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Climate Change and Psychology – A scientometric analysis –

By Stefan Kenst*, Niklas George*, Nida ul Habib Bajwa, Gabriel Muinos, Angela Castrecchini, Enric Pol, Sergi Valera



**UNIVERSITÄT
DES
SAARLANDES**



**university of
 groningen**



**UNIVERSITAT DE
BARCELONA**

Abstract

The cause of climate change is widely accepted among scientists, with human actions identified as the root cause. Understanding human behavior and its underlying beliefs and values related to climate change is crucial for effective mitigation and adaptation strategies. Since climate change is a worldwide phenomenon, it is necessary to take cultural differences on psychological variables and their impact on climate change-related behaviors into account. Additionally, the prevalent bias in psychological research, which focuses on participants from Western, educated, industrialized, rich, and democratic (WEIRD) backgrounds, limits the generalizability of findings. To address the extent of this bias in climate change psychology, a scientometric analysis was conducted to explore the differences in research topics across countries. The results confirmed that psychological research topics related to climate change vary between countries and they indicate the presence of the WEIRD bias. This highlights the need for a broader representation of diverse populations in climate change psychology research to enhance the applicability and effectiveness of interventions.

Theoretical background

Few scientific topics have such broad consensus as the debate over the cause of climate change, with 90-100% of scientists agreeing that human actions are causing the global temperature rise (Cook et al., 2016). As industrialization has led to increased demand and use of fossil fuels to meet energy needs, human actions and market choices, such as the production of manufactured goods, increased mobility, or increased demand for plastic packaging of products, have led to increased CO₂ emissions into the atmosphere. In 2022, global annual CO₂ emissions from energy combustion and industrial processes will reach 36.8 gigatons, the highest level ever recorded (International Energy Agency, 2023). While CO₂ emissions in the European Union (2.5% reduction) and the United States (0.8% growth) have decreased or increased only slightly, emissions in emerging and developing countries in Asia have increased by 4.2%. South Asian countries, in particular, face a conflict in balancing their intentions to grow economically with the goal of reducing greenhouse gas

emissions (Sekine, 2021). Different countries have benefited from technological and economic revolutions at different paces, but as the consequences of climate change are particularly catastrophic in the countries with the highest levels of emissions (Intergovernmental Panel on Climate Change, 2022), more and more countries are realizing that they need to change the main cause of climate change: human activity.

While human activity has contributed to a 1 degree Celsius rise in global temperatures, there are also opportunities for human action to reduce the impact of climate change. By using low-carbon energy supplies, adopting energy-saving behaviors, consuming products with a lower carbon footprint, or changing the way we travel, human behavior can help mitigate climate change (IPCC, 2022). Although the human factor plays a major role in the development of climate change, human behavior remains the least understood variable in the climate change system. Understanding the underlying beliefs and values about climate change is key to motivating people to engage in both mitigation and adaptation behaviors (Steg, 2023). As a result, more and more research in several domains of psychology is now devoted to the topic of climate change.

One discipline that explores the relationship between human behavior and climate change issues is environmental psychology. Environmental psychology studies the "transaction between individuals and their built and natural environments" (Gifford, 2014). Applying established models from other psychological disciplines, such as social psychology, cognitive psychology, or industrial and organizational psychology, the discipline of environmental behavior studies factors that contribute to pro-environmental behavior and designs interventions to get more people to act in more environmentally friendly ways (Pinzone et al., 2019; Zafar et al., 2023; Zibarras & Coan, 2015). For example, meta-analytic findings have shown that the most effective motivating factors for people to adapt to the consequences of climate change are descriptive social norms, negative affect, and outcome efficacy (van Valkengoed & Steg, 2019). However, in addition to identifying the underlying factors for changing people's climate change-related behaviors, it is paramount to consider the hindering factors in order to design effective interventions. Even if people have values and beliefs that

facilitate their engagement in climate change mitigation, several barriers may prevent people from taking the desired actions, such as low perceived impact of actions, low salience of their values, or high behavioral costs (Steg, 2023). In order to fundamentally change human behavior for the sake of climate resilience, more detailed causal relationships between these factors need to be uncovered.

As climate change is a global phenomenon, researchers need to consider whether identified causal relationships of psychological variables may differ across cultures. For example, one of the most motivating factors for adapting to climate change, descriptive norms, appear to have different effects across cultures. Descriptive norms generally motivate people to perform a certain behavior that is perceived as the normal behavior of most people in a given situation (Cialdini et al., 1990). However, when examining the motivational substructure more closely, social norms lead to different behaviors due to culturally different needs (Gelfand & Harrington, 2015). Social norms serve social functions in the form of impression management, in the sense that people who are being evaluated tend to rely more on social norms. However, in situations with high accountability, people from individualistic cultures tend to be more competitive, whereas collectivists would show more cooperation. In contrast, situations with low accountability would trigger more competitive behavior from collectivist people than individualists (Gelfand & Realo, 1999; Yamagishi, 1988). In summary, as psychological variables show different causal relationships across cultures, it is of utmost importance for climate change research to differentiate between different psychological effects that arise as a result of cultural influence.

However, on a more global scale, there is an inequitable distribution of research findings in psychology in that research predominantly examines samples of Western, educated, industrialized, rich, and democratic participants, also known as the WEIRD bias in psychology (Henrich et al., 2010). Henrich's assumption is based on the finding that 96% of psychology research participants surveyed between 2003 and 2007 would fit the WEIRD criteria (Arnett, 2008). A lack of global diversity makes the generalizability of research findings questionable, as applying theories and constructs from WEIRD countries to non-WEIRD countries could create blind spots in research. Without

acknowledging cultural differences and their impact on the human psyche and behavior, the variability of psychological research findings is underestimated. Henrich (2010) was able to confirm that there is significant variability within and between countries, such that WEIRD samples do not validly represent the populations for which inferences are being drawn.

Although the WEIRD bias makes it difficult to compare psychological research and to promote the generalizability of research findings, the extent of the WEIRD bias has not yet been studied for many subfields of psychology. For some areas of psychology, there is preliminary evidence for the extent of the WEIRD bias. For example, Bajwa et al. showed that there is a dominance of US first-authorship in industrial and organizational psychology, although internationalization is slowly increasing (Bajwa & König, 2019). Furthermore, for topics such as climate change and psychology, the magnitude of extent is even more important to consider, as different countries around the world contribute to and experience different consequences of climate change. This is especially important as the Intergovernmental Panel on Climate Change concludes that the regions most vulnerable to climate change will disproportionately experience the most devastating impacts (Intergovernmental Panel on Climate Change, 2022). Since we assume that these countries also suffer from a WEIRD bias, the question for the field of climate change psychology is to what extent the WEIRD bias exists for this issue. To address the question of the extent of the WEIRD bias in psychological research on climate change-related topics, we conducted a scientometric analysis that provides insights into the similarities and differences in psychological research topics across countries. Since different countries in the world show differences in the consequences of climate change as well as in their CO₂ emissions, we conclude that climate change-related topics differ significantly between countries. To test this hypothesis, we will perform a keyword analysis for each country, which will provide insight into the basic research focus of a country. Affiliation data on the authors' countries of origin will serve as a proxy for the WEIRD bias in psychology by indicating how research topics based on authors' given key words may differ across countries.

H₁: The publication numbers of WEIRD countries are higher than non-WEIRD countries.

H₂: The psychological research topics based on keyword analysis will be different in different countries of the world.

Method

Data

Data used in this analysis was gathered from the Scopus database (Elsevier B.V., 2023), which provides access to a wide range of scientific research across various disciplines, including journals, conference proceedings, and other scholarly publications. Scopus covers articles from both established and emerging fields of study, contributing to research across different scientific domains.

The final query to select climate-change psychology publications followed a multi-step approach. First, publications were included if they contained keywords related to climate change in the title, abstract, or author-given keywords. The climate change keywords used were based on the United Nations' Sustainable Development Goal 13 (UN General Assembly, 2015). This goal addresses the global challenge of climate change. Examples of included keywords are *global warming*, *climate action* or *environmental education*. See Table A1 for a detailed list of keywords. Additionally, we narrowed down the query based on the All-Science Journal Classification Codes (*What is the complete list of Scopus Subject Areas and All Science Journal Classification Codes (ASJC)?*, o. J.). These codes provide a classification system for scientific literature, dividing it into multiple subcategories. As our hypothesis is centered around psychological research, we limited the query to the category of psychology. Furthermore, initial observations indicated that publications with the keywords “drug” or “geomorphology” tend to generate a high number of false positives, which would have limited the validity of the dataset. Therefore, the respective keywords were explicitly excluded when running the query against the Scopus database. By combining the aforementioned approaches into a single search string, the query resulted in a dataset consisting of 2,250 publications.

Variables

To describe the dataset over time, publication amount and citation related indicators were analyzed. The publication amount is defined by its number of publications juxtaposed to another criterion (like publication year). The citation related indicators are calculated based on the number of citations a publication has received. The pure number of citations can be misleading as the citations usually are accumulating over time. Therefore, in addition to the number of citations, citation indices like the Hirsch-index (h-index) (Hirsch, 2005) or the annual citation rate (ACR) was used. The h-index acknowledge the number of publications as well as the number of citations. Usually done for authors, the h-factor expresses that (in our case) an author or country has h publications that have at least h citations. The annual citation rate is calculated by dividing the number of citations a publication has received by the number of years since its publication.

To examine and analyze the uneven distribution of research in line with our hypothesis, countries were assigned to the authors based on the affiliations of the first authors. The information regarding the affiliations of the first authors was retrieved from Scopus. Out of 1,949 first authors, 1,853 countries were identified, resulting in a percentage of 4.93% for missing data.

The second variable of interest is the keyword variable, which consists of keywords provided by the authors to describe and classify their publications. Each publication can assign multiple keywords to a publication. In this dataset the authors assigned on average 5.40 keywords to their publications. As not all authors assigned keywords, this variable contained missing values as well. Out of 1,949 publications 1,493 contained keywords. Therefore, 23.40% of data were missing keywords.

Underlying topics

To capture more generalized research trends, the keywords needed to be grouped into topics. The first step in topic modeling involved unifying certain keywords. Since the keywords are provided by authors and there is no standardized way to define them, there are multiple variations in how keywords can be expressed. For example, keywords can be written in American or British English, in singular or plural form, and in some cases, with or without hyphens (e.g., pro-environmental behavior). To address these minor differences, the Levenshtein distance (Levenshtein, 1966) was

calculated for each keyword compared to all other keywords. The Levenshtein distance measures the number of character changes required to make one word identical to another. If the Levenshtein distance was exactly one, the keyword was replaced by the most frequently occurring spelling of that word.

Next, Latent Dirichlet Allocation (LDA) was conducted to identify underlying topics. LDA is a statistical modeling technique used for discovering topics within a collection of documents (Bittermann & Fischer, 2018). Before creating the token-vectors for the LDA, the keywords were filtered using common stop words in the English language (e.g., "a", "the", "and"). In regard to predefined parameters, the topic modeling process was carried out for four topics, as this number appeared to best fit the underlying data. In the subsequent steps, the probability of each publication's relevance to the topics was determined, and the topic with the highest probability was assigned to the respective publication.

To compare countries, the publications were assigned to topics based on their topic probabilities. Subsequently, the proportion of each topic within each country was calculated. A heatmap was generated to compare the topic distribution among the top ten most productive countries. Additionally, for the top 20 most productive countries, a world map was created for each topic, visually illustrating the geographic distribution of research topics.

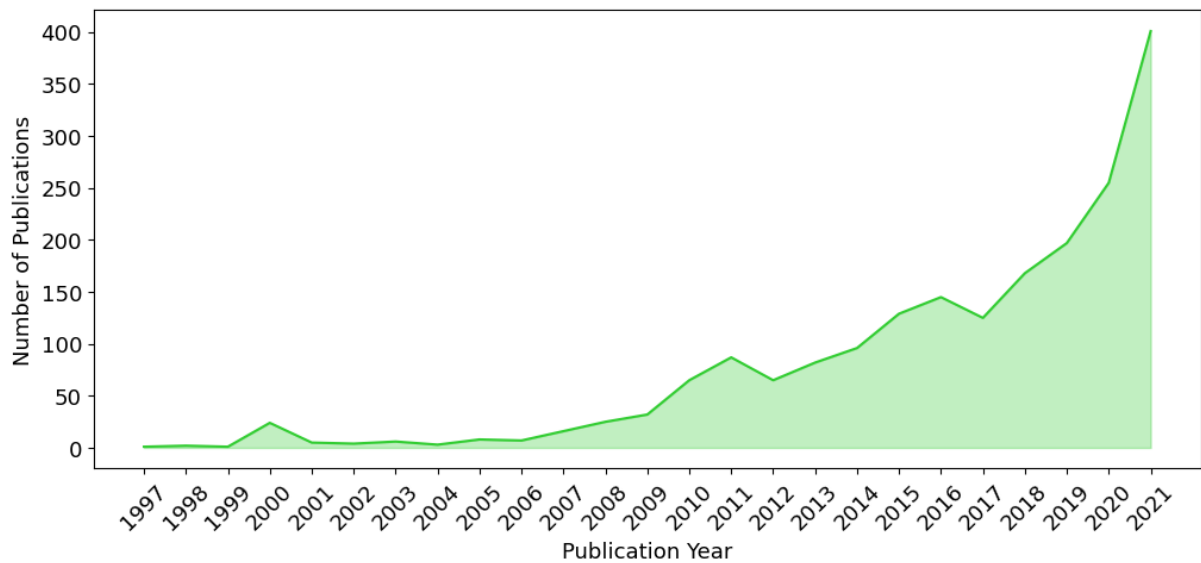
Results

Descriptive analysis

Figure 1 displays the trend of research growth or decline over time by plotting the number of publications. Since the dataset was collected in 2022, the data for the most recent year may be misleading. To address this, the plot in Figure 1 was truncated to end at 2021, providing a more accurate representation of the research trends. As shown in Figure 1 there is a general increase of publications observable. Particularly starting from around 2006, there appears to be a consistent upward trend in publications, with two minor dips occurring around 2012 and 2017.

Figure 1

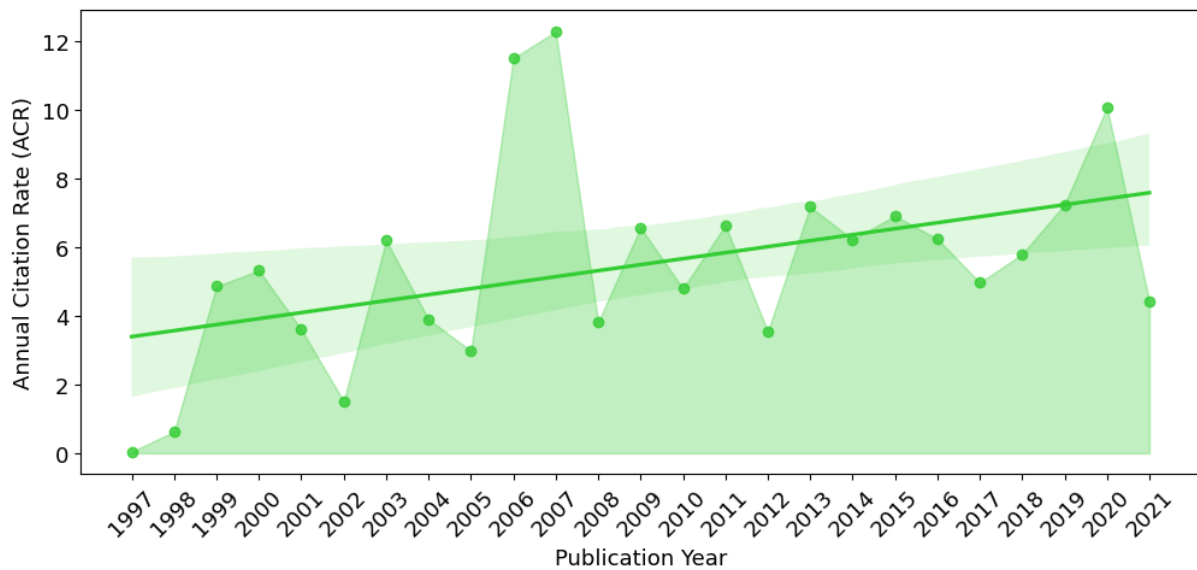
Climate change research production over time



Apart from absolute publication numbers, the number of citations is an important indicator of scientific outreach and the significance of a scientific topic. To account for the accumulation of citations over time, the Annual Citation Rate (ACR) was used instead of absolute citation numbers. Figure 2 illustrates the ACR over time. The ACR represents the mean citation rate adjusted for the influence of time. According to Figure 2, a slight increase in citations per paper over time can be observed. In the years 2006 and 2007, the ACR is remarkably high, indicating that the average citation per publication, adjusted for the factor of time, was elevated during those years. The exceptionally high ACR during those two years can be attributed to a combination of factors, including a scarcity of publications in those years (as evident in Figure 1) and a small number of highly cited publications that inflated the mean citations for that period.

Figure 2

Annual Citation Rate (ACR) over time



Geographic Differences

To highlight differences in keywords, the dataset had to be grouped by countries. The countries were determined based on the first author's affiliation. 77 unique countries were extracted based on the first authors' affiliations. Table 1 presents an overview of the publication metrics for the countries grouped under their respective geographical sub-regions. The total number of publications demonstrates that the predominantly WEIRD regions of Northern America, Europe, and Australia and New Zealand account for the majority of publications and have accumulated the highest number of citations. This observation is not surprising at first glance, considering that these regions have a higher number of publications. However, citation indicators such as the h-index or the citation per publication (TC/TP) reveal that publications from these regions are also cited more frequently on average. Moreover, nearly half of the citations from Northern America are associated with 50 citations or more. This substantial citation count is also reflected in the h-index, which indicates that Northern America has 79 publications with at least 79 citations.

Table 1*Publication and citation indicators for geographical regions*

Sub-Region	≥200	≥100	≥50	≥20	TC/TP	H	TP	TC
Northern America	26	61	116	206	35.00	79	644	22,541
Northern Europe	10	33	64	150	31.91	57	397	12,668
Western Europe	5	18	47	97	30.97	47	260	8,053
Australia and New Zealand	4	10	19	69	26.85	36	181	4,860
Southern Europe	1	3	14	35	23.06	29	115	2,652
Eastern Asia	0	3	12	29	19.58	24	95	1,860
Latin America and the Caribbean	0	0	0	3	6.13	9	45	276
Southern Asia	0	0	0	4	7.47	8	32	239
Western Asia	0	1	2	5	15.96	9	27	431
Eastern Europe	0	0	0	0	3.92	7	25	98
Sub-Saharan Africa	0	0	0	3	10.88	8	16	174
South-eastern Asia	0	0	0	0	5.71	5	14	80
Northern Africa	0	0	1	2	48.00	2	2	96

Note. ≥200 - ≥20 = number of publications that reach respective number of citations; TC/TP = Number of citations divided by number of publications; TP = total number of publications; TC = total number of citations; H = h-index

Breaking the Northern American Sub-Region further down into countries it becomes apparent that the United States of America accomplish for the most of publications and citations in this region. Overall, the United States of America account for 87.11% of publications and 85.03% of citations in Northern America and therefore for 28.78% of publications and 34.88% of citations in the whole dataset.

Topic modeling

The word clouds in Figure 3 to are based on the results of the LDA. In each word cloud the top 10 words identified by LDA are listed. The titles of the word clouds are derived from the most frequently occurring words and a selection of ten random publications associated with each cross-checked topic. The first topic focuses on the impact of climate change, including aspects such as the mental health and anxiety related to climate change, as well as the psychological well-being effects of climate change related events like wildfires. The second topic encompasses a wide range of analyses examining the extent of climate change, incorporating non-psychological variables such as the Gross Domestic Product or carbon emission. The

third topic explores novel theories aimed at explaining psychological phenomena that are relevant to climate change. Lastly, the final topic investigates theories that address climate change mitigation through behavioral approaches, such as collective action.

As topic assignment is based on latent variables of the observed documents (keywords), LDA does not guarantee an even distribution of publications across the topics. The distribution of the topics in the is illustrated in Figure 4. The more global topic of Theory Development accommodates for the largest proportion of publications followed by Climate Change Mitigation.

Figure 3
Topics of climate change psychology according to the LDA

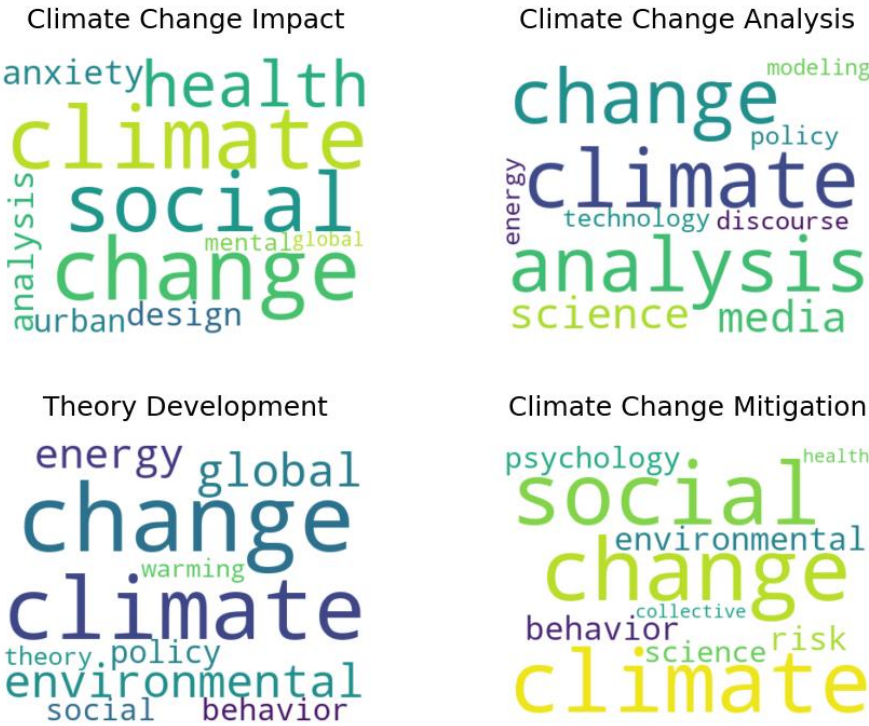
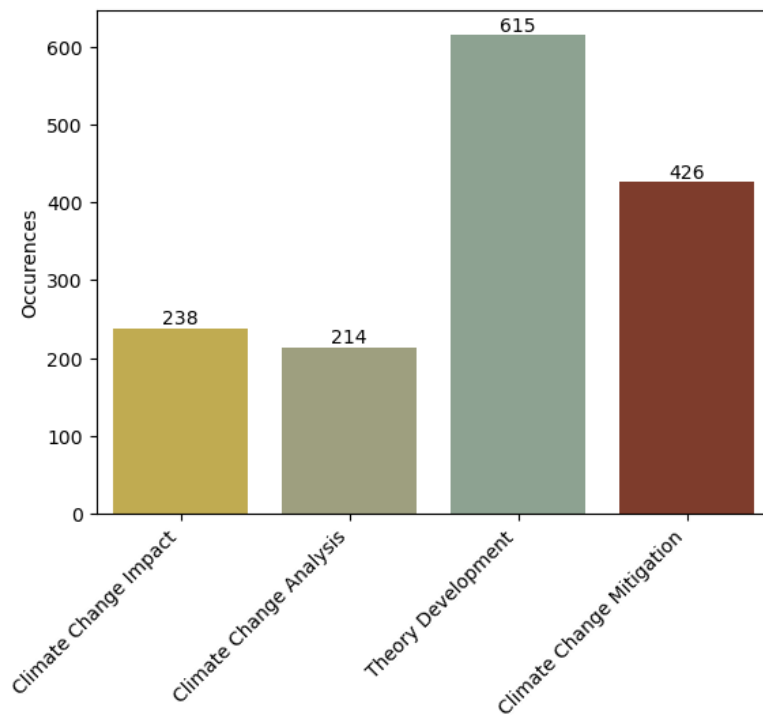


Figure 4

Topic distribution of psychological climate change publication



Distribution of topics across countries

The heatmap in Figure 5 displays the distribution of topics across different countries, with similar colors indicating similar proportions of publications associated with each respective topic. Firstly, in terms of the topic of Climate Change Impact, the Kingdom of Norway emerges as the primary contributor. More than a third of the Kingdom of Norway's research is focused on this topic. The United Kingdom of Great Britain and Northern Ireland follows closely, allocating one-fifth of its research to Climate Change Impact. Secondly, regarding the topic of Climate Change Analysis, the People's Republic of China leads in research output. Approximately 36 percent of its research is categorized under this topic. Thirdly, the topic of Theory Development receives a substantial proportion of research from the majority of countries. This finding aligns with Figure 4, which illustrates a higher volume of publications in the broader conceptual area of Theory Development. Lastly, the topic of Climate Change Mitigation encompasses approximately a quarter of the research outputs from each country. Notably, the Commonwealth of Australia's research is predominantly

centered around this topic, accounting for 38 percent of its publications. In contrast, the People's Republic of China has a relatively low percentage (11 percent) of research focused on Climate Change Mitigation.

Figure 5

Heatmap of topic distribution within the ten countries with the most publications



In addition to the heatmap depicted in Figure 5, the world map illustrates the geographical distribution of the top twenty most productive countries concerning the topics discussed (refer to Figures 6 to 9). By utilizing the world map, multiple countries can be visualized simultaneously, granting greater visibility to countries with fewer publications. This facilitates a more comprehensive analysis of their geographical locations. Notably, Figures 6 to 9 reveal varying research percentages across different topics.

Several noteworthy aspects stand out in the world maps. For instance, the United States of America, being the country with the highest number of publications and citations in the examined dataset, appears to concentrate a significant portion of its research on Climate Change Mitigation and Theory Development. In contrast, non-western countries such as the Republic of India, the People's

Republic of China, and the Federative Republic of Brazil seem to prioritize Climate Change Impact and Climate Change Analysis. However, the Dominion of Canada, along with Scandinavian countries like the Republic of Finland and the Kingdom of Norway, deviate from this distribution by also contributing substantial percentages of their research to Climate Change Impact and Climate Change Analysis.

Figure 6

Worldmap of countries' percentage of Climate Change Impact research

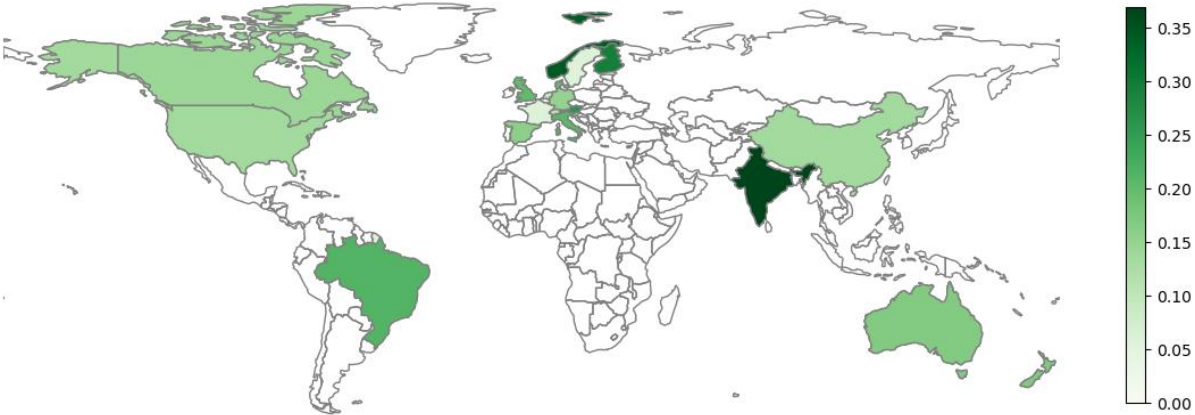


Figure 7

Worldmap of countries' percentage of Climate Change Analysis research

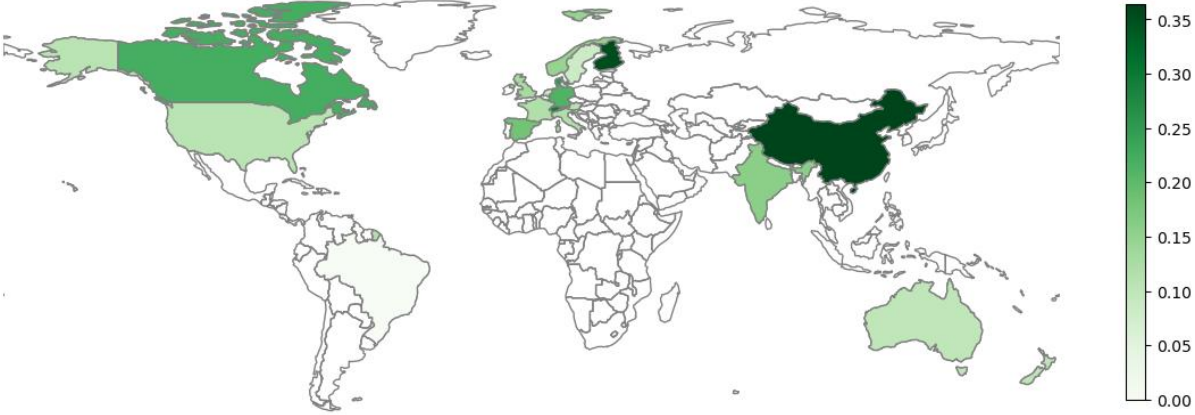


Figure 8

Worldmap of countries' percentage of climate change Theory Development research



Figure 9

Worldmap of countries percentage of Climate Change Mitigation research



Discussion

The primary goal of this scientometric analysis was to explore the uneven distribution of psychological research in terms of topic distribution and total numbers of publications on climate change across countries, investigating a potential WEIRD research biases in this field. To accomplish this, the hypothesis that research topics vary across different countries globally was examined.

The initial findings of this study reveal a notable bias towards the United States of America in terms of publication and citation counts, reflecting the prevalent WEIRD bias observed in psychological research. The overwhelming dominance of the West, specifically the United States of America, in citation and publication metrics is well-known phenomenon within the field of psychology (Arnett, 2008) and its sub-disciplines. This trend is also evident in environmental psychology, as highlighted by Tam and Milfont (2020), where a majority of publications originate from the United States of America. Furthermore, Tam and Milfont showed that a significant proportion of publications in the field of environmental psychology appears to focus exclusively on a single country.

In addition, to compare the topic distribution, a topic modeling technique (LDA) was employed to aggregate keywords. The findings indicate the presence of four topics related to climate change psychology. Those topics were labeled Climate Change Impact, Climate Change Analysis, Theory Development, and Climate Change Mitigation.

The distribution of topics provides insights into the research orientation of non-western countries, specifically their emphasis on Climate Change Impact and Climate Change Analysis. These topics seem to be less closely associated with fundamental, theory-driven psychological phenomena and instead focus more on the technological aspects of human behavior. Consequently, this orientation may contribute to the perpetuation of WEIRD biases, as the technical nature of these topics may be less influenced by cultural variables in comparison.

However, depending on the methodology used, the identified topics may vary in terms of their level of abstractness and clustering. For instance, Tam et al. (2021) conducted a comprehensive review of environmental psychology, which identified and categorized multiple outcome variables

(e.g., climate change beliefs) and theoretical perspectives. These theoretical perspectives encompass sociopolitical processes, persuasion processes, group-related processes, and other processes.

It is worth noting that other reviews of environmental behavior might arrive at different conclusions. For instance, Craik (1973) theorized the existence of multiple distinct topics relevant to environmental psychology, which partially aligns with the topics emerging from our findings in climate change psychology. One example is the topic of Quality of Sensory Environment, which aligns more closely with the identified topic of Climate Change Analysis. This topic incorporates various environmental measurements, such as noise levels, into the analysis of the environment and its interaction with psychological processes.

However regardless of which level to group research topic around the globe, the findings indicate that these topics are distributed unevenly across different countries. This confirms the hypothesis that keyword analysis would reveal variations in topics across different countries. Regardless of the theoretical conceptualization of these distinct topics, it appears that countries have different research focuses and alignments in their studies of climate change psychology.

Limitations

This scientometric analysis has certain limitations that could affect the interpretability of the results to some extent. The first limitation concerns the potential presence of publication bias inherent in the Scopus database. It is essential to recognize that Scopus may have biases in its selection process for including journals and conferences. Hence, attempting to estimate the precise bias of research concerning geographical disparities or WEIRD research using the Scopus dataset introduces a certain degree of error variance. However, Scopus encompasses a substantial portion (ca. 33%) of journals and conferences listed in Ulrichsweb (Mongeon & Paul-Hus, 2016), which provides a reliable dataset.

Additionally, in order to conduct an LDA, it is necessary to determine the number of topics in advance. Consequently, the results can differ based on the assumptions made during this stage (i.e.

the number of assumed categories). While this factor does not impede the identification of uneven global research by topic, it does introduce the caveat of potential limitations in the validity of the chosen topics. However, LDA has proven as a valid instrument in psychology and beyond (Bittermann & Fischer, 2018).

Implications

Firstly, the objective of this study is to provide insights into the extent of WEIRD research in environmental psychology, specifically focusing on climate change-related issues and topics. By gaining an understanding of the prevalence of WEIRD research in this area, we hopefully can enhance our comprehension of the applicability of psychological theories. Furthermore, this awareness of WEIRD tendencies in psychological research can serve as an additional rationale for researchers from non-WEIRD countries to actively engage and make significant contributions to this field.

Secondly, the findings of this study shed light on another aspect of the issue of geographical disparities in research. The results indicate that not only is research unevenly distributed in terms of publication numbers and citations, but also in terms of research focus. While this observation is not inherently concerning, it implies that certain topics may have a stronger representation of WEIRD biases. In line with the objective of reducing WEIRD biases, understanding the distribution of topics among psychological publications in various fields can potentially contribute to a more comprehensive understanding of which topics are particularly susceptible to biases stemming from WEIRD perspectives and research practices. This knowledge might ultimately aid in fostering a more holistic perspective in research and its generalizability.

Lastly, it is hoped that the findings of this study provide evidence that topic modeling and scientometrics can effectively contribute to describing international research trends and psychological hot topics using quantitative data. Conducting topic analysis with the aim of not only describing geographical disparities in research focus but also understanding ongoing research biases has demonstrated its usefulness. This will hopefully add another valuable tool to the existing

methods for analyzing research biases in the field of psychology and beyond.

Future Research

In summary, there should be a closer examination of the influence of cultural variables and dimensions on the identified research topics, considering the observed uneven distribution of research. Exploring the relationship between the identified topics and cultural variables can yield valuable insights into the extent of WEIRD research biases. By understanding how cultural factors intersect with research foci, we can gain a deeper understanding of the biases present and work towards mitigating their impact on the field of study.

Furthermore, further research should be conducted on the factors that result in uneven distribution of research, particularly within the field of psychological climate change research. While some factors, such as sample selection convenience (Henrich et al., 2010), are already known, the influence of a country's research infrastructure on the prevalence of WEIRD tendencies may have a more significant impact. Identifying the beneficial factors that contribute to the success of psychological climate change research in the United States of America can also help enhance such research in non-WEIRD countries.

Further research should prioritize investigating the influence of WEIRD bias on various topics across the world. Conducting a comprehensive analysis of specific subtopics within the global research landscape can facilitate the identification of local experts and best practices in countries that specialize in particular areas. Additionally, creating a more detailed and geographically clustered overview of topics in psychological research can aid in identifying blind spots and emerging trends.

Conclusion

In conclusion, the scientometric analysis carried out in this study has provided insight into the differences in research topics related to climate change across various countries, thereby confirming the presence of the WEIRD bias. This bias is not limited to the dominance of certain countries, such as the United States of America, in terms of publication or citation rates, but also manifests in the uneven distribution of research on psychological aspects of climate change worldwide. These findings serve as an additional warning sign, highlighting the need for further attention and action to address the WEIRD bias in psychological climate change research.

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Appendix A

Table A1

Search terms used for the dataset query

Search Terms	
global warming	environmental education
climate action	sustainable development education
climate adaptation	energy conservation
climate change	food chain
climate capitalism	food chains
climate effect	land use
climate equity	small island developing states
climate feedback	clean development mechanism
climate finance	glacier retreat
climate change financing	ice-ocean interaction
climate forcing	ice-ocean interactions
climate governance	nitrogen cycle
climate impact	nitrogen cycles
climate investment	ocean acidification
climate justice	radiative forcing
climate mitigation	sea ice
climate policy	sea level
climate policies	sea levels
climate risk	thermal expansion
climate risks	drug
climate services	geomorphology
climate service	ipcc
climate prediction	ecoclimatology
climate predictions	eco
climate signal	climatology
climate signals	climate
climate tipping point	bioeconomy
Green Climate Fund	carbon
regional climate	emission
regional climates	megacit
climate awareness	anthropocene
adaptive management	warming
disaster risk reduction	greenhouse
ozone	unfccc