



# Humanum

Issues in Family, Culture & Science

Issue One - 2016

## Human Population and the Natural Environment: Old Questions, New Answers

CATHERINE PAKALUK

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In 1798, Thomas Malthus problematized the question of human population growth relative to natural resources in his essay on the *Principle of Population*: “This *natural inequality of the two powers of population and of production in the earth*, and that great law of our nature which must constantly keep their effects equal, form the great difficulty that to me appears insurmountable in the way to the perfectibility of society.”<sup>[1]</sup> However, the difficulty that human population would outstrip food production never reached the predicted Malthusian crisis for two reasons. First, fertility rates did not increase after 1800, but rather slowed.<sup>[2]</sup> Second, due to advances in agricultural technology, the food supply increased, and there is today more food per capita than in any previous era.<sup>[3]</sup>

Theories that later based themselves on a Malthusian framework, such as Paul Ehrlich’s 1968 *Population Bomb*, speculated similarly that whatever the trends had been from 1800 through 1950, the *future ratio* of population growth to food production would become unsustainable, and would ultimately lead to mass starvation. Ehrlich argued that human fertility must decrease even further if human society were to flourish. However, the *Population Bomb* has been largely discredited—both by subsequent works of scholarship and nearly fifty years of counterfactual evidence.<sup>[4]</sup>

Since that time, with a change in emphasis, the environmental movement has been the primary inheritor of Malthusian-Ehrlichian rhetoric. Where Malthus highlighted the tension between *human population* and the *quality of human life*, the modern environmental movement has

instead advanced a paradigm that sets *human population* in competition with the *quality of the natural environment*. This latter is aimed not at the problem of human flourishing, but at the problem of natural flourishing, understood to mean primarily the health and proliferation of plants, wildlife and various habitats.[5] To wit, “Since the early 1970s, many researchers have found correlations between [human] population size and impacts on resources including water, air, and plant and wildlife species.”[6] For this reason, activists working from within the environmental paradigm have tended to encourage limitations on human fertility and birth, like Erlich, considering birth control to be environmentally friendly.[7]

The picture has become gradually more complex, however. To begin with, chemical-hormonal contraceptives have come under scrutiny for emerging adverse effects of estrogenic compounds on both natural and human ecology.[8] Moreover, environmental scholars have begun to argue that the paradigm pitting human population against natural environment is itself overly simplistic regarding the true relationship between human and ecological populations. In the remainder of this essay, we draw attention to some contemporary studies that help to characterize more accurately the relationship between human population and environmental health.

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In 2014, conservation biologists Mason Bradbury and Jianguo Liu from the Department of Fisheries and Wildlife at Michigan State University, together with M. Nils Peterson from the Fisheries, Wildlife, and Conservation Biology Program at North Carolina State University, proposed a new equation for estimating the human impact on the environment.[9]

Where prior scholarly work estimated various models of the impact of human population *per se* on environmental outcomes, Bradbury, Liu, and Peterson found that the absolute number of households (and not the absolute number of people) was an equivalent, and in some cases better, predictor of environmental impact.[10] They observed that variation in the *grouping of people* into households determined consumption, waste, and impact.[11] Both the overall number of households and the average household size were predictive of the consumption of natural resources and environmental impact.

The importance of this discovery is clear given the recent observation that although “population growth...is slowing and even reversing in some places,”[12] this “has not translated into reducing human consumption of natural resources and impact on the environment.”[13] The authors state:

The number of households is often equal to, or better than, population at predicting CO2 emissions [...] fuelwood [...] per capita automobile use [...] and species endangerment. For example, *population growth accounted for only one-fourth of increased energy consumption in the 1970s and 1980s, whereas the remaining 3/4 was related to per capita increases driven largely by*

households.” (Emphasis ours.) [14]

The figure above, that one-fourth of energy increase is due to population growth, while three-fourths is related to *per capita* increase in energy use, suggests that the driving force behind human impact on the environment is plausibly behavioral, namely, increased individual consumption of energy and other natural resources.

A reason for this is offered by one of the study’s co-authors, Jianguo Liu, a prolific environmental scholar, in a 2003 study: smaller households “demand more household products and have lower efficiency of resource use per person because fewer people share goods and services in smaller households.” [15] Liu suggests that researchers direct their efforts towards households because “households are basic socioeconomic units and share resources (e.g., energy, land, and water) among occupants.” [16]

Note that in the context of this research, a “small” household is one with fewer inhabitants, whereas in contrast a larger household has relatively more inhabitants. Observed variation in household size across regions and time is largely driven by sociological factors, such as grandparents living with children and grandchildren, older children living at home longer or moving out sooner, and not by variation in family size (e.g. number of children). Downward trends in family size have been remarkably stable and convergent—with total fertility rates continuing to decrease in every part of the globe. [17]

Along with the work on the lower efficiency of smaller households, scholars have also identified a trend that they term “household proliferation,” the fact that there are more households per person than there were in the past century. Liu gives an example to illustrate household proliferation: “If the average household size in 2000 (3.9 people per household) had remained at the 1985 level (4.4 people per household), there would have been 172 million fewer households in all countries combined by 2000. In other words, there were 172 million “extra” households due to the decline in the average household size alone.” [18]

Households are not an insignificant factor for the focus of environmental work. According to a study by Dietza et al, “direct energy use by households accounts for approximately 38% of overall US CO<sub>2</sub> emissions, or 626 million metric tons of carbon (MtC) in 2005. This is approximately 8% of global emissions and larger than the emissions of any entire country except China.” [19]

Although there is not a comprehensive study demonstrating the relationship between household size and the efficient allocation of resources, such as decreased *per capita* consumption, there are several studies highlighting the ways in which larger households are more efficient.

A first consideration is the amount of land that household proliferation consumes. Smaller household size means that more houses are built per person, requiring more land use, more

natural resources to build the house, and more infrastructure to support the spreading houses. Bradbury and his colleagues gave the following estimate for the amount of land used due to smaller households: “Assuming that each of the additional households occupies a 210 m<sup>2</sup> house ... then an additional 185,800 km<sup>2</sup> of housing area would be required. This estimate may be conservative because land area for household-related infrastructure (e.g., roads, yards, and retail) can require 2–4 times as much land as the actual land used for the home.” [20] But not only are the number of houses per person growing, the houses tend to be larger: “In addition to increasing numbers of households, the global trend is toward larger homes. In the United States, homes more than doubled in size between 1950 and 2002 ... In China, houses tripled in size with per capita floor space increasing ... between 1978 and 2002.” [21] Further, “sprawl,” or a decreased density of houses, has affected land conservation: “Rising affluence has also contributed to sprawl, which magnifies the environmental impacts of housing by virtue of low-density development patterns that require both more land and automobile-based transportation infrastructure.” [22]

In *Effects of Global Household Proliferation*, Liu argues that there are a great many negative effects of converting land to residential areas, including that it “reduces area for food production,” “pollutes water through release of household waste and changes hydrological cycles through land-use change,” “reduces area for production of fuel, wood, and fiber,” “destroys plants directly and indirectly,” “emits CO<sub>2</sub>,” “reduces areas (e.g., wetlands) for flood regulation,” “destroys organisms and habitat of organisms that can decompose waste and toxins,” “harms organisms that can purify water and air,” and more. [23]

A second consideration is the amount of energy, water, durable goods, and waste that is produced by the household unit. In a 2007 study, Liu and his co-author, Eunice Yu, found a clever way to measure the difference in use of resources. They studied the difference in uses of resources between married and divorced couples. [24] Their results were stunning. In terms of energy and resources, “in 2005, divorced households spent 46% and 56% more on electricity and water per person than married households. Divorced households in the U.S. could have saved more than 38 million rooms, 73 billion kilowatt-hours of electricity, and 627 billion gallons of water in 2005 alone if their resource-use efficiency had been comparable to married households.” [25] They also speculated that, “because of higher consumption per person, an individual in a divorced household may also generate more waste (solid, liquid, and gaseous material like greenhouse gases) that contributes to global environmental changes such as climate change and biodiversity loss... other studies show that waste per person increases with a decrease in household size.” [26] Since durable goods, such as large home appliances, are usually shared within a household, the authors of the 2014 study found that regular household goods also increase with household proliferation: “if the global trend toward household sizes of 2.5 continues, then at least 800 million additional durable household goods (e.g., televisions, refrigerators) would be needed *even without population growth*, assuming each household has one of each.” [27] (Emphasis ours.)

A third consideration of household proliferation and resource efficiency is automobile use. In his 2004 study of demographics and per capita environmental impact in transportation, Brant Liddle found that “in the U.S. as the size of a household increases the average miles driven per person in that household falls.”[28] Liddle’s study confirmed the more efficient use of transportation in large households, which is an important factor, especially considering that in the United States “cars and small trucks consumed between 75 and 80% of fuel used on highways from 1980 to 2000.”[29]

Taken together, households with fewer persons have less efficient use of resources including: land conservation; amount of energy, water, durable household goods, and waste that is produced by the household unit; and automobile use. Given these considerations of the environmental impacts of household proliferation, how big is this trend, and what are the main causes?

A first observation is that household numbers are growing much faster than population: “Among the 172 countries ... 136 countries (79 %) had faster increases in household numbers than population sizes during 1985–2000.”[30] Globally, households relative to persons increased by “12.6% from 1985 to 2000.”[31]

Several causes of household proliferation have been identified, including declining fertility, aging of the population, divorce, and young adults living independently. Among these, fertility has been surmised to be the greatest driver of smaller households. “Since 1950, fertility rates have fallen from 4.9 to 2.6 globally, falling 30–50 % in developed nations and over 200 % in developing nations other than those in sub-Saharan Africa.”[32]

As fertility rates are dropping, communities are also increasingly moving toward living as nuclear families instead of extended families since 1987.[33] This includes many among the elderly population who live alone: “Aging provides one explanation for why household sizes have continued to decline rapidly even in developed countries where fertility rates have been stable for decades”[34] because “older people are living longer and maintaining small households longer after their children move out of households.”[35]

At the same time, “the younger generation is contributing to household proliferation by leaving home sooner.” [36] This fact is especially clear in the United States where “since the 1940s, the percent of unmarried adult children living with their parents dropped from over 70–35% ... This new independent life stage created 6.7 million households for unmarried people in their 20s in the US.”[37]

A final contributor to smaller households is divorce. According to Liu, 15% of all household heads in the United States were divorced persons. In general, divorced households are 27-41% smaller than married households.[38] To give a sense of the scale, Liu uses an example: “If divorced households in the 12 study countries around 2000 had combined to have the same

average household size as that of married households, there could have been 7.4 million fewer households.”[39]

Yet the question still remains, why are persons and communities making decisions that contribute to household proliferation? Some researchers suggest that it is a preference for privacy, while others claim that “rising incomes” and “relative importance of public and private household goods” are important factors.[40] Bradbury writes: “In addition to the factors discussed above, economic growth, and shifts in distribution of wealth should be evaluated as potential drivers of shifts in household size.”[41]

Taken together, these studies raise fascinating new questions about the evaluation of various lifestyle and behavioral choices—since household proliferation and size are primarily functions of these. It would seem that if three-fourths of the increase in energy use has been a consequence of increased per capita consumption, then the most serious environmental impacts may be described as tragic consequences of human behaviors, and seemingly luxurious behaviors at that. Liu and his co-authors have stated that one goal of their research is “shifting the focus toward households [which] could facilitate movement from a human-versus-nature ethic to a humans-situated-within-nature ethic.”[42]

This approach seems highly complementary to that taken by Pope Francis, who ultimately locates environmental crises in a moral failure indicated by consumerism, overblown consumption and waste. He writes: “to blame population growth instead of extreme and selective consumerism on the part of some, *is one way of refusing to face the issues*. It is an attempt to legitimize the present model of distribution, where a minority believes that it has the right to consume in a way which can never be universalized, since the planet could not even contain the waste products of such consumption.”[43] Lessons deriving from recent environmental scholarship can provide practical guidelines for learning to be better stewards of creation.

*Catherine R. Pakaluk, PhD (Harvard, 2010) is Chair and Assistant Professor of Economics at Ave Maria University, as well as the Founder-Director of the Stein Center for Social Research.*

*Angela M. Winkels is a Junior Research Fellow at the Stein Center for Social Research, and a 2015 Summa Cum Laude graduate of Ave Maria University in Classics and Literature.*

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## Endnotes

[1] Thomas Malthus, *An Essay on the Principle of Population* (London: St. Paul’s Church-Yard, 1798), 5.

[2] Include data on TFRs in US as an example.

[3] Bjorn Lomborg, "The Truth About the Environment," *The Economist*, April 2, 2001, <http://www.economist.com/node/718860>.

[4] Jonathan V. Last, "Paul Ehrlich: Even Worse than the New York Times Says He Is," *The Weekly Standard*, June 2, 2015, <http://www.weeklystandard.com/print/paul-ehrllich-even-worse-than-the-new-york-times-says-he-is/article/962990>.

[5] Mason Bradbury, M. Nils Peterson, and Jianguo Liu, "Long-term dynamics of household size and their environmental implications," *Popul Environ* 36 (2014):74. "An Essay on the Principle of Population (Malthus [1798] 1970; Wolman 2001). Ehrlich and Holdren helped frame concerns about the influence of human population on the environment with their famous model, I = PAT: where impact (I) = population (P) × affluence (A) × technology (T) (Ehrlich and Holdren 1971)."

[6] Ibid.

[7] Jessica Prois, "Voluntary Birth Control is a Climate Change Solution Nobody Wants to Talk About: A Growing Population means Greater Environmental Strain. The Solution Could be Rooted in Women's Rights," *Huffpost Impact*, December 10, 2015, [http://www.huffingtonpost.com/entry/birth-control-climate-change\\_us\\_565339cde4b0258edb322194](http://www.huffingtonpost.com/entry/birth-control-climate-change_us_565339cde4b0258edb322194).

[8] Tim Worstall "Women on Contraceptive Pill Should Pay \$1,500 a Year More Tax" *Forbes*, June 3, 2012, <http://www.forbes.com/sites/timworstall/2012/06/03/women-on-contraceptive-pill-should-pay-1500-a-year-more-tax/#2f7736315bfd>.

[9] Mason Bradbury, M. Nils Peterson, and Jianguo Liu "Long-term dynamics of household size and their environmental implications," 73.

[10] Ibid., 74.

[11] Ibid.

[12] Ibid. "Population growth, however, is slowing and even reversing in some places. Most of Europe, North America, and many developing nations including Brazil, China, Chile, and Costa Rica had birthrates below replacement levels in 2010 (at least 45 nations faced absolute declines in population size in 2010" (World Population Prospects: the 2008 Revision 2008).

[13] Ibid.

[14] Ibid.

[15] Ibid.

[16] Eunice Yu and Jianguo Liu, “Environmental Impacts of Divorce” *PNAS* 104.51 (2007): 20629.

[17] See for instance “Fertility rate, total (births per woman)”, <http://beta.data.worldbank.org/?indicators=SP.DYN.TFRT.IN&view=chart>.

[18] Jianguo Liu, “Effects of Global Household Proliferation on Ecosystem Services,” in *Landscape Ecology for sustainable Environment and Culture* ed. Boji Fu and Bruce K. Jones (Netherlands: Springer, 2013),105.

[19] Thomas Dietza et al, “Household Actions can Provide a Behavioral Wedge to Rapidly Reduce US Carbon Emissions,” *PNAS* 106.4 (2009): 18456.

[20] Mason Bradbury, M. Nils Peterson, and Jianguo Liu “Long-term dynamics of household size and their environmental implications,” 81.

[21] Ibid, 82.

[22] Ibid.

[23] Jianguo Liu, “Effects of Global Household Proliferation on Ecosystem Services,” 108-109.

[24] For the sake of clarification, it should be stated that environmentalists are currently engaged in a debate about the environmental impact of divorce. Scholars such as Solveig Glestad Christiansen and Vegard Skirbekk have argued, in their 2015 article “Is Divorce Green? Energy use and marital dissolution” that although divorced couples do indeed consume more resources per capita, they have a lower fertility than married couples, and so ultimately have less environmental impact.

[25] Eunice Yu and Jianguo Liu, “Environmental Impacts of Divorce,” 20629.

[26] Ibid.,20632.

[27] Mason Bradbury, M. Nils Peterson, and Jianguo Liu “Long-term dynamics of household size and their environmental implications,” 81.

[28] Brant Liddle, “Demographic Dynamics and Per Capita Environmental Impact: Using Panel Regressions and Household Decompositions to Examine Population and Transport,” *Population and Environment*, 26.1 (2004): 25.

[29] Ibid.,36.

[30] Jianguo Liu, "Effects of Global Household Proliferation on Ecosystem Services," 104.

[31] Ibid.

[32] Mason Bradbury, M. Nils Peterson, and Jianguo Liu "Long-term dynamics of household size and their environmental implications," 78. N.B. Although in the short term declining fertility has been identified as the main driver of household proliferation, it is possible that declining fertility rates will lead to a decline in household numbers *in the long term*.

[33] Ibid.,76.

[34] Ibid.,78.

[35] Ibid.,80.

[36] Ibid.,80.

[37] Ibid.,80.

[38] Ibid.,80.

[39] Eunice Yu and Jianguo Liu, "Environmental Impacts of Divorce," 20630.

[40] Mason Bradbury, M. Nils Peterson, and Jianguo Liu "Long-term dynamics of household size and their environmental implications," 80.

[41] Ibid., 80.

[42] M Nils Peterson et al, Liu, "A Household Perspective for Biodiversity Conservation," *The Journal of Wildlife Management*, 71.4 (2007): 1243.

[43] Ibid., 50.