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CLIMATE RESEARCH IN LITHUANIA AS A LENS FOR SCIENCE COMMUNICATION: A BIBLIOMETRIC ANALYSIS AND IMPLICATIONS FOR PUBLIC TRUST

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Abstract

Climate change poses urgent challenges globally, yet public understanding and trust in climate science are undermined by widespread misinformation. Small countries, such as Lithuania, contribute to climate research and face unique challenges in engaging their citizens with scientific knowledge. In this study, we present a bibliometric analysis of climate-related research outputs from Lithuania (2005–2024) as a basis to inform a more extensive investigation into public attitudes toward science. The growth and orientation of Lithuania's climate research are contextualized against European and global trends, revealing a rapid expansion in output and increasing integration into international collaboration. We analyze publication trends, topical clusters, co-authorship networks, influential authors, institutions, and journal prominence. Additionally, we conducted a quantitative analysis of projects funded by the Research Council of Lithuania, the main funding body of R&I institutions in Lithuania. Results from both studies indicate that while Lithuania's climate research strengths lie in technical and environmental domains, there is a gap in

social science perspectives. We discuss how this gap can be addressed through targeted communication strategies and public engagement interventions.

Keywords: *climate science, science communication, climate change, bibliometric analysis*

1. Introduction

Climate change is not only an environmental and scientific issue but also a pressing social challenge. Effective climate action depends on an informed public, yet misinformation continues to hinder progress (United Nations 2021). While European surveys indicate high levels of concern (93% of respondents in the 2019 Eurobarometer consider climate change a serious problem), this concern does not consistently translate into understanding or action. In Lithuania, recent data show similar trends: 94% of citizens support climate adaptation, but gaps in knowledge and trust remain (EIB 2024; Lewandowsky et al. 2017). Trust in science is especially critical in countries such as Lithuania, where rapid socioeconomic transition and rising exposure to online misinformation complicate public engagement with climate issues (Skaržauskienė et al. 2020; OECD 2023). As national climate impacts become more visible, building public understanding of scientific findings is increasingly important for democratic legitimacy and support of climate policy (Stoknes 2014; van der Linden et al. 2017).

Prior research has linked scientific literacy to climate risk perception and policy acceptance (Echavarren et al. 2019; Giden et al. 2017), yet relatively little is known about how national scientific communities shape public-facing climate knowledge. Global bibliometric studies on climate research are extensive. Studies such as Haunschild et al. (2016) and Wang et al. (2018) document a growing interdisciplinarity and strong international collaboration, while Chen et al. (2023) highlight the increasingly networked nature of global climate science. Fu and Waltman (2022) argue that bibliometrics can illuminate how national research systems align with international policy goals. However, few studies have focused on smaller countries, such as Lithuania, where the dynamics of climate production, funding, and public communication may differ significantly. This study addresses that gap by analyzing Lithuania's climate research output over the past two decades, using bibliometric and project funding data. We examine the evolution of national research contributions, identify thematic clusters, and consider how these patterns can inform science communication and public trust when it comes to climate change.

2. Methods

2.1. Bibliometric analysis

Data collection. We conducted a bibliometric study using the Scopus (Elsevier) database to identify climate-related publications involving at least one author affiliated with a Lithuanian institution (using the AFFILCOUNTRY [Lithuania] filter). An advanced search query (Figure 1) filtered documents by climate-related keywords in titles, abstracts, and author keywords (e.g., "climate change," "global warming," "climate adaptation," "greenhouse gas," and "sustainability"). The search covered the years 2005–2024, was limited to peer-reviewed journal articles in English, and was restricted to relevant subject areas (e.g., Environmental Science, Energy, Earth and Planetary Sciences, Social Sciences, and Economics) to exclude unrelated uses of the word "climate." After removing duplicates and irrelevant records, we retained 662 publications for analysis. For comparison, we also retrieved global (N=34,667) and European (N=9,222) climate-related publication sets using the same search terms. These were used to contextualize Lithuania's output over time.

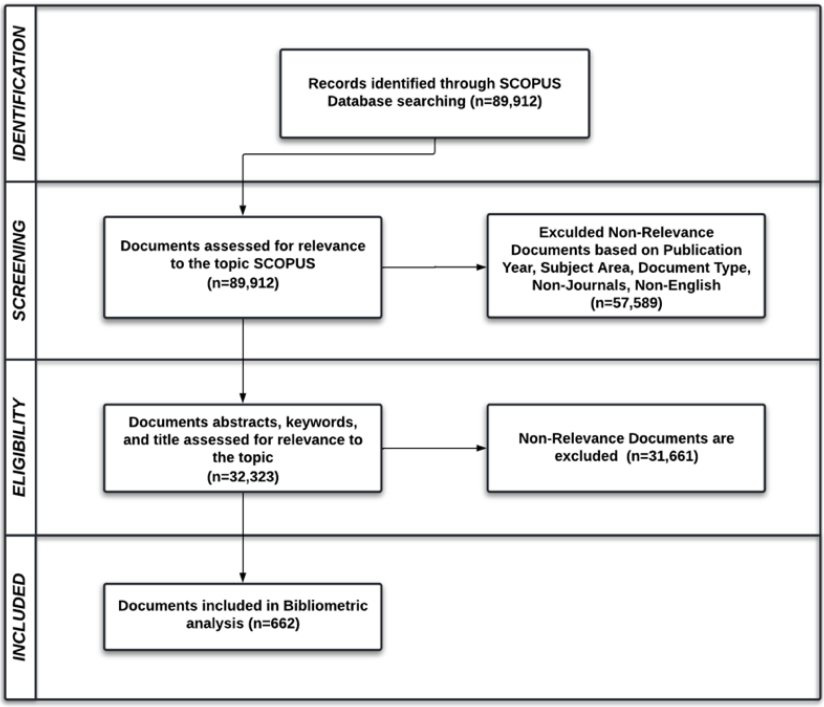


Figure 1: Research strategy for bibliometric analysis

Data analysis. Using Excel, Python, and VOSviewer, we analyzed publication trends, collaboration networks, and research themes. We calculated Lithuania's share of global and EU climate publications annually and identified co-authorship networks at both country and author levels (threshold: ≥5 publications) to map core collaborations. Keyword co-occurrence analysis (threshold: ≥5 mentions) revealed major research clusters. For impact assessment, we identified the 20 most cited Lithuanian climate publications and analyzed journal distribution, including output volume, citations, and impact factors. All analyses were conducted with careful attention to data accuracy, cross-checking the Scopus data with other sources where relevant.

2.2. Quantitative analysis of funded projects

We assembled a complete dataset of all Lithuanian Research Council projects from the public database (spektras.lmt.lt), including titles, abstracts, categories, funding, duration, institutions, disciplines, and status. Then we applied a keyword-based filtering strategy to flag projects explicitly addressing climate change. We scanned Lithuanian and English titles/abstracts for terms related to climate mechanisms and policy. We also tagged any project funded under climate-targeted subcategories, e.g., the national program LEK (*Lietuvos ekosistemos: klimato kaita ir žmogaus poveikis*). Finally, we manually removed false positives, e.g., projects where terms like "transition" or "resilience" appear in unrelated social or medical contexts. For each identified project, we extracted the funding scheme, start year, status (completed vs. ongoing), scientific field, institution, and funding amount.

3. Results

3.1. Bibliometric results analysis and visualization

Climate-related publications in Lithuania have grown sharply since 2005, increasing 144-fold by 2024, outpacing global growth in relative terms (Figure 2). While global and European output surged from the late 2000s, Lithuania's growth accelerated later, especially after 2015, reflecting expanded participation in EU-funded projects and a broader national climate agenda (Puukka et al. 2018).

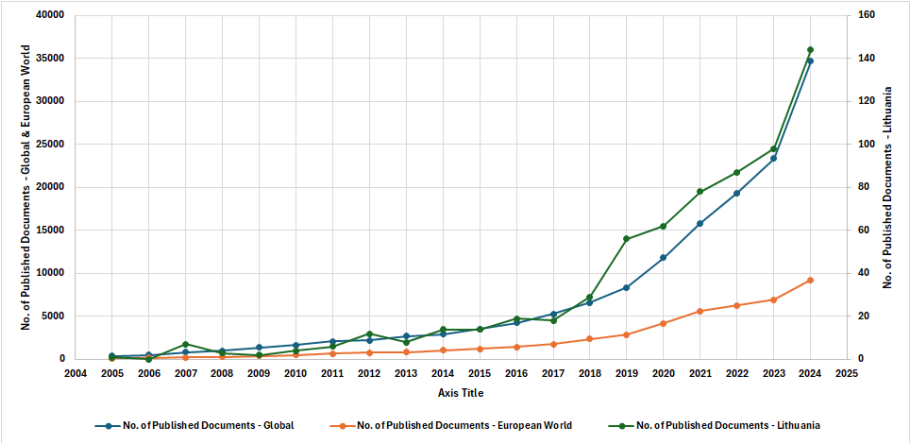


Figure 2: Baseline publication trends in Lithuania, Europe, and on a global scale

Most publications in the dataset involve co-authors from multiple countries, underlining international collaboration as a symbol of Lithuania's climate research output. The results show that Lithuanian researchers have partnered with a wide range of countries (89 in total), but a smaller subset accounts for most collaborations. The leading partner is Poland, which appears in 72 of the 662 publications. Following Poland, the next country that collaborates most frequently is China (53 publications). Other major partner countries include large Western European nations and neighbors: Italy (47 publications), the United Kingdom (42), Germany (41), and Spain (38). The collaboration network (Figure 3) identified 48 countries with ≥5 publications, and within this set, there were 41 distinct links (co-authorship connections) detected among them (with a total link strength of 1,482, which is the sum of co-authored paper counts across all pairs). This indicates that many collaborations are centered on Lithuania (one-to-one partnerships) rather than large, fully interconnected consortia. In practical terms, a lot of the international collaboration appears to occur via bilateral or small-group partnerships as opposed to substantial multinational teams on each paper.

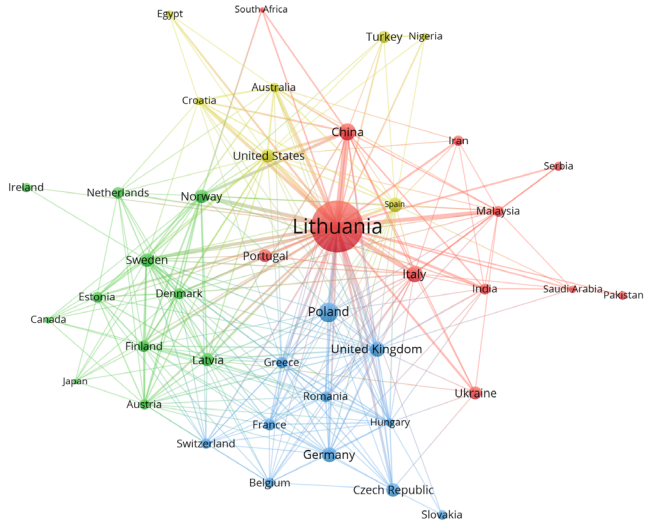


Figure 3: Country collaboration network

Shifting the focus to the institutional and individual level, the bibliometric analysis allowed for the identification of key players in Lithuania's climate research. The dataset includes 160 institutions across the globe, led by Vytautas Magnus University (114 publications), Vilnius Gediminas Technical University (110), and Kaunas University of Technology (107), among others. A long list of other institutions, both domestic and foreign, contributed between 10 and 14 publications each.

The publication output among Lithuanian climate researchers is highly uneven, with a few individuals accounting for a substantial share. *Dalia Štreimikienė* leads with 122 publications (18% of the total), focusing on energy economics and sustainability, and is a key node in international collaborations. *Tadas Baležentis* (48 publications) works on sustainable agriculture and efficiency modelling, with strong ties to China, Poland, and Ukraine. *Paulo Pereira* (32 publications) brings an international dimension to the field, specializing in land use and ecosystems. The dominance of economists and engineers among top authors points to a strong techno-economic focus in Lithuania's climate research, with limited representation of social or ethical perspectives. With the top 10 authors producing around 45% of all publications, the research landscape is highly concentrated, offering both cohesion and a potential risk if key individuals exit the field.

Keyword analysis of Lithuanian climate publications reveals six main thematic clusters: (1) sustainability and resource management, focusing on ecosystem services, circular economy, and carbon footprints; (2) renewable energy and climate economics, with strong attention to policy, CO_2 emissions, and economic growth; (3) energy security and

decision-making, using methods such as multicriteria analysis for evaluating energy options; (4) sustainable development and innovation, linking climate goals with digitalization and Industry 4.0; (5) agriculture and land use, addressing emissions, bioenergy, and rural development; and (6) energy efficiency and environmental impacts, particularly in the Baltic context, using performance benchmarking tools. These clusters emphasize techno-economic and policy-oriented approaches, with strong ties to EU climate priorities. Again, less apparent in these clusters are purely social or behavioral themes.

Finally, Lithuanian climate-related research is published across a wide array of journals, though a substantial portion appears in a few open-access outlets. The most dominant is *Sustainability* (MDPI), which accounts for 122 publications (about 18% of the total corpus). While the journal's broad scope and accessibility contribute to its popularity, its high volume has raised concerns about quality control in the scientific community. Still, the articles published there are widely cited, with over 3,000 citations collectively. Other key journals include *Energies* (40 publications), *Renewable and Sustainable Energy Reviews* (31), and the *Journal of Cleaner Production* (20), all of which reflect the strong emphasis on energy and sustainability topics in Lithuania's research landscape. The broader set of journals includes high-impact outlets such as *Science of the Total Environment* and *Sustainable Development*, as well as more regional or niche publications such as *Contemporary Economics*, *Zemdirbyste-Agriculture,* and *Journal of Security and Sustainability Issues*. This distribution supports findings from the keyword analysis: the research is concentrated in applied sustainability, energy systems, and policy, rather than in core climate science or social science for climate change.

3.2. Results of quantitative analysis of projects funded

Project-level data from the Research Council of Lithuania (LMT) were also examined to understand how climate-related research has been supported over time. Using a keyword-based identification strategy, 773 projects were classified as climate-related between 2009 and 2023. The vast majority (i.e., approx. 87% of 569 projects) originated from investigator-initiated competitive schemes. Government-commissioned initiatives accounted for 77 projects, and internationally funded programs made up another 127 projects, reflecting the country's participation in broader European research frameworks. Three targeted national programs, i.e., LEK (Climate Change Program), ATE (Energy Transition Program), and SIT (Smart Technologies and Innovation), account for most of the state-commissioned climate projects, with 38, 17, and 17 projects, respectively.

The number of funded projects shows peaks in 2012, 2017, and 2023, which coincide with key EU and national climate initiatives and calls (i.e., Horizon 2020 and Green Deal-aligned programs). Annual climate research funding (estimated as project budget × duration) reflects these cycles, with notable surges in 2017 and 2021. Cumulatively, investigator-led projects account for ~77% of climate research funding, with state-commissioned

projects contributing 12%, and international sources 11%. Although climate-related projects make up only 5–10% of all LMT-funded projects per year, their relative share has grown significantly from nascent levels in the late 2000s to more than 10% in 2023, signaling increased alignment with national and EU climate priorities.

Finally, disciplinary patterns show a strong tilt toward the natural and technical sciences, especially in fields such as physics (~27 projects), materials engineering (~24 projects), biology and ecology (~19 projects), chemistry (~15 projects), and environmental engineering. Some projects in the social sciences are present, particularly in the areas of public adaptation and environmental sociology, though they remain comparatively few. This disciplinary distribution mirrors the bibliometric findings, where technical and policy-oriented research dominate.

4. Discussion

The surge in climate-related publications in Lithuania corresponds with the overall boom in climate science worldwide since the mid-2000s. International studies have similarly documented a substantial increase in climate publications and a shift of focus toward applied solutions in recent years (e.g., Fu and Waltman 2022; Bartlett et al. 2024). Lithuania's strong orientation toward renewable energy, sustainability, and climate economics echoes this pivot to "climate solutions" research (Lu 2024). It also reflects regional priorities; as an EU member, Lithuania has been influenced by European research agendas such as the European Green Deal. Moreover, the high degree of international co-authorship we observed is typical for smaller research communities (Kamalski 2009; Poirier et al. 2015). Across scientific fields, smaller or emerging research countries often pursue collaborations abroad to access resources and expertise, resulting in a large share of their publications being internationally co-authored (Aksnes and Sivertsen 2023). The intense collaboration can be seen as a strength, leveraging global knowledge networks, and is consistent with findings that small countries benefit from international partnerships to enhance research impact (Aksnes and Sivertsen 2023).

In contrast, the lack of social science and communication research on climate in Lithuania stands out when contextualized. International assessments have increasingly stressed that climate change is not just a technical problem but also a profoundly social one (Hiltner 2024). Recent studies from rural, coastal, indigenous, and developing contexts show that collaborative approaches to knowledge production (e.g., co-production, participatory monitoring, and boundary work) enhance the legitimacy and usability of climate information (Levesque et al. 2021; Hill et al. 2020; Figus et al. 2022). In many cases, factors such as preexisting trust, source credibility, and media environment are more decisive than scientific content alone (Bogert et al. 2023; Diehl et al. 2019; Buys et al. 2014). However, social sciences where the participatory approaches are elaborated and contextualized, remain

underrepresented in climate change research globally (Overland and Sovacool 2020; Maxwell et al. 2022). Our findings confirm that this imbalance is pronounced in Lithuania's case. Whereas countries with larger research systems may have at least some dedicated climate communication or social impact studies, Lithuania's output appears almost entirely in the natural and applied sciences. This lack of social science engagement is noteworthy. It suggests that the academic discourse in Lithuania has, so far, been disconnected from questions of how the public understands or trusts climate science.

While the study offers a robust analysis of climate-related publication trends in Lithuania, several methodological limitations should be acknowledged. First, our reliance on keyword-based retrieval from the Scopus database introduces a risk of omission bias; relevant publications that do not explicitly use climate-related terms in titles or abstracts may have been inadvertently excluded. Second, the dataset is restricted to English-language, peer-reviewed journal articles, thereby omitting grey literature, reports, or articles published in Lithuanian, which could contain valuable insights, especially on localized or policy-relevant topics. Third, bibliometric approaches inherently focus on formal scientific outputs, meaning that non-published or practice-oriented knowledge (e.g., public engagement initiatives or ongoing projects) falls outside the scope of this analysis. Lastly, thematic clustering requires interpretive decisions during keyword normalization and labelling, which, while methodologically transparent, may influence how topics are categorized.

5. Conclusion

1. Lithuania's climate research output has grown significantly over the past two decades, with an especially sharp increase in recent years. This trend reflects not only the responsiveness of the academic community to global climate agendas but also the country's increasing integration into European and international research frameworks. The thematic concentration on sustainability, energy, and economic modelling shows that Lithuanian researchers are contributing valuable technical knowledge to the global climate discourse.
2. Despite the technical robustness of Lithuania's climate research, there is a persistent gap in the exploration of social, behavioral, and communication dimensions. Few studies address how the public understands, interprets, or engages with climate-related information. This imbalance may limit the broader societal impact of scientific findings, particularly at a time when misinformation, skepticism, and political resistance complicate the translation of science into policy and action.
3. Bridging the gap between climate science and public engagement should be a strategic priority. This requires not only increasing funding and institutional support for interdisciplinary research that includes social science perspectives but also developing targeted science communication strategies.

4. Strengthening public trust in climate science in Lithuania will depend on fostering two-way communication, rather than one-directional dissemination of facts. Engaging citizens as participants in knowledge production (e.g., through citizen science, participatory policy processes, and inclusive dialogue) can enhance the legitimacy and relevance of climate research. Aligning scientific efforts with public values and concerns is essential for building a climate-literate society capable of supporting ambitious mitigation and adaptation strategies.

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