

[a]All 1984 values have been updated to early 1985 Rp or US$.
[b]Rp 30,000 (US$27) is the monthly subsistence level for a family of five.
[c]Rp 50,000 (US$45) is the family poverty line, estimated at Rp 10,000/capita/month.
Source: World Bank, 1988:xxv.

Table 8 Transmigrant Reports on Incomes in Transmigration Areas Compared to Those Prior to Transmigration

Percent Reporting that Their Incomes are:	Repelita II	Repelita III	Total
Better	66	67	67
Worse	23	14	16
Just as good	10	17	15
Just as bad	1	2	2
(Sample)	(540)	(1,598)	(2,138)

Source: BPS Transmigration Income Survey, 1985. See World Bank, 1988:209.

wish to leave might be prevented from doing so because of illness or lack of funds to finance the return move).[39]

[39] The incomes of settlers in destination areas have generally been significantly lower than those of people already resident in the area (Table 7), and the proportion of transmigrants with incomes below the poverty line (some 48%) remained unchanged from Repelita II to Repelita III. Moreover, over half of settlers' family incomes came from off-farm employment, despite the general lack of nearby urban areas, poor road access and the physical isolation of transmigrant communities. Since much of this employment derives from temporary sources, such as the construction of new

Assessing the role of spontaneous migration -- in areas of origin and destination -- is also extremely important. Its magnitude is generally considered at least as great as that of sponsored migration over the past two decades, although estimates vary widely, even in World Bank publications. For example, spontaneous migrants are estimated at "about the same number" as sponsored migrants (World Bank, 1988:xli and xix, and World Bank, 1990b:5), at 56 percent of the total (1990b:142), at one and a half times the number of transmigrants during 1984-87 in Repelita IV, etc. In other developing countries, virtually all migrants are unsponsored, so it is unsurprising that in Indonesia many people migrate in various directions for reasons unrelated to the transmigration program. Since spontaneous migration is occurring at no direct cost to the government, it should be welcomed as a means of relieving demographic and economic pressures in the Inner Islands.

Furthermore, up to 50 percent of the transmigrants might have moved even in the absence of a transmigration program and therefore at no direct cost to the GOI. In this regard, it should be noted that by registering for transmigration, they had already indicated a desire to out-migrate; presumably, many were landless and therefore needed to move. However, given transport costs and a number of other barriers, most of the movers would probably not have gone to the Outer Islands, nor would they have been able to choose an alternative viable destination. Most transmigrants who would have moved even in the absence of transmigration programs would probably have gone to urban areas in Java, thus exacerbating the high rate of urbanization and its damaging effects.[40]

In determining the effects of transmigration programs, one key issue is to establish the extent to which spontaneous migrants are linked to the transmigrants. The World Bank, for instance, has noted that many spontaneous migrants are relatives of the transmigrants, who follow the latter, settle and take jobs as laborers in the same communities of destination (World Bank, 1988). To the extent this is true, then the transmigration program is getting more bang for its buck and further alleviating population pressures in Java; but equally, any environmental damage associated with these spontaneous migrants must be accepted as part of the impact of the transmigration program. However, as is evident from the World Bank quotations above, the crucial fact of which spontaneous migrants are tied to officially-sponsored migrants is not known. Its importance becomes evident below, in describing the environmental effects of spontaneous migrants in the Outer Islands.

Clearly an appraisal of the program should look beyond the effects on the transmigrants themselves to assess the consequences of transmigration for areas of origin and destination (c.f.,

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transmigrant settlement areas in the vicinity, future income prospects are cloudy. (See also the section below regarding Lampung.)

[40] The average growth of urban areas in Java is 4 percent (and higher still for intermediate-sized cities). With 10 million people, Jakarta is the seventh-largest metropolitan area in the world (World Bank, 1990b).

Bilsborrow, et al., Ch. 4).[41] This assessment requires an examination of effects on non-migrants, on labor markets and wage rates, on family incomes, and on the environment in terms of its productivity, sustainability and biodiversity. A full consideration of these implications is beyond the scope of this paper, but a number of documents, mostly of World Bank origin, contain a wealth of useful information. Consequences on areas of origin are addressed first; to date, these have generally been neglected in appraisals, particularly by environmental organizations focusing on deforestation and loss of biodiversity in Outer Island areas of destination.

Consequences of Transmigration in Areas of Origin

The first major intended consequence of the transmigration program was to reduce demographic pressures in the Inner Islands, principally Java. In one sense, this has not been achieved, nor, given population growth in Java, could it have been without the transmigration program being several times larger. Rural population has continued to grow, and rural population density to rise. Given natural population growth (the difference between the crude birth rate and the crude death rate) in the 1970s in Java, the rural population was set to grow by 13 million, but in fact grew by only 10 million -- transmigration accounting for half the difference (World Bank, 1988). Looking at the impact in terms of population growth, the natural rate of population growth in Java was 2.3 percent per year, but observed population growth, net of out-migration, was actually only 1.7 percent. A total of 2 percent of the population of the Inner Islands was moved in Repelita III, accounting for 15 percent of the islands' incremental population growth (World Bank, 1988:xxiii, 78).[42] The value to Java of the out-migration is implied by labor force growth and absorption figures for Java in the 1980s: whereas the growth of manufacturing in Java in the 1970s was such as to absorb 13 percent of the increment in the labor force, after 1983 it absorbed only 4 percent. Even the agricultural sector absorbed only 12 percent of labor force growth, although nearly 80 percent of the population lived in rural areas.

Out-migration is reported to alleviate stress on the environment (e.g., World Bank, 1990:xxvii, 59, which identifies a small reduction in soil erosion), but the direct environmental effects are unlikely to have been significant since most of the transmigrants from Java had

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[41] Partly as a result of its scale, the program's overall costs have been quite modest, at only about $1,500 per person, or $6,000 per family in Repelita III (World Bank, 1988). Costs would fall to less than half these amounts if spontaneous migrants were included (World Bank, 1988:xix). Such costs compare very favorably with those of other programs of directed colonization around the world, which, while smaller, involve very high government costs per settler family (see Oberai, 1988). The cost of providing farm work for the settlers averaged $3,000-$4,500 per worker, which, while higher than that of creating service-sector jobs in the informal sector in Java, is much lower than the average cost of creating new industrial jobs (between $10,000 and $20,000) (World Bank, 1988:xxiv).

[42] Estimated impacts on the future population growth of Java and Bali as well as the Outer Islands are contained in World Bank, 1988: 78-79; these estimations take into account "second-generation effects" of children born to children of transmigrants.

previously been landless laborers rather than small farmers (as stated in World Bank, 1988:4). To the degree environmental problems in the Inner Islands were due to farmers' over-exploitation of very small plots, they continue unabated.[43] However, reduction in the number of landless laborers should have positive environmental effects, although more indirect and difficult to quantify. First, the consumption demands of landless laborers influence local resource use; this is especially true of demands upon common property resources such as fuelwood and drinking water. Given their level of poverty, many of these families had probably illegally obtained their firewood for cooking from upland slopes ("foraging" in Jagannathan, 1989) rather than paying for it. Their out-migration should therefore cut back the rate of deforestation of the few wooded areas left on Java's upward slopes, thus reducing pressure on watersheds and soil erosion, and also alleviating to some extent the island's serious water supply problems. If, in fact, soil erosion in Java has stabilized or declined in the 1980s (see World Bank, 1990:59-60), it is certainly possible that transmigration (and spontaneous out-migration) has been a contributory factor. There may also have been potentially important, related economic benefits: rice and other food the out-migrants would have consumed had they not migrated, is now available for others. Potential crop sales to urban areas may in fact lower food prices. Wage rates of those landless workers remaining in the area may rise because the downward shift in the labor supply curve may improve their standard of living. (However, in an essentially surplus labor context, such an effect is likely to be minimal.)

Clearly therefore, transmigration has created probable, although modest, economic and environmental benefits in areas of origin. Their measurement is difficult, since, ideally, it requires a comparison of what has happened with what hypothetically would have happened had out-migration not occurred.[44] A carefully designed sample survey of households and communities in areas of origin would be very helpful in determining how they have been affected by the out-migration.[45]

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[43] See the Haskoning study, based on GIS satellite observations of W. Java in 1976 and 1986, cited in Jagannathan (1989). Also, the upland area devoted to dryland rice in Java doubled in 1981-85, even with the out-migration; this alleviates rural poverty in the short-run but is not sustainable in the absence of large investments in (unaffordable) bench terraces.

[44] A full-fledged macroeconomic-demographic regional developmental model, incorporating environmental effects, could be used to compare the "with" and "without" circumstances, but its data demands would be enormous.

[45] A first and relatively inexpensive approach would be to administer community questionnaires to leaders and informants in a sample of villages where the proportion of the population that left was significant. These villages may be identified by project documents of the Ministry of Transmigration, or by surveys undertaken in destination areas (see next section). More reliable (but more expensive to obtain) than subjective responses of village leaders, would be physical measurement of the extent of deforestation and soil degradation. In either case, the aim would be to determine whether rates of deterioration had declined with the easing of population pressures. Evidently, many other effects in the community, such as those on agricultural yields, incomes, wage rates, etc., could also be investigated by such a process. In the absence of baseline data, sample villages of high out-migration could be compared with villages which did not have significant out-migration, but were otherwise

While there is no systematic accounting of the extent to which transmigrants from Java have come from particularly crowded, particularly poor, or particularly environmentally-degraded communities, it is undoubtedly true that the movement of large groups and even whole villages has, in some areas, relieved environmental stress considerably. Whole villages that were considered too close to volcanoes were moved; populations in areas with low-productivity, limestone soils, and high population densities were earmarked for transmigration.[46] A study of the characteristics of origin communities is needed to assess the extent to which they were located in environmentally-fragile or degraded areas.

Environmental Degradation and Related Problems in Areas of Destination

The environmental impact of migrants on their area of destination depends on: (a) the number of migrants; (b) the size and characteristics of the area of in-migration; and (c) migrants' resource use. These three factors determine both the amount of land used directly for agricultural purposes, and the extent to which additional lands (such as national parks, other public lands, community lands and common property resources) are exploited. Given that indigenous and pre-existing populations in Outer Island areas of destination are far lower than the populations of Inner Island areas of origin, the impact of migration flows on population growth has been substantial in many in-migration areas. From 1980 to 1985, the flow of in-migrants accounted for 19-37 percent of population growth in the Outer Islands, up to 65 percent in various receiving provinces (World Bank, 1988--see Table 11), and even higher proportions in many kabupatan (districts) and kecamatan (subdistricts).[47] The overall rate of population growth in the Outer Islands increased from its natural rate of 2.3 percent per year (with both fertility and mortality higher than on Java-Bali) to at least 2.6 percent per year -- the result of net in-migration.

By allocating small 1-2 ha. plots to settlers, the GOI attempted to reduce the scope of environmental degradation and land-clearing on the Outer Islands, and, not coincidentally, reduce its own costs. But this has made it difficult for settler families to achieve more than subsistence levels of income. There are several reasons why this has occurred; and these reasons have both direct and indirect implications for the environment (World Bank, 1988).

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similar. The effects of out-migration on samples of households in the two types of communities could also be compared; these would be based not only on cross-sectional analyses (which have inherent limitations for inferring relationships over time), but also on analyses of changes over time within households. Although such surveys sound ambitious, Indonesia has an impressive history of carrying out large-scale surveys for government planning purposes, and the transmigration program is one of Indonesia's largest development projects, with its effects neither well-known nor documented. Moreover, the cost of such surveys would be only a fraction of the total transmigration project cost.

[46] I am indebted to Stephen Mink for this observation. These areas were probably south of Yoggakanta.

[47] Unfortunately, sub-provincial data are not provided in Bank documents.

Table 9 Sponsored Transmigrants as Percent of Receiving Province Populations

Province	Number of Sponsored Transmigrants ('000)		Sponsored Transmigrants as % of Provincial Population[a]		Sponsored Transmigrants as % of Population Increase	
	1971-80[b]	1980-85[c]	1980	1985[d]	1971-80	1980-85
Aceh	9.6	61.0	0	2	2	6
N. Sumatra	1.8	37.1	0	0	0	3
W. Sumatra	34.8	23.2	1	2	6	6
Riau	29.3	177.9	1	8	6	52
Jambi	96.0	107.8	7	12	22	35
Bengkulu	41.7	61.1	5	11	17	34
S. Sumatra	141.3	379.0	3	10	12	48
Lumpung	133.3	188.2	3	5	7	13
Sumatra	487.8	1,035.3	2	5	7	21
W. Kalimantan	23.7	131.9	1	6	5	46
C. Kalimantan	9.4	109.8	1	11	4	65
S. Kalimantan	41.0	91.4	2	6	11	41
E. Kalimantan	29.6	55.5	2	5	6	14
Kalimantan	103.7	388.6	2	6	7	37
N. Sulawesi	11.2	18.8	1	1	3	8
C. Sulawesi	51.5	75.5	4	8	14	29
S. Sulawesi	36.5	25.0	1	1	4	5
S.E. Sulawesi	37.9	92.1	4	12	17	62
Sulawesi	137.1	211.4	1	3	7	19
Maluku	4.3	35.1	0	2	1	17
Irian Jaya	10.6	75.6	1	6	4	48
Other[e]	n.a.	7.9	n.a.	n.a.	n.a.	n.a.
Total	743.5	1,753.9	1	4	7	25

[a]Source for data on provincial population--BPS, Statistik Indonesia 1984, Table 3.1.2; data on households from 1983 Agricultural Census.
[b]P. Gardner, Provincial Population Projections (Jakarta: UNCHS/GOI NUDS project, 1985), Table 4.
[c]Transmigration Department, Daftar Proyek Transmigrasi Yang Dibina Tahun 1985/86 (to August 1985).
[d]1980 figures include migrants moved from 1971-80, and 1985 figures include migrants moved from 1971-85.
[e]Nusa Tenggara Barat (NTB), Nusa Tenggara Timur (NTT) and East Timor (World Bank, 1988:75).

Source: World Bank, 1988:75.

First, despite improvements in Repelita III over earlier plans, site appraisals often remained inadequate, and site selections were correspondingly poor. Probably this was partly the result of the sheer speed with which large numbers of families were settled. Whitten (1987) reports that 56 and 43 percent of the sites in Repelitas II and III, respectively, were later found to be inadequate, necessitating additional government outlays to assist the affected settlers.[48] Many selected sites had soils too infertile to sustain crops for more than a few years -- a common problem worldwide in converting tropical rain forests to agricultural use. Second, with each Repelita it has become increasingly difficult to find good quality sites. Third, the provision of agricultural support services (viz., seeds, fertilizer, and pesticides for the first 12-18 months; technical assistance; credit) has often been inadequate. Fourth, the GOI has rarely carried out the second stage of land-clearing, which was to provide settlers with 1-2 additional cleared ha on which to plant tree crops.[49] Fifth, soil conditions have suffered from the use of mechanized equipment for land-clearing (the thin layer of good topsoil and surface vegetation being plowed under and rendered useless for agriculture). Although this latter problem had earlier been recognized and semi-mechanized methods were increasingly used in Repelita III as a result, even more labor-intensive methods should apparently have been used; these would have reduced environmental degradation and generated more off-farm employment, badly needed by the settlers in many transmigrant areas (World Bank, 1988; Whitten, 1987b:para. 4.1).

The long-run sustainability of settler plots remains unclear. Under present circumstances, with plots often too small to sustain families given soil conditions prevailing in the Outer Islands -- thin, acidic topsoils which often last only a few years before losing their fertility, particularly where rains are heavy -- and in the absence of significant government aid (see below), the transmigrated farmers are likely to experience declining farm incomes. Moreover, with the inherently rural nature of transmigrant communities, off-farm sources of employment are rarely likely to help much (but note the discussion of Lampung below). In such situations, one consequence, not discussed in World Bank documents, is likely to be increased exploitation of local forests for products that can be used or sold, such as wood (thus depleting public forests) and animals (thus destroying fauna).

Spontaneous migrants are undoubtedly already doing this, as well as clearing new areas for their homesites. But there appear to be no direct data on their environmental impact, and indeed little data on their activities or even their socioeconomic status. For example, in the careful assessment of the transmigration program by the World Bank (1988), there are estimates of the <u>number</u> of transmigrants, but no data on their characteristics, access to or use of land, income levels and sources, and environmental impact. This is a major informational gap. Combined with our inability to quantify the proportion of spontaneous migrants tied to transmigrants by year and area, it makes it impossible to measure the environmental impact of spontaneous migration <u>or</u> of transmigration. However, some broad indicators are available.

The situation of spontaneous settlers is particularly precarious because they lack any legal

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[48] Unfortunately data are not provided by island or province.

[49] It has been found that tree crops -- rubber, oil palm and coconut, and, in the highlands, coffee -- generally provide higher incomes per ha in transmigration areas than upland or lowland rice and cassava, the most common food crops.

claims to land in the form of land titles, and therefore have no stake in achieving sustainable yields and protecting the land. Given the widespread lack of enforcement of restrictions against exploiting protected forests and natural reserves (the usual situation in frontier environments throughout the Third World, including both Ecuador and Guatemala also), there is a strong *a priori* presumption that spontaneous migrants are responsible for more damage to the environment per family than transmigrants:

> "In the current absence of effective land-use policies, policing and employment opportunities around forest boundaries, the new settlers cause great damage to the productive and protective potential of forest lands ... At present, there are few signs that most areas gazetted as reserves are able to maintain their integrity ... " (Whitten, 1987b: paras. 8.1.3 and 8.1.4).

Of course, this type of degradation is also likely to be caused by transmigrants to the degree that their plots do not provide an adequate income, other local employment opportunities are insufficient, and enforcement mechanisms protecting local forests are weak.

It is widely believed that a lack of secure land titles facilitates -- and may even stimulate -- improper land-use practices that result in land degradation.[50] If true, then spontaneous migrants are likely to have a greater negative environmental impact than sponsored migrants. Unfortunately, the process of seeking land titles is extremely long and costly in Indonesia, requiring, first, a cadastral survey that costs $70 -- far more than a farmer working a tiny plot can afford -- and, second, a series of administrative steps involving trips to the local provincial land registration office and document transmission between this office, the local village and the national land registration office in Jakarta, the Directorate General of Agraria. For the past several decades, in fact, few land titles have been allocated for rural plots in Indonesia; higher priority is given to issuing titles for urban sites and public sites, such as road rights-of-way. A second major problem for spontaneous migrants in seeking land titles is the prevalence, and legal recognition, of traditional or customary collective land ownership by communities through *adat* law (World Bank, 1988:135). Most land in the Outer Islands that is not contained in state-protected forests or national parks, belongs to some local population group or community. A spontaneous settler may request permission to use a plot of land, clear some forest and make other "improvements" to the land that raise its market value, only to have it "repossessed" by the community whenever it chooses, with no compensation paid. This provides a powerful incentive to use (and abuse) "open" lands instead.

The situation for government-sponsored migrants is different, in that land settlement issues and competing land claims are usually resolved between national, local, and provincial governments before transmigration occurs. The settlers then have secure land titles and consequently a vested interest in maintaining the quality and productivity of their land. Given the high proportion of the transmigrants thought to have been landless in Java and the usual thirst for land with secure titles that is typical in low-income, agrarian societies, the expectation of a secure land title is probably a major incentive for people in Java and Bali to register for

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[50] But see Bromley, 1989.

transmigration with the authorities. To the extent this is true, then what is done for the transmigrants to ease their adjustment in areas of destination becomes of secondary concern. If sites are evaluated sufficiently carefully in terms of agricultural potential, then highly-motivated migrants will usually manage to survive in the new environment. Thus a low-cost program providing transportation, land titles, and initial technical assistance to spontaneous settlers would allow the government to exercise some control over spontaneous migration movements, while reducing their negative environmental impacts. A greater recognition of the importance of spontaneous migrants is evolving in the Bank and probably in the GOI (Whitten, 1987b: para. 8.1.2; TAG, 1991:3).

An understanding of the process of transmigration (and of spontaneous migration) and its effects on the families involved is a crucial precondition for correctly appraising short- and long-run impacts on the environment. Although estimates of deforestation in developing countries are unreliable, and Indonesia is no exception, there is little doubt that considerable deforestation has occurred -- see Table 2 above.[51] Since, until recently, the Outer Islands have had extremely small populations, most of the deforestation there has occurred in recent decades and at the hands of in-migrants. In Indonesia as a whole, depredatory commercial logging and forest fires, including a huge one in eastern Kalimantan in 1983, together account for perhaps one-third as much deforestation as the expansion of the agricultural frontier (World Bank, 1990). The World Bank's 1988 report on transmigration provides data on estimated forest cover and the extent of deforestation resulting directly from the movement of 1.5 million transmigrants to the Outer Islands during the period of heavy transmigration from 1979 to 1984. Since the volume of transmigration was roughly as high in this quinquennium as in all other periods combined (1905-79 and 1984-90 -- see Tables 7 and 8 above), doubling these figures may provide an approximation of the direct effects of transmigration on the rain forests of Indonesia. Data for each of the 18 provinces in the Outer Islands are also provided by the World Bank (1988: Table 5.1); according to this source, it is only in the most southern province of Sumatra, Lampung, that transmigration has caused a loss of forest area in excess of two percent.[52]

Subsequent to 1985 the World Bank and the FAO have prepared divergent estimates of the pace of deforestation in Indonesia. A study by the TAG (Transmigration Advisory Group) in 1991, based partly on satellite imagery, provides a persuasive case that the new 1991 FAO estimates are much too high. The TAG study was in part subjective (based on the knowledge and personal experience of TAG personnel in Indonesia) and in part objective (counting 10 km^2 dot squares of cleared areas from 1:250,000 land use maps compiled around 1985). Areas known to belong to plantation and industrial estates or to have been cleared for purposes other than transmigration are identified, as are transmigration sites. For the small holders (which refers to spontaneous migrants since the indigenous population is very small and for the most

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[51] Whether it actually amounts to 32 percent for the country as a whole, as stated by the WCMC, is not really known.

[52] It is important to clarify footnote (a) of Table 4: most of the area comprised by transmigration settlements (estimated at 70 percent by the Ministry of Transmigration) was from areas that had been logged over or deforested earlier and not regrown, or from grasslands or barren areas without significant tree cover (World Bank, 1988:Ch. 5). Thus, only 30 percent involved deforestation.

part practices a shifting cultivation that leaves no permanent mark on the landscape), "a visual estimate is made of the extent of forest clearance that has progressed during the same 20-year period ... a steady, more or less annual encroachment along the entire length of the forest boundary. Clearly this component of the study provides the greatest scope for inaccuracy... ." The results of this exercise, perhaps the best that can be hoped for until the results of comparable landsat images over time are analyzed, are presented in Table 10.[53]

The total area cleared by transmigration over the two decades in all the islands combined is estimated to be 9,300 km². If the area of swamps and estates cleared is added (see fn. (a) to the table), then the total amount of deforestation attributable to transmigration during the 20-year period is 16.1 thousand km², or 1.4 percent of the total forest area in the Outer Islands. This amounts to an annual average rate of deforestation of 80,000 ha (more specifically, an average of 110,000 ha/year in the 1980s, and 61,000 ha/year in the 1970s). A breakdown of land-clearance by island shows a range from 5 percent of the forest area in Sumatra (where 69 percent of all the tropical deforestation in the Outer Islands has occurred) to only 0.02 percent in Irian Jaya. Within Sumatra, land-clearance accounted for 6.4 percent in Jambi, 10.9 percent in South Sumatra, and a high of 15 percent in Lampung (see case study below).

The TAG study indicates that the principal culprits are spontaneous migrants, who are estimated to have cleared at least twice as much land as the transmigrants. However, this figure is thought to be a significant underestimate; smallholders may in fact clear three-to-four times as much area per family as the transmigrants, instead of "only" twice as much as was assumed (TAG, 1991:10). (This is for a variety of reasons, including those cited above: lack of land titles, less government control over their activities etc.). The only provinces where transmigration accounted for a significant proportion (40 percent or more) of deforestation were cases where the absolute amount was very small (such as Irian Jaya, Southeast Sulawesi) or where substantial swamp clearance is linked to transmigration (Jambi, Lampung, S. Sumatra). The total estimated rate of deforestation of the sponsored and spontaneous migrants together was 237,000 ha per year, excluding losses from commercial logging and forest fires. When these latter are added (80,000 and 70,000, respectively, in World Bank, 1990b:xxi), the average rises to near 400,000 ha/yr., which is about one-third of the 1991 FAO estimates (ibid., p. 11).[54]

To the extent spontaneous migrants are "tied" to transmigrants (such as relatives) and follow them to the same general destination areas, the damage they cause must also be considered the responsibility of the transmigration program. Indeed, the transmigrant programs

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[53] The GOI has committed itself to "synchronous remote sensing imagery at 5 or 10-year intervals (preferably to coincide with the national population census) in order to monitor changes in forest cover and land use patterns" (TAG, 1991:3).

[54] However, logging involves construction of access roads, which opens up areas to settlers (World Bank, 1990b,xxi,3). While the effects in Indonesia (with its dispersed insular nature) cannot be as dramatic as in Ecuador, they are still important. Most of the logs are exported (Peluso, 1990).

Table 10. Deforestation Arising from Transmigration and Spontaneous Migration

Province	(A) Gross Area (RePPProt) sq km	(B) Forest Area (RePPProt) sq km	(C) Forest as % of Gross B --- % A	(D) Total Cleared (estimated) sq km F+G+H	(E) % Cleared D --- % B+D	(F) Transmigration 1971-60 sq km	(F) Transmigration 1971-60 % of D	(F) Transmigration 1961-90 sq km	(F) Transmigration 1961-90 % of D	(G) Other 1971-90 sq km	(G) Other 1971-90 % of D	(H) Small Holders 1971-90 sq km	(H) Small Holders 1971-90 % of D
Sumatra	437,994	217,610	49.7	26,300	10.8	2,578	9.8	3,627	13.8	4,941	18.8	15,154	57.6
Kalimantan	535,684	400,104	74.7	14,782	3.6	201	1.4	1,038	7.0	1,755	11.9	11,788	79.7
Sulawesi	186,145	112,694	60.5	4,774	4.1	601	12.6	650	13.6	40	0.8	3,483	73.0
Maluku	59,059	50,167	84.9	511	1.0	--	--	97	19.0	0	0	414	81.0
Irian Jaya	414,800	349,583	84.3	1,059	0.3	72	6.8	452	42.7	79	7.5	456	43.2
Total	1,633,682	1,130,158	69.2	47,426	4.0	3,452	7.3	5,864	12.4	6,815	14.3	31,295	66.0

"Other" comprises estates and swamps, which are largley cleared by labor available from the transmigration settlements.

Source: TAG, 1991.

often "open up" new areas by providing road access. Those "spontaneous" migrants who do follow are migrating to areas where there is more governmental presence and therefore more control over, for example, intrusions into nearby protected forests, than in areas where truly "spontaneous" migrants go independently of their sponsored counterparts. Consequently, their environmental effects are not as damaging as those of the latter group. Doubling the figures in Table 10 on the effects of transmigration on forest clearing (the hypothesized result of taking account of spontaneous migrants associated with the migration program), produces total deforestation of over 200,000 ha per year in the 1980s, which represents a significant chunk of the world total of some 17 million ha (IIASA Newsletter, 1991).

In evaluating the environmental effects of the transmigration programs, both the GOI and the World Bank have concentrated, appropriately, on tropical deforestation. Other forms of degradation have therefore been neglected. For example, the important ecological functions of swamplands and tidelands are rarely recognized. Because they have better soils, these lands are described as being suitable for transmigration and rice growing (World Bank, 1988, passim). But the biological life in such wetlands is usually very rich; they are breeding grounds for many animals and fish, and they serve as a sink to absorb and purify rainwater and river flow. Whitten (1987b: para. 4.1) questions the pell-mell draining of swamps in some areas (S. Sumatra) and argues for more research on the ecological consequences of this activity. In addition, discussions of forest clearance rarely consider the "collateral damage" resulting from new human settlements (whether of transmigrants or spontaneous migrants) -- damage due to intrusions below the level of actual clearance, such as harvesting natural forest products at greater than sustainable levels, or poaching animal populations, and thereby trampling on native plant species of indeterminate value. It is therefore important for ecologists and biologists to participate in site assessments and long range planning for Indonesia.

The Case of Lampung, Sumatra

Lampung is the southern-most province of Sumatra, directly across the Sunda Strait from West Java, and an easy boat or plane trip from Jakarta. Its area amounts to some 33,000 km², and its population, which was only 16,000 in 1905 and 376,000 in 1930, had reached 5.25 million by 1986.[55] Lampung is still largely rural, with only its capital, Bandarlampung, having over 100,000 inhabitants. (Bandarlampung, in fact, has over 500,000 inhabitants). Population density has risen from less than 5 per km² to over 200/km². It is an economically poor province, with some 40 percent of its population below the poverty line. Population growth averaged 5.8 percent per year from 1945 to 1980, two-thirds of this being due to in-migration; the island's rural population growth was the fastest in Indonesia from 1971 to 1980. In 1986, transmigrants and spontaneous migrants together with their immediate descendants constitute, respectively, 25 and 60 percent of the population, thus completely outnumbering the native population.

The transmigrants were generally settled in lowland areas and grew lowland rice with some corn and cassava, while the spontaneous migrants settled in the highlands and grew coffee and diverse food crops, including upland rice, cassava, and vegetables. The new lowland hybrid

[55] The source for virtually all these data is Benoit et al., 1989.

rice strains provided good incomes for the lowland farmers with the result that less than one-third of their family income came from off-farm employment. Upland farmers, by contrast, struggling against topography and poor, acidic soils, probably received over half their income from off-farm activities (with over 40 percent of the adults working away from their plot).

As a result of population growth, over-crowding in the southern lowlands area became so severe that a substantial program of local trans-migration within the province was organized. Between 1980 and 1986, about 200,000 people were moved, mostly to upland areas in the north of the province. Unfortunately, continued spontaneous migration to the lowland areas compensated for the effects of this internal transmigration (p. 173). Lampung is now the most heavily populated of the Outer Island provinces, and a program to encourage out-migration has been established.

In terms of environmental change, two tendencies are evident. First, continuing population growth has fragmented plots as result of division among heirs (pp. 267, 281), particularly in the lowlands, where farms may soon become too small to be economically viable. In the uplands spontaneous settlers have cleared land excessively, incorporating slopes that without proper terracing are too steep for agriculture; this has had "negative consequences for the environment" (pp. 133, 191, 416). Given low yields, most upland farmers have not achieved sufficient surplus to purchase fertilizers and pesticides. Rice yields have further deteriorated over time and farmers have responded by switching to cassava, which further damages the sandy soil:

> "This dangerous evolution is seen on all the transmigration centers growing upland food crops and installed on the poorly-fertile soils of Sumatra and Kalimantan" (p. 279).

In consequence, spontaneous settlers are becoming increasingly dependant on off-farm labor. Over the past decade most have managed to survive because of the demand for temporary labor to work on large-scale infrastructure improvements and the construction of new transmigrant communities. But how long can this continue?

In 1900 forests covered nearly 100 percent of the province, but now "survive here and there with difficulty" (p. 347). Despite a massive increase in secondary roads and in vehicles, about half the upland communities continue to have poor access to roads and therefore to markets. Few spontaneous migrants have land titles. Numerous illicit settlements now exist, many of them in what are supposed to be protected forests, where enforcement is minimal (p. 307). In general, spontaneous migrants have had far more deleterious effects on the environment than sponsored transmigrants (p. 299). Without large-scale improvements in infrastructure and off-farm employment, expansion of upland farms and switching to tree crops, further credit and technical assistance, and better roads, the "transmigrants' grandchildren will [also] have to ... transmigrate" from Lampung (p. 283).[56]

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[56] The ORSTROM study has a developmental bias: this is evidenced by its downplaying the value of reforestation in western Lampung to control soil erosion and flooding (p. 277), and in its views of wetlands: "marshes are more than a constraint, they represent a potential" (p. 371); "the excellent results from draining swamps on the east coast ...will have to be extended to the entire east coast"

Conclusions and Implications

Indonesia is such a large, multifaceted country and the transmigration program such a mammoth social experiment, with a plethora of positive and negative effects on the welfare of humans and the natural environment, that drawing broad conclusions is foolhardy at best. Moreover, yawning gaps in the data and knowledge base preclude such conclusions. Here, therefore, "lessons" are limited to a series of comments about project design, data and research gaps, and several policy issues. Except for data and research gaps, most of these points are not new.

During the course of the various transmigration programs, much has been learned which has led to improvements in project design and implementation. Site selection is now recognized as crucial, and increasingly so as the number of potentially satisfactory sites declines (few are left on Sumatra, and there were probably never more than a small number on Irian Jaya). Biologists and ecologists should be involved in the planning phase to help protect against selecting areas which would compromise important species and habitats. For example, wetlands should rarely be drained for transmigration sites. In some areas anthropologists and ethnologists should be consulted to assess potential impacts on local tribal peoples.[57] Planning and administrative coordination across the key government agencies must continue to be improved. A Master Plan on the environment for the current five-year development plan (Repelita V) is to be prepared by 1992; presumably this will greatly expand upon an earlier plan prepared in 1982, when concerns about environmental issues were far less developed (World Bank, 1988:xxxvii; World Bank, 1990b:xxxv-xxxvi). A better and more complete classification of lands -- for protected forests and reserves, logging concessions, estates, transmigration settlements, and other purposes -- would be a positive first step towards better overall regional planning and site selection for settlers.[58] To protect topsoil, new areas should be cleared using the least mechanical means available; road maintenance must follow road construction; credit that extends more than one cropping season should be available to transmigrants, as should more technical assistance, fertilizers and marketing assistance. Plots, particularly in dry upland areas where most new settlements are being located, should be larger, and tree crops should be encouraged, as should greater recycling of organic material.[59]

(p. 279); the in-migrants from Sulawesi setting up estates in the east "neglected estuary banks" (p. 305). Indeed, the whole process of peopling Lampung is called "impressive" (p. 293).

[57] The Transmigration program has been criticized by environmentalists for its presumed impact on tribal populations in Irian Jaya. But in fact, only 17,000 families have been settled there through 1990, all in the coastal lowlands where there are few tribal residents; there are said to be no plans to create transmigrant communities in the densely populated highlands (World Bank, 1990c:4).

[58] See also the extensive discussion in World Bank (1991a).

[59] The Bank recommends plots of 3 ha, which seems too small in comparison to the size of plots needed to sustain settler families in other countries. Limiting settler families to 3 ha plots ignores traditional customs of inheritance; plots will be too small to sustain the families of children of the transmigrants.

Perhaps most important, the role of spontaneous migrants must be explicitly recognized, and incorporated in project design and evaluation. Given the strength of demand to migrate, the government could encourage migration cost-effectively by scaling back its large-scale transmigration program and concentrating instead on providing to spontaneous settlers minimal forms of assistance, such as transportation, tools to clear and prepare a plot, food to sustain them for the first year, as well as seeds, credit and technical assistance. This would cost much less than the outlays incurred by the transmigration program, and would compensate for the extra costs imposed by the other recommendations above, since these latter involve a greater concern with quality and long-run settlement sustainability than with quantity, which has heretofore been the principal focus of the program. In any case, the pace of transmigration must be slowed, and the situation of previous settlers improved and made sustainable, otherwise many migrants will return to Java or Bali, or push further into the forests to establish new sites, creating a cycle of deforestation similar to that thought to occur in the Brazilian Amazon.

What have been the environmental effects of transmigration to date? Available information suggests that these have been less negative then feared in areas of destination, and less positive than hoped for in areas of origin. That said, there are no systematic data on the extent to which out-migrants come from environmentally critical or demographically crowded villages in Java (Whitten, 1987b: para. 8.1.2). Innovative survey research, based on representative samples of households and communities, is needed in both areas of origin and destination in order to collect data necessary for analyzing the behavior of migrant and non-migrant households, including their reasons for migrating or not migrating; such data will also have implications for family welfare, resource use and sustainability. Other issues to cover include: agricultural practices and technology, perceptions about local soils, past land clearing and future plans for clearing, problems encountered, and migration intentions. These data should help in identifying appropriate policies in areas of distribution, in assisting the colonists' adaptation to their new environment, and thus in enhancing the sustainability of transmigration. Such surveys can also determine the extent to which sponsored and spontaneous migrants are linked, and should therefore be analyzed together in order to measure the full impact of transmigration on population flows, income, employment, and the environment.

It is important to note that thus far only the short-run effects of transmigration are evident; the long-run effects may well be far greater and more damaging to the environment. To investigate long-term effects, samples of migrants (of both kinds) in both older and newer transmigrant communities should be selected; this would allow a determination of how the practices of the former have changed over time, and of how their welfare and the surrounding environment have been affected. A final and quite different dimension of needed research concerns the type of crops to grow or animals to raise in various highland and lowland situations in the Outer Islands. Research is needed on the choice of crops and seeds, on the viability of low-input cropping (Sanchez and Benites, 1987), and on the potential for commercializing native plants (given that all three of the generally-promoted tree crops have poor market prospects).

Clearly, the above discussion indirectly implies certain policy prescriptions, particularly the provision of more technical assistance to settlers. Several issues, however, are worthy of a more developed focus -- land titles, for instance, have not been discussed at length in this case study. Although the Basic Agrarian Law of 1960 gives the state ultimate power to claim land and allocate it for the "public good," the government has not seized land from local communities

in Outer Islands in order to make it available to transmigrants. Instead, land transfers have been negotiated, and compensation paid. However, the cost, complexity, and time involved in obtaining land titles are such that spontaneous migrants rarely obtain them. *A priori*, this suggests such migrants are likely to engage in depredatory land use practices, but further evidence (along the lines of that obtained for Lampung) is obviously required to realize more definitive conclusions. In any case, the land titling process should be simplified, and probably entrusted entirely to the provinces, which are in a much better position to conduct the necessary physical survey and legal (local community or *adat* law) appraisal of plots (see World Bank, 1990b:xvff). In a related vein, the fees and royalties charged for logging concessions should be greatly increased, and the concessions reviewed and renegotiated more frequently, to ensure that they more closely reflect full resource costs to Indonesia (see also World Bank, 1990b:xxii).

Last, but not least, little has been said about population growth. This latter makes the population of Java ever denser despite out-migration, accounts directly and indirectly for the population growth of the Outer Islands, and therefore imposes further stress on their fragile environments. Recognizing the threat to development posed by population growth, Indonesia has initiated one of the most effective family planning programs in the Third World. Its ambitious goal is to reduce the crude birth rate from 44 in 1970, to 22 by the year 2000. In 1985, the rate stood right on target at 33, and in 1990 is said to have reached 28 (World Bank, 1990c). However, further fertility reductions are likely to be more difficult to achieve. While the total fertility rate (births per woman over the course of a lifetime) fell from 5.5 in the 1960s to 3.4 in 1987 (the date of the last national fertility survey for which results are available--see CBS, 1989), desired family sizes are still moderately high, averaging 3.2 for the country as a whole, 2.9 in Java/Bali, and 3.8 in the Outer Islands. But for girls aged 15 to 19 and for those with secondary education, they average only 2.6 and 2.3, respectively, thus suggesting that they are likely to continue to fall. To achieve this end, greater efforts will have to be expended and more funds made available (World Bank, 1990c).

VI. Case Study: Migration and Desertification in the Sudan[60]

The Context

Sudan, the largest country in Africa, covers some 2.4 million km^2 -- an area equivalent in size to the U.S. east of the Mississippi. According to the most recent census, held in 1983, the population is around 21 million; this is estimated to have grown to 25.2 million by 1990. Sudan continues to have one of the lowest population densities in the world -- seven persons per km^2 -- but this is deceptive since much of the country is arid, and population distribution is largely determined by the availability of water. Population growth, fertility, and mortality all continue to be high in a country which -- like most of sub-Saharan Africa -- is at the early stages of its demographic transition. The total fertility rate is estimated to have been 6.7 in the 1960s,

[60] This case study draws extensively on Bilsborrow and DeLargy (1991), which in turn drew upon DeLargy (1987). The author is grateful to Pamela DeLargy for insights provided in personal communications. Falkenmark (1989) has pointed out that "desiccation" is a better term than "desertification."

6.0 in the 1978/79 fertility survey, and 5.0 in the latest (DHS) fertility survey of 1989-90 (Sudan, 1991). The infant mortality rate was over 150 in the 1960s and, according to the latest UN data, is still over 100. The rate of population growth, 2.9 percent per year, may well rise before it falling in response to a decline in mortality rates. While the government now recognizes the problems posed by rapid population growth (including pressure on natural resources like land and water), has created a National Population Committee, and formulated a national population policy, implementation of effective measures remains limited: for example, only 6 percent of married women use contraceptives.

The dominant geographic feature is the Nile. The area between the White and Blue Nile Rivers south of their junction is the Gezira, the world's largest agricultural project -- an irrigated cotton scheme begun in the 1920s, which is still (with enlargements) a key part of the Sudanese economy. The economy is primarily agricultural, with 80 percent of the population dependent on agriculture; about two-thirds of agricultural production is from rain-fed areas, despite debilitating droughts and a concentration of government aid on large irrigation schemes. According to the World Bank, per capita income grew from $130 (U.S. current dollars) in 1968 to $440 in 1979, fell to 320 by 1985, and then rose again to $480 by 1988, which puts it at about the same level as Indonesia. The two countries have little else in common. Sudan has a far less egalitarian distribution of income,[61] less socioeconomic infrastructure, recurrent droughts and famines, and a decades-old civil war between the Moslem Caucasian north and the Christian/animistic Negroid south that has seriously drained development funds and efforts. Literacy is also very low (28 percent for men and only 6 percent for women in the 1983 census), with great regional disparities (e.g., 58 percent overall in Khartoum province versus 4 percent in the Southern province of Bahr El Ghazal).

Modern agricultural development is concentrated along the Nile and its tributaries, but there is increasing investment in mechanized agriculture across the wide plains of the savannah belt, where rain-fed production is possible. This is a major agricultural area, and has 90 percent of the irrigated and mechanized farming. Just to its north is the other principal agricultural area, the Sahel zone, with rainfall of 300-500 mm/year (compared to 500-800 mm/yr. in the savannah zone, and less than 300 mm in the semi-arid and arid zones north to Egypt). Sedentary farmers are numerous in both the Sahel and savannah zones. Most have small plots: 73 percent have less than 5 feddan (2 ha).[62] Traditional agricultural land, "suffers severe fragmentation and holdings are very small, averaging less than 2 feddan, with 80 percent having less than 3 feddan" (Abu-Shaikha, 1983). Most of these families are below the poverty line. In the country as a whole, some 70 percent in rural areas and 20 percent in urban areas are below the poverty line (ibid., 92ff). Moreover, it is in these rural areas, especially Darfur and Kordofan in the West and the Eastern and Red Sea provinces in the East, where recent famine and environmental

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[61] Income levels in rural areas are very much lower than in urban areas, which contributes to rural-urban migration. In a 1967/68 household sample survey, mean rural incomes were roughly a third of urban incomes (148 Sudanese pounds per year vs. 411, with 4% of urban and 34% of rural households having less than 100 pounds: Abu-Shaikha, 1983: 31). Income distribution in the country as a whole worsened between the 1950s and the 1970s (ibid., pp. 32, 35).

[62] One feddan = 1.03 acres.

degradation have been most pronounced (Abu-Shaikha, 1983). A closer look reveals a complex pattern of desertification, deforestation, and erosion due both to the combination of increasing human and animal populations (livestock accounts for 40 percent of agricultural GDP: World Bank data) and to traditional and modern agricultural practices that "mine" the vulnerable sandy and clay soils for short-term gain, leaving them unable to regenerate (Sudan, 1986:4; Ibrahim, 1984).

Natural Resource Degradation[63]

Although much of the north is arid and semi-arid, the soils themselves are generally adequate; the real limitation is water. Sudan once had substantial forests: tropical closed-canopy forests in the south, and open savannah forests throughout the rest of the country. Recent estimates indicate it has lost 74 percent of its initial forests (WCMC, 1992 draft:65). The rate of recent deforestation has apparently been high (cf. Table 2 in Section III above).[64] If annual increments in tree stock by province are compared with consumption levels for 1983 in Abu Sin and El Sammani (1987:33, from data of the Sudan National Energy Commission; the same data are used by Whitney, 1987), then every province outside the southern region, including rural provinces like Kordofan and Darfur, shows a significant deficit.[65] Excluding the south, consumption was 60 million m^3, compared to growth ("annual allowable cut") of 15 million m^3. In a study of the causes of deforestation in the Sudan, Whitney (1987:120ff) states that the amount attributable to household fuelwood consumption rose from 7,500 km^2/yr. to 28,000 km^2 between 1960 and 1980.[66] This was due to: (a) an increase in population; (b) the growth of urban areas; (c) an increase in per capita consumption; and (d) a decrease in the volume of woodland stock growing in accessible areas ("growing wood stock equivalents"). In fact, (d) accounted for only 11 percent and (b) and (c) together for only 27 percent of the increase, which was therefore attributable overwhelmingly (61 percent) to (a). The National Energy Administration of Sudan predicts that within 10 years all of northern Sudan will lack wood for

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[63] Much of the material in this section is derived from an unpublished 1987 paper by David Pearce. A version of this paper is Chapter 6 of Pearce, D.; Barbier, E., and A. Markandya, 1990. Sustainable Development: Economics and Environment in the Third World, Earthscan, London, 1990.

[64] Legislation passed in 1984 prohibits cutting down trees without government permission, but there has been no enforcement.

[65] The south is omitted because of the civil war.

[66] Commercial logging, overgrazing, fire, and pests, collectively accounted for less than 10 percent of deforestation.

energy unless a massive program to regenerate forests is undertaken.[67]

Finally, Sudan has the largest wetlands in Africa by a factor of five (WRI, 1990), mostly in the south along the upper reaches of the sluggish but clear White Nile. The Blue Nile, on the other hand, rushes down the deforested slopes of Ethiopia into the Sudan, carrying vast amounts of topsoil with it, which enrich agricultural land in Sudan's Nile valley, but also silt up the river downstream of the Aswan Dam (in southern Egypt) far faster than had been expected.

Natural resource degradation is related to migration movements in the Sudan. For example, the loss of fuelwood and trees contributes directly to human migration movements. Similarly, the draining of wetlands to create new irrigated agricultural schemes has attracted migration to the central and eastern areas.[68]

Types of Migration

The population of the country is largely rural and settled. An estimated 11 percent is nomadic and about 20 percent resides in urban areas, with urbanization proceeding rapidly (particularly since the 1984-85 famine), and the primacy of the three-city capital area increasingly pronounced - there are now over 2 million permanent residents in the Khartoum metropolitan area plus perhaps a million more displaced persons from the south and west). Environmental degradation and drought have made it difficult for rural families to survive with animal husbandry and cultivation alone, so many families have some members engaged in wage employment that involves migration -- either to urban areas or large farms -- at some point during the year (El Sammani et al., 1986). Significant forms of migration[69] include: (1) nomads, who may be considered "permanent migrants"; (2) seasonal (and sometimes permanent) migration by over a million people from subsistence farms in the West to large, irrigated agricultural estates in the Gezira and the East, especially to pick cotton; (3) a large semi-nomadic population engaging in shifting cultivation in the Sahel zone; (4) high and steady rural-urban migration, with many families having one or more members working in a city; (5) the 1984-85 movement, apparently permanent, of about a million "environmental refugees" from the West to Khartoum and the East in response to the drought and possibly the southward

[67] However, there are no reliable forest inventories for the Sudan. Anderson and Fishwick (1984) state that consumption exceeds annual supply by 70 percent. The need for a national inventory of forests is widely recognized (Sudan, 1986; World Bank data).

[68] See (3) in next section, and also the later section on the Jebel al-Awliya Dam.

[69] A general discussion of internal migration movements is found in Ahmad et al. (1987). But serious deficiencies in census data, along with the fact that the last census was in 1983, only covered the northern area, and did not obtain place of previous residence, reduce the value of the data. Also, linkages with environmental processes are not described by Ahmad et al..

movement of the Sahara desert;[70] and (6) half a million migrants to the Khartoum area, displaced by the civil-war in the South. There is also (7) a high rate of net international emigration of semi-skilled, skilled, and professional workers to the Gulf and other Arab states, resulting in serious shortages of educated labor in some sectors; on the other hand, the money remitted (in 1984-85, over $3 billion, equivalent to 40 percent of official GDP) is crucial to the economy. Last (8), Sudan is host to a million political refugees from Ethiopia, Uganda, and Chad, who contribute to ecological imbalance in certain areas of the East and West, notably through their heavy fuelwood use.

Environmental Degradation in Areas of Origin, Migration and Further Degradation through Extensification

A major cause of desertification in the Sudan is said to be the expansion of cultivation onto marginal lands, partly in response to declining yields in existing fields (in turn due to soil depletion, erosion, and salinization caused by population growth and poor land-use practices). The expansion of rain-fed, mechanized, and irrigated agriculture in the context of population growth and government export-oriented agricultural policies,[71] combined with the skewed distribution of land and lack of land titles or secure tenure, is thought in recent years to have pushed cultivators and pastoralists onto increasingly marginal lands. Links exist between the so-called desertification process and all eight types of migration listed above.[72] Given constraints of time, space and documentation, not all these linkages can be analyzed. The remainder of this case study therefore discusses linkages, as seen in the literature, for types (1), (2), (3), and (5), and examines whether environmental factors were seen as significant causes of migration, and, further, what were seen as migration's environmental consequences. This study also looks at the strength of the evidence backing claims in the literature.

One region where these patterns have been well-documented is northern Darfur, an arid area of high rainfall variability, where mixed subsistence cultivation and pastoralism are traditional. Nomadism is highly-suited to such areas of variable rainfall, as elaborate grazing

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[70] While the literature contains numerous references to the Sahara desert's rate of southward advance -- at 5 km per year or more -- these appear (Nelson, 1990:7) to derive from a single source (Lampung, 1975), and have been hotly contested. It is not clear how uniform or "permanent" the vegetation loss is, nor whether it involves more than the replacement of palatable by unpalatable species. What is clear is that the natural environment has suffered serious degradation, from a combination of drought- and human-induced forces: Nelson (1990) attributes 70 percent of the problem to this combination.

[71] The policy bias towards mechanized farming contributed to rural-urban migration: family farmers were forced off their land to make way for mechanized farms, and, though some have found local wage employment, the living standards of many declined, so they migrated to the cities. The large farms also blocked traditional nomadic grazing paths and created conflict between nomads and farmers.

[72] This is the case regardless of whether desertification is caused by recent trends or by the short-term drought cycle (e.g., two years of every 10) which has been evident throughout Sudan's history.

routes make efficient use of scarce water and vegetation. Herds follow rains at calculated intervals, allowing vegetation to replenish itself each year; sedentary animal husbandry, in contrast, by using the same land year-round does not allow for replenishment. As the population has grown in Darfur, areas of sedentary livestock show a pattern of vegetation virtually disappearing near settlements (Ibrahim, 1984):[73] such settlements are always built around secure sources of water, and the many boreholes dug in the 1960s-70s during the national campaign for universal provision of water became centers of such settlement. From the air, desertification rings can now be seen around each of these settlements (Rahman, 1986:6).[74] It now appears that the boreholes were too deep, given the sparse natural vegetation available in the vicinity. The provision of so much water attracted too many people and animals in relation to the size of nearby grazing areas.

Previous patterns of shifting cultivation in northern Darfur are giving way to large agricultural projects, which involve completely clearing large areas of trees and vegetation, leaving bare, vulnerable soil. Topsoil is then scratched and loosened during planting and weeding, and exposed for 8-10 months between rains. Much is blown into the atmosphere, contributing to the increasing levels of atmospheric dust and wind erosion. Most large projects in Darfur -- as well as the small farmers who have gone into cash cropping -- raise millet, a crop which does not protect against soil erosion, since it sticks straight up and is planted fairly far apart. As a result, land productivity has declined significantly from over 600 kg/ha in 1960/62 to 350 kg/ha in 1973/75 (Ibrahim, 1984: Table 27). Thus, the move towards "modern" rain-fed agriculture -- in practice, monocropping millet -- has not been successful and has contributed to land degradation.

A family of six consumes about 1,500 kg of grain per year and must therefore cultivate at least 15 ha. for its subsistence (Ibrahim, 1984). The population of the region has grown ten-fold since the beginning of the century, and the animal population has also dramatically increased over the last 40 years. This, combined with the expansion of commercial farms, has placed considerable stress on cultivable land; most families do not now have access to the needed 15-ha minimum for growing millet. Fallow times have accordingly been reduced: 72 percent of farmers now engage in permanent cultivation without any fallow periods (Ibrahim, 1984: Table 28), while only 7 percent allow the recommended minimum of four years for soil fertility replenishment. Thus the traditional system of rotating crops and fallowing has largely been abandoned, and land has consequently been degraded. Population increase has led to excessively intensive cultivation which, in turn, has led to soil erosion and impoverishment. To compensate for the 50 percent decrease in millet yields, the population of the region, increasing at a rate of 2.5 percent per year (net of out-migration), has expanded the area under cultivation. For millet, for example, this has expanded from 392,000 ha in 1960 to 1,055,000 ha in 1975, further denuding the landscape of vegetation and thereby pushing pastoralists northward to more confined grasslands where overgrazing inevitably occurs (Ibrahim, 1984).

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[73] "Although average population density in the Sahel zone is less than 10 inhabitants per km^2, it is said to be, in fact, overcrowded" (Ibrahim, p. 17).

[74] Barnes (1986) notes that urban firewood demand has created rings of deforestation up to 100 km radius around many cities in sub-Saharan Africa.

An accompanying problem in northern Darfur is deforestation, caused by both land-clearing for cultivation purposes and tree-cutting for fuel and building materials for the growing population. Fuelwood constitutes 94 percent of household energy consumption in the Sudan (with animal dung and crop residues accounting for another 5 percent, though these are needed for natural fertilizer and animal feed) (Anderson and Fishwick, 1984: 12), and for 82 percent of all energy consumed. The average consumption of wood per family is a donkey load (50-70 kg) per week; over a year, a family uses 195 trees and shrubs (Ibrahim, 1984: Fig. 37). Replacement or replanting is virtually nonexistent. The distance traveled to obtain wood has risen: rapidly-increasing wood prices (in both Darfur and the country as a whole) are mostly due to increased transport costs.

Linkages between the environment, permanent out-migration, and seasonal labor migration from the large provinces of Darfur (North and South) and Kordofan in western Sudan are also described by: deJong-Boon, ed. (1990); El Sammani and Nour (1986); Rahman (1986); and Khogali and El Sammani (1986). The broader picture of environmentally-induced migration flows and the effects of human (and animal) population movements on resources in the western Sudan is sketched in Figure 3. In recent decades, the population of these provinces has been growing at a (natural or a priori) rate of around 3 percent per year, at the same time as the frequency of droughts has increased. Nomads living in traditional grazing lands in the northern parts of the province (where annual rainfall is less than 300 mm) have had to move southward with their herds of cattle, sheep and goats (Rahman, 1986:6; Khogali and El Sammani, 1986:170 ff). Improved veterinary services have led to better survival rates for diseased animals, with the result that livestock numbers per capita have tended to rise: in Kordofan, the number of all animals combined rose by over 300 percent in 1957-81, according to El Sammani and Nour (1986: 347). Increased herd sizes and the increasing southward migration of nomads and pastoralists have both led to worsening conflict with sedentary farmers.[75] Major nomadic migration routes are also being closed off by increases in the number and size of permanent settlements of sedentary farmers; these force pastoralists to concentrate herds in the fewer areas that are not closed off, thus increasing pressure on vegetation and water resources, and thereby causing further land degradation.

In attempting to achieve total production sufficient to maintain their standard of living, sedentary farmers have responded to the general decrease in rain since the late 1960s (see Nelson, 1990, chart 1) by expanding the quantity of land in use. This is done by reducing fallow land and has the effect, over time, of reducing soil fertility and hence yields (Rahman, 1986: 8).[76] Farmers then sought to further expand areas under cultivation (especially in

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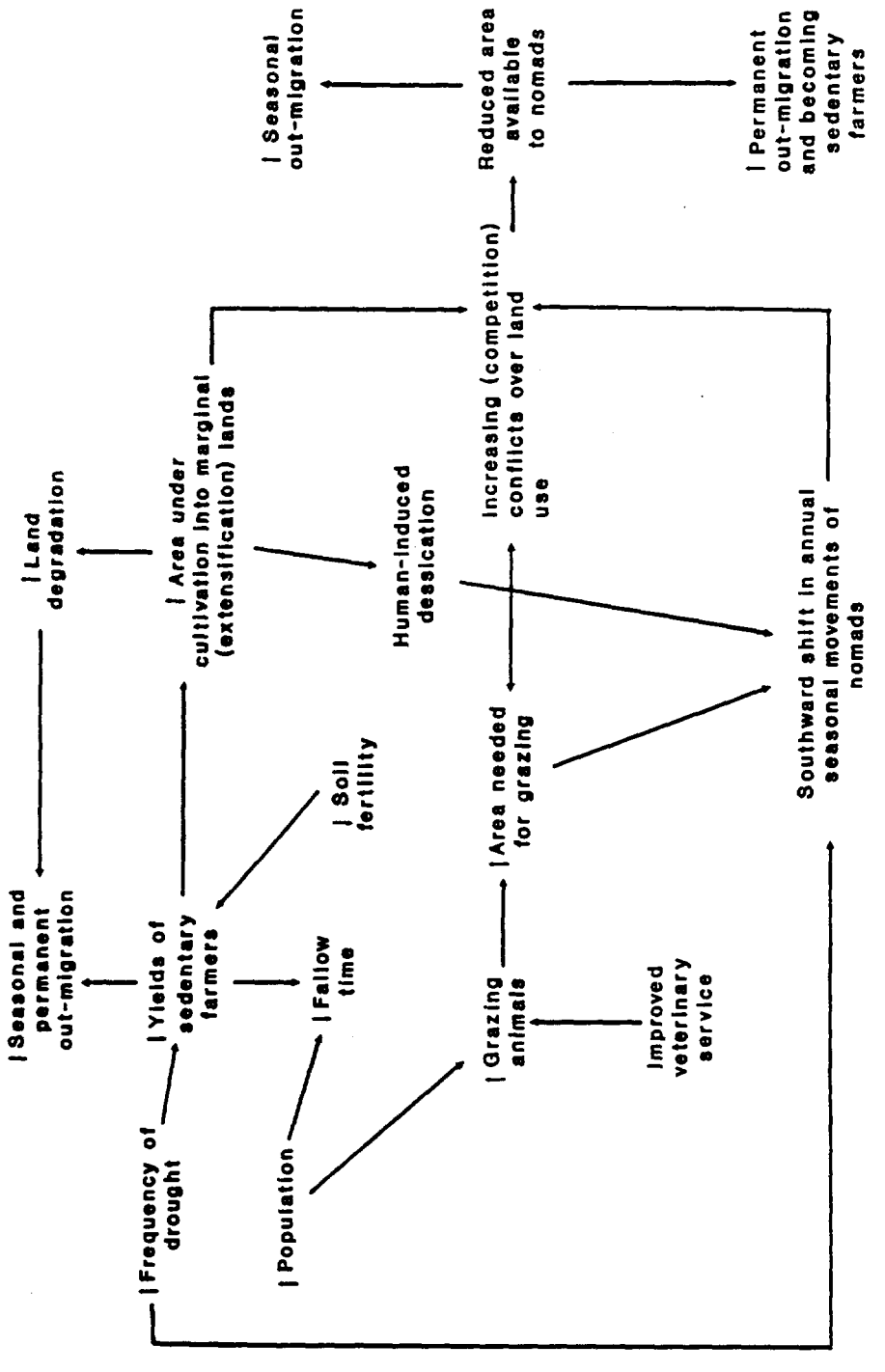
[75] In recent years, this has happened widely in sub-Saharan Africa: c.f.,Little on Kenya, in Little and Horowitz (1987), and studies cited in Bilsborrow and Stupp (1987).

[76] It is interesting that El Sammani and Nour (1986: 350 ff) attribute the decline in agricultural yields between 1960 and 1985 to the "loss of trees" (p. 352). Leguminous gum arabic trees (Acacia senegala), which provide needed organic matter, are not only nitrogen-fixing, but also serve as effective shelterbreaks and windbreaks, so the substantial depletion in their number is seen as particularly costly (deJong-Boon, 1990: 335).

Figure 3 Demographic and Environmental Interrelationships in Kordofan, Sudan



millet, the basic food) onto nearby marginal lands, where rainfall averaged as little as 200 mm. Although extensification is, in fact, responsible for most of the increase in agricultural production in the Sudan over the past 30 years, this more recent extensification in the western Sudan, usually involving short-distance migration within the west, has generally involved the increasing use of low-fertility soils and/or areas of low-rainfall. As a result, yields are low and, after a few crops, fall further, thus spreading desiccation. This, in turn, increases the likelihood that families will need to send someone (usually the head and/or oldest sons) elsewhere (usually east) as seasonal migrants, to generate sufficient income for the family to survive in western Sudan. If sufficient income cannot be generated, the whole family must move to survive.

The seasonal migration of male wage laborers from western Sudan to large-scale irrigated agricultural schemes in the Gezira and eastern provinces involves a good fit between the dry season (slack time) in the west (November to June) and the peak labor demand periods in the east (Khogali and El Sammani, 1987: 176 ff). Indeed, "sedentary" farmers living in the northern parts of Kordofan and Darfur have long engaged in seasonal migration, leaving at the beginning of the dry season to work on agricultural estates in the Blue Nile province (traditionally tapping gum arabic trees); recently, this seasonal migration has increased in volume and has become directed more to the Gezira and Khartoum areas (Khogali and El Sammani, 1986:167), possibly in response to increased demographic and environmental pressure in the western Sudan. Yousif (1986) notes that Gezira projects provide permanent employment for about 100,000 tenant farmers as well as half a million seasonal migrant families (p. 4), about half of whom come from the distant western provinces. Based on the 1981 Gezira Village Census and his own survey of 627 seasonal migrants, Yousif finds that almost all (some 88 percent) of the migrants from the West have access to land and engage in rain-fed agriculture in their areas of origin. In general, whole families move, but less than 10 percent bring their animals.

Spatial mobility in the form of these large-scale seasonal migrations from the west help the national economy by providing cheap labor for large-scale irrigation projects. However, the large numbers involved and their total dependence on their employers in places of destination have resulted in very low wages that have done nothing to alleviate rural poverty. Indeed, survival strategies of western farmers based on seasonal migration to the Gezira may only serve to perpetuate it (Khogali and El Sammani, 1986: 180). Moreover, since most of this migration is seasonal, it does not permanently alleviate population pressure in areas of origin (e.g., northern Kordofan), and land degradation therefore continues in these places (ibid., p. 182). The only long-term solutions are thought to be demographic -- permanent emigration to other areas, or reduced fertility (ibid., 184-5).

The Case of the Jebel al-Awliya Dam

Traditional relations between rainfall, land use and human and animal migration movements in the Sudan are illustrated in Horowitz and Salem-Murdock (1987). They describe the situation in the area of the White Nile Province, along the river of the same name, in Central Sudan south of Khartoum, prior to and after the effects of this major irrigation project. Semi-sedentary farmer-pastoralists west of the area would traditionally graze their animals and raise millet (mainly) in their uplands home areas during the four-month wet season, then bring the

animals down to the valley on the west side of the Nile during the dry season, to graze and water them. By the time the rainy season caused the river to overflow its banks and restore the swamps along the river, grasses would have returned to the uplands and the farmers with their animals would return to their home areas. This natural cycle was dramatically altered by two factors: the Jebel al-Awliya Dam, finished in 1937; and the acceleration in population growth due to decreased mortality, which probably became significant in the 1950s.

The dam was built to provide water for irrigated cultivation of cotton for export. But by eliminating the swamps caused by annual flooding, the dam deprived upland herders of grazing for their animals during the dry upland season. At the same time, both human and animal populations grew, thus raising the area needed for pasture. Farmers were consequently forced to expand the area under cultivation onto marginal land (for example, north into semi-arid areas), where soil fertility declined after only a few seasons. Animal-raising also became more problematic as livestock had to be kept throughout the long dry season in the uplands where food and water were scarce. As a result of these difficulties, male household heads migrated to the irrigated area during the dry season to work as seasonal laborers for large and small farms. These latter did not want the migrants to bring their animals because it was thought they would distract them from their labor (Horowitz and Salem-Murdock, p. 99). With the irrigation, native populations near the river, which used to be dispersed in the dry season, now became more concentrated, thus putting further pressure on the land.

Land Tenure Issues

The issue of land tenure in the Sudan and its relationship to land use is important and complex. Historically, land tenure in the Sudan has been under the jurisdiction of the traditional community or tribal leaders (called "Native Administrators"). Through the tribal households (*dar*) system, they allocate land, water and tree rights to people in the community, and to others who may in-migrate. However, these rights of use (*usufruct*), while they can be inherited and subdivided among heirs, are not full ownership or property rights, since they can only be sold back to the community. In most cases, the traditional system served to ration access to resources in such a way as to maintain their productivity.[77] In 1970, the Unregistered Land Act formally abolished traditional land controls and Native Administrators, declaring that all land not previously registered, which was almost all, was the legal property of the state (i.e., central government). The government, in turn, gave legal control to appointed local councils. Although the tribal leaders still have considerable power over land use, their control is weaker, a factor which is said to have led to deforestation in some areas (deJong-Boon, 1990: 22; Abu Sin and El Sammani, 1986: 61). In some cases, the diminution of their authority has resulted in quasi-common property rights situations, where the "tragedy of the commons" has taken

[77] It is difficult to say what would have happened if the system had continued to the present, with population almost doubling between 1970 and 1990.

effect.[78]

Whether to provide more secure land tenure, and in what form, continues to be a significant issue. A 1986 Sudan Government document recommended registering user rights and granting "long-term leases of 25 years, with heritable rights but without the right to subdivide the holdings" (Sudan, 1986: 17). While some form of user rights short of full private property rights, would be desirable if effectively implemented, these would not permit their leasees to sell them, thus reducing the incentive to invest in improving land, or even in maintaining its fertility, particularly during the latter part of the 25 years.[79]

Conclusion

In contrast to the other case studies above, the Sudan study has focused on environmental degradation in migrants' areas of origin. This author is not aware of any research on the extent to which either seasonal or permanent out-migration has alleviated environmental pressure in areas of origin. Some of the permanent migration flows to areas outside the west have also had negative environmental repercussions in areas of destination that have received little attention: overcrowding of people and animals on the fringes of the Gezira and other mechanized farm and irrigation projects, vegetation destruction, etc.

Push factors have probably played a larger role in internal migration in the Sudan than in most countries, given the high degree of rural poverty and the vagaries of the weather. People have been migrating from the west and south toward Khartoum and the northeast since at least the 1950s, well before the environmental crises and famines of the 1970s and 1980s. But population growth and more frequent droughts have caused significant increases and changes in these movements.

Population growth in recent decades has led to an expansion in areas under cultivation by sedentary farmers onto marginal areas. This has apparently caused significant land degradation and desiccation, and has led also to increasing encroachment on the traditional grazing lands of nomads, forcing them onto even more marginal areas, which are overgrazed and degraded in turn. This degradation is directly influenced by human practices and should not be viewed as temporary and/or climate-induced. "Man himself is the ultimate victim of desertification" (deJong-Boon, 1990: 352), and also its cause. That said, given the poverty of a rural population that continues to grow and the expected absence of a dramatic improvement in yields, the

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[78] The term is from Hardin, 1968. The same tragedy is evident in areas unaffected by the 1970 Act, i.e. where open access to a resource was already in place: one specific example is trees on common lands in Kordofan communities (deJong-Boon, 1990: 22).

[79] Of more immediate concern is the recent practice of allocating long-term leases to high-quality land in central Sudan to Khartoum residents for a pittance (one Sudanese pound per feddan). Since the Civil Transactions Act of 1984, reflecting Shari'a law, allocates 100 percent of the right to the crops produced on the land to the owner and none to the cultivator, this has created a wealthy coterie of urban landlords and has not helped rural farmers or laborers. It is also thought to contribute to monocropping and a quick-returns approach to land use, both of which are deleterious to the environment. Low prices for land in mechanized agriculture may also contribute to soil mining.

arguments for allowing further expansion of the agricultural area are powerful (see Sudan, 1986).

Among the many policy remedies suggested are: land tenure and regulation of land use rights; increased credit and a shift in its allocation toward small farmers in rain-fed areas (deJong-Boon, 1990: 337); much higher land-user (lease) fees and a rationalization of the current plethora of complex, small land taxes; a land inventory, and assessment of land capabilities to plan new population settlements;[80] taxes or user fees for water and cutting fuelwood; community woodlots, to encourage community regulation of tree cutting; restoration and preservation of gum arabic trees in western Darfur; reconstruction of shelter breaks and windbreaks to reduce water and wind erosion; price policies which provide incentives for agricultural production and exports (such as gum arabic) rather than disincentives; and diversification of the economies in intermediate-sized cities to increase off-farm, non-agricultural employment (deJong-Boon, 1990: 355); and, of course, lower population growth. Environmental education and training for farmers and government officials are also important. Evidently, there are also a number of serious research needs, including: better data and maps on tree/vegetation cover; research on testing new semi-arid seed varieties under conditions prevailing in Sudan; and survey research on small farmers and pastoralists to better understand their land use practices, reasons behind them, migration experiences and plans, and so on.

VII. Some Tentative Conclusions

These are arranged into four categories: first, general conclusions, based largely on the three case studies, on the linkages between rural poverty, migration and the environment; second, evidence on the role of environmental factors in influencing (out-) migration decisions; third, findings about the effects of migration on the rural environment in both areas of origin and destination; and last, a short list of policy improvements many countries should consider. Evident throughout is a final, uncategorized conclusion, namely the severity of existing data limitations.

General conclusions.

In all four countries, whether we are looking at out-migration from densely populated highlands or lowlands areas, whether the form of environmental degradation is deforestation, soil erosion or desertification, and whether the actual movement is autonomous or induced by the government, rural poverty, migration flows, and environmental degradation appear closely linked, despite a scarcity of direct data at the micro or household level. Environmental factors in areas of origin sometimes influence out-migration, and environmental consequences in areas of destination are often widespread, negative and readily apparent in situations of land extensification associated with migration to marginal lands. Even a small number of in-migrants

[80] As Ethiopian refugees leave eastern Sudan to return to Ethiopia, this will create labor shortages and openings for Sudanese on the large mechanized projects south and east of Khartoum.

can cause considerable damage to such fragile environments. The environmental literature has focused on the consequences of deforestation of biologically rich tropical rainforests, but has failed to examine its underlying causes. These latter can only be understood in the context of those factors underlying on-going rural-rural migration movements: why people leave their areas of origin;[81] why they choose fragile environments as their destination and why they engage in environmentally-destructive land use practices. Unfortunately, this study cannot provide complete answers to such questions given the lack of appropriate data and analyses. This is due to lack of interest -- at least, until very recently -- in developing country environmental matters, and also to the concentration of migration research on rural-urban migration -- a concentration which reflects the "urban bias" of researchers, almost all of whom were raised in urban areas, and which parallels the urban bias of development policies in general (Lipton, 1987). The lack of appropriate research also reflects the discipline-bound nature of academic departments around the world, which conflicts with the multidisciplinary approach needed to analyze the subject effectively.

Environmental Causes of Out-Migration

Linkages between environmental factors and migration are likely to become more important over time as rural populations continue to experience significant natural population growth throughout the developing world, and as environmental degradation continues to worsen, as expected. These developments will continue to threaten living standards, exacerbate rural poverty, and stimulate out-migration. Given the omnipresent concern of Third World governments to reduce out-migration from rural areas (especially rural-urban migration), some redirection of policies to ameliorate the pace of environmental degradation in rural areas of out-migration might usefully complement present policies dealing mainly with rural employment and infrastructure.

Migration's Environmental Effects

The environmental consequences of in-migration for rural areas of destination depend on: (a) the size of the migration flow compared to the physical size of the receiving area; (b) the origins, background, characteristics and attitudes of the migrants; (c) the ecological conditions, carrying capacity, and competing demands for land in the receiving area; and (d) national government and local community policies. Relevant policies include those relating to: the use of land, trees, and water resources; the permissible size of plots and land-titling policies; access roads and marketing assistance; credit and extension services; and agricultural pricing, including taxes and subsidies. Evaluating the environmental effects of in-migration requires understanding how land use and land clearing decisions are made in frontier environments. The environmental costs in areas of destination must be compared to the benefits to the migrants themselves in the

[81] The theory of the determinants of migration can be used to evaluate the extent to which environmental factors influence out-migration decisions. But migration surveys have not specifically inquired about the role of environmental factors.

area of destination plus any environmental benefits in areas of origin. In the particular cases examined here, negative environmental consequences appear to be less serious in Indonesia and more serious in the Sudan, with the Latin America cases falling in between. The case of Indonesia illustrates the potential environmental value of policies that direct rural-rural migration flows rather than allowing them to take a spontaneous and ecologically-dubious course. Site selection can reduce environmental damage, and the migrants can be provided with assistance that help them adapt to their new environment and therefore induces them to remain in that area. But, given the high demand for transmigration, the GOI became more involved than necessary; it could have provided fewer benefits to a larger number of migrants and thus cut down on the total cost of the program.

While there is an incipient literature on the environmental consequences of in-migration for destination areas, in the countries investigated here and in others, there is almost nothing on consequences for areas of origin. These also will depend on (a), (b) and (d) above, as well as on (c) redefined to cover origin rather than destination areas. With regard to (b), a key factor is the out-migrants' landholdings in places of origin. To the extent the out-migrants are from the landless or very small farm-size categories, out-migration is linked closely to rural poverty. If it is from small farms, it can help moderate pressure on the land and alleviate overly-intensive agricultural practices. There is a presumption that this is the case in all four countries, although there is little data on origin areas of rural-rural migrants. However, in the cases of Indonesia and Ecuador, for which some micro-level survey data do exist, well over half the migrants appear to have been landless in their areas of origin, so their exit cannot directly alleviate pressure on land in farms. However, given a broader view of resource use and depletion, it is evident that the landless pressure resources from the demand side, and that these -- for example, fuelwood and water use -- can be important concerns in densely-populated areas, where these resources have already been seriously depleted. This issue of depletion of "common property resources," has not been investigated in any of the case-study countries here (nor perhaps anywhere else).

Relevant Policies

A brief list of policies to deal with the problems of environmental degradation in migrant destination areas would usually include:[82] preparation of a detailed national inventory of land and water resources,[83] and a land use plan to protect biologically important or fragile areas and direct new agricultural settlements elsewhere; coordination of this plan with the construction of

[82] Some of the countries, especially Indonesia, have already adopted some of these.

[83] Such an inventory would ideally assess not only the land's physical aspects, capabilities and current use, but also legal titles and competing (e.g., indigenous) claims. Even in countries with seemingly vast, untapped land areas, such as Indonesia and Ecuador, there really is no "vacant" land. Either adat law grants control over traditional lands to local communities in Indonesia, or indigenous populations use and depend upon large areas for their customary shifting cultivation practices, as in the Ecuadorian Amazon.

roads;[84] better coordination across government agencies in the development and the implementation of policies related to land use;[85] reductions in population growth, as an underlying driving force behind migration decisions; improvements to land-utilization in traditional areas of settlement, to reduce both over- and under-utilization of land;[86] development of a system of land tenure which provides land users with incentives to maintain productivity;[87] environmental education programs both in schools and for farmers, designed to create a national environmental consciousness and a greater appreciation for the country's natural beauty and assets; and the promotion of new and appropriate systems of data collection and analysis,[88] to assist in understanding underlying processes and developing more refined and appropriate policies. Finally, broad-based macro-development policies aimed at improving incomes in rural areas, relative to urban areas, can have significant beneficial effects in terms of reducing

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[84] Deforestation, or any other form of natural resource degradation, cannot automatically be viewed as negative in the context of high rural poverty. Given poverty levels, migration is going to take place; policies must therefore be in place to ensure that it is directed to areas that are less ecologically fragile or important (e.g., in terms of biodiversity). Road construction is an important component of such policies.

[85] All four countries need to make improvements in this regard: too many agencies work at cross-purposes in all the cases examined in this study.

[86] Poor land-utilization, and consequent rural poverty, is another factor behind out-migration. Corrective policies may include land taxes, presumptive income taxes on land, or land redistribution.

[87] Such systems include secure land titles held by individuals, groups or communities, or community control over land-use. There are many examples of traditional communities exercising effective and sustainable control over their land and forest resources, even in modern times and under growing population pressures and external intrusions. This is true for all the countries examined here. Another example is Meru district on the north slopes of Mt. Kenya, as described by Bernard, 1989.

[88] Note the repeated importance of having better macro and micro data in order to undertake better policy-oriented analyses. Key macro-level data needs include a time series of Landsat data to show changes in vegetation, forest cover, and land use over time. This can then be matched with maps showing administrative boundaries, transportation corridors, and population concentrations. This is not an easy process and requires interpretation of satellite photographs, familiarity with GIS mapping, etc. It would also be useful for countries to undertake agricultural censuses as often as population censuses, and develop a system of matched ID codes so that the data can be matched and combined by computer. That would facilitate relating agricultural production and land use to demographic processes, including migration. An alternative would be to include several simple demographic questions, along with several on land clearing, in the agricultural census (or even an agricultural survey) (see Bilsborrow and Geores, 1990). At the micro level new and innovative surveys of migrants in areas of destination, with questions on land use and clearing, and of populations in areas of out-migration as well, are needed to provide the data necessary to develop a better understanding of environmental aspects of the determinants and consequences of migration (see conclusions of case studies above and Bilsborrow et al., 1984).

poverty, environmental degradation and rural out-migration.[89]

[89] Indonesia has had considerable success with such a policy during the last two decades.

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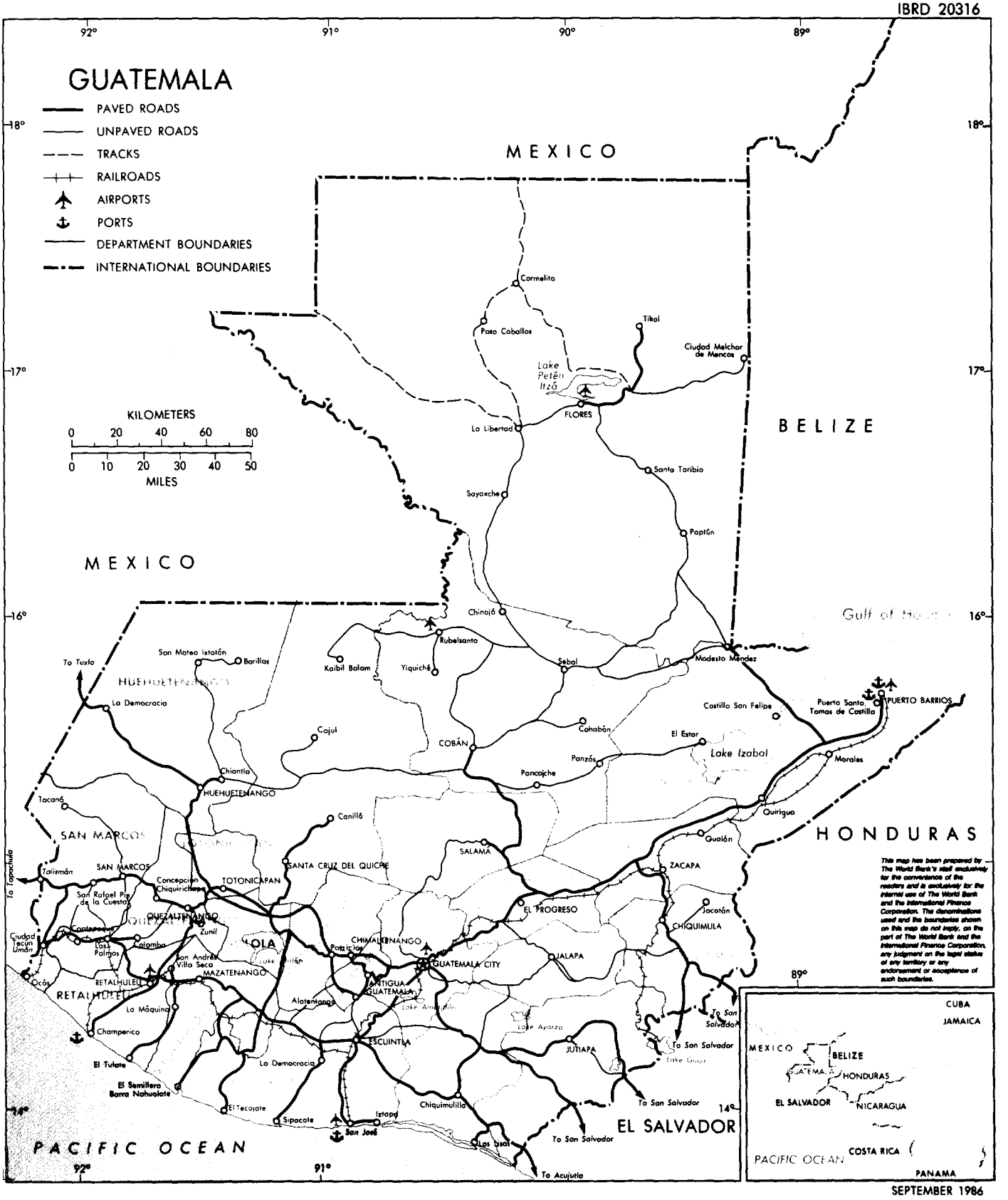

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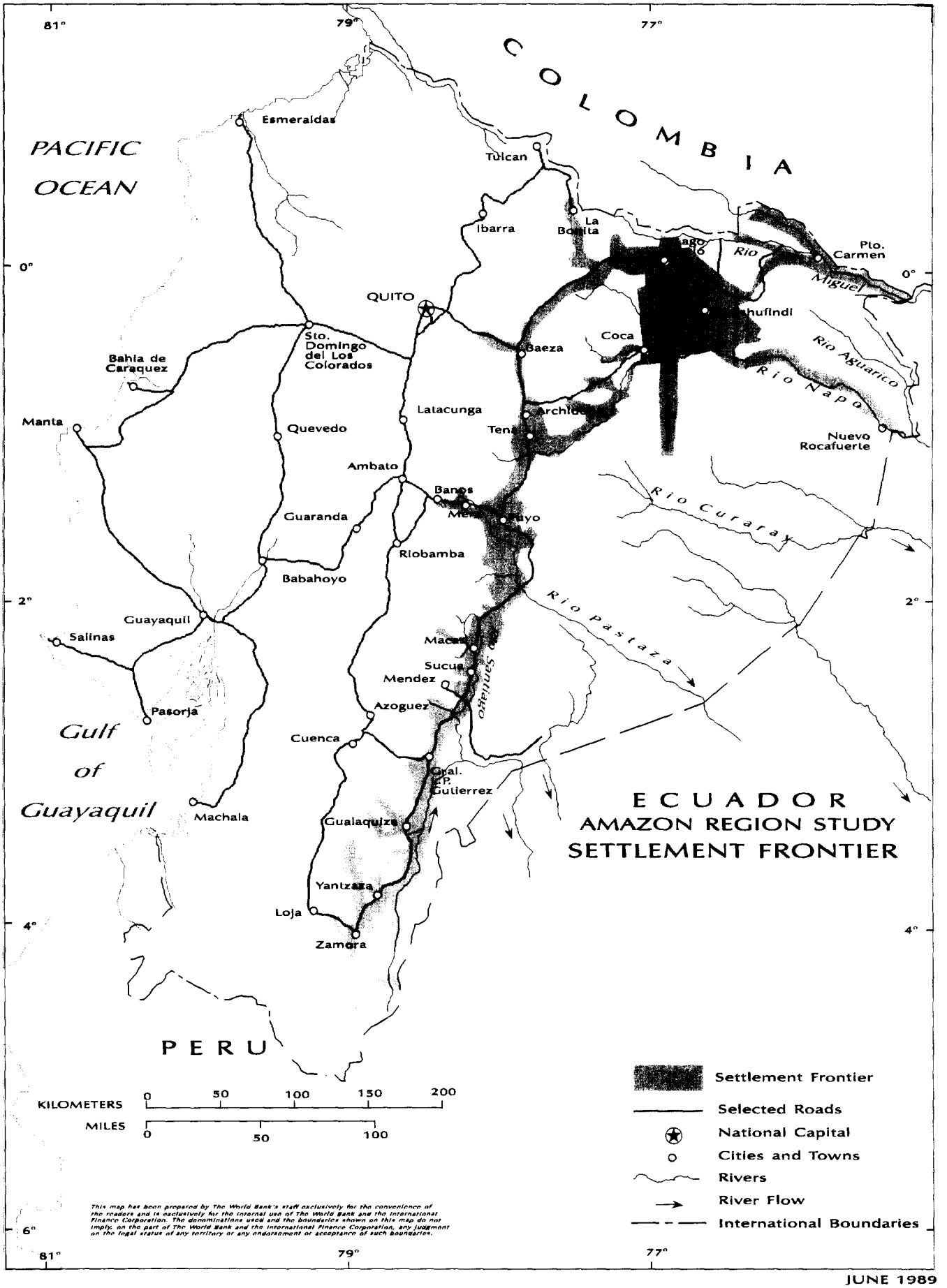

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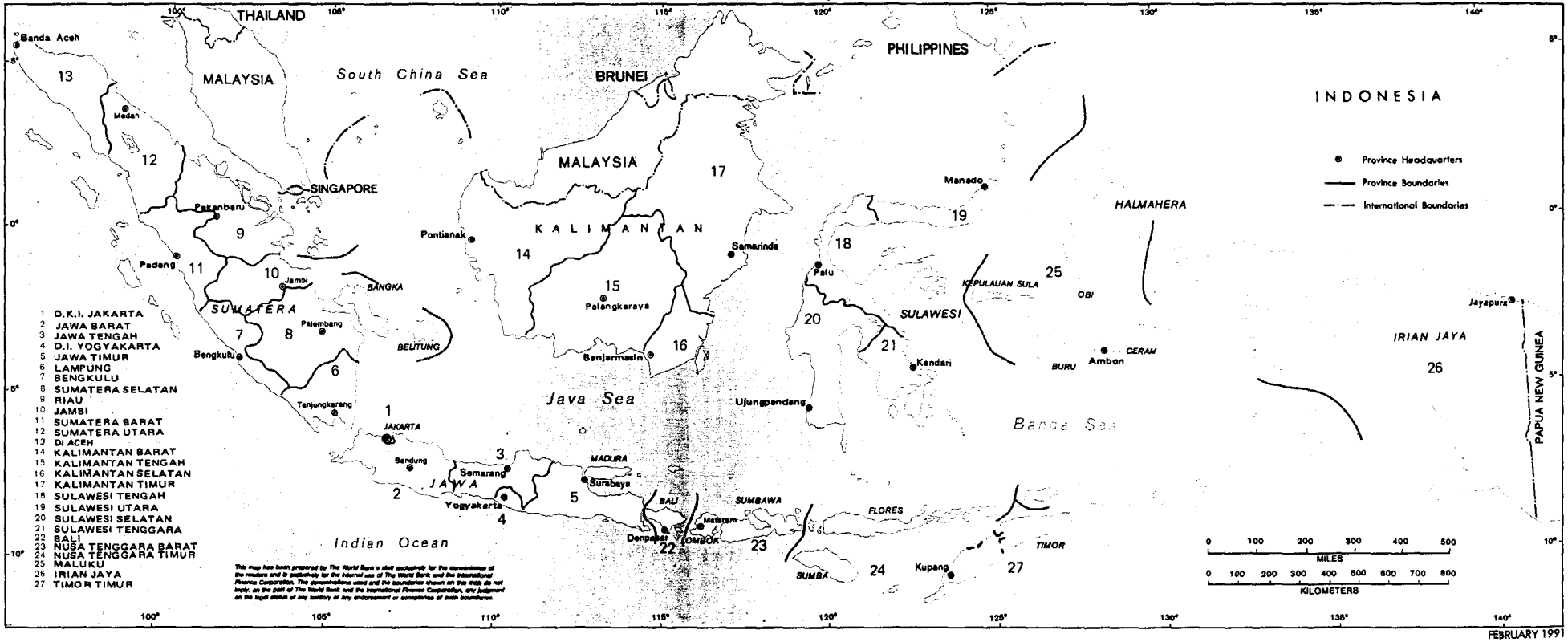

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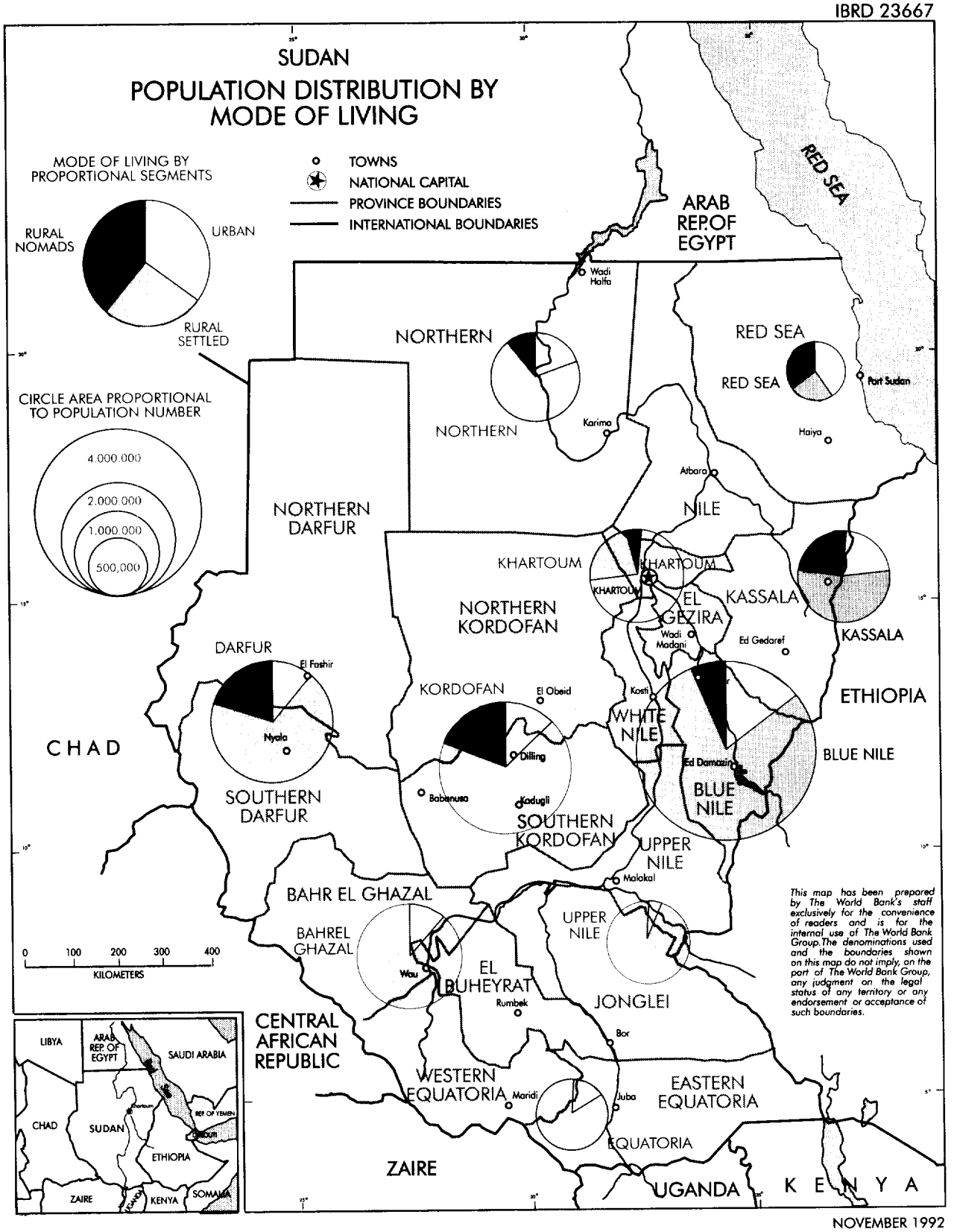

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