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The human dimensions of climate change: A micro-level assessment of views from the ecological modernization, political economy and human ecology perspectives

Lazarus Adua [a, *], Richard York [b], Beth-Anne Schuelke-Leech [c]

[a] Department of Sociology, Anthropology, and Criminology, University of Northern Iowa, Cedar Falls, IA, USA
[b] Department of Sociology, University of Oregon, Eugene, OR 97403-1291, USA
[c] The John Glenn School of Public Affairs, The Ohio State University, USA

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ABSTRACT

Understanding the manifold human and physical dimensions of climate change has become an area of great interest to researchers in recent decades. Using a U.S. nationally-representative data set and drawing on the ecological modernization, political economy, and human ecology perspectives, this study examines the impacts of energy efficiency technologies, affluence, household demographics, and biophysical characteristics on residential CO_2 emissions. Overall, the study provides mixed support for the ecological modernization perspective. While several findings are consistent with the theory's expectation that modern societies can harness technology to mitigate human impacts on the environment, others directly contradict it. Also, the theory's prediction of an inverted U-shaped relationship between affluence and environmental impacts is contradicted. The evidence is somewhat more supportive of the political economy and human ecology perspectives, with affluence, some indicators of technology, household demographics, and biophysical characteristics emerging as important drivers of residential CO_2 emissions.

1. Introduction

The earth's atmosphere is steadily warming. Global surface temperatures in the eleven years between 1995 and 2006 were the highest since 1850, and average temperatures continue to rise (IPCC, 2007, 2013, 2014). Some of the most dramatic indicators of the higher-than-normal global surface temperatures come from the Arctic Region where age-old ice-sheets (in Greenland) and glaciers are thawing. The crisis of global climate change, largely caused by human-driven increase in the atmospheric concentration of long-lived greenhouse gases (GHGs), has become the most daunting modern-era environmental challenge to humans and ecosystems. This study addresses human dimensions of climate change, focusing specifically on household level drivers of carbon dioxide (CO_2) emissions, the GHG that contributes most to climate change. Drawing on the ecological modernization (EM), political economy (PE), and human ecology (HE) perspectives, we examine the impacts of specific energy efficiency technologies, affluence, household demographics, and biophysical characteristics on residential carbon dioxide emissions in the United States.

* Corresponding author.
E-mail addresses: lazarus.adua@uni.edu (L. Adua), rfyork@uoregon.edu (R. York), schuelke-leech.1@osu.edu (B.-A. Schuelke-Leech).

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EM is a theoretical perspective that focuses on how the central institutions of modern societies may be restructured to "solve the fundamental problem of the ecological crisis" (Spaargaren and Mol, 2009, p. 68). A key proposition of the EM perspective is that technological innovations can pave the way for the "greening" of production and consumption (Christoff, 1996; Huber, 2009a, 2009b; Jensen and Gram-Hanssen, 2008; Mol and Janicke, 2009). The PE perspective, on the other hand, questions the extent to which efficiency technologies can counteract the impacts of the rising scales of production and consumption that generally accompany modernization. It argues that technological innovation often accelerates resource consumption (Foster et al., 2010; Schnaiberg, 1980; Schor, 2005). The HE perspective, which compliments the PE perspective (York and Mancus, 2009), focuses on the dynamic interrelationships between human populations and their natural, social and cultural environments. It recognizes that population characteristics, affluence, and biophysical features influence anthropogenic environmental impacts (Catton, 1980; Catton and Dunlap, 1980; Dietz and Rosa, 1994, 1997), and may sometimes overrun technological advancements.

There is widespread recognition of climate change's ominous potential to disrupt the functioning of social and biological systems, and of the need to act to reduce human effects on the climate. Some of the social impacts of climate change include global and localized food security challenges (IPCC, 2007, 2014; Parry et al., 2004); disruption of the traditional lifestyles of native and aboriginal people (Furgal and Seguin, 2006); increased prevalence of food-borne, water-borne and viral diseases (IPCC, 2007; Bultó et al., 2006); increased injuries and deaths from severe weather events (CCSP 2008; IPCC, 2014; Karl et al., 2009; Melillo et al., 2014); and water supply difficulties in some locations (CCSP 2008; IPCC, 2007; Karl et al., 2009; Melillo et al., 2014). While social systems are already being buffeted by the negative impacts of climate change, the IPCC (2007, 2014) observes that failure to act quickly and decisively to mitigate rising emissions of GHGs will likely lead to the grave situation where these impacts exceed the capacity of natural and human systems to adapt.

An important precondition for effective response to this global menace is a better understanding of its physical and human dimensions. Consistent with this need for understanding and the overwhelming importance of global climate change, there is a growing body of social scientific literature on the subject (Clement and Schultz, 2011; Dietz and Rosa, 1994, 1997; Dietz et al., 2013; Jorgenson and Clark, 2012; Lutzenhiser and Hackett, 1993; Marquart-Pyatt et al., 2011; Pellow et al., 2000; Rosa and Dietz, 1998, 2012; Rosa et al., 2004; Rudel, 2001; Weidner, 2002; York, 2012; York and Rosa, 2012; York et al., 2003a). A good proportion of these studies has examined the socio-structural and demographic drivers of climate change. The reality, though, is that this line of research and its associated theory testing has yet to reach a reasonable closure on the key facts of climate change's human dimensions. Contemporary social science theories on the environment still require substantial empirical evaluation. We contribute to this important endeavor by harnessing a recent nationally-representative U.S. household (micro-level) data set to evaluate some propositions of the theories identified above (the EM, PE, and HE perspectives). Our focus on households is warranted by the fact that they are important loci of many of society's environmentally-significant decisions and choices. While several studies have analyzed the anthropogenic drivers of climate change at this level, focusing especially on energy consumption (Abrahamse and Steg, 2011; Adua, 2010; Lutzenhiser, 1993, 1997; Lutzenhiser and Hackett, 1993; O'Neill and Chen, 2002), a good proportion of them were either based on subnational data or excluded several important variables.

In terms of practical significance, this study represents a de facto evaluation of one of the United States' top approaches to mitigating the emission of GHGs, efficiency improvement in energy utilization. As a result of a well-orchestrated disinformation campaign concerning the science of climate change (Dunlap and McCright, 2011), and whipped up fears about the economic consequences of limiting the emission of GHGs, the nation's current policy focuses quite heavily on efficiency improvement via technological innovations.[1] This paper provides an analysis of how anthropogenic factors at the household level are helping drive the ongoing atmospheric concentration of GHGs. In the remainder of this paper, we first briefly discuss climate change and its associated human dimensions. Second, we discuss the theoretical perspectives we are drawing upon. Third, we describe our data and methods. Finally, we report and discuss our findings.

2. Climate change and its human dimensions

In its Fourth Assessment Report, the IPCC characterized climate change as "any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC, 2007, p. 30). While the term does encompass global cooling, the current concern is about global warming. Global warming is caused largely by the rising concentration of GHGs (principally CO_2, CH_4 and N_2O) in the earth's atmosphere, which helps trap excess heat. The atmospheric concentration of these gases now greatly exceeds pre-industrial levels (IPCC, 2007, 2014). The concentration of the most important greenhouse gas, CO_2, crossed the frightening milestone of 400 ppm in May 2013 (Kunzig, 2013).[2]

In newly released reports, the IPCC (2013, 2014) clearly asserts that humans are primarily responsible for the rising atmospheric concentration of GHGs over the past two centuries. The fastest rates of growth in GHGs between 1970 and 2005

[1] Another strategy heavily favored by policy-makers today, especially the Obama administration, is the development and use of renewable energy sources. While the nation is yet to enact a coherent climate change policy, the Obama administration (via the EPA) is also currently considering rules to tighten the emissions of greenhouse gases by power plants.

[2] NOAA reported that on May 9, 2013, daily concentration of CO_2 crossed the 400 ppm milestone. This milestone was last reached during the Pliocene epoch (about 5.3 to about 2.6 million years ago). The pre-industrial era concentration of CO_2 was around 280 ppm (IPCC, 2007).

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