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Completing the Picture: The Challenges of Bringing "Consumption" into the Population-Environment Equation

[Consumption is] human transformations of materials and energy. [It] is environmentally important to the extent that it makes materials or energy less available for future use, and ... through its effects on biophysical systems, threatens human health, welfare, or other things people value.
– Stern 1997

Consumption all too often is treated as a passive process, indeed, merely a natural result of 'real economics,' namely, production and its variants of growth, investment, trade and innovation… [Instead] we might reconceptualize all economically productive activity as using up, as consuming, [or] as degrading.
– Princen 2001

I. Introduction

As scientists, activists, and policy makers have struggled with how best to understand the relationship between population and environment, they have come up against different paradigms for conceptualizing the "problems" or the relationship. Ever since the 1960s when Hardin's and Carson's essays galvanized the environmental movement, created justifications for new disciplines in the social and biological sciences, and established new agencies and policies, the primary focus has been upon models and measures of production (Princen 2001). Consequently, producers were to blame for consuming too much, not being efficient enough, or shirking standards to the detriment of human health and well-being. The reason for an overwhelming focus upon production processes may have been that the mechanisms for affecting change and thereby improving efficiency seemed more apparent, more amenable to change, and more likely to cause a dramatic improvement in environmental conditions. For example, the outcome of concerted government regulation and taxation policies has been, in fact, relatively dramatic improvements in energy efficiency among producers in the United States (Smil 2003). Nevertheless, in the last decade all of the energy gains in the production sectors in the

U.S. economy have been offset by households and individuals through the purchase of larger automobiles and larger houses. The result is that the United States is no better off in terms of per capita energy consumption than it was a decade ago (Smil 2003).

Initially identified as the "A" in the IPAT equation (Environmental Impact = Population x Affluence x Technology) (Ehrlich and Holdren 1971; Dietz and Rosa 1994), consumption has garnered increasing research attention in recent years, from reviews by Myers (1997), to reports by the National Research Council (Stern *et al*. 1997) and the OECD (2002), to advocacy-oriented publications (Brown *et al*. 1992; Durning 1996). Much of this research falls outside what has been traditionally construed as the population-environment literature, and has been carried out by economists, ecologists, industrial engineers, psychologists, sociologists and anthropologists.

Recently, three different social science research agendas have developed that begin to systematically explore consumption. These initiatives suggest particularly fruitful first steps. We briefly review these three literatures in section II. In section III we suggest that there are related lines of inquiry in the population-environment literature that could be usefully situated within a population, consumption, and environment (PCE) framework. Finally, in section IV we present a conceptual framework for understanding the population-environment literature that incorporates production and consumption into the model, and we propose some PCE research areas to which the population-environment research community could make significant contributions..

We need to introduce a caveat at this point. During much of the last decade, the population-environment literature has primarily focused upon providing evidence for linking demographic characteristics and processes to environmental outcomes or conditions. Demonstrating this linkage has been very successfully accomplished through spatial modeling approaches and locating humans and human activity next to or within environmental conditions or contexts. Central questions in this literature are: How do basic fundamental demographic processes, like fertility, mortality, population growth rates, and migration affect environmental outcomes? What are the reciprocal relationships and interdependencies among demographic and environmental variables? How do intervening conditions affect the population-environment relationship? The consumption and environment literature asks a set of related, but quite different questions. Which human activities are the most significantly disruptive to the environment? Who is most responsible for these destructive outcomes? What causes environmentally disruptive outcomes? And, how are environmentally disruptive activities changed (Stern et al. 1997)?

A further reason that the population-environment literature has progressed along a separate path from the consumption-environment literature is that the former has largely focused on developing countries (and particularly subsistence-level rural societies) whereas the latter has focused heavily on developed countries. Although not a perfect measure, a quick count of the PERN eLibrary holdings by continent reveals that three-quarters of the citations relate to developing countries and only one-quarter to developed countries. Explicitly introducing consumption into the equation, and especially

developing comparable metrics that are relevant in both the developing and developed worlds, may help to bridge the gap in the literature.

The population-environment literature developed coincidentally with the literature on environmentally significant consumption, but a significant cross-fertilization of ideas has not yet occurred. Although most population-environment researchers give a nod to the IPAT model, which is the most important bridge between population-environment and consumption-environment literatures, rarely is the model explicitly tested and subsequently refined (exceptions include Dietz and Rosa 1997). In this paper, we propose a small step forward towards the integration of ideas from each area.

II. Three Social Science Research Agendas

Here we briefly review three areas of consumption-environment research.[1] In the first, we describe how social scientists have shifted their attention from nationally aggregated consumption statistics to household-level analyses of several important consumption domains. In another line of research, biological, physical and social scientists have developed indices to measure the ecological footprints of human behavior at a number of different levels of analysis and shown how ecological footprint indices are valid and predictive. Finally, in a third line of research social scientists have begun to explore how values and attitudes shape consumption behavior, how consumption may in turn shape attitudes towards sustainable consumption, and how values and attitudes shape lifestyle choices.

Households as Units of Analysis

Per capita energy consumption has been one of the most commonly used metrics of consumption for a number of reasons. It is easy to measure (relative to materials consumption), it has easily convertible units (joules, calories, watts, etc.), and each unit of energy consumption is environmentally meaningful (in terms of pollutants or greenhouse gas emissions). Yet understanding of national-level *per capita* consumption of any resource offers limited insight for policy action, since variations within populations can be great, and they are significantly influenced by household characteristics. O'Neill *et al.* (2001), working in the area of population and climate change, found that changes in the number of households are a better predictor of greenhouse gas emissions than overall population growth. This is because later ages at marriage, divorce, and longer life spans have resulted in smaller household size, whereas the actual energy needs per household (given that the same number appliances, etc., were generally needed) do not diminish in proportion to the size of the household. In fact, research in California found that energy consumption for a one person household was only half that of four and five person households (Lutzenhiser 1997).

[1] These reviews are not meant to be comprehensive, but are meant to capture the gist of the line of research. We welcome readers' feedback and suggestions for sources and citations.

Using households as a unit of analysis has other advantages. Although households are not the only units of final consumption in society – both the public and private sectors consume products[2] – we can say that these other units of consumption, to a greater or lesser degree, support the wellbeing of the population, and that the population itself is composed of economically and socially integrated units called households. Thus, households are the end-users or beneficiaries of most of the forms of consumption that occur in other units, even if indirectly. Furthermore, apart from a small minority of households, household members generally pool economic resources and act collectively with regard to consumption.[3] Thus, it can be said that households represent a useful scale for consumption-environment studies.

Spangenberg and Lorek (2002) have identified three household consumption "clusters" that together account for nearly 70 percent of an economy's material extraction and energy consumption, and more than 90 percent of land use. These are construction and housing, food and nutrition, and transport and mobility.[4] Bin and Dowlatabadi (in press) similarly attribute significant portions of final consumption to households. Using a consumer lifestyle approach (CLA), they estimate that when taking account both direct and indirect demands for energy by households, more than 80 percent of energy used and CO_2 emitted in the US are a consequence of consumer demand. This is double the previous estimates, which generally only accounted for the direct energy demands for home energy and personal travel.

Trends in housing-related energy consumption, which are driven by heating technologies, house area, insulation, and appliance ownership, appear to be saturating (Schipper 1997), yet they currently account for an estimated 49 percent of household energy consumption (Langhelle 2001). Research on housing-related energy use in California demonstrated that both social (lifecycle stage, wealth, ethnicity) and technical (age, type, and size of housing and number of appliances) factors shape household energy consumption (Lutzenhiser 1997). Hispanic and Asian households had significantly lower energy consumption than white or African-American households, and attached multi-family units were also more energy efficient. According to Lutzenhiser, conventional modeling approaches, with their focus on "typical" households and amorphous stocks of housing, fail to recognize the importance of the material environment's social dimension (e.g. status-graded buildings, equipment and behavior).

In contrast to housing, there is no evidence of saturation of demand for mobility (Schipper 1997). In fact, private car use is increasing in almost every country, and the number of passengers per car is decreasing (Fuchs and Lorek 2001). And whereas the highest proportion of travel used to be for work, Carlsson-Kanyama and Lindén (1999)

[2] Stern (1997) makes the important point that in addition to being significant consumers in their own rights, the public and private sector make decisions that can significantly constrain a consumer's ability to choose more environmentally benign forms of consumption. This can happen through government policies (e.g. to invest more in new highways and less in public transportation) or product design and packaging..
[3] It should be added, though, that by focusing on households we miss some sub- populations, such as students and institutionalized people.
[4] For a literature review on the factors affecting each of these, see Fuchs and Lorek (2001).

report that more than 50 percent of travel today is related to leisure time activities. They report further that an individual's life cycle stage and income significantly influence mobility, with the youngest and eldest in society traveling least, and the highest income groups traveling the largest distances (and a greater proportion of that distance by car and airplane). Interestingly, each succeeding generation seems to have higher expectations in terms of personal mobility, which does not bode well for the sustainability of household transportation.[5]

Food and nutrition demands by households clearly account for a large proportion of global land use, and estimates of the total energy consumption used in the production, processing, storage, preparation, and transportation of food range from 20-30 percent (Heilig 1993, Langhelle 2001). Only 10 percent of the energy consumed is actually used to produce the food; the remainder is consumed in the processing-distribution chain. As societies develop, generally a higher proportion of the diet is made up of animal proteins which are much less efficient than plant proteins, and have higher environmental impacts. Research efforts are underway to develop novel protein foods (Zhu 2003), but given the degree to which food preferences are embedded in culture, it is unclear how successful such programs will be in convincing households to shift to new food types.

Duchin (2003 and 1997) and Reusswig *et al.* (2003) have proposed the use of household typologies developed by market research firms for the understanding of household types and their environmentally significant consumption patterns. Households are clustered according to factors such as income, geographic locations (urban, suburban, or rural), neighborhoods, and spending patterns. The approach also relies on identification of lifestyles, which will be discussed below. Such research seems ripe for the contribution of demographers and sociologists. However, there are potential limitations to the use of clusters defined for the purposes of marketing: firstly, households are dynamic, forming and dissolving according to the life cycle stage; secondly, the clusters are not developed according to theories of sustainable consumption but rather by the utilitarian desire to market more goods; and lastly, there is as yet no agreed upon method to map particular cluster types to actual environmental impacts, though ecological footprints might offer one such approach (see below). Furthermore, work on household consumption patterns has found unexpected complexity in consumption decision-making owing to the internal dynamics of households. Intra-household bargaining and power have direct implications for spending and savings behavior (Wilk 1998).

This movement from national-level analyses of *per capita* consumption to households as units of analysis mirrors a movement in the population-environment literature from a concern for the depletion of non-renewable resources such as fossil fuels and minerals, to an interest in the dynamics of household decision-making vis-à-vis land use, fertility, migration and livelihood strategies. Thus, although the two literatures appear to be moving along parallel tracks, there is a great deal in common. Spangenberg and Lorek have contributed greatly to our understanding by shifting attention from the icons of

[5] Zacarias-Farah and Geyer-Allely (2003) project that by 2020 the vehicle stock of OECD countries will grow by 32%, the total vehicle kilometers traveled will grow by 40%, and air travel will triple. Much of this is due to projected increases in tourism.

conspicuous consumption – such as CD players, cell phones, household electronics and various kitchen gadgets – to the most environmentally significant forms of consumption, which have to do with the maintenance of daily household functions such as heating living space, eating, and travel to and from work and leisure activities.

Ecological Footprints

Measuring the resources consumed to support people's lifestyles or the impact of human activities has generated a number of intensive efforts to account for all environmental impacts of human activities, including externalities. Recently, this line of research has been labeled ecological footprints (an approach and term developed by Rees (1992) and refined by Wackernagel and Rees (1995)). Ecological footprints research has generated some debate (see *Ecological Economics* (March 2000) about how it is measured and its ultimate usefulness for capturing the impact of humans upon the environment. Nevertheless, it builds on a long conceptual tradition that draws upon research in geography and ecology which coined terms such as 'ghost acreage' and 'shadow areas' when describing the amount of area used to produce a particular product or activity actually extended well beyond the boundaries of the site where the activity takes place (Deutsch et al. 2000). Research on ecological footprints derives directly from earlier efforts to estimate carrying capacity and represents an important refinement upon carrying capacity models.

Recently Van Den Bergh and Rietveld (2004) performed a meta-analysis of the literature concerning population growth and carrying capacity limits. Besides finding considerable variation in the possible size of the world's population that might be sustained under a variety of conditions, the study also finds that population levels at the time of the study strongly predict the studies' projected sustainable population level. Further, on average, the projected outer limit of population levels to be sustained by the earth's resources are significantly below those of medium-variant estimates of population size in 2050 when the earth's population is expected to stabilize. The meta-analysis revealed several shortcomings in current research about the limiting factors for population growth. Currently, emphasis in the population-environment and consumption-environment literature has been upon food, land, or energy as limiting factors. Instead, the carrying capacity literature also points to other limiting factors, including freshwater, forest products, and nonrenewable products such as fertilizer (Van Den Bergh and Rietvold 2004). The carrying capacity research inquiry has effectively been incorporated into the ecological footprints research

The power of the ecological footprints analysis is its explicit attempt to account for externalities of human activity. It can be calculated as a stock and it takes into account trade (imports and exports). It can generate a per capita figure of net carbon released or it can generate an areal measure (hectares of biologically productive land), both of which are attention-getting figures. Some argue that the figures provide only limited insight or direction for policy, because the footprint is too unrefined and the models are not dynamic (Moffatt 2000; Rapport 2000). Nevertheless, the approach has generated considerable scientific activity, yielding promising future research and potential insights.

These activities include assessing dynamics (feedback loops, thresholds, and non-linearity), accounting for temporal shifts, and spatial variability. Some have suggested incorporating the findings from ecological footprints research into dynamic simulation models, which are merged into geographic information systems. Because it has generated debate about the component contributions of human activity and their biophysical manifestations, it has also yielded productive research and findings regarding the accounting of ecosystem services (e.g. Jansson *et al*. 1999). One line of research that has aided in the development of ecological footprint measures is the investigation of life cycle assessment of products (goods or services) (Pennington et al. 2004; Rebitzer et al. 2004) – these models and their related equations provide improved and important baseline information for the ecological footprints indices.

One of the debates in the ecological footprints literature is about how to determine from which unit of human activity or which ecological outcome to generate aggregate stocks. Research efforts have been expanded from evaluating industrial activity at particular types of factories or agro-industrial sites (Chambers 2001; Folke 1988), to individuals (Best Foot Forward 2000), to urban settlements (Ciu et al. 2004; Folke et al. 1997), and to nations (Wackernagel et al. 1999). These debates are well-founded and buttressed by mixed empirical results. The population-environment literature has learned from its work with geo-referenced data that different levels of aggregation yield very different relationships between demographic, social, and environmental outcomes (Entwisle 2001). Although the ecological footprints research has generated a wealth of evidence, a major hurdle is to collect and account for the externalities of human activity at multiple levels of aggregation, from individuals to households, to communities to nations to the globe. Given the insights generated by the work on household consumption, it may be particularly useful for the ecological footprints research to focus on this social unit in a variety of different contexts.

Values, Attitudes, Behavior and Lifestyle

In the West much of what is now considered normative in terms of consumer behavior was not always thus. Historians trace the origins of the consumer culture to the breakdown of rigid class hierarchies, the rise of middle classes, and relaxation of religious inhibitions on conspicuous consumption (Wilk 1998). A key question becomes, can the culture change again? Can self-definition by consumption bundle be substituted with societal values emphasizing satisfaction, satiation and sublimation (Kates 2000)?[6]

Consumption behavior is determined by a constellation of factors, including *intrinsic* factors such as psychological makeup, education level, values, and attitudes, and *extrinsic* factors such as disposable income, time availability and social relations (Spangenberg and Lorek 2002). Intrinsic factors shape consumer preferences, while extrinsic ones determine the degree to which preferences (or aspirations) can be realized. Given that behavior is first shaped by values and attitudes, research suggests that it is possible to

[6] Duchin (2003) writes that one objective for sustainability science is to "recommend alternative behaviors that can substantially reduce the physical impact of household activities on the environment and to identify material and social contexts in which households might come systematically to consider alternatives."

shape people's attitudes towards consumption through public education campaigns or consumer awareness (similar to campaigns against smoking, drunk driving or other harmful activities).

Thorgerson and Olander (2002) find in their review of the literature that environmentally friendly behavior is indeed related to certain values, and that reasons for changes in values can be traced to three basic causes: differences between generations, changing conditions over an individual's life cycle, and periodical influences such as major personal or societal-wide events (e.g., marital breakdown or war). In their own research they explore the possibility that over the long term behavioral changes may shape values, and that thus there is a reciprocal rather than uni-directional relationship. This has practical importance, since it is often argued that engaging consumers in low-cost activities such as recycling can reduce their incentive to undertake the more costly behavioral changes required for sustainable consumption because they feel that they have already done enough. In a panel study of Danish consumers, Thorgerson and Olander found that values such as universalism (i.e. strong beliefs in "protecting the environment," "unity with nature," "social justice," and "equality") can strongly affect the propensity of consumers to avail themselves of new opportunities to engage in environmentally sustainable consumption activities (in this case, source separation of recyclables). They argue that over the longer term, engagement in such activities – even if symbolic – can result in values shifts which will influence other areas of consumption behavior towards enhanced sustainability.

Sanne (2002) argues that consumers are largely "locked in" to consumption patterns owing to technical, structural and political factors beyond their control. He notes that although many in the sustainable consumption debate point to the necessity of a change in values as a precursor to behavioral change, that there is a note of resignation in such assertions because it is difficult to identify an agent for such a change whereas there are many consumption-promoting agents already at work. As a potential way out, he suggests that individuals are not only consumers, seeking to maximize personal utility, but also political agents and members of society. As consumers they may have little incentive to change the *status quo*. But as political actors, they can be convinced that for societal wellbeing, consumption patterns need to be reigned in even if it comes at a cost to their individual preferences.

Lifestyle has been an analytically fuzzy concept that nevertheless captures something that is missing in the values research, namely the way in which consumers identify with certain lifestyles (through trendsetting or emulation) as a way of defining themselves. Lifestyle preferences are shaped during formative years, and once they have been formed consumers literally buy into a consumption package – large homes, heated pools, good schools, etc. – that dictates their income needs and work patterns (e.g. dual income rather than single income households). Values certainly shape lifestyles, but because lifestyles can be clustered according to certain factors (discussed above), they may offer a means for policy analysts to identify levers for change that would be most relevant for each cluster, or to focus on those clusters deemed to have the most environmentally significant impacts.

Population-environment research could undoubtedly benefit from more research that explores environmental values as they relate to environmentally relevant behavior such as land clearing, tree planting, sustainable fishing, or consumer purchases. However, in post-modern cultures such as the United States and Europe, it seems at least plausible that there is an increasing disconnect between values and behavior, with individuals espousing many lofty "universalistic" and "benevolent" ideals that have little connection to their day-to-day behavior. Furthermore, if, as the household research suggests, the most environmentally significant behavior occurs at the "core" (the daily commute, household heating, and eating patterns) rather than at the "margin" (impulse buying, electronic gadgets), then it may be that the choice set is fundamentally constrained by factors that are difficult to change. Thus, one could promote shifts in values through environmental education or public information campaigns, but that would not impact the ultimate behavior because extrinsic factors affecting consumption behavior remain unchanged.

The preceding discussion highlights three literatures, which directly address issues of consumption through the identification of critical social units of consumption (i.e. households), the accounting of the externalities generated by human activity, and the values shaping consumption decisions. We turn now to a brief discussion of a field that has received significant funding and generated important empirical results about the relationship between population and environment.

III. Situating Land-Use/Land-Cover Change Research Within a PCE Framework

One line of research inquiry that implies, but is not explicit about the importance of consumption, is the land-use/land-cover change field. This research effort has received significant funding from a number of sources and generated important findings for the population-environment field and we propose that these findings are also important for the consumption-environment field. We briefly summarize this line of inquiry and suggest how it might be situated within a population, consumption and environment framework. In so doing, we also suggest new ways in which the field might consider measurement of environmental conditions as they relate to human activity.

From studies in Brazil to studies in Ecuador, Thailand, India, Nepal, and the U.S. Great Plains researchers have made significant advances towards linking human activity to environmental conditions, particular land use, land-use change, land-cover or land-cover change. These studies have primarily focused upon social units smaller than a nation, frequently focusing their attention upon households and household activities with regards to land-use change or settlements in relation to land-cover change. The findings in this field of research are voluminous and we only summarize them briefly. From Thailand, Walsh et al. (1999) have found that the more local the social and spatial scale the more likely they are to find population and environment links. As the observational lens is expanded to counties, regions or nations, the relationship grows fuzzier – a critical finding for any attempts to view processes at larger scales (Evans et al. forthcoming; Walsh et al. 1999). The implication of these findings is that individuals, households,

communities, and nations are nested sets of social relationships within interrelated ecosystems. Clarifying the nature, conditions, character of the linkages between levels of analysis is paramount to overcoming the fuzziness.

Consistent with the findings of the earlier research on household and energy consumption, land use/land cover research has also observed that household formation has a more profound effect upon land-use/land cover change than does population growth *per se* (Liu et al. 2003; Lutz 1994; Rindfuss et al. 2003). In the process of developing linked databases, refining and interpreting satellite imagery, and "groundtruthing" those linkages the empirical challenges created new insights for many of these observers and several excellent collections of research (for example, Fox et al. 2001; Liverman et al. 1998; Walsh et al. 2002). One of the most challenging and potentially productive results of the collaboration of demographers, geographers and ecologists in this realm of research is realizing and then modeling the dynamics of household formation, growth, composition and dissolution. These are central interests in the field of demography, but the integration of spatial modeling has demanded more careful attention to the fluidity of household boundaries and household dynamics (Rindfuss et al. 2003).

One way in which the land-use/land-cover change research program might build a bridge towards the consumption-environment literature is to develop indices or measures of how particular land covers or land-use changes could be characterized in terms of consumption of resources. In some cases this is a relatively simple shift in syntax, answering questions such as how much biomass was consumed by clearing forested land to create a cultivated plot. In other cases, the effort might involve more nuanced measures which capture the potential consumptive quality and the foregone consumption or opportunity costs of particular land cover schemes. Encouraging land-use/land-cover change researchers to consider consumption may shift the contributions of this line of research towards the fundamental questions asked by the environment-consumption field about environmentally significant outcomes and conditions. For example, research on global climate change has recently identified the importance of carbon sinks as a critical environmental factor for estimating the extent of global warming. Estimating which types of land cover and land use in which regions of the world yield more or less carbon sequestration has yielded valuable insights (Bloomfield and Pearson 2000; Brown et al. 1995; Busch et al 2000; Canadell 2000). A more complicated task, but one which may be feasible is to develop measures of land cover that estimate species richness or potential biodiversity. Another approach would be to develop land cover analyses that measure how land cover fragmentation in particular regions reflect diminished biodiversity or ecosystem health or regenerative capacity.

Similarly, the consumption-environment literature could learn from the land-use/land-cover change research about how to link household dynamics to patterns of consumption. Entwisle (2003) has noted that households grow, shrink, multiply and disappear. Further, particularly large changes in consumption may be highly correlated with points of household transition (moving, marrying, childbirth) (Entwisle 2003). Thus, the research on households and land-use change suggests that particular moments in household life cycles are points to observe environmentally significant shifts in consumption.

IV. Conclusion: Conceptualizing a PCE Relationship

In the preceding section, we explored how the population-environment research that links populations to social units, such as households or settlements, has proven particularly insightful as these social units are the primary sites for consumption decisions. In section II we reviewed how social scientists in the consumption-environment field have been helpful in defining how households and urban settlements are critical foci for environmentally significant consumption. We also briefly reviewed recent work and debates about ecological footprints. Although this field is relatively nascent, it does build on earlier work in geography and it explicitly attempts to account for all the externalities associated with human activities as they relate to the environment. It is the accounting schemas that have generated the most debate, but which have also generated a wealth of empirical exploration and evidence. Finally, we reviewed the literature on values and attitudes. This appears to be the most challenging of the three topics, but we suggest that understanding shifting values and attitudes could make a useful contribution to a unified PCE research area. Applied and theoretical demographers, in particular, may be able to bring insights to these issues, given their experiences with sexual behavior and family planning.

Figure 1 provides a framework for thinking about the components of the population-environment relationship taking into account consumption. Each component is dependent upon a limited set of other components. We have also identified elements within each component that are more typically observed or measured. We have purposely under-specified the linkages and imposed a nested set of linkages between the components. At the top of the diagram are population outcomes and at the bottom of the diagram are environmental conditions. In between are a set of derivative factors that eventually link to the central element – the organization of production and consumption. Within this we have identified four mechanisms that influence how humans interact with environmental services. These mechanisms are how technology affects efficiency of resource extraction and use, how entitlement regimes mediate allocation access to environmental resources, and how markets distribute environmental services. Environmental services are the critical proximate measures of environmental resource use by humans, and the ways in which environmental services are consumed affects environmental conditions and outcomes.

In Figure 2, we provide a schematic of the consumption chain and specify in more detail the influences on household consumption that have been identified in the literature. These major influences are represented by the set of boxes with dashed lines which influence demand. Although the diagram shows the supply being determined by the demand, note that this does not represent endorsement of the notion that supply is strictly determined by consumer sovereignty. We acknowledge the important consumption demand represented by the public and private sectors, and the many influences on consumer demand such as marketing and the constrained "choice sets" available to consumers owing to governmental policies and the design of products by industry. This constellation of factors ultimately impacts renewable and non-renewable resources through the productive sectors in a manner similar to the one described in the lower half of Figure 1.

In our review we have mentioned in passing some ways that demographers and others working in the population-environment research field might contribute to a new population-consumption-environment (PCE) field, and ways in which consumption research may inform population-environment research. We conclude here with a list of research areas in which population-environment researchers may be able to make contributions to integrated PCE research:

- Household research: Population-environment researchers have long used the household as a unit of analysis. The understanding of demographers and others involved in land-use/land-cover change about the dynamics of household life cycles can contribute to PCE research by examining how dynamism and lifecycle stages affect consumption patterns.
- Values research: the Knowledge-Attitudes-Practice (KAP) "gap" has been used in family planning research to explain why people express a desire to limit fertility but do not use contraceptives. Can this be a useful heuristic for understanding why people express concerns about the environment yet do not alter their purchasing patterns or environmentally damaging activities? The KAP gap approach could also help us to understand consumer values and behavior vis-à-vis "green" products and willingness to pay (eco-labeling)
- Consumption transitions analogous to the demographic transition: Just as countries experienced the demographic transition earlier than others, some countries appear to be undergoing incipient consumption transitions (dematerialization, reductions in ecological footprint). What can we learn from those countries that can be transferred to the laggards?
- Impacts of trade and consumption on the developing world: The ecological footprint "deficit" (the degree to which a country's consumption demands in terms of hectares of biologically productive land exceed its actual arable land area) represents one way of accounting for the spill over effects of developed country consumption patterns on developing countries (Wackernagel *et al.* 2002). There has already been useful research on the impacts of various export products (farmed fish or shrimp, bananas) on the local environment of developing countries, but more of this kind of research could usefully be undertaken, especially with regards to manufactured products.
- PCE dynamics in the developing world: There is a great need to understand the ways in which rapidly urbanizing developing societies may either emulate the consumption patterns of industrialized societies or choose alternative paths.
- Modeling approaches: Lutz (1994) developed PDE models of developing countries, and land-use/land-cover change modelers have explored likely scenarios of future land-cover change under various assumptions. Are we ready to develop integrated PCE models with explicit environmental impact scenarios using our understanding of households as consumption units, trends in income and societal values, and our understanding of ecological footprints?

This review of the consumption-environment literature and subsequent exploration of ways in which an integrated PCE field of research might emerge from the separated

population-environment and consumption-environment literatures has necessarily been incomplete. It is our hope that this cyberseminar seminar will offer an opportunity to explore this topic further and, in so doing, provide further input on the most useful directions for future collaboration between the fields.

Figure 1: Population-Environment Conceptual Framework (italics indicate conceptual dimensions and measures)

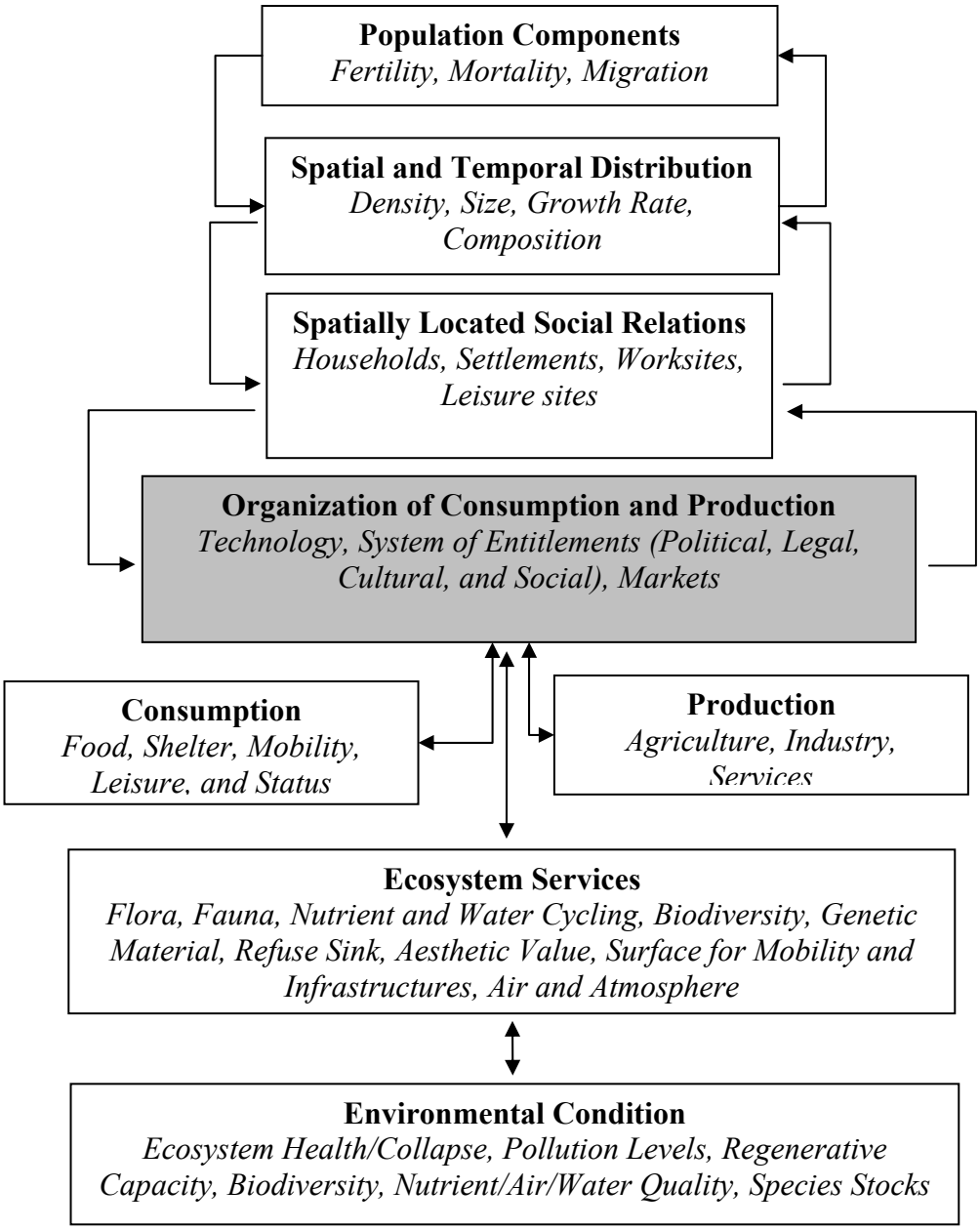
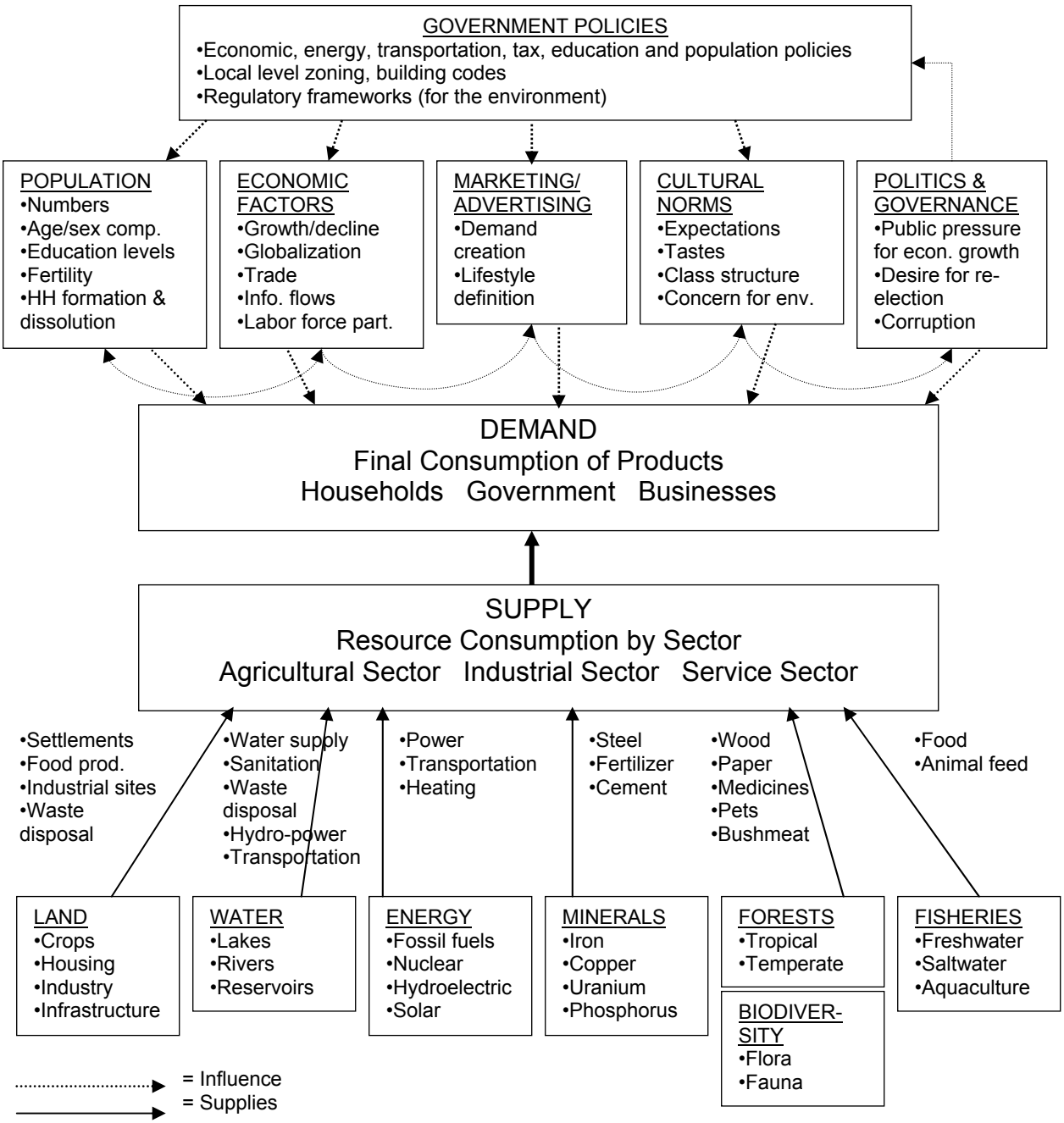


Figure 2. Consumption Chain and Major Influences on Final Consumption



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