Popul Environ (2014) 35:225–230
DOI 10.1007/s11111-014-0208-1

GUEST EDITORIAL

Introduction: understanding the links between population dynamics and climate change

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Published online: 26 February 2014

> "Global environmental change is about humans changing global environments, and about humans, individually and collectively, shaping the direction of planetary and social evolution" (ISSC/UNESCO 2013: 4).

The growth in scientific understanding of the climate system and its sensitivity to greenhouse gas emissions is a remarkable accomplishment by physical scientists during the last quarter century (IPCC 2007, 2013). Now, social scientists, including demographers, need to be more robustly involved if we are to achieve a complementary systematic understanding of the human causes and consequences of anthropogenic climate change and reach agreement on how to respond. Recognizing this challenge, the International Union for the Scientific Study of Population (IUSSP)—the preeminent international professional association of population scientists—established a new scientific panel on climate change in 2011.[1] Overall, the panel's aims are as follows: (1) strengthen and expand the network of population researchers working in this field; (2) encourage the development of a richer and deeper understanding of the ways population processes interact with climate change; and (3) ensure this improved understanding is made available to a wide range of researchers and policymakers. Our general guiding

[1] Panel members are Susana Adamo, Adrian Hayes (Chair), Leiwen Jiang, and Wolfgang Lutz.

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questions include the following: What do we already know about the empirical linkages between population dynamics and climate change? How can we best investigate these links and what are the key research questions? What are the most promising topics to explore and the most fruitful theoretical and methodological approaches? (http://www.iussp.org/en/panel/panel-climate-change).

The first international seminar organized by the new IUSSP panel was designed to address such questions. It was cosponsored by the Australian Demographic and Social Research Institute (ADSRI) at the Australian National University and held in Canberra during November 27–29, 2012. *Population and Environment* Editor-in-Chief, Lori Hunter, participated in the seminar, and she and the panel enthusiastically embraced a proposal to publish a selection of the seminar presentations (after appropriate revision and review) in order to invite broader participation in the discussion. The present special issue of POEN, composed of six papers, is the result of this endeavor.

One of the most exciting developments in the climate change research community at present is the development of a new generation of climate scenarios, constructed in such a way so as to facilitate (among other things) interdisciplinary research and assessment. The first three papers following this Introduction describe the innovative features of these scenarios. Hunter and O'Neill give a brief introduction, explaining the conceptual framework used in the construction of the so-called Shared Socioeconomic Pathways (SSPs), the range of socioeconomic and ecological factors incorporated in the SSPs, and the underlying rationale. Currently, five SSPs have been identified as core "representative pathways." The framework is designed to be open to further iterative revision, and the authors point to some areas where the demographic and population-environment research communities can contribute to this effort, especially regarding the population assumptions embedded in the SSPs and the way demographic factors such as urbanization interact with other SSP elements. They also show how the SSPs can be used fruitfully to organize and sharpen the relevance of population-environment research; for example, if we can relate research on how socio-ecological systems are changing in specific local settings, at least in part, to SSP storylines, then we can better assess how these changes may reduce or amplify broader challenges to mitigation and adaptation, respectively.

The paper by KC and Lutz describes in more depth what they call the "human core" of the SSPs: They and their collaborators have "translated" the qualitative narratives used to define the five basic SSPs into quantitative assumptions and have constructed five alternative demographic scenarios using population projections by age, sex, and level of education for 171 countries through to 2100 (and beyond). Education is a major source of heterogeneity in population dynamics and also an important condition of socioeconomic development (place of residence or urbanization is another); incorporating this heterogeneity represents a considerable advance from the way population dynamics were integrated in earlier scenarios used by the climate community (Nakicenovic et al. 2000). KC and Lutz summarize some of their results. For example, under SSP1 (Sustainability) and SSP5 (Conventional development), the global average of mean years of schooling among adults (male and female) can be expected to reach about 12 by mid-century. This, they argue, can be expected to accelerate demographic transition. SSP3 (Fragmentation) and SSP4

(Inequality), however, draw a more pessimistic picture, based on an assumption of stagnation in the *increase* in school enrolment. The authors project a world population of 12.6 billion for SSP3 by 2100 and 9.3 billion for SSP4, compared to only 6.9 billion for SSP1 and 9.0 billion for SSP2. The authors' graphical representations of possible future worlds in terms of population size and embodied human capital are striking (see their Figure 2), especially when juxtaposed with projections of other SSP elements (see Jiang's Figure 3) and with the varying levels of mitigation and adaptation challenges these pathways represent. The paper illustrates some of the potential uses of SSPs in research programs mentioned by Hunter and O'Neill.

Currently, there are four key elements to the SSPs in their quantitative incarnation: population, education, urbanization, and GDP. Jiang, in his paper, mentions the different modeling groups that have worked on projections for the different elements. These groups work independently much of the time, but of course, they also need to communicate and work together at times to ensure the SSPs are constructed in an integrated and coherent fashion. Jiang provides a preliminary yet powerful check of internal consistency among the demographic and economic assumptions used. He starts with the pattern in the direction of *changes* (not levels) in the values of the four key elements corresponding to the quantified assumptions for countries divided into three groups (by level of country income or development, sometimes labeled "regions") and for each of the five representative SSPs (see his Figure 1B). He then ascertains whether this pattern implies a positive, negative, or mixed-case correlation between each of the six pairs of elements for each of the 15 SSP-by-country group cases (see his Table 1). He then reviews the research literature on the 6 bivariate relationships (summarized in his Figure 2). Finally, he compares the implied correlations (in terms of their direction) with those described in the research literature and finds they are "reasonably consistent." In the final part of his paper, Jiang goes on to test whether the implied relationships are also consistent with the actual quantitative projection results produced by the different modeling teams. Again, the large majority of correlations—derived and implied—are consistent in terms of their sign, but there are interesting exceptions (see his Table 3). Some may be due to the fact that different modeling groups used different definitions of "region," but clearly, the relationships between different demographic and socioeconomic elements—and importantly, the way these relationships may change in the future—require further study. Jiang provides a model of how such research can be focused.

The last three papers are more empirically driven. Liddle gives a critical review and summary of the recent research literature examining the impact of demographic factors (population size, urbanization, and age structure) on carbon emissions (28 papers published since 2010). Population size emerges as essentially a scaling factor. Meanwhile, the relationship between urbanization and emissions is complex and varies depending on contextual and intervening factors. If the dependent variable is disaggregated to separate out, say residential electricity use and/or road energy use, then more interesting and useful findings emerge. Urbanization is itself a crude indicator, and Liddle points out that sometimes population density is a more discriminating measure. Similarly, when studies use a rough-and-ready measure of

age structure (e.g., ages <15, 15–64, 64+ years), then the associations with carbon emissions are weak or insignificant, but if age is disaggregated so as to more precisely reflect life-cycle behavior, then strong associations with emissions/energy use are confirmed. Liddle closes his paper with suggestions on how to advance the macro-level population and the environment literature using regression techniques. The value of sharpening our understanding of the empirical links between the population and emissions/energy use variables he discusses is obvious for further refining SSP narratives and their quantitative assumptions, especially when it comes to developing "extended SSPs" for individual countries and assessing their mitigation challenges.

The last two papers focus on adaptation. A common human response to location-related stress, whether the cause is economic, social, political, or environmental, is to try and move to a "better" location, i.e., temporary or permanent migration or displacement. Some commentators foresee waves of "environmental refugees" on an unprecedented scale in the coming century due to climate change (Myers 2002), and although their "projections" may be based on little systematic analysis, they sometimes make headline news. It is important that the population-environment research community provides a balanced view of possible migration outcomes. Migration events somehow related to extreme weather events or environmental stress need to be studied in depth under a wide range of contexts and conditions, and furthermore compared systematically to other kinds of migration and to other kinds of coping behaviors, and even at different points in the life cycle of climate-induced migration (Martin 2010:1–2). The paper by Fussell, Curtis, and DeWaard exemplifies one kind of case study needed by focusing on recovery migration. They examine how migration flows in and out of the City of New Orleans (NO) compare immediately before and after Hurricane Katrina, using data from the US Internal Revenue Service to identify changes in pre-existing migration patterns. Some people who were displaced later return to NO, and others do not. Meanwhile, yet others from neighboring counties (and a few from further afield) migrate to NO during the recovery period for the first time, attracted by opportunities accompanying rebuilding projects. The authors found a spatial concentration and intensification of the in-migration dimension, and contraction and shrinking of the out-migration dimension. Changes in the pre-existing "migration system" cannot be understood as a random response to a "natural disaster," it requires examining changes in economic and political systems too. We need to understand these dynamics and how they play out in other local and national settings, if we are to build an evidential base for assessing "challenges to adaptation" and migration as a way of coping with them.

Nevertheless, place together with its climatic and ecological features *is* an important determinant of human behavior and adaptation, and it has too often been overlooked by social scientists. Coupled natural and human systems will be put under additional stress by climate change, and the adaptation literature draws attention to the confluence of population and environmental changes in specific kinds of locations. The paper by geographers López-Carr, Priscope et al. focuses on developing a methodology to identify areas in Africa where climate change (specifically, decline in precipitation) and population dynamics (increasing

population density) combine to produce "hotspots" of vulnerability. The concept is simple, but operationalizing it with an appropriate "spatial clustering analysis" of existing data sets at adequate resolution is a notable methodological achievement. The results are interesting: a coincidence of decline in precipitation and high population growth in the Lake Victoria basin; in central Kenya and along the Djobouti and Eritrean coasts; and in central and northern Egypt. African specialists may not be surprised by these locations, but to see these results confirmed by statistical analysis helps put the formulation of adaptation plans and priorities on a firm evidential basis. Moreover, the authors take their analysis one step further by distinguishing areas not only of total population growth but also by age structure, zooming in on those with especially high rates of growth of under-5 and under-15 year olds. This takes the analysis beyond simply exposure to risk and begins to explore sensitivity to risk as well. These are areas where family planning programs and reproductive health services will take a generation or more to overcome the impact of population momentum. There are many lessons to be learned from studying the way López-Carr and his colleagues construct an integrated data set at continental scale and identify hotspots. Similar analysis is needed for other climate change impacts (aside from precipitation); for other population groups (aside from the young) and their differential sensitivities; and for the spatial and social distribution of resources needed for coping and adaptation (see de Sherbinin 2013).

One of the main conclusions from the November 2012 IUSSP seminar was that there is a major window of opportunity at present for population research on climate change if we position our research vis-à-vis the new generation of climate scenarios. As Hunter and O'Neill explain, the new Shared Socioeconomic Pathways can be thought of "as hypotheses asking about the relative importance of different processes in shaping mitigation and adaptation challenges." This in effect outlines a major new research agenda for population-environment specialists. Seizing this opportunity promises to generate more synergy and collaboration among population scientists working on different strands of research, and with other social scientists working on climate change; it could also increase considerably the visibility of demographic research among climate scientists. We hope the papers in this special issue will encourage more colleagues to get involved.

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