Urbanization and Environmental Quality: Insights from Ghana on sustainable policies

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ABSTRACT

The paper offers a policy-oriented discussion of the relationship between population, environment and economic development. Our particular focus is on the relationship between urbanization and environmental change. Their impact is often represented as strongly negative. We examine the relationship between nutrient levels in coastal lagoons, examining the degree to which these impacts are linked to population density in the watershed. We supplement this with information about environmental attitudes collected from a stratified, clustered random sample of households in six coastal districts of the Central Region. We conclude with some speculations about the implications for environmental change in the years after the Johannesburg Summit.

Introduction

Despite the evident and continuing interest in population-environment links, the direct interplay of human population dynamics and environmental change is difficult to identify and even more difficult to quantify. On one hand, the argument is frequently voiced that "population" - usually aggregate human population growth – has a substantial (and adverse) effect on environmental quality. On the other hand, some observers argue that there is less evidence of a manifest effect of population on the environment. This view is often voiced while disputing overall claims of the degree of anthropogenic impacts on the environment. In this paper and presentation, we attempt to offer some thoughts about demographic and social dynamics and environmental outcomes. In an approach that may admittedly be a bit ungainly, we will offer some quite general observations about population-environment relationships and then turn to more focused sociological and demographic insights from field research in coastal Ghana. We pay particular attention to the role of urbanization in demographic and environmental change. We also offer some preliminary measurements for human impact on nutrient content of coastal lagoons in Ghana. We augment the discussion with a concern for measuring and understanding the determinants of human behavior, in this case, behavior that has consequences for the natural environment.

While our argument is general, some parts of it are based on our ongoing research in coastal Ghana, where, in collaboration with an interdisciplinary set of colleagues, we have been examining water quality conditions in selected coastal lagoons, household drinking water quality and surveying human behavior.

As the pace of *urban growth* accelerates in developing countries, including African countries, so too does concern about the impact of urbanization on the environment, including urban consumption patterns and the environmental footprint of cities (El-Shaks in Rakodi, 1997; Torrey, 2004; UNCHS, 2001). Still, it is not quite clear how strong the role of urbanization is (White, 1996) or how strong the relationship is between city size and environmental impact (Torrey, 2004). (Strictly speaking, urbanization refers to the increasing *share* of the population residing in cities.) At the present time about half of the world's population lives in urban areas (United Nations, 2001). For the foreseeable future, urbanization will increase and urban growth in developing countries will outpace that in industrialized countries. Martine argues persuasively that concerns for the negative impact of urbanization may be misplaced, "Nevertheless, it is fundamental to recognize that curbing urban growth is not the solution to either environmental or urban problems" (Martine, 1996, p. 44). All this compels us to better understand the role of cities in demographic and environmental change.

Many see urban growth as coincident with positive trends in economic development, even as city growth brings some negative consequences for urban residents and for society at large (Williamson, 1998; World Bank, 2000a; White 1996). Few argue anymore for an optimal city size (Speare and White, 1992) or draconian growth controls. Nevertheless, many observers raise concern about managing urban growth and its environmental impact (Montgomery, 1988). More worrisome is the view that African urbanization may be decoupled from economic growth: "Cities in Africa are not serving as engines of growth and structural transformation" (World Bank, 2000a).

There is a further twist. Many policy makers, government officials, and the like have a negative view of urbanization. In a recent UN report, the majority of developing country national policymakers advocated policies to decelerate or reverse migration to metropolitan areas, and 80 percent of African country respondents felt the same way (UN, 2003). Another UN report argued that development agencies maintained an anti-urban stance in their programs, (UNCHS, 2001). While one might not want to put too much stock in such reports, it does suggest the rather negative light in which urban growth is often viewed. Additionally, urbanization is commonly thought to be linked to air and water pollution, sprawl, and the like (Cincotta and Engelman, 2000), with megacities even more problematically affected (NYT, 2002; El-Shaks in Rakodi, 1997). In a preparatory paper for the Johannesburg summit, a Swedish group wrote, "Urbanization and many aspects of globalization tend to distance people from their relation to ecosystem support….People become alienated from their dependence on access to resources and ecosystem functions outside the boundaries of their own jurisdiction" (Folke, et al., 2002, p. 39). Whether this perception is borne out in actual behavior remains to be seen. This is not to deny that urbanization is accompanied by a host of challenges; rather it is to argue that the connection between urban growth and other outcomes needs to be better understood.

Population distribution (beyond urbanization itself) matters as well. Coastal areas are gaining in population, bringing more population into the vicinity of sensitive ecosystems (Hunter, 2000). Internal rural-urban migration is implicated in these changes, and there is need to understand its determinants (Bilsborrow and DeLargy, 1991). In particular, a better comprehension of the sociological determinants of migration, and the behavioral patterns that characterize life in these coastal regions, is needed (Curran et al., 2002.)

The debate continues about the connections between population growth, urbanization, and the environment, and it is far beyond our space to review (see recent contributions by Demeny and McNicoll, 1999; Curran et al., 2002; DasGupta, 2002; Arizpe, Stone, and Major, 1994; Davis and Bernstam, 1991; National Academy of Sciences, 1986; National Research Council, 1993; UN, 2001). At the same time, attention has turned to issues of how environmental management is linked to development and economic policy in lower-income settings, and these issues have become the subject of policy analysis (Bartone et al., 1994; Hardoy, et al., 2001; Repetto and Gillis, 1988). In the African setting, concerns are now heard about the pace of urbanization itself, the environmental impact of population growth and urbanization, and the ability of the public sector to address environmental and urban service issues (National Academy of Sciences, 1986; Rakodi, 1997; Lewis and Miller, 1987; Stren and White, 1989).

In this paper we take up the issue of urbanization, population growth and environmental quality. The progress of the paper treats these issues as follows: First, we take up a broad conceptual issue of population, urbanization, and environment, drawing on the well-worn and well-known IPAT frame to pose the issue, and argue that we need to reframe the issue. Whether for better or worse, the IPAT framework continues to orient much contemporary thinking on environmental issues (Martine, 1996). Second, we turn to a comparison of Ghana and the UK as a thinking exercise to help orient this reframing. Third, we turn to several research results from our own demographic research that we hope help to inform and recast the discussion of population-environment links. These research results introduce (a) demographic modeling of urban

population dynamics; (b) the role of urbanization on demographic change, most notably the demographic transition; and (c) the micro-foundations of environmental change. We conclude the paper with some discussion of the implications of all of this for public policy.

Frameworks: IPAT, Comparing Ghana and the United Kingdom

The IPAT framework continues to lurk in the background of much discussion about environmental threat. "A sizable segment of the literature on population and environment during the past 25 years has take the ubiquitous I=PAT equation as the starting point." (Martine, 1996, p. 7). While the IPAT equation (or identity) orients much thinking, there is far less empirical evidence to show how much impact a population increment (or urban population increment) has on environmental quality. At one level it seems obvious, and so explicit or implicit IPAT notions spill into policy. "Despite its inadequacies, the IPAT formulation continues to be frequently cited by policy-making institutions." (Martine, 1996, p. 9). At the same time, demographers may be faulted for not engaging the issue with their expertise, as thoroughly as they might. In particular, despite the continue concern for population and urbanization impacts on the environment, recent AAAS and UN publications have made the case quite explicitly that empirical evidence is needed. In part, out paper is a response to this need.

To help frame the issue of population-development-environment interactions, consider a simple (albeit simplistic) comparison. **Table 1** compares Ghana and the United Kingdom on some key statistics. Remarkably, both have about the same land area. Consider a point, sometime in the future, of matching population density and income level for the UK and Ghana. To reach this point Ghana's population would grow about three fold (from its 2000 level of about 19 million) and its income would have to grow about tenfold. (Ghana's population is current growing at 1.7% and its economy at 4.5% [World Development Indicators, 2004].) What would happen to the physical environment in Ghana? Ghana is now experiencing deforestation (vs. reforestation in the UK) and the country has set aside a relatively small portion of its land for conservation. Where would the trends lead? We offer these estimates and projections to illustrate some of the trends and choices in economic development, demographic dynamics, and health that are linked to current actions.

Such a discussion also visits the debate about the existence and shape of an environmental Kuznets curve (EKC), the increase and subsequent decrease of environmental insult with national income. Even as contemporary scholars regularly make use of the EKC concept, some challenge it or its empirical manifestation (DasGupta, et al., 2002; Gangadharan, 2001; Harbaugh et al., 2002; Hill and Magnini, 2002; Perrings, 2001). Yet the connections are anything but obvious. The World Bank cited one study (World Bank 1994) arguing that structural adjustment policies promoted deforestation; yet a more recent study claims that the market liberalization of structural adjustment helped slow deforestation in Ghana, due to shifting relative prices for raw materials and finished products (Benhin and Barbier, 2001). In another example, Hettige and coauthors find evidence that industrial water pollution increases with increases in national per capita income and then levels off (Hettige, et al., 1997; World Bank, 2000b). There is some argument that environmental regulation does increase with economic development, even at low ends of the development scale (Roy, et al., 1995). Furthermore, authors such as Dasgupta have raised issues about the prevalence and persistence of poverty traps in low-income tropical

settings, interweaving concerns about development, environment and health (Bloom and Canning, 2001, p. 193; DasGupta. 2001, pp. 76ff).

The Rio Summit first placed in relief the conflict between wealthy and poorer nations on issues of environmental redress:

> In Rio the poor countries have spotted that what they do with their environments matters to the richer countries, which are therefore prepared to pay for third-world adherence to some green treaties and agreements . . . But for many it will make better economic sense to clear land and plant crops. That, after all, is what the rich countries--notably unbiodiversified America--have done. (Source: ARoot of Evil at Rio.@ *The Economist*, UK ed., 30 June 1993)

At the more recent Johannesburg environmental conference this conflict arose again with regard to the UN report:

> Officials from the United States and the United Nations praised the document, but it was sharply assailed by environmentalists and advocates for the poor, who complained that wealthy countries had weakened the language. (*NYT* 4 Sep 2002)

Indeed, much of the discussion placed issues of sustainable development within a context of poverty alleviation, the impact of global climate change on low income societies, and a perceived widening gap between rich and poor nations (UN, 2002; also see, e.g., Waki, 2002). Rather than detour to discuss the merits of Johannesburg or the reporting of the conference, we refer to this discussion to reinforce our case for the need to study precisely the interrelationships among social processes and environmental outcomes. Even the broad natural science literature has recognized the difficult political trade-off between economic development and environmental preservation:

> Developing countries cannot reasonably be expected to restrict their future emissions without being assured of a fair allocation scheme that will not impair their ability to develop.
> (*Science*, AEquity and Greenhouse Gas Responsibility,@ Sept 2000)

Recent writings on issues of natural resource management often stress behavioral and institutional factors (Arrow, et al., 1995; Cohen, 1995; Liu, NRC, 2002; Ostrom, et al., 1999); and indeed, reconciling policy objectives and local human behavior can be a challenge (Liu, et al., 2001). At the same time there is evidence that a more micro-level approach to studying the impact of human population on the environment may reveal significant variability over the human life cycle (Moran, Siquiera, and Brondizio, 2003)

To return to the stylized Ghana-UK comparison, we can ask a number of questions. What are the perceived environmental issues in a developing country setting such as Ghana? What environmental path will Ghana travel as it moves toward Britain? What path of demographic dynamics – births, deaths, migration, urbanization – will Ghana take? What will be the connection in Ghana between these demographic dynamics and environmental quality? What

role will social, economic, and institutional factors play in marking the demographic and environmental changes of the coming decades? Our argument is that understanding the micro and meso-level foundations of demographic and health-related behavior may be particularly informative for concerns about population-development-environment paths to be traced in the 21st century.

Research Setting and Research Design: Demography and Environment in Ghana

Some of the work here is based on formal demographic analysis. We use such an approach below (in particular, simulation of demographic dynamics) for the examination of urbanization trends. Subsequent portions of the paper are based on field research in Ghana, in which primary data collection was conducted. We now describe that site and design.

Research Site

Coastal Ghana offers a useful setting for population-environment research. The Atlantic coastline of Ghana has long been an area of settlement, and it has witnessed increasing economic activity and human impact in recent years. These activities span traditional farming and fishing, large scale industrial activities, and newer sources of economic development, such as historical and ecological tourism. The southern coast itself stretches for over 500km, and contains a range of ecological settings (Benneh and Dickson, 1988). It is also this coastal zone which has received a disproportionate amount of population redistribution and economic development. Several rivers feed into the coast, and lagoons punctuate the coastline.

Our specific research site is the coastal portion of the Central Region. Within this demographic-ecological setting we gather water samples from several lagoons that cross a number of areas (by initial perception) of human impact. (One of the lagoons is a protected Ramsar site.) Our population universe is defined by the six administrative districts that touch the coast within the Central Region.

Economic development has included growth in the service sector, decline in the public sector, and some growth in small manufacturing. Of particular interest for its cross-competing influences on the local marine environment is the growth of the tourism industry in Ghana. Both conventional beachfront (with links to historical sites) and the more recent eco-tourism have seen growth (*Economist* 7 September 1996). While on the one hand, the tourism market has placed development pressure on the narrow strip of land beside the sea (including the beach itself), it has also created economic pressure for an attractive and Acleaner@ environment. Kakum National Park, near Cape Coast, provides an example.

Population growth along the coast has exceeded that of other portions of Ghana, but growth varies by region along the coast. The Central Region has grown by an average of 2.0% per annum between 1984 and 2000, a bit below the national growth rate of 2.5%. The growth of the Greater Accra Region (the capital region) has outpaced other regions, averaging 4.4% annually, about doubling between 1984 and 2000. Ghana is more urbanized than the continent as a whole, but at 36% urban it is still low by European, North American, or Latin American standards. The urban fraction has increased from 23% in 1960. Urbanization brings with it, of course, attendant land consumption at the periphery, demands for fresh water supply and waste water treatment,

and other public infrastructure. A great deal of debate swirls around whether developing countries= policies manifest an Aurban bias@ or generate an Aurban crisis@ (Stren and White, 1989; Becker and Morrison, 1998). Ghana=s cities, notably Accra, have been subject to the same criticism. By extension similar issues arise in more modest-sized urban settlements, e.g., Cape Coast of the Central Region.

The research is a collaboration among the Population Studies and Training Center, Brown University, USA; the University Cape Coast, Ghana; and the School of Oceanography, University of Rhode Island, USA. The project is interdisciplinary, involving demographers, land use planners, and estuarine biologists.

Household Survey

We conducted a representative, household-based survey of the local population. In order to do so we implemented conventional survey research and demographic procedures and augment these with some special aspects of instrument design. To draw our sample we exploited the availability of the 2000 Ghana census. We randomly selected primary sampling units (PSU) from the set of 1156 Enumeration Areas (EA) in the census for the six districts. These EAs hold about 750 persons each, and they provide an efficient basis for household sampling on the basis of geographic clusters. The EAs have three strata defined by the Ghana Statistical Service: urban, semi-urban, and rural. Within each EA we randomly sampled households and interview all adults. Survey analysis in this paper is based on interviews conducted in 54 randomly chosen EAs. These interviews included 1198 households (response rate 92.4%) and 2506 adult individuals. Several of the demographic questions were modeled after the widely used Demographic and Health Surveys. Several environmental questions were modeled after such questions used in other international environmental surveys.

The instrument (questionnaire) contains a conventional household roster, a set of questions on demographic behavior, a module on health knowledge, a section on environmental awareness and attitudes, and a life history calendar. The household roster and demographic module provide information on the age, sex, educational, and occupational composition of the household. The data allow us to precisely examine the interrelation of key elements of demographic dynamics.

Water Quality Sampling

We have gathered information on the condition of the water in several coastal water bodies. Ultimately the objective is to connect water quality to human settlement and activity in the vicinity and throughout the watershed. Our decision about the inclusion of particular water bodies needed to reflect range of potential anthropogenic conditions, access by the research team, and particular hydrologic conditions. Coastal lagoons offer an appropriate source of environmental data reflective of anthropogenic influences.

After an initial reconnaissance we selected six lagoons in the Central Region for repeated measurement. We also selected two lagoons in the populous capital region of Greater Accra. While all the lagoons are small (0.7 to 8 km2), shallow (0.5-1m deep), and at least somewhat open to the sea throughout the year, they varied widely in watershed area relative to lagoon area and in the drainage density of their watershed. All of the systems have very large drainage areas relative to the area of open water. With the exception of Oyibi and Sakumo lagoons, salinities in

the inner portions of all the lagoons exceeded 30 for most of the year. This reflects the strongly seasonal distribution of rainfall in Ghana and the fact that evapotranspiration exceeds rainfall for all but about two months per year.

Our protocol called for monthly visits to each lagoon, with water samples drawn from two points in each location. Laboratory measurements involved several parameters of both organic (and ultimately inorganic) contents in the lagoons. These included measures of turbidity and solids, and three nutrient measures (PO_4, NH_4, NO_3). Lagoons were sampled from July 2001 to June 2002.

Results of Demographic and Environmental Research in Coastal Ghana

Urbanization

As we have stated, the growth of cities is frequently implicated in concerns about environmental deterioration. Almost half of the world's population currently lives in urban areas, and for the foreseeable future, urbanization will increase (United Nations, 2001). What is more, urban growth – and population growth generally – in developing countries will outpace that in industrialized countries. These urban areas, whether small towns or megacities, each develop an environmental footprint. Although there are important regional differences in the level and trend of urbanization, city growth has proceeded steadily throughout the developing world (Chen et al, 1998).

As we recounted at the outset, many policy makers, government officials, and the like have a negative view of urbanization, such as the 80% of African policymakers who see urban growth as problematic. Environmental concerns would serve to reinforce these overall urban growth concerns. Yet, there is a positive association of urbanization and urban economic development with overall economic growth (NRC, 2003).

Urbanization is particularly important in this regard, and for several reasons: (1) cities are at the forefront of the demographic transition, the shift from a regime of high birth and death rates to a regime of low birth and death rates. (2) cities expand and grow with economic development; and (3) cities have an environmental imprint that is distinct, and because they are involved in international and internal trade, the link between urban settlement and its environmental impact may be hard to trace. At the same time, because of the proximity of persons and the associated economic and social changes that accompany urban growth, cities may be at the forefront of the environmental transition. These realities raise the issue of whether urbanization can provide feedback that might slow population growth and advance initiatives for environmental amelioration. Lowry, for instance, argues that cities can be allies in the movement to maintain a cleaner environment (Lowry, 1991).

As we mentioned above, urbanization is often viewed negatively in developing country policy contexts (UN, 1999) and generates concerns about environmental impact. We wish now to give some further insight into the process of urbanization and the consequences of urbanization for other demographic behavior, most notably human fertility. We draw in this section from work on the recent NAS Panel on Urban Population Change, whose results appear in the consensus volume, *Cities Transformed,* and on our own current research in coastal Ghana.

Urban Population Dynamics

We argue that patterns of urban growth are often misunderstood or misinterpreted for their longer term demographic context. Large rates of growth for particular cities – say 6 or 7 percent per annum – often are seen as newsworthy, but are less often viewed in their historical and demographic contexts.

The first point to make is that high rates of urban growth – the change in the total urban population per annum – may be expected in a developing country context, particularly in a setting of higher overall population growth rates and a relatively large share of an initially rural population. Details of the argument and some of the formal derivation are given in the NAS report (National Research Council, 2003). Results include such findings as:

- A realistic, *fixed* regime of fertility, mortality, and rural-urban migration rates will lead to a declining urban growth rate (UGR)
- Urban growth rates are expected to be very high at the onset of the urban transition, as large pools of rural origin persons move to cities at the prevailing rural-urban migration rate
- The Urban Growth rate (UGR) is sensitive to rates of natural increase, and differential rates of natural increase across urban and rural territories.

The upshot is that some of the things that we see in worldwide urban trends are exactly to be expected, suggesting that we should reorient our thinking. Note that growth rates of large cities in Asia did decline over the last few decades. One should not confuse the urban growth rate (UGR – the change in the urban population per annum) with urbanization (the change in the *share* of the population that lives in urban areas.)

In developing countries nowadays the pace of urbanization is now much higher than that of today's high-income countries at their time of industrialization and urban transition. What is different is the way in which the demographic transition has proceeded in the two regions and historical eras. To oversimplify a bit, contemporary Less Developed Countries (LDCs), especially those in Africa, are urbanizing in a regime of higher overall population growth rates, which fuel higher overall urban growth rates. Many of these developing countries – including China, Mexico, and Indonesia - have experienced what we term a "compressed demographic transition," moving from one regime to another in a shorter period of time. Some implications of this compressed transition for age structure and economic growth have been pursued elsewhere (Bloom and Canning, 2001; PRB 2004).

Urbanization and the Fertility Transition

Urbanization is also associated with the demographic transition. The growth of cities (and their share of national population) is also associated with the demographic transition, but not in lock-step. Here we will examine from our own research project the independent influence of city residence on birth rates. While it has long been acknowledged in the demographic literature that urban birth rates were lower than rural rates, less has been known about the mechanisms that give rise to the differential. On the one hand simple aspects of composition – more highly educated persons, younger cohorts – may be the reason. On the other hand, there might be an effect of city residence over and above these other factors. In addition, demographers have often

puzzled about the rate of change: did a downward adjustment in fertility take place within the childbearing span of a migrant to the city, or did it occur across generations? Rarely has data been available to answer the latter question, but our survey allows us to do so. Detailed results of this analysis are available (White et al, 2004).

A synopsis of our results is presented in **Figure 1**. We use a discrete time hazard model, predicting the probability of a birth in a given year, conditional on the probability of one not yet having occurred to that point. We control for children ever born, age, birth cohort of the woman, educational attainment, employment (or being in school), and residence. (The sample includes 1436 women 15+ years of age.) First, our results give an important overall picture of the traits that predict childbearing behavior, and some of these results echo what appears elsewhere in the demographic literature. We find that the rate of childbearing rises through the young adult years and then declines, as is well-known. We also find, quite importantly, that younger cohorts of women are bearing children at significantly lower rates than older women, even if we control for other influences. We also confirm the well-established result that more education, particularly secondary education, and current school enrollement is associated with lower rates of childbearing.

Finally, we find that urbanization is associated with declines in childbearing. Figure 1 presents odds ratios for the various traits. It indicates that even after controlling for age, education, and cohort, urban residents bear children at a rate 12% less than rural women. (This is the bar in Figure 1 with 0.88 value and labeled "Urban" to represent urban residence in the year prior to the birth.) This is a fairly substantial impact, and it is noteworthy that this urban residence effect persists in the face of other influential traits known to be correlated with urbanization, namely age, cohort and education. More detailed results (not shown) indicate that the urban residence effect is more pronounced in delaying the first birth. We also find that while there is no statistically significant effect of rural- urban migration on overall childbearing, there is a tendency to delay the second birth.

Overall the message for this paper is that urbanization is clearly associated with a decline in fertility rates, and hence a slowing in the overall population growth rate. It suggests further that for those who view the demographic transition and lower population growth rates favorably, urbanization will have an indirect but positive influence on that outcome.

Water Quality

Our initial results show a wide range in nutrient levels and other water quality measures across the several lagoons. All indications are that this range is not only linked to anthropogenic impact, but also influenced by other hydrogeographic factors for each lagoon. In order to account for the few very high concentrations in nutrients, we calculated median concentrations over the annual cycle for each lagoon. Oyibi and Sakumo were found to be fresher than the other systems; they are also higher in nitrite plus nitrate that was probably carried in with the river or ground water. The lack of oxidized nitrogen in the lagoon waters may reduce the amount of the nitrogen load that is denitrified in the systems since most nitrogen removal will have to be supported by coupled nitrification-denitrification in the sediments.

The median annual concentrations of total dissolved inorganic nitrogen varied much more dramatically, with a range of over 1000. This finding confirms our impression that the selection of lagoons would capture a wide range of anthropogenic fertilization. **Figure 2a** indicates that, at least in terms of simple correlation, population density is related to nutrient concentration. We plot Mean annual dissolved inorganic nitrogen (DIN) versus a simple measure of population in the lagoon watershed.[1] The most urban location of Korle lagoon occupies the upper extreme. Sakumo is also in the relatively urbanized setting of Greater Accra.[2] Nakwa, at the low end of the distribution, is in a less settled area. measures. Korle lagoon, in Accra, emerges as extraordinarily concentrated. By contrast, Muni lagoon exhibits lower than expect (for its watershed population density) DIN. Perhaps this is a result of the fact that Muni is a Ramsar protected wetland.

A common pattern in all of the lagoons (except perhaps Korle) is a marked bloom of phytoplankton during all or part of the July- October period (results not shown graphically). Assuming that the June preceding our first samples in July was similar to that at the end of our study, it seems reasonable to assume that these blooms were stimulated and supported by the wet season nutrient pulse of the preceding year. With the exceptions of Oyibi, Sakumo, and Korle , the blooms appear to have been pervasive throughout the lagoons. As the blooms declined, ammonia and phosphate concentrations increased modestly as the organic matter was decomposed. Median chlorophyll concentrations over the annual cycle ranged over 100 fold among the lagoons, with highest values in the more urban locations of Sakumo and Korle. Oyibi Lagoon also produced a very intensive bloom in the inner region. With these exceptions, however, the variations in median chlorophyll were modest and did not correspond well with our preliminary assumptions.

We also measured the ratio of stable nitrogen isotopes (^{15}N:^{14}N) in a variety of animals from the lagoons to see if this was a useful indicator of anthropogenic nitrogen in the systems. The results showed relatively good agreement among species within each lagoon and between parts (body vs claw) in a crab species. Muni had the lowest $\Delta\ ^{15}N$ values at about 6-8 ‰, similar to DIN in the coastal water. The other low DIN lagoons ranged from about 9-13‰ depending on species and lagoon. The highest values by far (14-19‰) came from organisms taken from Sakumo . Such heavy nitrogen strongly suggests that sewage is making an important contribution, even though no treatment plant discharges there.

While there appears to be a relationship between population density and lagoon nutrient impact, the connection may not be so uniform or universal. **Figure 2b** presents the same information for Ghana lagoons and adds points for US Atlantic Coast lagoons. Clearly the relationship between density and DIN is not so evident in the Atlantic Coast. While this latter set of lagoons is found in a temperate environment and with different hydrogeographic features, but it is likely that levels of economic development may be responsible for the observed differences. In particular,

[1] A more sophisticated measure of population potential at the watershed gave similar results.

[2] The DIN value for Muni will almost certainly decline markedly once corrected for ammonia measurements. The annual median dissolved inorganic phosphorus values also show Nyanya very similar to Nakway and Amisa and reinforce our prediction that Muni DIN values will come down markedly with correction.

public sector investments to control runoff and human waste discharge may be the operating factors (Nixon et al, 2005).

Results: Environmental Attitudes

In this final empirical section of the paper, we again make use of our household survey, but this time, we present some results on environmental attitudes. In its most general form, we would argue that a far more informed policy for environmental amelioration – the "What path Ghana?" question – will be traced if we have a better understanding of the micro foundations of environmental change; by this we mean the knowledge and behaviors at the level of the individual household that impinge on environmental activities and policies.

The current discussion of national and international environmental policy takes MDC's and LDC's to be adversaries. Some of the discussion arising post-Rio and some of the recasting of Johannesburg rests on a tension between economic growth vs. environmental preservation, further mapped onto national development groupings. Arguably missing from that discussion is information about how local residents in affected regions behave and what perceptions they have about these issues. This aspect of local residents' actions and views is all the more important as we consider problems of "social aggregation." Since so many environmental problems involve externalities, it is unlikely to be the case that individual human behavior will accurately reflect aggregate environmental costs and benefits. Institutions greatly matter when dealing with this asymmetry; including political structures, informal social controls, property rights and rules for dealing with free-rider problems (Ostrom et al., 1999; Harrison and Matson, 2001). It is also quite clear that there are some very important challenges of generating suitable information flows, maintaining compliance, and identifying an appropriate institutional arrangement (Dietz et al., 2003).

Our research on environmental attitudes examines two issues among others. We seek to understand what level of environmental awareness exists in a low income setting. Second, we seek to determine what traits of individuals or households are associated with sets of environmental attitudes or concerns. In a setting such a Ghana, where a substantial fraction of the population is illiterate, but in which democratic and market transitions are well underway, this question is crucial. In the paragraphs that follow, we give only a brief introduction and example for some of our preliminary findings on this matter.

Figure 3 presents results on environmental awareness for the adult population of our study region. **Figure 3a** presents a simple tabulation of the percentage of the population able to voice an opinion about environmental quality for a locale, by scale. In successive questions in our survey we varied the locale from the immediate vicinity (village or urban community), to Ghana as a whole, to the world. While admittedly crude, this does give us a window on the relationship of geographic scale to awareness.

The results are telling. Almost all of our respondents could voice a view about the quality of the natural environment in the local area. Clearly they have views – other work suggests well-formed views in many cases – about the state of the natural environment nearby. These views are based on a variety of conditions and considerations, everything from sanitary disposal of human

waste, to deforestation, to depletion of fish stocks. As the geographic scale increases, environmental awareness – the ability to voice an opinion – declines. About 80% of respondents could express a view (did not answer "don't know") regarding environmental quality in Ghana overall. When it came to world environmental conditions, the percentage with enough comfort and awareness to voice an opinion declined to about half. This is as would be expected, but it is noteworthy that the decline is substantial.

We also investigated what individual traits predicted environmental awareness. **Figure 3b** shows the results. Literacy (in other models educational attainment) is the overwhelming strongest predictor of environmental awareness. That some measure of education would move people out of the "don't' know" category is no surprise. But the role of other traits may be interesting as well. Awareness was higher for men and slightly higher for the young. Notably, those listening to the radio regularly were more likely to express an opinion. How and why mass media exposure matters, even after adjusting for other traits, would be an interesting follow-up. Finally, those voting in the last (2000) election were more likely to express a view.

Finally, we took a look at those who expressed concern about environmental issues. **Table 2** and **Figure 3c** present results from a direct question about whether protecting the environment should take priority over economic growth. (This question is exactly parallel to one used in developed country settings and we used it for that reason). A second analysis (not shown) created a simple index of the level of environmental concern (very serious, somewhat serious, not very serious, not at all serious) across four environmental areas: forest, drinking water, fish stocks, general pollution on a scale from 0 to 16 points. To gain a better calibration of the relative concern for environmental issues, we need to understand how environmental concern rates against other issues. To do so, we computed a parallel index for social problems (hunger, crime, health, prejudice) and subtracted that value from the environmental concerns scale. Thus the higher the value of the difference score, the more concern a respondent showed for a set of environmental conditions. (Other scaling and statistical specifications gave similar results.) Both of these approaches give broadly similar indications of the personal traits that are associated with environmental concern, and we show only the "priority" results here.

Literacy is strongly related to expressing an environmental priority, as is SES. Striking, perhaps, is the relationship with voting. Those who voted in the previous election were 50% to 70% more likely to express environmental concern than others, even after controlling for the several other personal traits. These results are strongly suggestive of a view that social change and economic development (increased education and income) will bring with them demands for environmental protection and amelioration.

We also examined the role of residence history. Some have expressed concern (see Curran, 2001) that migrants to an area, given that they do not have a long history of ties to a locality, may have less concern for maintaining the integrity of natural resources in the vicinity. We did not find this to be the case. Most differences between lifetime residents, recent migrants, and others were negligible and not statistically significant, with one exception: lifetime residents were about 35% *less* likely to express the view that environment is a priority over economic growth. While we have not had a chance to analyze this relationship in further detail, one possibility is that

lifetime residents are more likely to be found in some of the traditional occupations of the area. The concern for their livelihood may be what we are seeing in the statistical results.

Taken together, these findings can provoke some further thinking about human behavior and the environment, specifically the micro-foundations of environmental change. The results point quite strongly to the finding that low income country residents do have demonstrable and differentiated views about the environment, and moreover, that their views are better formed and more readily voiced regarding the environment close to home. The statistical results also indicate some relationships that would be expected: that education and literacy are related to environmental awareness and concerns. Less obviously, the results also point to a finding in which voting (perhaps a proxy for a sense of political engagement, an ability to act on collective issues) taps a key trait in environmental awareness and concern. Local health concerns linked to the environment (water and air pollution, local sanitation) may be particularly salient point in the feedback loop between human behavior and environmental quality. Finally, these results give little or no support to the notion that recent migrants in a community , being less tied to the local social fabric, are less environmentally concerned than other local residents.

Conclusions

In this wide-ranging discussion, we have attempted to address some key aspects of the relationship between human population dynamics and environmental change. In this final section we will summarize our main points and extend them into a short conclusion about policy issues.

- First, the discussion of population-environment connections needs to move beyond thinking about population as an undifferentiated aggregate. To be sure, much writing about human impact on the environment has already done so, or at least, it has begun to question the magnitude of the influence of population growth on environmental outcomes. At the same time, composition and context matter. The results on urbanization demonstrated, first that urban dynamics are often misunderstood and hence run the risk of being misinterpreted for policy. One should expect initial urbanization in developing countries, e.g., contemporary sub-Saharan Africa states, to occur with high rates of urban growth. At the same time, one should expect these growth rates to decline with the evolution of systems of population redistribution. In fact, this has been the case in Asia, where urban growth rates (UGR) have fallen steadily for large cities. Moreover, one does need to be alert to points where urban growth rates and urbanization (two distinct demographic entities) are out of line with expectations.

- Second, this paper demonstrated that in our coastal Ghana study site, urbanization (here long-term city residence) is associated with higher levels of nutrient content, an indicator of anthropogenic impact. While there is some evidence for a relationship between population density and pollution, a companion analysis for the US shows that this is not the case. The differential results point the possibility of some pattern akin to an environmental kuznets curve.

  Urbanization also brings with it lower levels of childbearing, even after adjusting for other traits of the women. This finding is parallel to results with less refined data from

other sources. The implication is that urbanization will, in most settings, operate to slow childbearing, and therefore plays a role in expediting the demographic transition. Policy hostility to urbanization (as we have seen is often the case) may be better replaced by programs to accommodate and manage rural-urban migration, as urbanization accompanies demographic and economic transitions.

- Third, this paper took up the issue of the environmental awareness at the local level (in a low-income society). We discovered the vast majority of the adult population in our Ghanaian study site expressed environmental awareness of issues close to the locality in which they lived. Such household survey results suggest that environmental awareness is indeed present, especially at the local level. When we investigated the relationship between personal traits and the expression of any view or a view of environmental concern, we find that literacy, gender, and participation in the electoral process all matter. Conversely there is no evidence that newer residents to an area are disruptive for environmental concerns. The preconditions for environmental change may be present. This suggests that locally oriented work on environmental issues, communication, education, mobilization, may pay significant dividends. The local should not be overlooked in our concern for the global.

Can one put demographic dynamics, urbanization, and environmental attitudes all together? Yes. The overarching argument is that we should worry less about growth of population overall and the growth of cities and more about the detailed manifestations of growth patterns. More important still, we should be concerned about the social processes that underlie environmental change. The growing literature on economic development and the environment strongly suggests that with rising income we wish to consume a higher quality environment. This, we argue, is the case in Ghana. Economic development is the ally of environmental quality, and so might be urbanization, since it is associated both with economic development and slower rates of population growth. Rapid economic development in low-income countries may, ironically, pay environmental dividends. In the face of inevitable population growth and increasing consumption in these countries, how one finds a path becomes the challenge. Theory and empirical evidence both suggest that a more optimistic path for population, development, and environment is possible.

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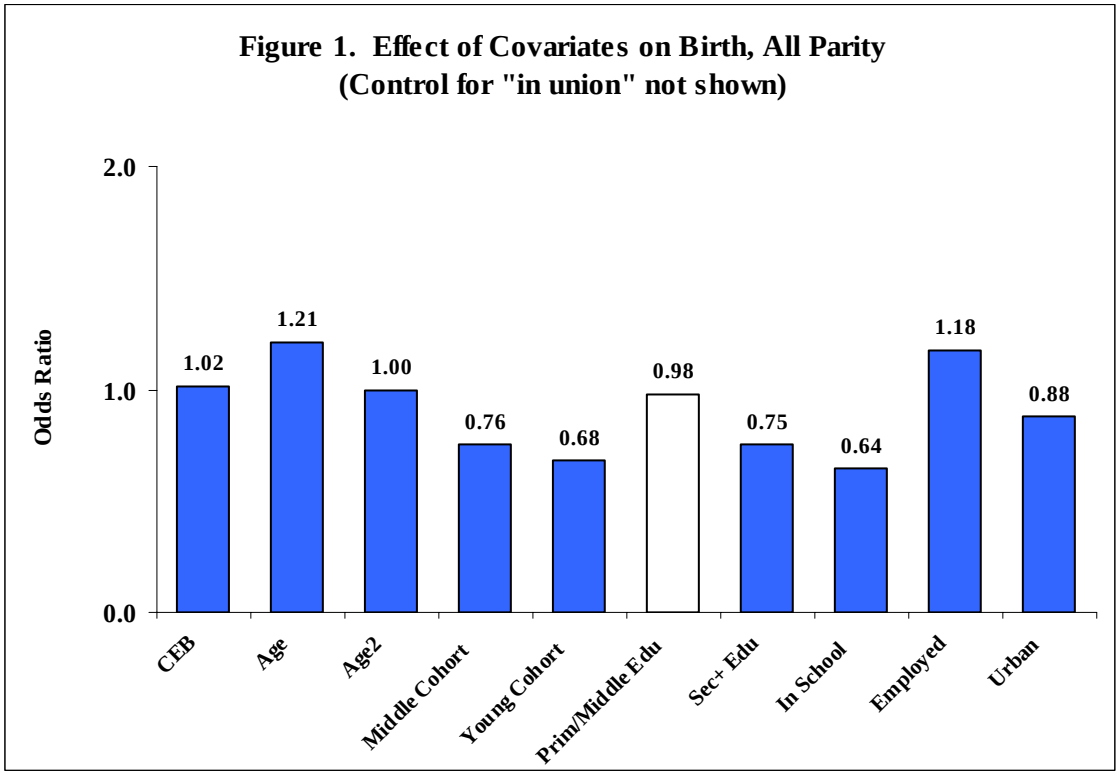
Table 1
Demographic, Health, and Environment Comparisons, Ghana and United Kingdom

	Ghana	UK	
Total Population in 2000 (million)	20.0	59.0	*UN, 1999*
Total Area (square kilometers)	238,540	241,705	*WRI, 2000; World Bank, 1999*
Stationary Population (million)	62.0	61.0	*World Bank, 1992*
Population Urban (percentage)	36.3	89.4	*WRI, 2000; World Bank, 1999*
Total Fertility Rate	4.6	1.7	*WRI, 2000; World Bank, 1999*
Life Expectancy	57.9	77.2	*World Bank, 1999*
Income per Capita (PPP in US dollars)	$1910	$23550	*World Bank, 2002*
Forest Area (hectares)	9,608	2,236	*WRI, 2000*
Average Annual Change in Forest Area (%)	-1.3	0.5	*WRI, 2000*
Emissions of Organic Pollutants (/worker)	0.2	0.2	*UN, 1999*

Table 2. Regression results for expression of environmental concern, adults respondents to the Ghana Coastal Survey 2002.

	"Env Is Priority"	
Voted	0.60	*******
Radio	-0.47	***
Newspaper	-0.13	
Literate	0.29	**
Male	0.26	**
Age	-0.003	
Lifetime Resident	-0.45	*******
SES Index	0.08	***
Urban	-0.33	***
_cons	0.609	
N	2501	

* P<0.05
**P<0.01
**P<0.001



Source: Ghana PCE Survey 2002. Sample of 1436 women age 15+. Discrete time hazard model with 28,213 person-year observations.

Figure 2a. Watershed population density and annual median concentrations of dissolved inorganic nitrogen, Ghana coastal lagoons.

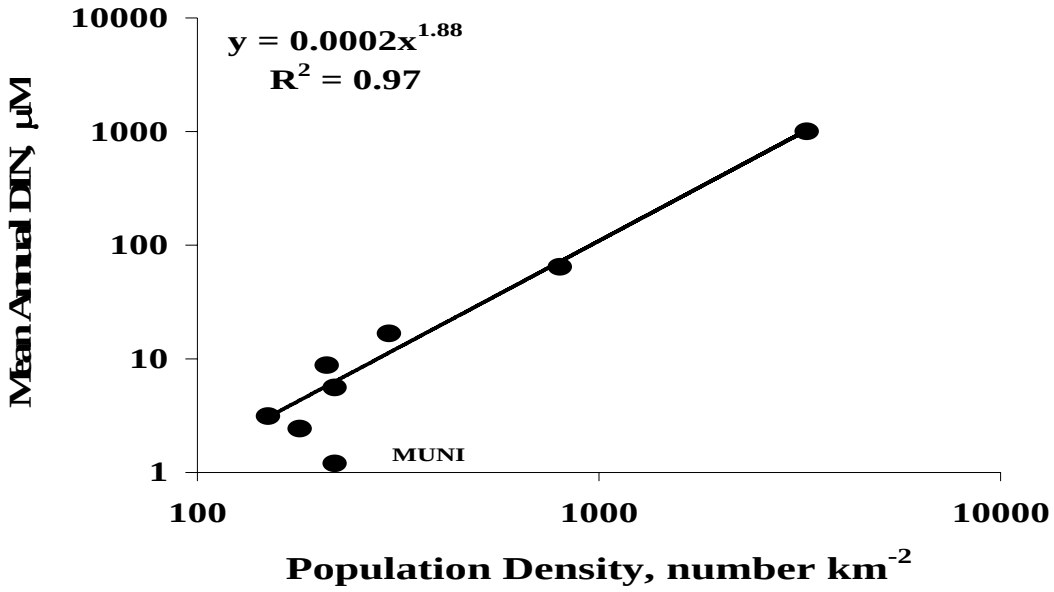


Figure 2b. Mean annual concentrations of dissolved inorganic nitrogen in the coastal lagoons of Ghana (solid circles) and some coastal lagoons on the Atlantic coast of the US (open symbols, X, and +) as a function population density in the watershed.

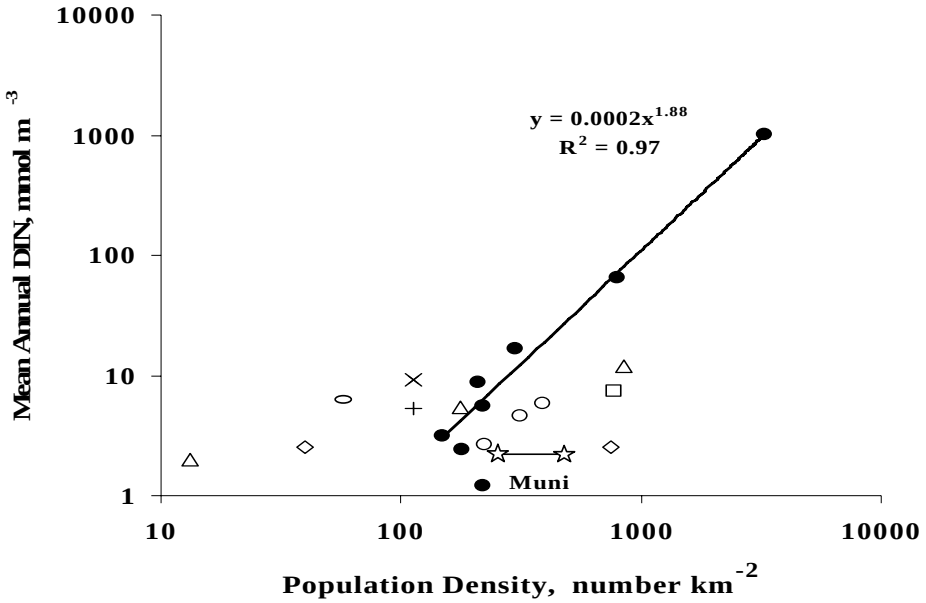


Figure 3. Environmental Awareness, Coastal Ghana 2002

Figure 3a. Percentage of Adults Expressing Environmental Awareness, Ghana Coastal Central Region, 2002, N=2506 Adults

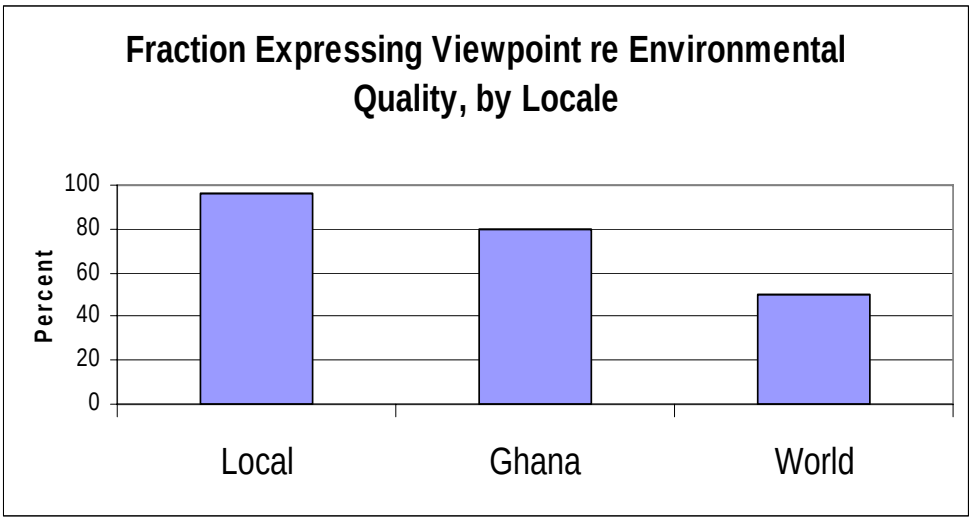


Figure 3b. Odds Ratios for Regression predicting Level of Environmental Concern, Ghana Coastal Central Region, 2002, N=2506 Adults

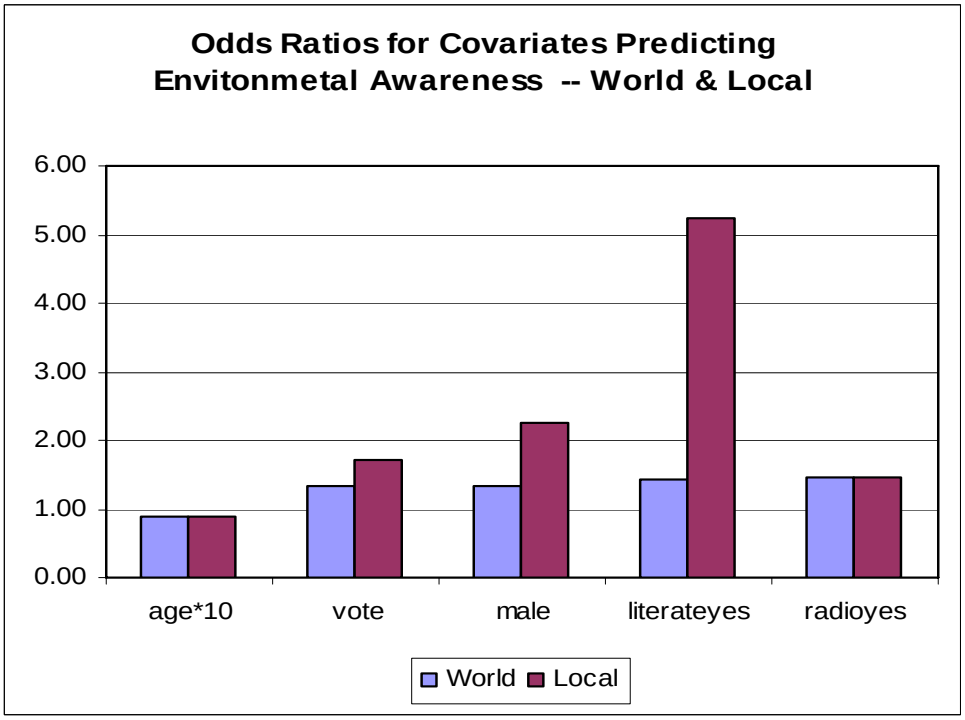


Figure 3c. Odds Ratios for Logit Regression predicting "Environment is a Priority", Ghana Coastal Central Region, 2002, N=2506 Adults