Recommendation to consider the crucial impacts of trends in smaller household size on sustainable development goals

By Danan Gu[1], Qiushi Feng[2], Zhenglian Wang[3], and Yi Zeng[3,4]
*(1. Population Division, Department of Economic and Social Affairs, United Nations; 2. National University of Singapore; 3. Center for the Study of Aging and Human Development, Duke University; 4. Center for Healthy Aging and Development Studies, Peking University)**

Importance of Households for Sustainable Development

The Rio Declaration, Agenda 21, the Johannesburg Plan of Implementation on sustainable consumption and production, and the Rio+20 Declaration have consistently emphasized the essentiality of promoting sustainable patterns of consumption and production to realize objectives of and requirements for sustainable development. To support these goals, this brief makes a recommendation to consider the crucial impacts of trends in smaller household size.

Compared with the individual, the household is often a more relevant unit of analysis for energy-related consumption, human impact on environment, and thus sustainable development (Lutz and Prinz, 1994; Ryszawaka-Grzeszczak, 2010; Bradbury et al., 2014). This is because energy and energy-related commodities such as water, food, transportation, and social services are often purchased and consumed by households, not individuals. It is estimated that household energy consumption represents about 35% of global energy consumption (IEA, 2004). In the United States, for instance, out of all energy consumed by road vehicles, household vehicles account for 68% (UN, 2007); in the Republic of Korea, the household sector was responsible for about 52% of the national primary energy consumption in 1980-2000 (Park & Heo, 2007).

Household also plays a key role in energy-related environmental issues such as emissions of greenhouse gases and ozone-depleting substances, acidification, pollution, resource scarcity, and species endangerment. For example, households are responsible for about one-fifth of energy-related CO_2 emissions in the United States (Abrahamse et al., 2005). Air pollution, both indoors and outdoors, is closely related to household energy consumption, especially in developing countries where clean fuels are not available and effective interventions are hard to implement (IEA, 2004). Accordingly, there has been a rising consensus among scholars that the environmental impact of energy consumption could be better understood using the household instead of individual as the unit of analysis (Cohen et al., 2010; UNEP, 2011; Bradbury et al., 2014).

Estimates and projections of household numbers are therefore important to better understand domestic and global energy demands and associated environmental impacts. In this regard, households matter even more than population. For example, researchers found out that in some countries where population declined, human impact on environment was mainly driven by the rapidly growing numbers of households; this growth was due to divisions of traditional larger households into smaller ones (Bradbury et al., 2014). The trends of much faster growth of households than population is reflected in Figure 1, which illustrates ratios of annual growth rate of total number of households over annual growth rate of total population. These ratios were 2.1-3.4 in Brazil, China, and France and as high as 11.6 in Japan in 2000-2010, and it was 2.0-6.6 in U.K. in the entire 60-year period from 1950 to 2010. Household estimates and projections should also consider that households vary by size and structure, housing tenure type (e.g., own vs. rent), and household characteristics, and that these

variations lead to varied patterns of energy consumption as well as other energy-related goods. Empirical studies have confirmed that these household characteristics are important determinants of energy consumption (Dalton et al., 2008; Feng et al., 2011; Prskawetz et al., 2004).

Lack of Household Analysis in the Sustainable Development Agenda

Given the impact of households on energy consumption and the environment (An et al. 2001; Pachauri 2007), households should be highlighted in the agenda of sustainable development (Dietz et al., 2009; Peterson et al., 2013); however a focus on households is largely invisible in this field (Bradbury et al., 2014). Several obstacles are responsible for this shortcoming. First, relative to individuals, households are more difficult to estimate due to high variability in composition and lack of available household data compared to population data (Bradbury et al., 2014), recent effort notwithstanding (Daiolglou et al, 2012). This comes as no surprise to demographers who have noted that household demography usually lags behind population demography (Bongaarts, 2001).

Second, household projection methods and their applications are still limited. Although the traditional headship-rate method has been criticized widely for its methodological problems and inability to forecast detailed household information such as household types and sizes (Mason and Racelis 1992; Spicer et al. 1992; Murphy 1991; Grundy 2013), it is still widely used. So far, with less than a dozen of studies that applied detailed household characteristics obtained from an extended cohort-component method to the consumption analyses and projections (Dalton et al., 2008; Feng et al., 2011; Prskawetz et al., 2004; Smith et al., 2008; 2012; Zeng et al., 2013; 2014), such an integration practice is still absent in the existing literature.

Third, most models of resource consumption and energy use ignore or do not fully consider the growth of household numbers (Kowasari & Zerriffi, 2011). Most efforts are concentrated on modeling of development and evaluation of intervention programs for new energy-saving technology or cleaner fuels (Abrahamse et al., 2005; Bertoldi & Atanasiu, 2007; Borge & Kelly, 2011; Staats et al., 2004), without considering the scenario that the number of households will continue to grow. With greater numbers of households consuming energy, the ability of technological innovations to reduce energy consumption may be limited.

Implications of Future Household Change on Sustainable Development

Important demographic household trends – increasing number of households and decreasing size of households – should influence our future agenda for sustainable development. One recent study reported that household growth has been faster than the population growth in almost every country and almost every time period since 1800 (Bradbury et al., 2014). Faster growth of households is likely to persist in the foreseeable future, largely due to shrinking household size. One recent study warned that if the average household size had been 2.5 people globally in 2010, then the number of households of the world would be 2.7 billion, 0.8 billion more or a 41% increase from the current actual 1.9 billion (Bradbury et al., 2014; United Nations Human Settlements Programme, 2007). Other demographic trends, including higher divorce rate, more internal and international migration, and the vanishing co-residence social norms all contribute to these transformations in households, which leads to a smaller household size (Dalton et al., 2008; O'Neil et al., 2010; Zeng et al., 2013; 2014). For example, the household size in 2010 in Japan was 2.5 dropping from 5.1 in 1950; it was 2.3 in 2010 in the U.K. decreasing from 3.8 in 1950; and it was 3.2 in 2010 in China decreasing from 4.7 in 1981 (see Figure 2).

Two articles published in *Nature* show that a rapid increase in households of smaller size, which results in higher per capita energy consumption, implies a larger demand for resources (Keilman 2003) and poses serious challenges to biodiversity conservation (Liu et al., 2003). For instance, in EU countries, overall residential energy consumption per household declined from 2000 to 2009; however, at the same time electrical appliances and lighting per household increased by 1.7% annually, and the total amount of consumption has been increasing since the mid-1980s (Lapillonne, Pollier, & Sebi, 2013). Considering these facts, a larger number of households would imply an immediate increase in energy consumption (Mackellar,

et al., 1995). It is likely that demands of housing units will increase, even when population growth slows (Bertoldi & Atanasiu, 2007; Klinenberg, 2012; Peterson et al., 2013; Smith et al., 2008; 2012; Zeng et al., 2013). Moreover, larger housing units, which consume more energy per household, are becoming a global trend, especially in developing countries. In the United States, the area measurements of dwellings more than doubled from 90 to 210 m^2 between 1950 and 2002 (Bradbury et al., 2014); in China, this increase in size was more than fourfold, from 8.1 to 36.7 m^2 in rural areas, and nearly quintupled from 6.7 to 32.3 m^2 in urban areas, between 1978 and 2010 (Bradbury et al., 2014; NBSC, 2012).

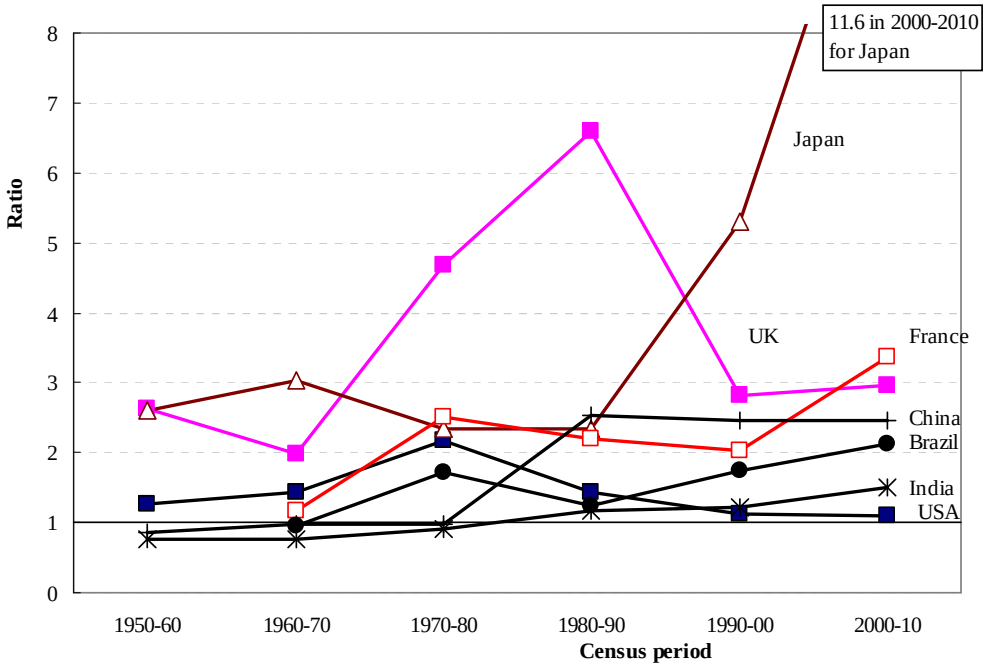
Recommendations

As noted in the Rio+ 20 declaration, fundamental changes in consumption and production are indispensable to achieve global sustainable development. We call for a proposal to consider projections of households and consumption as a more central factor in evaluating human impacts on environment (Daioglou et al., 2012; Linderman et al. 2005; Liu et al. 2003; Peterson et al. 2013) so as to better highlight the crucial role of households in sustainable development.

We also advocate for more efforts to collect household data. Data inadequacy is a major barrier to incorporating household characteristics into energy consumption models. Data are still lacking to measure household size/structure, expenditures, ownership, and energy consumption type and amount, especially over time and in developing countries (Kowasari & Zerriffi, 2011). We highly recommend routine inclusion of these questions in censuses and major surveys. Moreover, we recommend use of new methods, such as the ProFamy method (Zeng et al., 2013; 2014), which is able to forecast detailed household information such as household size and type using conventionally available demographic rates as input.

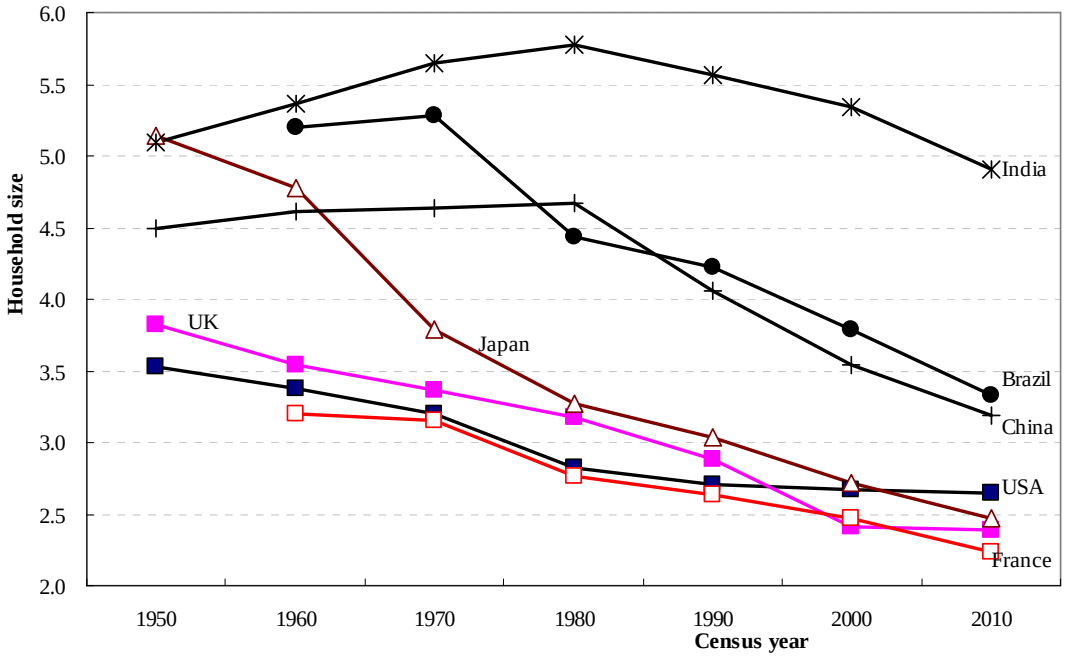
Last, we recommend integration of household and energy consumption projections, which will definitely result in better understanding of domestic and global energy demand trends. These methodological recommendations will enhance the sustainable development agenda. Unavoidable demographic changes are coming, so it is better to prepare early for the future we want.

Figure 1. Ratios of annual household growth rate to annual population growth rate in the census periods for selected countries, 1950-2010



Note: ratio greater than 1 indicates a higher growth rate of total number of households than that of population.
Sources: United Nations Statistics Division online database and national statistics office of each country.

Figure 2. Average household size in census years for selected countries, 1950-2010



Note: Although the census years are not the same for all countries, we presented them as roundness.
Sources: United Nations Statistics Division online database and national statistics office of each country.

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