



A quantitative analysis of the causes of the global climate change research distribution



M. Pasgaard^{a,*}, N. Strange^{b,1}

^a University of Copenhagen, Faculty of Science, Department of Food and Resource Economics, Rolighedsvej 23, DK-1958 Frederiksberg C, Denmark

^b University of Copenhagen, Faculty of Science, Department of Food and Resource Economics, Center for Macroecology, Evolution and Climate, Rolighedsvej 23, DK-1958 Frederiksberg C, Denmark

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ABSTRACT

During the last decades of growing scientific, political and public attention to global climate change, it has become increasingly clear that the present and projected impacts from climate change, and the ability adapt to these changes, are not evenly distributed across the globe. This paper investigates whether the need for knowledge on climate changes in the most vulnerable regions of the world is met by the supply of knowledge measured by scientific research publications from the last decade. A quantitative analysis of more than 15,000 scientific publications from 197 countries investigates the distribution of climate change research and the potential causes of this distribution. More than 13 explanatory variables representing vulnerability, geographical, demographical, economical and institutional indicators are included in the analysis. The results show that the supply of climate change knowledge is biased toward richer countries, which are more stable and less corrupt, have higher school enrolment and expenditures on research and development, emit more carbon and are less vulnerable to climate change. Similarly, the production of knowledge, analyzed by author affiliations, is skewed away from the poorer, fragile and more vulnerable regions of the world. A quantitative keywords analysis of all publications shows that different knowledge domains and research themes dominate across regions, reflecting the divergent global concerns in relation to climate change. In general, research on climate change in more developed countries tend to focus on mitigation aspects, while in developing countries issues of adaptation and human or social impacts (droughts and diseases) dominate. Based on these findings, this paper discusses the gap between the supply of and need for climate change knowledge, the potential causes and constraints behind the imbalanced distribution of knowledge, and its implications for adaptation and policymaking.

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1. Introduction

In the past few decades, climate change has become a central theme in many political and public debates on the local and global scene. The scientific community has contributed extensively to these debates with various data, projections and discussions on the future climate, as well as on the causes and effects of the expected climatic changes. Notably, the impacts of a warmer, more unpredictable and extreme climate are not expected to be evenly distributed across the globe. Some regions will experience potentially detrimental changes such as increased drought or flooding, while others may find that conditions for agricultural production improve (Hare et al., 2011; IPCC, 2007; Richardson

et al., 2009; Stern et al., 2006). Many regions with a high risk of negative impacts from climate change are found in the less developed parts of the world and often have a low adaptive capacity (Preston et al., 2011; Richardson et al., 2011). Scientific knowledge has been shown to play an increasing role in understanding potential climate change impacts and in forming debates and policies (Dessler and Parson, 2010) at global, regional and national scales. Increasing scientific knowledge transfer may contribute to decreased uncertainties and increased adaptive capacity of individuals, institutions or governments (Adger et al., 2009). However, scientific research on climate change appears to focus predominantly on the more developed and less vulnerable regions of the world (e.g. Felton et al., 2009; Ho-Lem et al., 2011; Kiparsky et al., 2006). Indeed, the Intergovernmental Panel of Climate Change (IPCC) notes a “lack of geographical balance in the data and literature on observed changes in natural and managed systems, with a marked scarcity from developing countries” (Rosenzweig et al., 2007, p. 117). This leaves a potential gap or

* Corresponding author. Tel.: +45 3533 1640.

E-mail addresses: mase@ifro.ku.dk (M. Pasgaard), nst@ifro.ku.dk (N. Strange).

¹ Tel.: +45 3533 1753.

mismatch between the supply of and the need for knowledge on climate change to be explored and addressed.

This study is one of the first to analyze for congruence between research efforts and research needs at the country scale in relation to climate change. We expand by analysing the potential causes of global distribution of climate change research. With a bibliometric analysis we aim to identify potential mismatches between the global need for knowledge, measured as climate change vulnerability, and the supply of knowledge, measured by scientific publications. The analyses presented here include country level indicators on wealth, education, research expenditures, press freedom, state stability, corruption, development assistance and environmental footprint. These explanatory factors are included in order to facilitate a discussion on some of the potential causality and reasons for any mismatch between recent supply of and need for scientific knowledge in climate change. As in Sarewitz and Pielke (2007) we borrow from economics the concepts of “supply” and “demand” of knowledge to discuss the relationship between the production of scientific results and their potential use for filling the knowledge gap in different regions of the world.

The use of bibliometric analyses as a method to study trends and patterns in the published scientific literature has gained interest in the past few decades with the increasing number of (easily accessible) online databases as well as software programs for various analyses and statistics. In environmental science, for instance, the method has been used to study which themes, key words or sub-fields are the most common within a given research field (e.g. Fu et al., 2010; Janssen et al., 2006; Kiparsky et al., 2006; Mao et al., 2010; Preston et al., 2011; Zhang et al., 2010) or to study which authors, journals or countries contribute to the literature within a given field (e.g. Aksnes and Hessen, 2009; Fu et al., 2010; Janssen et al., 2006; Kahn, 2011; Karlsson et al., 2007; Kiparsky et al., 2006; Ma and Stern, 2006; Smith et al., 2009; van der Zaag et al., 2009). Several studies have addressed the link between scientific publications and environmental or climatic changes. Janssen et al. (2006) analyzed the relationship between different knowledge domains (resilience, vulnerability and adaptation) within the research activities on human dimensions of global environmental change. van der Zaag et al. (2009) studied the gap in water research on adaptation to climate change published by developing countries, and Felton et al. (2009) assessed climate change literature that considered the conservation management of biodiversity and ecosystems. Finally, Karlsson et al. (2007) take the analysis a step further with a quantitative study of the generation of scientific knowledge in environmental research between developed and developing countries in relation to geographic, social, political and economic characteristics.

It is widely understood in the scientific community that scientific evidence supports that the global climate system is moving beyond the patterns of natural viability and the natural range of the human living conditions (Richardson et al., 2011). Knowledge exists on potential impacts and the literature has extensively discussed the potential instruments that could effectively deal with climate change. The great challenge is to develop more geographical specific knowledge and to integrate this knowledge into the development of country or regional level trajectories. One important precondition is to understand how the level of scientific information on climate change in a particular geographical setting varies with characteristics of the socio-economical and socio-political system. To our knowledge, bibliometric analysis has not been applied to analyze potential gaps between climate change research needs and supply at a global scale, and more specifically not on how economic, institutional and political factors could influence the supply of climate change research on a particular geopolitical setting (country or region).

To address the gaps outlined above this study explores the following questions: How does the number of climate change publications match the vulnerability in a country to climate change? How is this relationship related to the socioeconomic and institutional characteristics of a country? Finally, how is the number of publications concerning climate change across countries related to the first author affiliations of the publications? These questions are addressed in the remaining parts of the paper, which are structured as follows. Section 2 briefly presents the methods used for searching climate change publications and sorting the dataset. The model and variables used for the analyses are presented in Section 3. In Section 4, the results are presented, and in Section 5 the findings and implications of the analyses are discussed.

2. Data collection

In order to analyze the potential gap between the supply of and need for climate change knowledge, data was collected on the global distribution of the *supply of knowledge* (measured by climate change publications) and the *need for knowledge* (measured by climate change vulnerability). In order to analyze and explain this relationship, data was collected on various socio-economic and socio-political variables. The search and review of climate change publications follow guidelines for systematic reviews (Pullin and Stewart, 2006; Davies and Pullin, 2007) adapted to the research questions and purpose of this study.

2.1. Climate change publications

To assess the supply of climate change knowledge in terms of research publications, two types of data were collected: (1) *case country publications*, the number of publications concerning climate change (effects, impacts, mitigation, etc.) for a specific country, and (2) *first author publications*, the number of publications by first authors based in a specific country (their institutional affiliation).

Country publications were obtained from the Web of Science database (part of Web of Knowledge databases provided by Thomson Reuters) between July 12 and July 16, 2010. The database was searched for articles, proceedings papers and reviews within the time span 1999 to July 2010 using the search phrases *climat* AND change** and *global warming* (with asterisk wildcards). In order to focus the search on knowledge domains within climate change research, including human dimensions, and to reduce redundancy in the dataset, the search was run with related phrases such as *effect*, *impact* and *adaptation* (using the appropriate search wildcards). The search was run for a total of 197 countries of the world based on the United Nations list of recognized countries (UN, 2006) and including Antarctica and Greenland. In each case the search was made by adding country name (e.g. France) and adjectives (e.g. French) to the search history. Subsequently, the search was narrowed by excluding selected “Subject Areas” in Web of Science, and finally, the country publications were manually checked to exclude irrelevant publications from the database, such as terminological or geographical noise (see Appendix). For the manual check, all retrieved publications were exported into EndNote X3 software (see also McAllister et al., 2009). In order to analyze first author affiliations, the data was exported from EndNote to the bibliometric software HistCite™ with a custom designed EndNote reference style. The first author publications (analyzed in Section 4.4) obtained with HistCite™ was used to sort the publications in the final dataset by the country and institution of the first author.

Finally, in order to supplement the quantitative analyses presented above, we did a qualitative screening of titles and abstracts of a randomly selected sub-set of publications to assess

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