# Climate justice in adaptation policy: an evidence map and author’s gender analysis

Keywords: climate change, adaptation policy, gender, climate justice, intersectionality, topic modelling, unsupervised machine learning, Big Data, evidence synthesis

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## Abstract

Climate science is unanimous on the urgency of action in both mitigation and adaptation arenas. The people who have least contributed to the anthropogenic climate change are already suffering from the slow onset impacts and acute disasters; and the currently implemented policies only exacerbate the existing inequalities. It is thus crucial that a just approach is pursued, whereby the interests of the socially marginalised groups are made central and integral to all research and policy related to environmental governance, especially in adaptation efforts. With mounting popularity of *intersectional feminism* and *climate justice* in both academia and activism, it begs further investigation into whether increasing women participation rates in science can have broader positive effects. This paper presents a systematic map of the climate change adaptation policy scholarship, which is rooted in machine-assisted methodology for gender estimation and thematic space analysis. By applying a mixed method for gender prediction from the first name and Structural Topic Modelling (STM) approach for identifying topical trends in the text corpus, I investigate the relationship between the gender variables and inclusion of topics related to the conceptual framework of *climate justice*. The results support the argument for higher representation rates and more welcoming conditions for women researchers, as they reveal a positive effect of author gender being estimated as female and the topic proportion of topics such as *Pathways to Equity, Local Communities, Gender, Food Security,* and *Displacement and Mobility*. This work further highlights the gaps in climate change adaptation policy research associated with underrepresentation of the voices and interests of various minority groups. Finally, the findings presented here confirm previously outlined patterns of gender disparities in academia.

## Introduction (1135)

There is a consensus in the literature on the disproportionate effects of climate change and the inadequacy of currently implemented policies to account for the needs of the less powerful. While climate change poses an unprecedented global challenge, it also provides an opportunity to rethink and deconstruct the existing systems and institutions that clearly are not working for anyone apart for the most privileged [references]. Despite the nature and scale of the climate crisis, powerful actors as represented by the economic and political elites are halting meaningful action, while the socially marginalised groups, having contributed the least to the causes of climate change, are suffering from its immediate impacts [references]. Furthermore, in the world we live in today, vulnerable communities are susceptible to multiple emerging and intersecting risks that exacerbate one another and reduce the adaptive capacities [references]. Hence the urgency of a more equitable approach in climate action. The *climate justice* framework conceptualises such action as aimed at tackling climate change, while prioritising human rights by explicitly addressing multiple intersecting injustices that are or can be made worse by the absence or delay or misguided implementation of mitigation and adaptation activities, or even by their implementation (Robinson, 2011; Sultana, 2021).

The most inclusive and transparent scientific processes have been shown to provide outcomes that are not only most equitable but that also reflect the best available knowledge. Producing scientific evidence specific to the experiences of the most vulnerable groups is integral to enabling non-discriminatory climate action (ICRC, 2020; IPCC, 2022). It is thus critical to ensure that the expertise and informing processes are inclusive of the socially marginalised groups; that vulnerable actors are given the chance to speak up, participate, and make their concerns not only heard, but also acted upon. And as different forms of inequality intersect and reinforce one another, tackling them requires an intersectional approach (Hillert, 2023; ICRC, 2020; Liverman et al., 2022).

**H1:** Climate justice is an underrepresented topic in adaptation discourse.

Evidence of male domination in scientific processes is also ample.

Historically elitist and exclusively white male endeavour, science has contributed to the spread and persistence of discriminatory ideals (‘How Nature Contributed to Science’s Discriminatory Legacy’, 2022)*.* And even as we see more inclusive policies and higher women’s participation rates, gender bias and other discriminatory biases persist in both natural and social sciences [references]. Among the IPCC’s contributing authors in the 6th assessment cycle, only 33% were female. This could be seen as a significant improvement from 1990, when the number was as low as 8%, or even 2013 with 21% - but did the dynamic change as much as the numbers?

Ensuring women's agency has proven essential in both tackling emerging crises at the grassroots level and changing the course of international climate negotiations (Robinson, 2019). It has become evident that encouraging women’s participation leads to an overall fairer representation of the needs and interests across minority groups. However, while women are becoming more prominent figures in climate negotiations and activism, there is still much work to be done before gender equity can be fully realised in the climate research community, as a recent report from the IPCC Task Group on Gender highlights (Liverman et al., 2022). The survey revealed that both discussions and scientific writing are still dominated by men - even with lower disparity than in previous eras, women still feel less confident in speaking up. After the report was presented at the Panel’s 49th Session in May 2019, a second task group, the Task Group on Gender Policy and Implementation Plan, was commissioned to develop a draft for the IPCC Gender Policy and Implementation Plan, that was reviewed and adopted at the Panel’s 52nd Session in February 2020. The policy has instituted the goals of enhancing gender equality in the IPCC processes, creating a gender-inclusive environment, and gender-sensitive training, as well as the stepwise procedures towards achieving them, thus allowing for continuous monitoring and better transparency (IPCC Task Group on Gender, 2020).

**H2a:** Publications in climate change adaptation scholarship are dominated by male authors.

**H2b:** The gender gap is larger for the supervisory authorships.

Of course, women's agency has not always been intersectional and inclusive of all; in its early waves, feminism was exclusionary of racial minorities, and today it often is exclusionary of transgender or other gender non-conforming people [references]. However, many recent feminist authors and public figures like Nancy Fraser, bell hooks and Sara Ahmed, among others, have built a strong argument for *intersectional feminism*, which this study builds upon in the context of climate science and policy. Contrary to a prejudiced belief that women are inherently more caring and should thus focus their academic efforts on related topics, the hypotheses are supported by the assumption that women are socialised as a minority and are thus more attuned to the needs of other underrepresented groups [references]. Consequently, it is believed that women scholars are more likely to integrate justice concerns in the scholarship relevant to policy making in climate change adaptation.

**H3a:** Research groups where the conceptual author is female tend to publish on climate justice-relevant topics more often.

**H3b:** Research groups where the supervisory author is female tend to publish on climate justice-relevant topics more often.

**H3c:** Research groups where most authors are female tend to publish on climate justice-relevant topics more often.

One must be cautious when examining the gendered literature landscape as the underlying patterns could be reinforced by women’s network- or opportunity-driven preference for better gender-balanced subfields and research groups [references]. Further possible counter arguments to the case that women in climate science could also be agents for other marginalised groups include, for instance, possibility of token inclusion of women authors, or the pressure women experience to comply with dominant scientific practices, or the phenomenon of women researchers being ‘ghettoed’ into certain scientific domains considered ‘more suitable’ for them. This is revisited in the discussion part of this paper.

Adaptation policy scholarship is ample and fragmented, making it hard for policymakers to stay well-informed. Machine-assisted systematic evidence maps allow to identify the main patterns and gaps in the literature. In this study, we implement empirical evidence synthesis methods for testing intersectionality arguments from theoretical feminist literature. Specifically, we focus on the climate justice framework within adaptation policy. As climate adaptation focuses on minimising exposure and building resilience to climate change impacts, an equitable approach is of utmost importance. The specific area of climate science is also selected as one where a researcher could explicitly assume a human-centred approach or rather exclude it from the agenda. While geographic and temporal analyses of the topical spaces of related literature have been presented [Sietsma, Callaghan], there have not been a study that would focus on locating climate justice concerns in the adaptation policy research landscape and examining the impacts of gender (in)equity.

## Methods (811)

In this study we build on recent computer-assisted evidence synthesis [reference] by predicting author gender and exploring prevalence of topics related to the *climate justice* framework. As the objective of this study is to describe structural preferences for social justice topics in climate scholarship, a systematic mapping methodology is applied, and the guidelines for high quality evidence synthesis are followed (Haddaway et al., 2018, 2020).

In this study, we apply a query previously designed by Sietsma et al. (Sietsma et al., 2022) to search for the literature on climate change adaptation policy. The query is recorded in the Supplementary Table 1. Climate governance specific to adaptation is particularly vulnerable to reinforcing implicit bias and thus reproducing existing injustices. It is also the area of climate science most closely related to human beings. It thus creates a unique topical space, where one could either include a social justice dimension in the research agenda, or rather ignore it. It is also a sentiment expressed in existing research that adaptation policies must be assessed for justice considerations (Juhola et al., 2022). The query is implemented on Scopus and Web of Science, resulting in 70 319 document records after deduplication that contain author-specific information. We process the data to extract all the necessary variable values [refer to daggity and a graph that captures every step]. We clean first names for all the authorship instances by getting rid of empty records, initials and special characters before deriving a gender estimate (confusion matrix and performance metrics for the estimation method are provided in Supplementary Tables X-XX). We exclude papers published in economics from consideration for first and last author gender as the authorships there are conventionally listed alphabetically.

Structural topic modelling (STM), a kind of unsupervised machine-based text corpora modelling, was selected as the main methodology for this analysis due to its scalability and relevant advantages in comparison to previously developed topic models. Namely, structural topic modelling allows for integration of metadata into the process of topic model construction (Roberts et al., 2019). Topic modelling variations, such as Latent Dirichlet Allocation (LDA), Correlated Topic Modelling (CTM) and STM have been widely applied to perform evidence mapping at a scale. Previous work on the datasets thematically similar to this (in varying degrees) have implemented STM to identify temporal and geographical trends in climate change adaptation scholarship (Sietsma et al., 2021); CTM to analyse sentiment in mass media discourse on climate change (Rabitz et al., 2021); LDA to determine research gaps in research on human mobility and drought or heat (Zander et al., 2023).

A key parameter of interest for topic models is the number of topics, which determines the granularity of the analysis. During data exploration, models with between 100 and 150 topics were found to be the most promising. In line with best practice, we therefore ran multiple topic models in this range at an interval of 10 topics, and assessed the results both qualitatively (i.e. looking for distinct topics on subjects of interest without substantial duplication within topics) and quantitatively (based on semantic coherence, exclusivity and held-out likelihood). Quantitative measures for topic quality did not result in a clear best number of topics in this range; As suggested by Müller-Hansen *et al.*, when the question one pursues to answer with the support of a topic model is qualitative in nature, the decision on the final number of topics should be based on the sought-after level of granularity and the intelligibility of the model outputs (Müller-Hansen et al., 2020). Based on expert judgement, a model with 120 topics was found to have a good balance between detail and coherence, so we further ran 20 different models at this value, selecting the final model in the same manner. The resulting topics were then named and categorised in an exercise involving 2 experts to ensure consistency.

We pull effect estimates for metadata variables, including control variables and gender variables. Here, we apply the built-in functionality of the **R** package for STM to estimate the effects of the author’s gender, and the control variables, on the topic proportions for each of the topics considered relevant for *climate justice*.

The methods applied in this study are subject to both systemic and conceptual limitations:

1. dataset-related limitations (such as exclusive focus on English-denominated literature, and reproduction of publication-related biases [Cislak, 2018; Ahmed, 2021; Gneezy, 2003, Liverman, 2022, Reskin & Roos, Patricia A., 1991]);
2. limited performance and bias towards Western names of the gender prediction tools [];
3. assumption of state-imposed binary gender identity;
4. crudeness of topic estimation and subjectiveness of evaluation of the model’s outputs (Grimmer & Stewart, 2013);
5. possible tokenism in authorship and justice vocabulary [].

Nevertheless, the methodology is considered adequate for the purpose of investigating and presenting the patterns from a large text corpus, as well as studying an entire population of academics rather than individuals.

## Results (764-2192)

This section reports first on the gender composition of the climate change adaptation scholarship, then its thematic landscape, and finally, the causal links between the two.

## 3.1 Gender composition (602)

In line with previous findings from different academic subfields (González-Márquez et al., 2023; Larivière et al., 2013; Nielsen et al., 2017; West et al., 2013), I find climate change adaptation policy scholarship to be male-dominated, as depicted in Figure 4. In reality, the number of female authors could be slightly lower due to the upward bias of the tool used for gender estimation towards prediction of ‘female’ authorship instances as described in the subsection 4.2 of this paper; or slightly better, if names disregarded due to ambiguous gender estimations do indeed more often belong to women researchers, similarly to the records of initials instead of full first names; or rather comparable to the ones captured here if the described effects cancel each other out.

Particularly, I find the last author position to be largely held by men researchers - 70.27%, compared to 29.73% of women. As the last authorship in natural and social sciences (apart for economics) usually corresponds to the project supervisor or the head of the working group, this finding illustrates once again the ‘leaky pipeline’ problem, where gender parity is lower in higher career stages. Among the first authorship instances, representing the researchers who often contribute most to the conceptualisation and assume most of the work for the project, 39.04% are predicted to be women, and 61.96% men. This is a higher women participation rate than for the majority of the scientific disciplines described before, with the exception of, for instance, the subfields in medical research related to ‘care’ and veterinary medicine or, in sociology, - those related to sociology of the family and gender (González-Márquez et al., 2023; West et al., 2013). It is also higher than the share of women contributing authors in the IPCC AR6, which was equal to 33%. As the IPCC assessment reports synthesise knowledge from 3 major areas (corresponding to the 3 working groups): science, impacts, and mitigation; women are least represented in physical science (27%), most represented in impacts (40%), and quite poorly represented in mitigation (31%) (Liverman et al., 2022). Considering that the field of climate change adaptation policy falls under the umbrella of ‘impacts’, the subset of documents I am working with, and the estimated authors’ genders seem to be in harmony with the levels of women participation in the broader context of climate scholarship. Intuitively, the relative number of papers where most authors are predicted to be female is even lower, at only 23.34%. This is a worrying number as it indicates a possibility of *token participation* of women researchers in a lot of projects. A situation where female researchers are part of the process but are indeed discouraged from expressing their opinions or are facing additional pressure in the form of increased competitiveness is not uncommon in a male-dominated environment as men are reported to be more oblivious to the challenges that women are facing and oftentimes fail to adjust the processes in an appropriate way (Liverman et al., 2022).

add gender parity by region/country

Overall, these results show a slightly more positive picture than those described before and corresponding to different time periods and scientific fields. However, they also provide further evidence of the persistent gender gaps and highlight the importance of further work towards tackling this issue. The need for continued efforts towards tackling gender-based discrimination is especially pronounced for developing countries, as women there are more likely to experience intersecting discriminating pressures.

## 3.2 Topical space description

Topic modelling is often applied to explore general trends in textual data. Here, we ran topic modelling on titles, abstracts and keywords, which is common for analyses on large corpora (González-Márquez et al., 2023; Sietsma et al., 2021). We applied structural topic modelling to investigate dominant themes in the climate change adaptation policy literature, identify topics responsive to one or more of the concepts central to the climate justice approach, and the publications closely associated with these.

In line with previous findings indicating a recent increase in social scientific research within the climate adaptation literature and a lag in ‘solutions’ - oriented research (Sietsma et al.,

2021), I find the thematic landscape of the climate change adaptation policy scholarship is quite

heavily technical and ‘problem’- rather than ‘solution’- focused. However, several prominent topics are formed that can be seen as corresponding to ‘enabling’ responses. These include *Urban Planning, Water Management, Climate Strategy, Resource Management, Pathways to* *Equity, Adaptation, Carbon Capture and Storage (CCS), Climate Finance* and *Green Energy*, as can be seen in the Supplementary Table 5. Social sciences are mostly represented by the following topics: *Socio-Economic Vulnerability, Pathways to Equity, Adaptation, Climate* *Finance, Governance, Decision-Making, Policy, Public Perception, Displacement and* *Mobility, Economic Analysis, Local Communities, Gender, Tourism* and *Culture.* Several topics are harder to classify as they correspond to interdisciplinary areas, such as *Climate Risks,* *Climate Strategy, Resource Management, Mitigation* and *Knowledge.* That being said, I do not analyse temporal or geographic trends in topic prevalence in this work as these are thoroughly covered in a recent paper on global developments in adaptation research (Sietsma et al., 2021).

The literature that deals with disproportionate climate vulnerability can potentially be both about climate impacts and how they are currently being distributed or about strategic approaches towards eliminating the systems of oppression or at least avoiding their reinforcement in the climate governance arena. Hence, these aspects can also be brought up in technical literature or literature from natural sciences, and publications describing the ‘problems’ rather than ‘solutions’. However, they largely correspond to the thematic course of social sciences and literature on *enablers*.

[add references]

Through expert assessment we identified X topics that were related to distributive, or procedural justice, or recognition, in the light of climate adaptation governance. Topic labels corresponding to these are the following, in the order of their prevalence in the text corpus: *Pathways to Equity, Socio-* *Economic Vulnerability, Local Communities, Food Security, Gender, Displacement and* *Mobility, Developing Countries,* and *Island Territories.* The most frequent terms for each of these topics are captured in the Supplementary Tables 1,3 and 5. As described above, *Displacement and Mobility* was not identified as a separate topic in the dataset with inferred gender of the first author, and the keywords associated with the topic in two other cases were observed as associated with such topics as *Island Territories, Developing Countries, Gender,* and *Local Communities.*

Thus, we observed some of the expected topics in the corpus, but far from all. For instance, while indigenous peoples and grassroots communities have been explicitly covered, alongside general socioeconomic vulnerability topics, there was no topic that would clearly include racial injustice concerns in the context of climate change adaptation, which quite possibly indicates a gap in this field of research. Another topic that seems to be omitted altogether, at least at this level of granularity, is *intergenerational justice*. Despite the centrality of the concept to climate discourse, it does not appear to hold a steady position among the scientific publications on climate change adaptation governance. Other socially marginalised groups that have not found prominent representation in climate change policy adaptation research were the LGBTQ+ community, differently abled persons and caregivers. It is possibly still unclear how climate adaptation policies could particularly disadvantage these minority groups. Another reason for omission of these topics could be the pursued level of granularity for this work. In other words, this could be an indication that these topics are significantly less prominent, but not necessarily non-existent.

## 3.3 Effects of gender on topic prevalence

The novelty of this work lies primarily in the quantitative analysis of the effects of an author’s gender on the topical output of their research. In a recent work that followed rather similar methods but investigated biomedical scholarship, Gonzàlez-Màrquez et al. have shown that women researchers are more represented in research on nursing, education and psychology, but are severely under-represented in disciplines related to engineering and, for example, surgery (González-Márquez et al., 2023). However, to our current knowledge, a similar investigation into climate literature does not exist up to date. By implementing the controls [refer to daggity], we try to eliminate overestimating the effect of author gender on topic prevalence. Furthemore, we do not argue that men and women possess any inherent qualities that make them more or less likely to choose any topic. Rather, that the patriarchal structures have made it easier for men to ignore persistent injustices compared to women.

Intuitively, the effects of the author’s gender on topic prevalence in their publication vary in size based on the topic we are investigating and the author’s position. Generally, the topic proportions in the dataset are quite different for each of the topics, hence, the results are presented as relative differences rather than absolute changes in topic proportions.

[one paragraph to describe the forest plot that captures effects of gender variables]

[one-two sentences to describe the effects of control variables]

Overall, the results, even if not entirely homogenous, indicate a positive statistically significant effect between conceptual and supervising author being a woman, as well as the majority of the research group being women, and the inclusion of climate justice topics into their agenda. The variation in the results is attributed to the level of authority or effective power different authorship positions are associated with.

## Discussion (511)

The omnipresence of implicit bias in social structures makes it particularly difficult to disentangle specific causal effects of the author’s gender on topic preference. Hence, as its author, I acknowledge that the results put forward in this paper may inherit the implicit biases present in academia. In other words, one must interpret the results of this analysis with caution, and keep in mind the limitations described above, as well as the precision metrics of the implemented tools.

As has been demonstrated, the rate of women participation in research on climate change adaptation policy at approximately 39% is higher than for other previously analysed scientific areas. However, it drops significantly with a higher status - only roughly 30% of project supervisors in the field are predicted to be female; and the observed collaboration patterns further highlight the gender gap persistent in climate science. Furthermore, with some topic-specific variability, justice considerations appear to dominate the agenda mostly for articles authored by women, as hypotheses suggest. Hence, this analysis supports the centrality of intersectional feminism to the adoption of climate justice framework in related research. I am aware of the possibility that the findings presented here could be misinterpreted and misused to support the argument that the level of scientific expertise somehow varies by gender or that the gender of an author of a scientific article in any way affects its validity. On the other hand, as set out in the beginning of the paper, I firmly believe that encouraging diversity in research teams as well as in policymaking processes ensures higher cognitive ability, inventiveness and fairness of the procedures and outputs. Furthermore, I completely disagree with the idea of evaluating any scholarly work, or any work for that matter, based on the person’s gender.

I would also like to highlight that a qualitative analysis is recommended to assess causal links between author’s gender identity and the topical output of their research. An in-depth review of the articles associated with climate justice topics would be necessary to be able to say to which degree these are representative of the interests of the socially marginalised groups.

Another interesting aspect of this relationship, which is not covered in this analysis, is the funding source and its causality on the topical contents and research group characteristics. Regarding the methods described here, they can be replicated and applied to different datasets, as well as enhanced through implementation of a different gender estimation tool or further machine-assisted topical classification as described in previous literature.

Finally, unless an in-depth qualitative study is conducted, one cannot judge whether the effect on topic proportion does indeed relate to the author’s gender and associated levels of awareness towards the needs of the socially marginalised groups, or to the phenomenon of being ‘ghettoed’ to ‘more’ or ‘less’ scientific subfields based on the scholar’s gender by the dominant practices.

Overall, this study presents a first insight into the topical space of the climate change adaptation policy literature, where links between the author’s gender and prevalence of topics related to the climate justice framework are outlined.

# need to cut another 150 words or so

3.2 + 3.3 = 940 words

now it is 970 + I need to add a couple paragraphs