Four Theories of Population Change and the Environment

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This paper evaluates current theories of the relationship between population change and the environment, particularly land use, in developing countries. Specifically, this paper critically reviews the literature and suggests what demographers can contribute to testing these theories. The literature can be divided into four main theoretical frameworks. Population growth plays a different role in each of these theories.

(1) For the neoclassical economists, *high population growth is a neutral factor;* it has no intrinsic effect on the environment. How population growth affects the environment depends on whether free market policies are operative. In an efficient market, population growth can serve to induce innovation and the development of advanced technologies. In an economy full of distortions, high population growth can exacerbate the effects of these distortions.

(2) For the classical economists or natural scientists, *high population growth is the independent factor* causing environmental degradation. As an increasing population puts pressure on fixed available resources to maintain or increase the population's standard of living, environmental degradation occurs as resources are depleted. Empirical work has generally centered on estimating the carrying capacity of land to determine what size population can be supported, given available resources.

(3) For many dependency theorists, *high population growth is a symptom* of a deeper problem, poverty. Environmental degradation and high population growth are linked, not in that one causes the other, but in that their root cause is the same: unequal distribution of resources maintained by distorted political and economic relations.

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(4) For analysts that see population as a proximate determinant, *high population growth is an exacerbating factor*. It strengthens the effects of the ultimate causes on environmental degradation. The degree to which these causes, such as distortionary policies and polluting technologies, damage the environment is intensified by the number of people.

It is argued that although these theories present very different world views, they are not necessarily mutually exclusive. Each one presents a partial view of why environmental degradation occurs: The neoclassical economists examine resource allocation issues, the classical economists and natural scientists examine scale issues, the dependency theorists examine distribution issues, and the proximate determinists examine how high population growth can affect all of these issues. Unfortunately, however, few quantitative studies have been conducted that actually measure land degradation and relate it to these theories. In addition, many of the assumptions underlying these theories have yet to be proven. What is needed is further empirical testing of these theories, and it is in this area that demographers may be able to contribute significantly.

INTRODUCTION

The postulated effects of population change on the environment are receiving a great deal of attention from policy makers. Most of this attention stems from a growing popular consensus that high population growth rates in developing countries are adversely affecting the environment.

The relationship is actually much more complicated. This paper evaluates current theories regarding the relationship between population change and land degradation in developing countries and suggests what demographers can contribute to testing these theories.

I argue that the theories reviewed, while based on different notions of ecology, the economy, and human behavior, are not mutually exclusive. Each explains an important component of the interaction between population change and land use. Together, the theories provide a framework to analyze resource allocation, scale, and distribution, and population growth's effect on these three factors.

Unfortunately, however, few quantitative studies actually measuring land degradation and relating it to these theories have been conducted. In addition, many of the assumptions underlying these theories have yet to be proven. In the absence of a stronger empirical foundation, it may be premature to invest large financial resources toward reducing fertility in order to improve the land. However, it can be argued that given the uncertainties about the population and land use relationship, it is only prudent to lower birth rates. What is needed is additional empirical testing of these

theories to inform policy choices. It is in this area that demographers may be able to contribute significantly.

This paper focuses specifically on land resources because of the centrality of land to many developing countries that depend on agriculture for a large portion of their national income, exports, and employment. If population growth does impair land quality, continued rapid growth rates could have serious economic implications for the welfare of these countries in the future.

REVIEW OF THE LITERATURE

The literature can be divided into four main theoretical frameworks—one based on neoclassical economics, the second based on classical economics or natural science, the third based on dependency theory, and the fourth based on a combination of these disciplines.

Neoclassical Economics

1. *Theory*. Neoclassical economists are concerned with whether an economy, under the pressures of a rapidly growing population, can provide an increasing or steady standard of living given that the natural resource base is finite. They argue that, under well-functioning markets, output can keep up with or outstrip population growth. In assessing the ability of the economy to provide for an increasing population, neoclassical economists look at two factors: the possibility of substituting manmade goods for natural resources and the ability of technology to allow more efficient use of the resources available. Generally, neoclassical economists argue that finding substitutes for natural resources is likely. As natural resources' prices rise, businesses will substitute towards synthetic materials or labor. Similarly, consumers will respond to rising prices for natural resources by shifting their consumption from resource-intensive goods to other goods.

Neoclassical economists rely on the ability of the market to respond effectively to resource scarcities. As resources become scarce, producers will look for ways to use them more efficiently. Producers will also hoard scarce supplies in order to reap higher profits from anticipated future high prices (Stiglitz, 1979).

A 1986 National Research Council (NRC) report, *Population Growth and Economic Development: Policy Questions*, was written partly within the context of neoclassical economics. It is argued that, in theory, the market is capable of dealing with resource scarcity as outlined above. In prac-

tice, however, it is acknowledged that markets often do not function well, particularly in developing countries, making efficient allocation of resources less likely. Population growth may exacerbate these inefficiencies.

Julian Simon (1981) writes in the neoclassical tradition. Simon argues that an increasing population is a long run stimulus to economic development. As population increases, the number of consumers increases, which leads to increased demand. This will spur producers to expand and utilize new and efficient technologies to meet the demand. Overall living standards will rise. More people mean more bright people, which increases innovation in the economy.

Simon argues that there is no need to worry about the depletion of natural resources: In this world, there are few resources that are not either growable or replaceable. Simon also cites data showing that the costs of many resources have declined in recent years, indicating low scarcity or high substitutability among natural and other capital.

2. *Population Growth and Land Degradation—Theory and Evidence.* Neoclassical economists treat land as any other resource or factor of production. As the demand for land rises, people will substitute away from land towards labor or other factors. As land becomes scarce, new technologies are adapted or invented to increase production on existing land. Simon (1983) notes that with improved technology people also will be able to farm previously unusable land. He foresees no limits to the production potential of the Earth.

Ester Boserup (1965, 1981) also emphasizes innovation and land intensification as a response to population growth. She argues that as the number of people per land unit rises and the returns to the land per worker hour begin to fall, pressure for the land to provide for those additional people increases. The search for greater productivity per land unit leads to the adaptation or innovation of new technology and to a subsequent intensification of land use. Intensification of land use occurs in several stages, from decreasing fallow periods to multiple cropping cycles.

Boserup's thesis concludes that as certain resources become scarcer (land in this case), technology is adopted that uses more intensively the relatively more abundant factor (labor). Rapid population growth in this case spurs economic development.

Increasing land use may lead to erosion, if hills are farmed, or to a reduction in soil fertility, if fallow periods are shortened to the point that the land has insufficient time to replace lost nutrients. However, Boserup (1970) argues that simple technology, such as the utilization of fertilizer and terracing, can prevent such degradation.

The 1986 NRC report also indicates that population growth can promote changes in land use, which can offset the negative impact population growth may have on labor productivity and the amount of land cultivated or the intensity with which it is cultivated. Such changes include the additional use of fertilizer, improved markets, changes in property rights, and agricultural research. The report points out that, "with the important exception of Africa, per capita agricultural output has risen in most developing regions during the recent period of rapid population growth" (NRC, 1986, pp. 33-34).

Hans Binswanger and Prabhu Pingali (1989) look at the positive association between population density and agricultural intensification. They identify the ways in which farmers have adapted to increasing population, using both traditional and modern technology. Under traditional systems, farmers first expand the area under cultivation. When extensive strategies are no longer feasible, farmers begin to intensify land use through terracing, drainage and irrigation, manuring systems, increased labor, and the use of animal power. Binswanger and Pingali note that farmer-generated technology is sufficient to support a slow increase in population, but is not able to sustain a fast growing one. Rapid increases in yield must be accomplished through the use of modern technology. Modern technology includes biotechnology, mechanization, and chemical fertilizers.

Parker Shipton (1989), in a study of densely populated areas south of the Sahara in Africa, demonstrates that as population density has increased, people have responded with innovations and conservation measures to increase output. He observes such changes as the use of irrigation, decreasing fallow periods, and the use of the plough. Shipton defines a "critical transition stage" during which a population adjusts to its increase in size. It is during this stage when one is most likely to observe land degradation. Shipton supports his argument with evidence from Kenya that indicates that land deterioration is greatest in areas of middle population density, not in areas of high or low density.

Joachim Metzner (1982), in his detailed analysis of an island area, Sikka, demonstrates that a growing and high density population has been able to adapt its agricultural system to meet its rising needs without any decline in yields or other evidence of land degradation.

In summary, under the neoclassical economic framework, land degradation can be the result of several processes.

(1) It may be a *short-run response to population growth,* during which period people devise new, more efficient ways of using the resource.

(2) Degradation can occur when *markets are not working efficiently.* For example, many land resources are commonly owned, such as public

lands, making it difficult for them to be included in the market. People's use of these resources is free to the individual, although there may be a social cost to utilization. There are no built-in incentives for individuals to conserve the resource as their neighbors may use it up instead (Stiglitz, 1979).

(3) Land degradation can be the result of *efficient depletion of land resources* for production. Neoclassical economists postulate that some land degradation is acceptable as long as the market offers alternatives to these resources for the future.

3. *Policy*. Neoclassical economists argue that the market is the best vehicle for pricing and allocating natural resources. Policies should be oriented toward getting the prices right by removing constraints to the efficient working of the market, as in (2) above (Warford and Partow, 1989). Such policies should be oriented towards making people pay the full cost of using a common resource, better defining common property rights, reducing subsidies that encourage overexploitation of a resource, etc.

Government allocation of resources is seen as inefficient and thus inappropriate policy. However, government intervention can help promote research and development for natural resource substitutes (Stiglitz, 1979). Government-supported research—if planned well—could address the short-run effect of land degradation resulting from the lag time between a perceived need for increased use of a resource and development of the innovation required to meet this need, as in (1) above.

Neoclassical economists would not advocate population policies to fundamentally address land degradation. However, it is acknowledged by some that fertility reduction can buy time while resource substitutes are found or market or institutional inefficiencies are addressed.

4. *Strengths and Limitations*. Neoclassical economic theory is useful in explaining resource allocation in a market economy under efficient conditions. Land degradation can result from distortionary prices or other market failures. Neoclassical theory gives us a framework by which to judge these imperfections and design policies to correct them.

There are limitations to neoclassical economic analysis of population/resource issues. First, the theory does not distinguish between scale and allocation. Even if the market efficiently allocates resources, it tells us nothing about what should be the optimal scale of our economy, given the physical limits of our ecosystem. There are many Pareto optimal solutions, depending on population size, technology, etc. The market gives us little guidance in choosing among these allocations, all of which are efficient.

This critique implies that population size, if not relevant in determining efficient allocation, is important in determining optimal scale. The scale issue leads us to attempt to "maximize cumulative lives ever lived over time at some level of per capita resource use sufficient for a good life" (Daly, 1986, p. 40). Thus, there is a trade-off between increasing standards of living and increasing people.

Second, it has not been shown that elasticities of substitution between natural resources and other factors are always high (Georgescu-Roegen, 1979). There may be a limit to the ability of technology or other innovations to create goods to substitute for natural resources. There are physical laws beyond which no substitution is viable; wheat cannot be grown with only labor (Smith and Kurtilla, 1979).

Since substitution possibilities are ultimately limited, Foy and Daly (1989) argue that the carrying capacity of the ecosystem should be viewed as a constraint to resource allocation. An ecologically unsustainable scale is undesirable because of the necessity of some natural capital for growth. Natural capital is not totally interchangeable with manmade capital; in fact, natural capital is necessary for the production of manmade capital. Environmental problems occur when natural capital is depleted at a rate that diminishes the carrying capacity of the Earth. Carrying capacity should be expanded before the scale of an economy (or the indirect and direct uses of the environment) expands.

Third, it is often difficult to identify distorted prices and their causes. We do not know the "true" value of land resources—it is not something that can be fully calculated. Thus, it is difficult to arrive at a "true" cost of using resources (Georgescu-Roegen, 1979). A similar problem may be that people do not adequately take into account the needs of future generations when deciding current levels of resource use. Many argue that the future is discounted more heavily than it should be. Future demands are not adequately predicted, leading to resource prices that are too low from an intergenerational welfare perspective (Repetto, 1987).

Fourth, neoclassical economists discount the importance of the *rate* of population growth in determining the ability of an economy to provide an adequate standard of living. Harley Browning (1970) argues that a high rate of growth places more pressure on land than a slow rate, because under rapid growth, the period for economic and social adjustment to increased population is shorter. The less time there is, the more likely it is that people will degrade the environment to meet their short-term needs before technology can be adopted to adjust to new factor prices.

Peter McLoughlin (1970) presents a similar argument. The faster the rate of population growth, the more rapidly land must be intensified. Rapid

intensification may be difficult to accomplish, causing a "frustration gap" between what people need to maintain their standard of living and what is presently available to them. However, McLoughlin acknowledges that communities with the largest frustration gap are the most amenable to new innovations. Thus, part of his argument actually supports neoclassical theory.

Finally, neoclassical economics provides little guidance in analyzing the institutional or other factors that may impede farmers' access to the technologies or capital necessary to use their resources more efficiently. People's income differences also affect their ability to adopt technology with increasing population density. As Nathan Keyfitz (1989) argues, it is the people who are the best off that have the greatest potential to innovate.

5. *Summary*

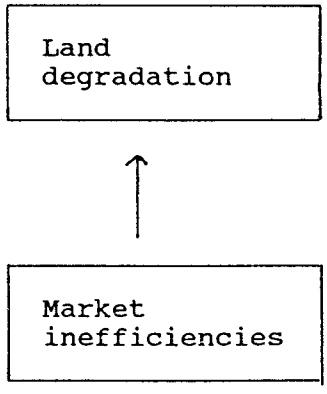

TABLE 1.

Classical Economics and Natural Science Perspectives

1. *Theory.* Classical economists, like their neoclassical colleagues, are concerned with whether an economy, under the pressure of high population growth, can provide an increasing or steady standard of living given that the natural resource base is finite. However, classical economists argue that sustainable output cannot keep up with rapid population growth. This theory is based on the work of Thomas Robert Malthus (1914). He argued that population grows at a geometric rate, while the food supply increases in a linear progression. As population increases, it will at some point outstrip the food supply resulting in falling living standards. Malthus assumed diminishing returns to increased labor for a fixed area of land.

Natural scientists approach the population-environment question similarly. They also emphasize the fixity of the Earth's resources and limits to the capacity of the Earth to provide for its inhabitants. Natural scientists argue that each individual has a negative impact on the environment by using up fixed resources. If the population exceeds the carrying capacity of the Earth, then death rates will increase to bring the population down to a sustainable level (Ehrlich and Holdren, 1987).

Neomalthusian and natural science perspectives form the basis for much of the current popular literature on population and the environment. It is argued that environmental degradation occurs as a growing population puts pressure on fixed available resources to maintain or increase the population's standard of living. Environmental degradation is one of the symptoms of the growing pressure population is putting on the ecosystem.

Lester Brown, the primary author of *State of the World*, bases many of his arguments on natural science and classical economics literature. He argues that many developing countries are stuck in the middle stage of the demographic transition (high birth and low death rates). The resulting high population growth rate has stressed the carrying capacity of many countries, creating environmental degradation (Brown, et al., 1987). Countries get into a "demographic trap," i.e., cannot move onto the final stage of the demographic transition (low birth and death rates), because they are caught in a vicious cycle where high population growth and environmental degradation cause and are caused by each other. Both place strains on the ability of the economy to provide for its population and the resulting poverty sustains parents' desire to have large families. He argues that without increasing economic growth or family planning, a growing population will lead to continued environmental degradation and poverty (Brown and Jacobson, 1986).

2. *Population Growth and Land Degradation — Theory and Evidence.* Nafis Sadik (1989) in the *United Nations' State of the World Population 1988* also uses natural science arguments to contend that population growth and uneven wealth distribution are the fundamental causes of land degradation. Because the most rapid population growth is occurring in developing countries, areas least able to afford or fix ecological destruction, Sadik argues that the situation is urgent. Before rapid population growth put pressure on natural resources, farmers used long fallow periods and crop rotation to protect fragile areas. This long-standing practice has been discontinued in many areas as growing numbers of poor people, particularly the landless, have increased cultivation of environmentally sensitive areas in an effort to sustain their needs. As the resource base is degraded, poverty is worsened, leading to increased use of fragile land.

Empirical work, applying natural science or classical economic perspectives, has generally centered around estimating the carrying capacity of land to identify areas where land degradation may be due to "overpopulation." A United Nations' Food and Agriculture Organization (FAO) study estimated the "population supporting capacities" of lands in 117 developing countries using data on climate conditions, soil quality, and land use (Higgins et al., 1983). The report concluded that the developing world, as a whole, would be able to support itself, in terms of food production, in the year 2000. However, given that the free movement of surplus food between countries is unrealistic, the study also presented estimates of the production potential of single countries based on low, medium, and high inputs of technology and capital. It was determined that over half of the countries would not be able to meet their food needs in the year 2000 with a low level of inputs (mainly labor). Almost a third of the countries could not meet their needs even with an intermediate level of inputs (some fertilizer, hand tools, and simple conservation techniques). Nineteen countries would not be able to meet their needs even at very high levels of inputs (advanced technology, complete mechanization, and all necessary conservation measures).

On a country level, Lee Talbot (1989) looks at land degradation in Kenya, particularly in the arid and semi-arid lands that support mainly livestock. He argues that pastoralists have traditionally extended their herds to new lands as their populations have grown. Now that there is no unused land available, due to the increase in numbers of agriculturalists as well as pastoralists, the growing populations are putting pressure on land resources. Because the capacity of the land is overreached by the numbers of cattle and people, overgrazing and subsequent soil erosion have resulted.

Richard Hosier (1984) looked at land degradation caused by deforestation in Kenya. He used measures of land quality and population density to show that large numbers of people on high-potential lands were correlated with low wood availability. Even though these lands had the greatest capacity to support large populations, it was these same areas that had been exposed to extended population pressure. This had drastically reduced indigenous and other trees. Hosier determined that the fuelwood shortage was not a result of weather or other ecological phenomena, but of density of people.

Looking at the statistical correlation between countries' forest-area change and population growth rates, A.S. Mather (1989) comes to a similar conclusion—that forest reduction is linked to high population growth rates—for most countries in the developing world. In countries with low population growth rates, forest area has been increasing.

Frank Bernard and Derrick Thom (1981) attempted to measure carrying capacity in two districts in Kenya, Machakos and Kitui. They define carrying capacity as "the number of people and the level of their activities which a region can sustain in perpetuity at an acceptable quality of life and without land deterioration" (Bernard & Thom, 1981, p. 386). Bernard and Thom calculated production potential using crude soil, ecological, crop yield, and land use data. They then determined carrying capacity by relating production potential to the caloric intake necessary to sustain the populations at the subsistence level. They used their final measures to identify areas of stress from population pressure.

Bernard and Thom concluded that the population in most subdivisions of Machakos had exceeded the carrying capacity of the land. The population in Kitui, on the other hand, was within sustainable ecological limits. Surprisingly, it was the areas that seemed underpopulated that had actually overreached their carrying capacity due to the low productivity of the land. Bernard and Thom noted that in areas of "overpopulation," land degradation such as soil erosion from overstocking of livestock and cutting of vegetation was evident. Such degradation reduces the long-run carrying capacity of the land such that fewer people can be supported in the future.

Some analysts have incorporated people's expectations regarding their standard of living into carrying capacity models. These authors argue that estimating carrying capacity at subsistence levels does not adequately indicate areas of population pressure, because people have different perceived "decent" standards of living that translate into different levels of use of the natural resource base. Two areas with the same population density and land quality can show very different levels of land degradation depending on the living standards of the inhabitants.

Akin Mabogunje (1970) examines the effects of expectations on resource use by the Egba of western Nigeria. He concludes that even at a fairly low population density, land use patterns have contributed to pressures on the resource base because of the rising expectations of the Egba. Mabogunje argues that increased expectations are natural in the course of development, as people attempt to attain a higher level of per capita income and consumption.

A few authors have used regional production capability as a proxy for carrying capacity. They argue that production is constrained by carrying capacity so current production capability will suffice as a measure of what the land can provide. If the consumption needs of the population outweigh land production then the area is "overpopulated" (Gupta, 1970). Nanda Shrestha (1982) used this method in Nepal. He determined that one could not claim, as others had, that Nepal was overpopulated. The results of his

analysis identified areas that could support more people, areas that were overtaxed, and areas that maintained a good balance between output and numbers of people. Shrestha argued that this uneven spatial distribution of the population in terms of regional productive capacity was a principal economic problem. In areas where production could not sustain the population, there was land degradation.

3. *Policy*. Classical economists and natural scientists advocate fertility reduction as the key to preventing environmental destruction and to improving living standards. Fertility reduction is necessary to keep the human population within the carrying capacity limits of the Earth. Some authors also advocate a more even spacial distribution of people.

Brown et al. (1987) argue that population policy is the long–run solution to halting environmental degradation. He advocates, as a first step, providing family planning to all areas. Family planning will reduce birth rates, create demand for its services (through creating awareness), and lead to lower infant mortality through birth spacing, which eventually may lead to lower fertility. However, family planning is not sufficient to reduce fertility as quickly as needed. Governments also need to institute other fertility reducing measures such as education, tax incentives, and restricting maternity benefits (Brown & Jacobson, 1986).

Ehrlich and Holdren add that population policy needs to be given immediate priority as it takes a long time to bear results and it can be politically sensitive to implement.

Contrary to the neoclassical economists, natural scientists argue that improvements in technology will only buy more time until the limits of the Earth's carrying capacity are reached (Ehrlich & Ehrlich, 1979). Natural scientists argue that innovation is only a temporary solution. If population density is too high, even the best technologies will not prevent environmental degradation. They argue that in the developing world, the spread of technological solutions is particularly difficult because of institutional, infrastructural, and other constraints. In sum, there is a limit to the ability of humans to substitute manmade capital for natural capital.

Even in areas where the dispersal of new technology is fairly effective, it is still a less efficient and more costly route of ameliorating land degradation than fertility control. Improved technology will only shift the focus of policy makers from what is really needed: population policy. Nevertheless, Ehrlich and Holdren concede that advances in technology and redistribution of resources are necessary for a worthwhile future (Ehrlich and Holdren, 1987). Other measures, such as land reform, may also provide short-run solutions, but in the long run, population stabilization is essential.

4. *Strengths and Limitations.* Natural science and classical economic perspectives are useful for understanding the significance of scale—i.e., the ultimate limits of population expansion. Carrying capacity provides a useful construct for realizing the limits of a region's ability to provide for its inhabitants. Practically, however, carrying capacity seems to be of limited use as it is very difficult to measure and changes from year to year with variable rainfall or new technical inputs. The number of assumptions that must be made within each model are usually great and can significantly affect estimates.

In designing carrying capacity models, analysts often fail to take into account the contribution of the industrial sector. For example, in the FAO study, Kuwait was designated a critical country. However, what Kuwait may lack in agricultural potential, it makes up for in the production of other goods (particularly oil) that it can use to trade for food. Similarly, a region's production is not just agricultural or land-based. There are remittances from family members in cities or in regional centers, which can make a large contribution to a family's ability to survive, even on poor land. It may be that the carrying capacity of a country depends heavily on the level of development of the industrial sector and its ability to absorb labor.

The estimation of carrying capacity also downplays the ability of technology to increase the growth in output per unit of resource or to regenerate degraded land. Carrying capacity can expand with appropriate inputs, technology, labor, etc. It is not fixed and measurable; it changes with time. Classical economists, however, focus primarily on the fixed nature of the resource and existing technology. For example, Parker Shipton (1989) observed that in central and western Kenya, cash crops were able to sustain a high population density. In these same areas, with subsistence crops and technology, a large population could not be sustained.

Natural scientists base their view on their studies of animal systems. Humans can often adapt their surroundings to meet their needs when animals cannot. People have adapted to increasing population in the past by migrating to other areas or intensifying their use of a resource such as land (Repetto, 1987). Although these innovations are difficult to predict, it is clear that people deserve more credit as creative problem-solvers than the natural scientists give them.

Natural scientists also do not recognize the extent to which institutions can affect a society's ability to adjust to increased population. The issue is not just that humans are increasing, it is also how they are increasing. Government and other institutions can often facilitate or hinder a population's adjustment to growth. Poor planning can result in large concentra-

tions of people on marginal lands. The right incentives can distribute people more evenly across land quality.

Many natural scientists would argue that the developed countries' consumption adds to the impact of rapid population growth rates on the environment (Ehrlich & Ehrlich, 1979). However, their prescriptions ignore the issue of income in the distribution of resources. Much environmental degradation, although occurring in areas of high population density and poverty, is caused by the demand for resources in the developed world. The poor, having access to fewer resources, are forced to overexploit them in order to maintain a subsistence living standard.

5. *Summary*

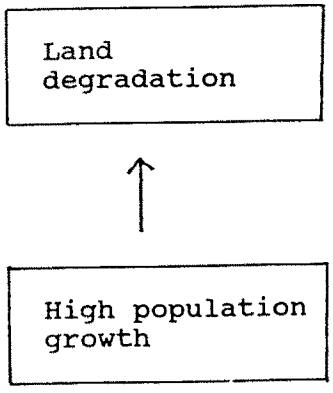

TABLE 2.

Dependency and Regional Political Ecology Perspectives

1. *Theory*. Dependency theorists focus their analysis on society's structure. They view environmental degradation as the result of changes in production systems or societal relations. Traditionally, dependency theory has emphasized exploitative developed–developing country relationships as the cause of these changes that have induced environmental deterioration in developing countries. Generally, such factors as the introduction of export-oriented production and of ill-suited technologies and management by international firms are cited as major contributing causes (Smith, 1984).

Several different perspectives have grown out of dependency theory. One argues that environmental degradation and population growth are linked, not in that one causes the other, but in that their root cause is the

same: poverty. It is the structure of society—the dynamic between the developed and developing worlds and the internal structure within developing countries—that leads to both. The population-environment "problem" is just an expression of a more fundamental reality, poverty.

Environmental degradation is partly the result of poor resource management. Lack of access to appropriate technology, capital, and resources by the developing countries, and particularly by the poor within those countries, greatly impedes resource management (Murdoch, 1980). Poor families desire many children because they will provide labor when they are young and security in the parents' old age. As income increases, parents will have fewer incentives to have many children because old-age income will be more secure and other goods will compete with children for time and resources. The poverty of the poor is maintained by an unequal distribution of income.

Regional political ecology also emphasizes society's structure. Its political-economy component emphasizes the historical and geographical context of land deterioration. While it is based primarily in political-economy, regional political ecology also examines the social and ecological factors that cause environmental degradation (Blaikie & Brookfield, 1987). Within this context, population is seen as one of the variables that may affect resource deterioration.

2. *Population Growth and Land Degradation — Theory and Evidence.* Land degradation occurs as poor farmers try to eke out a living on marginal lands with few resources and inappropriate technology. These farmers are denied access to resources, technology, and high potential land because of distortions in the structure of society, particularly unequal land distribution, landowner-tenant relationships, limited access to credit, and biases in technology against the peasant (Murdoch, 1980).

William Murdoch applies this perspective to the study of an area in the Philippines near Laguna de Bay. Poor farmers currently use a system of shifting agriculture to farm a group of hills. As the population of the community has increased, more pressure has been placed on the land, causing fallow periods to shorten to an ecologically unsustainable level. While Murdoch acknowledges that population growth has worsened the situation, he argues that these people could be sustained adequately on a small portion of the large sugar cane estates surrounding the hills. The fundamental problem is these people's lack of access to resources and technology that would provide them with adequate land and the ability to manage it sustainably. Such access would improve the community's standard of living and thus eliminate the need for parents to have large families (Murdoch, 1980).

Regional political ecologists differentiate among land types to account for variable capacities of land to sustain population pressure and to be reconditioned when degradation occurs. They emphasize socioeconomic differences across regions, which account for the degree of pressure put on the land.

In a study of Nepal, Piers Blaikie and Harold Brookfield (1987) argue that population growth can have both a positive and negative effect on land. The negative effect results from an increasing population living on ecologically sensitive land. As the population increases, people are forced to overexploit the resources available to them in order to maintain a subsistence living. It is this same population, however, that is able to provide the labor for an intensive conservation program, which aims to restore and reduce the effects of population pressure on the land.

Socioeconomic structures mediate or alter the effect of population growth on land use. In the Nepalese case, the class and economic structure explained the poverty of farmers, which led to their marginalization onto fragile lands. Their lack of resources and technology led to the overuse of the land, resulting in further poverty. Once given a few resources, the community was able to undertake a labor-intensive land management effort.

Susan Stonich (1989) also uses the regional political ecology framework to analyze land degradation in southern Honduras. She finds that the manner in which capitalist agriculture was introduced into Honduras led to the concentration of prime land resources in the capitalist sector. Farmers outside the modern sector tilled marginal lands with fewer resources leading to overexploitation of the land to meet people's needs.

A high population growth rate, 3.4% from 1974 to 1985, worsened the situation by stretching the few resources available to small-scale farmers even further. The marginalization of small-scale farmers also led to an uneven spatial distribution of people, with the highest population densities occurring on the worst land. Small-scale farmers responded by intensifying the cultivation of their low-quality land, leading to shorter fallow periods, conversion of forest to farmland, and watershed deterioration, all of which contributed to land degradation.

3. *Policy*. Murdoch (1980) argues that the solution to land degradation is poverty alleviation through economic development. Murdoch believes that with a more equitable distribution of resources and a restructuring of distorted social relations, poverty can be eliminated. With capital and technology, he claims there are no constraints (physical, biological, or

technical) to land productivity. Equitably distributed, resources can be used efficiently to provide adequately for the world's population without destroying the resource base.

Blaikie and Brookfield (1987) do not outline specific policies for dealing with land degradation. Policy interventions depend largely on which social or political-economic factors are seen as contributing to the degradation. Efforts should concentrate on identifying the least resilient and most important causal factors of environmental degradation. Blaikie and Brookfield develop a decision-making model that illustrates how a land manager makes a decision to conserve or not to conserve, given the structure of the surrounding world. Basically, if the benefits outweigh the costs, the land manager will conserve. If government policy concentrates on increasing the benefits to conservation, land managers will take actions to conserve.

Environmental interventions, such as tree planting and terracing, will not necessarily have a significant impact if the causes of degradation are socioeconomic and not lack of knowledge of land management techniques. Blaikie and Brookfield argue that the more degradation is linked to income distribution and societal structure, the less likely it is that technologically-based conservation efforts will succeed. Stonich argues that conservation efforts to halt land degradation will have limited success because they do not address the more fundamental problem of the structure of capitalist agriculture. Facing the problem directly is key to the success of any environmental policy.

Blaikie and Brookfield do not suggest policy measures for dealing with population pressure on the land specifically. They would probably not recommend population policies, because they often see population as a contributing factor, not the fundamental cause of land degradation.

4. *Strengths and Limitations.* Dependency and political regional ecology analyses are useful in that they look at the economic and societal structure within which population growth and the environment interact. Instead of hypothesizing relationships between two parallel trends, population increase and a degraded environment, the root cause of both is sought. Other research has been focused on the apparent link between the two processes without sufficient emphasis on their fundamental causes.

This type of analysis is instructive in understanding that it may not be the small-scale farmer who is to blame for land degradation. Many theorists have speculated that all that is needed for an improved environment is training for farmers living in deteriorating areas. It is assumed that the farmer does not know how to manage land and is ignorant about the agri-

cultural practices that cause damage. Most evidence today, however, indicates that poor farmers are aware of the degradation of their land and the reasons for it. However, they lack the resources to improve their land and their poverty induces them to mine their land unsustainably.

These theories also provide a framework to explain the variable outcomes within regions with similar land quality and population density. They can explain cases where there is no degradation even in the presence of high population growth.

These theories also exhibit some weaknesses. One, many dependency analysts just look at the relationship between the developed and developing world for an explanation of society's structure. Blaming the developed world ignores how a country's own internal institutions, economy, and political structure affect population and the environment.

Two, some analysts discount the usefulness of the concept of carrying capacity. While it may not be the fundamental cause of land deterioration, it does affect the *degree* of degradation, given the societal structure. Superior land quality can make a region less sensitive to inequalities and less prone to environmental problems.

Population growth can interact with the social structure in a similar way. A rapidly growing population can put more pressure on the land than a slowly growing population (as most of the analysts reviewed here realize). Norman Myers (1989) emphasizes the contribution population growth can make in his analysis of the "soccer war" between El Salvador and Honduras. Although the tensions that flared in 1969 were primarily the result of lack of access to resources by the very poor, rapid population growth rates among these same groups exacerbated the conflict. It was more difficult to subsist on marginal lands with large numbers of people, than with a smaller population.

Three, the evidence on the relationship between poverty and fertility is not uniform. While poverty and high fertility often go hand in hand, there is research that indicates that fertility decline can occur without economic development. In Ansley Coale's and Susan Cotts Watkins' study (1986) of the European demographic transition, it was clear that areas in France experienced fertility reduction before sustained improvements in their standard of living.

Along these same lines, the environment may affect poverty and fertility, not just the other way around. Some work in this area has been done. Robert Repetto (1989) concluded that in Java, areas with severe soil erosion also demonstrated lower birth rates than the national average.

5. *Summary*

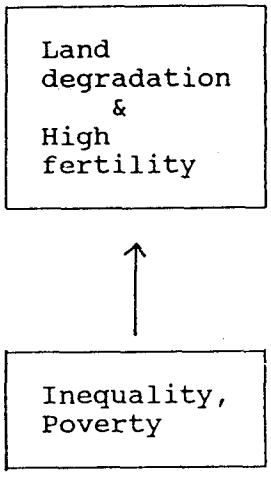

TABLE 3.

Population as an Intermediate Variable

1. *Theory.* There are a group of theorists who argue that rapid population growth is a proximate cause of environmental degradation, i.e., other variables work through population growth to affect the environment. Instead of ultimately causing environmental degradation, rapid population growth serves to intensify the effects on the environment of the root causes. These causes vary from region to region and include poverty, warfare, polluting technologies, distortionary policies, and developed countries' demand for resources.

R. Paul Shaw (1989a) argues that two opposing theories—one blaming population growth for damage to the environment and one absolving population growth of any effect on the environment—are reconcilable. Population serves to exacerbate the effects of the ultimate causes, yet because it is an intermediate variable, it is not the fundamental cause of environmental degradation.

2. *Population Growth and Land Degradation — Theory and Evidence.* Under the theory of population change acting as an intermediate variable, land degradation is ultimately the result of a multitude of factors.

Warfare in Vietnam caused large numbers of people to flee from their homes to refugee camps, which could not ecologically sustain such large concentrations of people. Distortionary economic policies can also lead to environmentally unsound concentrations of people, such as the Brazilian government's policy to subsidize human settlement of the Amazon. Subsidized food prices can hurt the rural farmer, leaving her or him with fewer resources with which to improve the land. The list of causes goes on.

Population growth can aggravate the situation by acting through the ultimate causes. If the ultimate causes were not operating, then population growth would make little difference. For example, if all polluting technologies were made clean, the number of users would not affect the environment. However, given that the ultimate causes have not been corrected, population growth exacerbates the problem (Shaw, 1989a). A polluting technology used by many people will create more degradation than if used by a few people.

Robert Repetto (1989) looks at the causes of soil erosion in Java. He argues that degradation is a result of high population growth in combination with a lack of employment opportunities and misconceived agricultural policies. Lack of employment opportunities has forced people to cultivate fragile lands. Java's agricultural policies have hindered the adoption of appropriate technology through the absence of rural credit and ineffective extension services. High population growth has increased demand on agricultural productivity, which, given these other problems, has overtaxed the ecosystem.

Shubh Kumar and David Hotchkiss (1988), in a study of Nepal, argue that deforestation of the highlands is a result of low agricultural productivity. Because farms are not producing enough to provide for the population, people have cut down the forests for farmland or for charcoal. Deforestation, in turn, has led to soil erosion and decreased land fertility. High population growth rates have contributed to the increasing demand on the ecosystem. Kumar's and Hotchkiss' study demonstrates that the deforestation reduces agricultural output further by increasing time required for wood collecting, thereby reducing the time spent on agriculture. The authors show that deforestation has increased the time needed to collect wood products by an additional 1.13 hours per day.

Richard Bilsborrow and Paul Stupp (1989) look at the effects of population growth on rural development in Guatemala. They conclude that land degradation from soil erosion and watershed destruction is mainly the result of deforestation. As farmers move out onto marginal lands to support their growing needs, they destroy the forest. Farmers are forced onto fragile

lands because of unequal land distribution. The rapid growth of urban areas has increased the demand for agricultural products, which has also led to land scarcity. Rapid population growth has exacerbated both of these processes.

3. *Policy*. Because population growth is not the fundamental cause of environmental degradation, population policy will only buy time while measures to attack the root causes are implemented. Population policy alone will not help the environment, unless other measures are taken.

Shaw suggests looking at the institutional, economic, and cultural factors that create conditions for environmental degradation. These factors include urban bias, distortionary fiscal and pricing policies, and land mismanagement in developing countries. He argues that addressing these factors will improve the environment.

In areas where the ultimate causes of environmental degradation are difficult to tackle or understand, Shaw does see room for population policies. There are some areas where rapid population growth is unsustainable. These enclaves are in areas where poverty mixed with high population growth rates is leading to overexploitation of the natural resources of the area. These areas are within all developing countries at the local level. In some of these places population policy might be effective in reducing land degradation.

Shaw would choose areas where the ultimate causes of environmental degradation are not so fixed that population policies will do little to ease the situation. Within these areas, Shaw recommends focusing family planning efforts on landless families, particularly women. Birth spacing should improve the human capital of these families, through better maternal and child health. Improved health will lead to better land management. Women are targeted because of their role as reproducers and producers (wood collection, subsistence farming, etc.) (Shaw, 1989a,b).

Repetto argues that, in the case of Java, policies must be undertaken in the three areas that are contributing to soil erosion: agricultural practices, economic policies, and high population growth. Fertility reduction alone will not alleviate the ultimate pressures that are causing soil degradation: distortionary agricultural and economic policies. Repetto notes that family planning and transmigration programs were pursued by the government to alleviate population pressure on land. Although these measures may have made the situation better than it might have been, it did not eliminate the problem of land degradation.

Kumar and Hotchkiss (1988) advocate strategies to improve agri-

cultural productivity, such as cultivating high value-added products such as horticultural products. Research, extension, and technology are needed to assist the farmers in increasing their output. Kumar and Hotchkiss do not recommend population policies.

Bilsborrow and Stupp (1989) suggest that fertility reduction programs are a good intermediate step to take while the fundamental causes of land degradation are addressed.

4. *Strengths and Limitations.* The theory provides a useful framework for analyzing how population change affects the environment through other variables. It provides a method of determining when rapid population may degrade the environment, given that these other problems exist.

There are limitations to this theory. One, it is difficult to see how population policy will buy time for the environment, when its effects on growth rates often take a long time to appear. Population policy can often be as difficult to implement—politically and institutionally—as the policies to address the ultimate causes of environmental degradation.

Moreover, by concentrating efforts on population policies, attention and energy may be diverted from the "true" causes of land degradation. Population policy, instead of buying more time, will alleviate the pressure on policy makers to address the fundamental problems of land degradation.

Two, while demonstrating population's indirect effect on the environment, the theory does little to explain the root causes of environmental degradation. Little attention is given to identifying the most important factors leading to land degradation; instead, a whole range of variables are proposed as the culprits. This approach gives flexibility to regional analysis, but offers little guidance on how to go about looking for the key problems or necessary policies.

5. *Summary (See Table 4)*

Summary

Table 5 summarizes the theories reviewed in this section. Each theory represents a particular lens—or point of view about how the world operates—through which land degradation is analyzed. For the neoclassical economists, the lens is the market; for the classical economists or natural scientists, it is fixed resources or carrying capacity; for the dependency theorists, it is the political economy; and for those that see population as an intermediate variable, the lens is the structure of society.

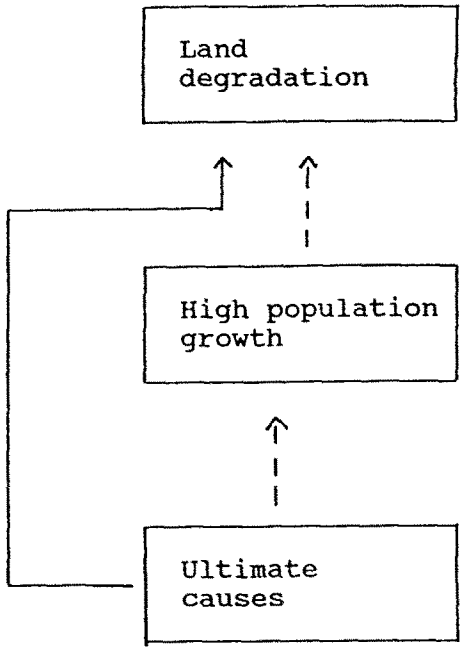

TABLE 4.

In all four theories, some factor or ultimate cause is filtered through the lens, which results in land degradation. In the market system, economic distortions such as common property and agricultural pricing policies lead to land degradation. Under the classical economics or natural science framework of fixed resources, high population growth is the ultimate cause. At a certain level, increasing population exceeds the region's carrying capacity, which results in environmental degradation. For the dependency theorists, unequal distribution of resources or poverty is the factor that, when maintained in the context of capitalist political and economic relations, leads to land degradation and high fertility. For analysts that see a wide variety of ultimate causes, land degradation results as these causes—in conjunction with high population growth—operate in society.

Policy recommendations for all four theories center around the ultimate causes of land degradation. Neoclassical economists advocate efficient markets, classical economists and natural scientists advocate reduced fertility, dependency theorists advocate income equality and resource re-

TABLE 5

Theory	Ultimate Cause		Lens		Result
Neoclassical	Economic Inefficiencies	→	**Market**	→	Land Degradation
Classical/Natural Science	High Population Growth	→	**Fixed Resources**	→	Land Degradation
Dependency	Inequality & Poverty	→	**Political Economy**	→	Land Degradation & High Fertility
Intermediate Variable	Various Ultimate Causes ↑ Policy	→ High Population Growth →	**Structure of Society**	→	Land Degradation

distribution, and other analysts advocate a mixture depending on the "true" ultimate cause. None of the policies center around changing or modifying the lens used to analyze land degradation.

Population growth plays a different role in each of these theories. For the neoclassical economists, *high population growth is a neutral factor*, it has no intrinsic effect on society. How it affects the economy depends on whether free market policies are operative. In an efficient market, population growth can serve to induce innovation and advanced technologies. In an economy full of distortions, high population growth can exacerbate the distortions.

For the classical economists and natural scientists, *high population growth is the independent factor* causing land degradation. Inherently, because of the finite resources of the Earth, population growth is a hindrance to the well-being of humans. Each additional person consumes additional fixed resources.

For some of the dependency theorists, *high population growth is a symptom* of a deeper problem, poverty. While high population growth can contribute to land degradation by preserving poverty, it is not the root cause.

For analysts that see population as a proximate determinant, *high population growth is an exacerbating factor*. It strengthens the effects of the ultimate causes on land degradation. While population growth is not the fundamental problem, it is a partial cause of land deterioration.

Although these theories present very different world views, they are not necessarily mutually exclusive. Each one presents a partial picture of why land degradation occurs. It may be determined that the causes of land deterioration in a country are the result of a combination of distorted pricing policies, a rapidly growing population confined to finite land, poverty limiting the resources available to conserve the land, and possibly other factors, such as a civil war, that inhibit rational land management. Each theory has its own strength: The neoclassical economists address resource allocation issues, the classical economists address scale issues, the dependency theorists address distribution issues, and the proximate determinists address how high population growth can exacerbate all of these issues.

THE CONTRIBUTION OF DEMOGRAPHY TO THE POPULATION-ENVIRONMENT DEBATE

This section explores what demography can contribute to our understanding of the causes of land degradation. The empirical research needed to test the theories reviewed in this paper and demography's potential contribution to these tests are examined. How demographic research could add a new dimension to the population-environment debate is then discussed.

Testing Land Degradation Theories

The evidence presented in this paper supporting each of the four theories is representative of the empirical work done in the last twenty years on population and land degradation. The work has generally been descriptive with little quantitative analysis, except for calculations of carrying capacity. (The numerous problems estimating carrying capacity are outlined above.) There have been few efforts to measure the quality of land over time and relate the theorized causes directly to these measurements. Most studies present only information on visible signs of soil erosion, declining yields, or deforestation. While the observable features of land degradation are important, the degree to which they have worsened is difficult to estimate without time series data. One reason little work has been done in this area is that it is a lengthy process, and actual measurements are complicated. All four theories could benefit from additional quantitative empirical research.

Table 6 outlines other information needed to further support each theory. Much of this information centers on questions about the lens used by

TABLE 6

Theory	Proof Needed	Can Demography Contribute?
Neoclassical/ Classical	1) Elasticities of substitution	No
	2) Technological capacity	No
Dependency	1) Poverty → Land degradation	No
	2) Poverty → High fertility	Yes
	3) Inequality → Poverty	No
Intermediate Variable	1) Ultimate causes → Land degradation	No
	2) High population growth exacerbates degradation	Yes

each perspective. Because the neoclassical economists and the classical economists or natural scientists are two sides of a coin, the empirical work needed to support both theories is the same. The two main assumptions the neoclassical economists make—high substitutability between natural and manmade resources, and human capability to engineer continued technological breakthroughs—are exactly what the classical economists and natural scientists argue do not exist. Past evidence indicates that elasticities of substitution between natural resources and other factors may not be as high as some neoclassical economists have claimed (Georgescu-Roegen, 1979). However, it is still unclear whether they are high enough to curtail fears about depleting our fixed resources. Whether humans are capable of making the technological advances needed to make our use of resources more efficient or to find replacements for resources may really be more a matter of judgment than empirical work. While we have been able to address numerous important issues in our world with technology, there are still many areas that defy our analysis.

Dependency theorists need to clarify several issues. First, it is not clear that unequal distribution between developed and developing countries and within developing countries causes poverty. Many of the debates on the impact of capitalist economic development have centered on this issue. Second, it needs to be shown that poverty leads to land degradation and to high fertility. There is a body of literature that does demonstrate a positive correlation among these variables. As mentioned earlier, however, fertility has declined in some low-income regions without economic development. It has also been shown that poverty can be present where there is no land degradation. It may be that the level of poverty must be great enough to give people little option but to mine their resources to maintain a subsis-

tence level. Their personal discount rate would favor their present consumption over their or their children's future consumption.

The proximate determinists have some points to test. First they must show that the ultimate causes advocated for each case are the most important factors in determining land degradation. Second, given that these are the real causes, how does population exacerbate land degradation through them? Analysis showing exactly how population growth interacts with these other causes would be useful. Studies, with controls for these causes, are needed to determine whether high population growth has an independent effect on land degradation. In general, the proximate determinists need to focus their efforts on developing a more complex framework to explain these interactions and their relationship to land degradation.

What demographers can contribute to these analyses is clear. Under the neoclassical or classical framework, demography can add little to the studies needed to help prove (or disprove) the theories. However, population experts have conducted research on the effects of population growth on economic development and vice versa. Much of the research done on the effects of population growth on development is inconclusive. Demographers can also assess how population growth might work with other factors to exacerbate land degradation. Some demographers have already begun work in this field, but it still lacks the quantitative rigor that characterizes most other demographic research.

Demography and the Environment

As the above discussion indicates, most of the current paradigms for explaining land degradation are not very conducive to the participation of demographers, which may explain why most of the studies to date have been done by analysts in other fields.

It seems reasonable to explore further what demographers might add to the population-environment debate, particularly outside the current theories. After all, the study of demography is fundamentally a study of people and their environment. What is needed is for demographers to include, in their regular research, information on how population affects and is affected by the environment. Most research that has been done in this area has focused on the population *growth rate* or *size*. Little work has examined the interaction of age structure, mortality, migration, and various population policies on the environment. It seems that this lens is lacking, yet necessary for any meaningful debate on population and the environment.

Bilsborrow (1987) has analyzed the response of communities to land

degradation. He concluded that people respond in three ways: demographically, by reducing their fertility; economically, by intensifying or expanding their use of land; or economically-demographically, by migrating to other areas. Such research adds to the frameworks under which population and the environment are studied.

Moreover, it is clear that the world's population is going to double, regardless of future reductions in fertility rates, because of population momentum. Research will undoubtedly contribute to developing strategies for adapting to a population twice the current size. Demographers are well-equipped to discuss where this growth is going to occur and to conduct further research on the potential effects of such growth on economic development, which in turn will affect the environment.

CONCLUSION

It is clear from the discussion of the four principal frameworks used to study population and land use that there is no consensus on the relationship. Most of the debate has centered on the two rival *policies* of the neoclassical economists and the classical economists or natural scientists. Consensus has been difficult to reach mainly because the empirical evidence is weak and inconclusive, and the diverse experiences of different regions make it difficult to generalize for policy. Because the linkage is unclear, it seems premature to conclude that curbing population growth is the only or most important remedy for land degradation.

It is relevant to note that this paper has focussed only on land degradation. It may be that population change plays a more conclusive role in affecting other aspects of the environment.

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