



Visualizing the shape of society: An analysis of public bads and burden allocation due to household consumption using an input-output approach



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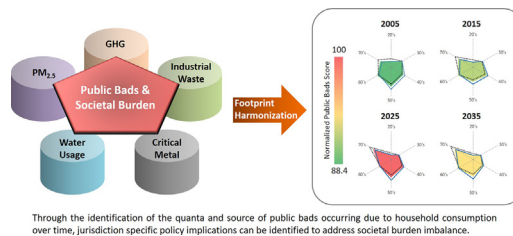
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HIGHLIGHTS

- Proposes an indicator to quantify lifestyle induced public bads and societal burden
- Applied to a case study, demonstrating the elucidation of societal 'shape'
- GHG, PM_{2.5}, water, industrial waste, and neodymium mining risk were considered.
- Potential applications as a footprint harmonizing tool in the footprint family

GRAPHICAL ABSTRACT



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ABSTRACT

This study investigates how our lifestyles can cause societal issue including a reduction in social equity due to the consumption of natural resources. Based on a range of household environmental footprints and their application to a quantitative social equity evaluation framework, a methodology is proposed which identifies the creation and origin of public bads within society. This research builds on the methodologies of energy policy sustainability evaluation incorporated with environmentally extended input output analysis in order to critically assess lifestyle-based consumption impacts, and to quantify the allocation of subsequent burdens across generations. Further, the proposed methodology is applied to a case study in Japan, an aging, shrinking population. Analysis identifies the increasing burden originating with elderly generations, and due to the resolution offered by the methodology, specifically identifies commodities and services which underpin these future burdens, allowing for policy implications to be drawn. The public bads and consumption burden indicator established through the described methodology is proposed as a footprint harmonizing tool to assess sustainability and supplement the footprint family.

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1. Introduction

Our lifestyle choices require the consumption of resources to sustain, and this consumption can be quantified in terms of the amount of capital expended, or alternatively in terms of the amount and types of resources that people consume. When the resources that people

consume are limited in nature, imbalances can emerge between sectors of society, often dependent on income or other socio-economic factors. Further, consumption of finite resources and energy to sustain our lifestyles has flow-on impacts including the generation of social ills such as pollution, and the depletion of critical materials. Ideally, the benefits and burdens within society would be shared equitably, however, in the case of the environment, and the depletion of finite materials, those who benefit most do not necessarily bear the burden that their lifestyles entail (Johnson, 2012).

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Japan, the focus of this study faces a combination of demographic issues including the highest level of urbanization, the most rapidly aging population and among the lowest working age population ratio when compared to its Asian peers and other nations with advanced economies (Chomik and Piggott, 2015). In addition, as the fertility rate is also declining, the population is shrinking, leading to a depletion in the labor force and negative impacts for the economy at large (Muto et al., 2016). The national government of Japan is cognizant of the demographic challenges at hand, and has identified the potential energy saving benefits that a declining population engenders (METI, 2014). At the same time, the Strategic Energy Plan (2014) recognizes that there are challenges ahead in coping with energy demand structure changes and the incorporation of technological innovation, complemented by the Long-term Energy Supply and Demand Outlook which takes into account demographic projections in designing the primary energy supply structure to 2030 (METI, 2015).

The aim of this research is to identify the impact of household lifestyle on the creation of public bads and environmental injustices between generations, and to assess this trend over time, as the population of Japan not only shrinks, but also ages. This research takes a unique analysis viewpoint, focusing on household lifestyle and consumption for household generations between the ages of 20 and 70 (and above). This research assesses the resultant generation of public bads such as air and land pollution from household waste, carbon dioxide and particulate matter from energy consumption, and the level of limited material consumption. Based on this assessment, the broader issues of environmental and energy injustice and social ramifications are addressed. This research combines the analytical aspects of household environmental footprints using environmentally extended input-output analysis (EIOA) and a modified application of social equity quantification and identification of burden distribution.

2. Background and literature review

This research is underpinned by environmental and energy policy assessment methodologies which consider lifestyle, consumption and social equity aspects. The three key concepts of social equity, environmental justice and environmental footprints using EIOA are detailed below, including a review of precedential scholarship which informs the unique approach proposed in this study.

2.1. Social equity and policy burden

This research builds on existing research efforts to evaluate social equity as well as the burden imparted on society through policy implementation. Such evaluative approaches are often grouped within social impact-cognizant sustainability evaluations. Some examples include the consideration of social equity within sustainable development (Campbell, 1996; Wheeler, 2002), the unequal impacts of climate change on lower income groups (Running, 2015), and national sustainable energy transition policy studies for Germany (Joas et al., 2016), Japan (Nesheiwat and Cross, 2013) and Italy (Magnani and Osti, 2016), among others, as well as multi-nation comparative studies (Laes et al., 2014; Geels et al., 2016). More recently, the emergence of the concept of energy justice has focused socially aware energy system research on the three core tenets of distributive, procedural and recognition justice (McCauley et al., 2013; Heffron and McCauley, 2017). It is from this concept of energy justice, and a focus on the distribution of costs and benefits due to the implementation of specific energy policies (distributional justice) that the importance of social equity and its quantification was brought to the fore (Chapman et al., 2016a, 2016b). Utilizing an investigation of specific energy policies in various regions and at multiple scales including the solar feed-in tariff in Australia (Chapman et al., 2016a, 2016b), participatory energy system scenario design at the national level, and social outcomes of mega-solar siting at the regional level in Japan (Chapman and Pambudi, 2018; Fraser and

Chapman, 2018), the Energy Policy Sustainability Evaluation Framework (EPSEF) was developed and refined using a number of social factors critical to energy policy. These factors typically included energy cost increases, health, employment, participation, subsidy allocation and greenhouse gas emissions, often using proxy indicators such as CO₂ and PM_{2.5}, among others.

2.2. Public Bads and factors of environmental justice

This study addresses generational household consumption and its impact on social equity outcomes, specifically identifying the creation of public bads which cause an inequitable or unjust distribution of burdens across household generations. The investigation of public bad generation and their final distribution across society has precedents in the environmental justice movement, which seeks to identify and redress the disproportionate allocation of environmental burdens or benefits which cause social inequality (Chakraborty et al., 2016). Recent research has expanded the scope of environmental justice studies beyond the unequal distribution of environmental ills, to incorporate the issues of empowerment, social justice and public health (Capaccioli et al., 2017). This broadening of the research scope has led to a number of recent noteworthy studies which underpin the design of this research in terms of factors investigated and scale, while supporting its originality and contribution to the academic field. This study is concerned with the emergence of public bads which impact upon lifestyles, generated as a result of household consumption. In order to identify relevant factors for a comprehensive investigation of these public bads, precedential literature is evaluated to elicit key factors and proxy indicators, beginning with the health-related issue of air pollution. The literature identifies an example of a national level investigation of China's rapid growth and subsequent increase in air pollution, which demonstrated flow-on impacts to self-reported health and happiness levels. Although impacts varied according to income, education employment and other factors, lower and middle-income groups were influenced by these factors more than the higher income groups (Gu et al., 2017). A focused study on exposure to air pollutants (specifically particulate matter) due to commuting and inequality between socio-economic groups was undertaken in London, however this study found no systematic relationship between income and exposure, with transportation type heavily influencing results (Rivas et al., 2017). Considering water usage and the tenets of environmental justice, Mahlanza et al.'s South African study clarifies the issues surrounding management of this limited resource (Mahlanza et al., 2016). Specifically, they identify issues with regard to policy development and stakeholder engagement and the expectation that access to water is a basic human right. Additionally, they find that when water provision is insufficient, householder's are forced to compromise on livelihood decisions, particularly the most vulnerable groups within society (Mahlanza et al., 2016). Waste, and particularly industrial waste, as addressed in this study, has been considered at the national level in India, identifying urban percentage as a strong predictor of waste generation, while also demonstrating that socially and economically disadvantaged groups are significantly more likely to generate hazardous industrial waste. For nations such as India undergoing rapid industrial development, the need to incorporate economic justice ideals into waste management approaches was extolled (Basu and Chakraborty, 2016). The scarcity of rare metals is well understood, and their concentration in specific geographic regions has led to the consideration of mining risk as a factor which can impact negatively upon householder's lifestyles. The fact that rare metals (this study focuses on neodymium) have unique properties with regard to modern technological applications, and suffer from a lack of alternatives, has led to research around global supply chains along with the need to address technical, environmental, social and recycling challenges faced by these materials (Golev et al., 2014).

Finally, with regard to the ethical consideration of intergenerational environmental justice Almassi investigates the notion of a reparative

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