Population and Environment Relationships in Developing Countries: A Select Review of Approaches and Methods

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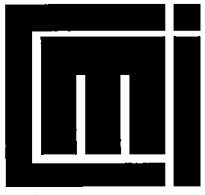

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Summary:
A diversity of opinion, theory, and conceptual approaches characterizes discussion of population and environment relationships among social scientists. This review captures some of this diversity by considering several of the more common perspectives which have been taken towards the topic. On this basis, a series of general recommendations regardign future research are made. The review also results in the conclusion that, for the near future, the "bottom-up" approach of micro-level study rather than the "trickle-down" approach of macro-level study, should be the driving force in social science research on population and environment relationships.

Indexing terms:
Population
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Diversity of perspectives. Research and interest in the links between population dynamics and environmental change was given renewed impetus by the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. The conference summary statement, "Agenda 21," recommended the development and dissemination of knowledge on the links between demographic trends and sustainable development including environmental impacts (United Nations 1993). Despite this final consensus, discussion on linkages between population and environment was highly charged in Rio. Grassroots development, environmental, and women's groups strove to keep the wider social and economic contexts in which population and environment relationships occur in the forefront contrary to the more focused interests of many population groups.

This diversity of opinion and approaches generally characterizes discussion of population and environment relationships in both public and academic contexts. The following review tries to capture some of this diversity by briefly considering some of the different perspectives which have been taken towards the topic. Although presented separately, many of these perspectives overlap and many studies reflect the influence of more than one perspective. This review merely begins to unravel some of the various strands which have historically or currently shaped thinking on the topic. The objective is to stimulate further thought and analysis of conceptual approaches and encourage their more explicit formulation in future research.

(a) Linear views: Malthus and Boserup.

Neither Malthus nor Boserup specifically address population-environment relations but rather the narrow topics of land use and food production . Implications on general linkages between population and resources, however, are frequently inferred from their work and their ideas probably represent the two dominant historical viewpoints within the topic. Both these perspectives emphasize the reciprocal, linear, and direct relationships which exist between population and their environment.

Malthusian theory (1798 and 1803, republished 1960) stresses that the growth of human populations always tends to outstrip the productive capabilities of land resources. The result is that 'positive' checks, such as famine and increased mortality, or preventative checks, such as postponement of marriage and limitation of family size, work to reduce population growth. Malthus suggests that population demands thus place direct limits on the availability of resources and that resources, in turn, place a direct restriction on population growth. Malthusian theory, formulated before the agricultural revolution, presumes that the productivity of environmental resources such as land are fixed.

Malthus did not foresee the important technological advances that have accompanied modernization. Writing after the agricultural and industrial revolutions, Boserup (1965, 1976, 1981) does take this technological change into account. She suggests that population growth and resulting increased population density 'induce' technological changes, for example the use of ploughs or fertilizer , which allow food production to keep pace with population growth. Again, reciprocal linear relationships between population, technological change in agriculture, and environmental change are suggested.

Some Conceptual Approches to Population and Environment Relationships

(a) Linear perspectives

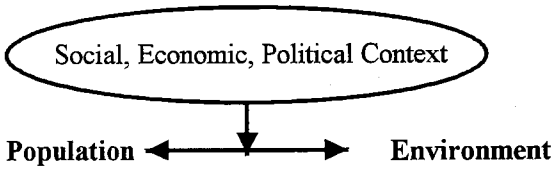
Malthus: Population ⟷ Environment

Boserup: Population ⟷ Technology ⟷ Environment

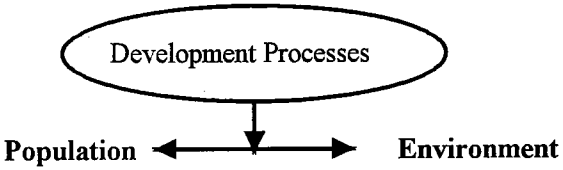
(b) Multiplicative perspective

Environment Impacts = (Population Size) (Affluence or per capita consumption) (Level of Technology)

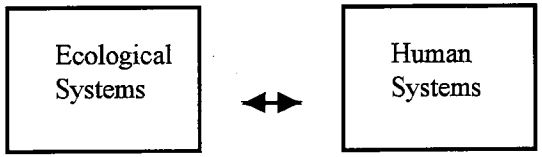
(c) Mediating perspective



(d) Development-dependency perspective



(e) Complex systems perspective



Malthusian ideas have informed much subsequent discourse on population-environment relations. This includes numerous descriptive studies on demographic and ecological trends (e.g. Brown et al. 1976; Ehrlich 1968; Ehrlich and Daily 1993; Ehrlich and Ehrlich 1977 and 1990; Ehrlich and Holdren 1971, 1974; Ehrlich et al. 1977; Eckholm 1976; Hardin 1968). The Malthusian viewpoint has also had an influence on the development of the concept of 'carrying capacity' which has lead to several global and national projection and modeling exercises (e.g. Cohen 1995; Higgins et al 1982; Lutz 1991; Meadows et al. 1972, 1992). The Boserupian perspective has also had an influence on global and regional research which examines the relationship between population growth and changes in agricultural production (e.g. Simon 1981, 1990) .

(b) *Multiplicative perspectives: the "IPAT " equation.*

Another current line of thought sees population size as interacting in a multiplicative way with other factors to create impacts on the environment. One of the most frequently used multiplier approaches, is the so-called "IPAT" equation in which:

Environmental impacts = (Population size) (Level of affluence or per capita consumption) (Level of technology)

or $I = PAT$

(Ehrlich and Holdren 1971 and 1974; Harrison 1992; Commoner 1991 and 1992). The IPAT equation sees the combined interaction rather than independent effects of population size, consumption, and technology as important in determining environmental change.

Shaw (1989a, b, c and 1992) has proposed an alternative multiplicative scheme in which the interactive affects between population, consumption, and technology are further specified. He distinguishes between ultimate causes, or the driving forces behind environmental impacts, and aggravating factors. In the case of environmental degradation, consumption and technology are ultimate causes while population is an aggravating factor which increases the intensity of impacts which ultimate causes have on the environment (Shaw, 1989c; Hogan, 1992).

(c) Mediating perspectives

Numerous studies focus on the context in which population and environment relationships occur or the social, cultural, institutional, and political factors which mediate relationships. Since the range of mediating factors which might be considered is wide, the various studies which have been carried out under this approach are also diverse. Bilsborrow (1992a and 1992b) has elaborated a mediating framework for understanding the impacts of population growth on land use and agricultural production in rural areas in Latin America. This framework considers how socioeconomic conditions such as poverty, government policies, and market demands determine whether population growth leads to technological change in agriculture, soil degradation, or

out-migration. Other mediating viewpoints focus more exclusively on social and cultural rather than economic and policy factors which mediate population and the environment relations (e.g. McNicoll 1990; Hogan 1992; Sahlins 1972). In contrast to the direct relationship between other animals and the environment, these viewpoints emphasize that social organization and culture filter and focus the relationship between human populations and their environment. Environmental change is thus viewed as a social as well as natural process (Schmink 1994).

(d) Development-dependency perspectives

Another perspective collapses all social, cultural and institutional factors that mediate population-environment relationships into the larger concept of 'development' and focuses on the way in which development processes mediate population and the environment relations. Emphasis is particularly placed on development trends which have kept the south 'dependent' on the North, e.g. mercantile exploitation and export of natural resources towards manufacturing centers in the North. This "dependency perspective" (Jolly 1991) stresses the overwhelming role that common international political and economic forces play in shaping both demographic factors such as population growth and environmental outcomes such as degradation in developing countries. This approach further suggests that even major global environmental problems (depletion of ozone, greenhouse effects, toxic waste accumulation and loss of biodiversity) are the direct results of the prevailing model of development (Martine 1992 and 1993). Duplication of this model in rapidly growing developing countries, as is the current tendency, is seen as compounding negative environmental impacts.

(e) Complex system perspectives.

An additional approach considers mediating factors as well as environment and population in a structured way or as a complex of interrelated systems. This approach aims to understand the how ecological and human-driven systems (sociocultural, demographic, and economic systems) interconnect to form larger "socio-ecological systems" (Gallopin et al. 1988) within which population and environment relationships are embedded. Population ecology, human ecology, and cultural ecology, all subdisciplines within anthropology, adopt this approach in studying how human systems reflect adaptations to a given ecosystem as well as how human systems may shape natural ecosystems (Drummond 1975, Hawley 1986; Netting 1986). This approach also accounts for large-scale structural changes such as development processes which may cause radical shifts in existing human and ecological systems and the relationships between them (eg. Tudela 1989 in Mexico).

(f) general observations

Each of the perspectives discussed above presents strengths and weakness in terms of the conceptual relationships and methodological steps implied. Malthusian and Boserupian approaches present the most straightforward theory on population environment in that they present clear propositions about relationships. However, their contrasting conclusions have frequently turned research on population and environment into a battleground for an ideological war waged between the so-called 'neomalthusians' and 'cornucopians' (Hogan, 1992). Also it is

difficult to operationalize both Malthusian and Boserupian concepts (e.g. population pressure or technological change) as variables which may actually be measured and studied.

Multiplicative approaches such as the IPAT equation, in contrast, provide a calculable formula for estimating environmental impacts. On the other hand, the IPAT equation may reduce complex phenomena to quantifiable generalities (broad measures of population, consumption, technology) thereby missing the local-level characteristics of resource use which may be key to understanding population and environment linkages. Mediating approaches are more sensitive to local and contextural factors which may shape population and environment linkages. Yet, the idea of "mediation" is ambiguous since the direction, priority, and nature of interactions between "mediating" socioeconomic factors and population and environment relationships is not always clear. Complex systems provide further specification of these mediations but demand comprehensive information across different sectors and at different levels of aggregation which may be difficult to obtain let alone process and analyze.

Across all studies, the concept of population has been limited largely to a focus on population growth (Hogan, 1992; Zaba and Clarke 1994). Mediating perspectives, however, do tend to consider other dimensions of population in relation to environmental change including migration and spatial distribution of population, nuptiality and land tenure patterns, household-level demographic characteristics (size and structure), and the reciprocal impacts of environmental degradation on population health. Environment, in contrast, has been defined in a diversity of ways across all approaches. Environmental variables considered in relation to population include specific resources (water, air, forests, land), climatic zones, or urban/rural location. Variables used to indicate environmental change or degradation also vary from specific quantitative measures of pollution, soil loss, and deforestation to more qualitative impressionistic reporting of overall deterioration. Current environmental concepts, however, generally adhere to a capitalistic models, which view the environment as a factor to be expended by populations (Leff 1993). Alternative notions deriving from other economic paradigms, for example the Marxian view of the environment as a "potential" which varies according to culture and productive technology, has not been widely integrated into current study.

With the exception of more anthropologically-oriented studies, investigators define a priori the concepts of population, environment, and the relationships between them. The perceptions of affected populations in terms of the boundaries of their environment, the perceived impact of their activity on the environment, and perceived reciprocal impacts of environmental change are generally not taken into account (Arizpe et al. 1993, Blaikie and Brookfield 1987; Izazola and Marquette 1994; Ness et al. 1993; Schmink 1994). This is the case despite the fact that environmental perceptions may be a key factor linking populations to environmental change.

Diversity in level of analysis. Besides their differing conceptual approaches, study of population-environment relationships varies according to the geographic level considered. 'Macro-level' study involves large units of analysis such as the globe, developing regions, countries, or regions within countries. Micro-level analysis, in contrast, involves smaller units such as households, families, or specific communities. Macro and micro-levels study imply

different data needs, methodological approaches, possibilities for the generalization of conclusions, and ultimately different information for policy formulation.

Macro-level research generally draws on existing aggregate data, involves quantitative approaches that make global, cross-regional or cross-country assessments, and produces conclusions that provide information on general relationships that apply to large populations or geographic regions. Data from global studies is thus useful in elaborating international and national policies. Micro-level research, in contrast, requires disaggregated data, frequently involves qualitative methods and specialized data collection, and produces less generalizable conclusions that relate to small specific populations or communities. Micro-level research, however, can draw upon much more detailed information to identify how social, economic, cultural and institutional factors influence the nature of population-environment relationships in different contexts. It thus provides useful information for formulating policies which affect specific communities, regions, and populations.

Although discussed separately, macro and micro level study may be effectively combined to give a more comprehensive understanding of linkages. Macro-level studies may identify broad hypotheses for testing at the lower geographic levels. For example, linkages between global consumption patterns and climate change might be explored at the national and subnational level to identify different patterns between and within countries. The majority of recent research on population and the environment however has probably been carried out at the macro level. Ehrlich's examination of the "population bomb " (1968) and "population explosion" (Ehrlich and Ehrlich 1990) as well as the study of global "limits to growth" by Meadows et al. (1972 and 1992) have attracted popular as well as academic attention for the last three decades. These global studies by natural scientists are perhaps the best known research on population and environment relationships to date. Taking the lead from their natural science counterparts, demographers and economists have also tended to consider the macro-level impact of population growth on global food supply, climatic change, or natural resource depletion (see for example, Ridker 1979; Simon 1981 and 1990; Lutz 1992; or Bongaarts 1992).

Many of these macro-level studies describe rather than explain the causal linkages between population and environmental change. Cross-sectional quantitative or qualitative data and relationships are generally presented and cause and effect over time simply inferred. As a result, these largely descriptive macro studies provide little insight into the causal relationships linking population dynamics and environmental outcomes at the household or community level and within critical regional ecosystems, such as tropical forests, mountain areas, dryland savannahs, or coastal regions (Blaikie and Brookfield 1987; Marquette and Bilsborrow 1994a). Greater micro-level study at the subnational, community, and household level is needed to explore these linkages (Blaikie and Brookfield 1987; Jacobsen and Price 1990; Clarke 1992; Bilsborrow and Geores 1994; Arizpe and Velasquez 1994; Arizpe et al. 1994; Zaba and Clarke 1994; Marquette and Bilsborrow 1994).

Data issues. Existing information has only begun to be exploited in the analysis of population and environment relationships. Existing agricultural census surveys and population census have been used for this purpose in Latin America (Stonich 1989; Stupp and Bilsborrow, 1989; Harrison, 1990; Bilsborrow and DeLargy, 1991; DeWalt and Stonich, 1992; DeWalt et al., 1993). The potential for similar use of existing population and agricultural census data exist in other regions (1992c). Several existing national and regional data bases also contain both population and the environmental data which might be used in future macro and micro-level research. These include the World Bank Living Standard Measurement (LSMS) Survey data (carried out in about a dozen developing countries), UNESCO Man in the Biosphere (MAB) Program data, and data collected by the Consortium for International Earth Science Information Network (CIESIN).

Geographic Information Systems (GIS) offer an important tool for combining demographic and environmental information for analysis and increasing attempts are being made in this area (see for example Rindfuss et. al. 1996). Some existing data bases which already use GIS to link relevant information on population and environment include the Global Environmental Monitoring System (GEMS) and the Global Resource Information Data Base (GRID) created by the United Nations Environment Program (UNEP) and the Famine Early Warning System (FEWS) maintained by the United States Agency for International Development (USAID). Scope exist for greater analysis of this linked information at the global, national, and subnational level.

Local-level population-environment monitoring systems (PEMS) have also been set up in some developing countries using GIS (Zinn et al., 1993). These systems are prospectively collecting demographic, health, socioeconomic and environmental data at the local-level for integration into GIS systems. Increased use of mapping and GIS technologies has also begun to occur among local communities groups themselves in an effort to learn more about population and resource relationships which affect them (Cultural Survival 1995; Poole 1995). Use of geographic positions systems (GPS) in conjunction with GIS is allowing this local-level information to be combined with higher level maps and information (Poole 1995). A wealth of important information on population and environment relationships increasingly exists at the community and local level which may be analyzed or aggregated up to higher sub-national and national levels for analysis.

Despite the availability of existing data, new information will inevitably take place as well. Given this fact, it is important to recognize the need to make population and environmental data more comparable in the future (Clarke and Rhind, 1991). Population data, for example, from censuses and surveys, are collected by political or administrative unit and may not match environmental data, which are collected by ecosystem, topographic, or climatic zone. The future investigation of population-environment relationships would thus benefit substantially from the collection of demographic data in a way that would facilitate analysis by ecological or climatic zone (Cruz et al., 1993; Zaba and Clarke, 1994). Greater comparability between population and geographic data will also facilitate the application of GIS to analyze relationships (Jacobson and Price, 1990; Clarke and Rhind, 1991; Cruz et al., 1993; Zinn et al., 1993).

Table 1. General Recommendations for Future Research on Population and Environment

General Recommendation	Comments
Specification of conceptual frameworks and broadening of concepts	A diversity of existing conceptual approaches exists for considering population and environment relationships. In many existing studies, the general approach and specific concepts of population and environment employed are only implicitly stated and should therfore be more explicitly state in future study. Consideration of population in relation to environmental change should go beyond population growth to also consider migration, spatial distribution of population, nuptiality, community and household-level demographic dynamics, and the reciprocal impacts of environmental change on population health. The environmental perceptions of affected populations should also be considered in future study.
Recognizing levels of analysis and the need for micro-level analysis	The study of population and environment relationships also vary according to the geographic level considered: the globe, regions, nations, communities, or households. More consideration should be given to defining what type of data, methods, and policy conclusions are most appropriate for macro versus micro-level analysis of population and environment relationships. Much existing research has been carried out at the macro-level. This research provides little insight into important local-level problems and in critical ecosystems (e.g. tropical forests, settled agricultural areas, coastal regions). The need therefore exists for greater micro-level research to explore these relationships.
More causal-temporal analysis	Many existing macro-level studies mainly describe aggregate cross-sectional information on population and environment from which causal relationships are inferred. The need exist for greater exploration of the causal and temporal sequence of events which link population and environmental change. Specific cause and effect relationships and long and short-term processes need to be considered. Again additional micro-level research over time with particular regions or communities will be useful in this regard.
Use of existing data and increasing compatibility in future data collection	There is a large potential for using existing data sources to analyze population and environment relationships. GIS offers a particularly useful technology for linking this information in the future. In the collection of new data , compatability between demographic and ecological information should be improved to faciliate their combined analysis.

Existing ongoing national or international data-collection existing might also be adapted to allow the future integrated analysis of population, land use, economic and environmental trends (Cruz et al. 1993). The design of an environmental module to be added to the Demographic and Health Surveys (DHS) has been proposed in this regard (PRC 1992) although it has not yet been adopted. Inclusion of an environmental module in the DHS could produce data that could be analyzed in conjunction with the extensive community-level socioeconomic and demographic data collected by the surveys. Such data could provide comparative national and household data on population and the environment which would be useful in both macro and micro-level analysis.

A general theory of population and environment relationships? Based on the above, a series of general recommendations are presented in Table 1 regarding future study of population and enviornment linkages by social scientists. In addition to these specific observations, some broader comments on the nature of future research may also be made.

The majority of population and environment relationships are played out as local dramas and should be first fully understood in this context. Even global environmental impacts (for example, loss of biodiversity or global warming) have their roots in processes played out within regions, communities, and households. With other processes, (for example, soil degradation and deforestation, urban environmental deterioration) their localized character is more intuitively apparent. As a result of this recognition, research would benefit greatly, at least for the moment, by an emphasis on what the sociologist Robert Merton termed middle range theory and research which attempts to explain as well as possible a limited phenomena in a specific context (Merton 1968).

The basic ingredient for moving towards such middle range theory and research is again micro-level research. As noted above, much of the resources and attention which have gone to the study of population and environment relationships have gone to expensive large-scale multidisciplinary studies or sophisticated macro-level modeling and simulation exercises headed by established academics with large research teams. For example, the Global Environmental Fund, the Human Dimensions for Global Environmental Change Project, The World Bank, the United States Agency for International Development (USAID), the United Nations (UNFPA, UNDP, UNEP) and private foundations such as the MacArthur Fund have directed many of their resources towards this type of macro-level research.

In the future, more of these funds should flow towards micro-level studies. This includes more support for studies carried out by graduate students, community groups, and local-level non-governmental organizations. A greater knowledge of population and environment relationships in the immediate future resides in the accumulation of these more humble 'middle range' studies rather than grandiose and costly multidisciplinarly studies and global projection exercises. The cost-effectiveness of this emphasis in terms of the amount of information to be gained is obvious. This is particularly relevant in the current environment of budget-cutting and restricted resources.

Ultimately, a more generalized vision of population and environment relationships, including the understanding of global relationships, may emerge from the accumulation of

micro-level studies. This understanding, however, will be built upon empirical evidence rather than the researcher's assumptions. Micro-level studies most importantly offer a way to accumulate and apply, little by little, information for constructing realistic policies affecting population and environment relationships at the household, community, regional, and ultimately national level. International policy-making may be built upon this alternative foundation of grass-roots involvement rather than global pronouncements of doom. The adage, 'Think global. Act Local' has particular significance in this context. For the near future, the 'bottom-up' approach of micro-level study rather than the 'trickle-down' approach of macro-level study, should be the driving force in social science research on population and environment relationships.

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