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Trends and Evolution in environmental communication: Bibliometric insights from the web 2.0 era

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Abstract

Environmental communication explores how humans interact with nature and reshape their environments. This paper investigates research trends, themes, and academic contributions in this domain, focusing on bibliometric analysis of literature published during the Web 2.0 era (2004-July 2024). Based on predetermined criteria, 604 articles were retrieved from the Scopus database for analysis. Using VOS viewer and Biblioshiny (R Studio), the study mapped keywords, conducted cartographic analysis, thematic mapping, and keyword clustering, highlighting the impact, influence, and evolution of environmental communication research. Findings indicate a decline in articles on this subject after 2022, while interest in citizen science and visual communication topics has grown since 2016. This research enriches the field by offering a detailed analysis of the most influential authors and countries contributing to environmental communication studies. It provides valuable insights into emerging trends and areas of focus within the discipline.

Keywords: Bibliometric analysis, research trends, environmental communication, thematic analysis, sustainable communication, web 2.0

1. Introduction

Environmental Communication (EC) is defined as the use of communication theories and strategies to manage and protect the environment while facilitating the exchange of information and ideas about ecological concerns^[1]. According to Cox^[2], EC enhances society's capacity to respond effectively to environmental signals that impact both human civilization and natural ecosystems. It has been evident that environmentalism has its roots grounded in environmental communication which in turn is inspired by the General Systems Theory (GST). Studies^[3,4] highlight the influence of environmental knowledge and concerns in shaping pro-environmental behaviors. Cox^[5] stresses the inseparability of communication from environmental knowledge, noting that undermining communication has widened the gap between environmental initiatives and their outcomes^[5]. Our interactions with the environment are shaped by observation^[7], dialogue^[8], and connection^[9, 10]. Originating in the United States, EC emerged as an interdisciplinary field, with notable contributions from scholars like Oravec^[11], who analysed John Muir's conservation advocacy in Yosemite^[12]. Lindenfeld^[13] argue that EC can bridge sustainability science and actionable knowledge. Action-based environmental education is critical for fostering eco-friendly behavior^[14, 15]. EC incorporates socio-political dimensions to stimulate change through public discourse^[16] and education^[17]. Media and communication play pivotal roles in addressing environmental issues and raising public awareness^[18, 19]. Research in journalism and mass communication reveals how media coverage influences public perceptions and knowledge of ecological challenges^[20, 21]. Adiga & Poornananda^[22] emphasize the importance of media attention and communication strategies to mobilize public action. Collaboration among researchers, activists, and policymakers is essential for creating effective networks and sharing knowledge^[17]. Recent EC studies have become media-centric, neglecting socioeconomic and political factors^[23]. Breveni^[24] urges EC research to focus on inequalities in resource accessibility and advocacy-driven practices^[25]. The late twentieth century witnessed rising public and media attention toward environmental concerns, bolstering EC research^[26].

However, journalists face challenges, including the time-intensive nature of environmental reporting and external pressures from media ownership [27, 28]. Despite initiatives like the International Environmental Communication Association (2011), gaps in EC research persist [29]. Meta-analyses [30] reveal socio-psychological factors, such as environmental risk perception and knowledge, as drivers of eco-friendly behaviour. Indian researchers [31, 32] have shaped the country's environmental discourse and policies. Moving forward, EC must balance rigorous research with actionable communication strategies to address environmental inequalities, increase public engagement, and promote sustainability. This study aims to explore the recent trends, themes, most influential authors, countries and the research collaborations prevailing in the domain of Environmental Communication.

2. Methodology

The term "statistical bibliography" was introduced by E. Wyndham Hulme in 1923. Bibliometrics stands out among literature review methodologies as a systematic and objective approach that employs quantitative methods to evaluate research trends, identify gaps, and highlight influential works. This methodology has become essential due to the rapid growth of academic publications, which has made keeping up with all developments unmanageable. Tools like Bibliometrix (R), Citespace, and VOS Viewer aid in bibliometric analysis, ensuring a comprehensive assessment of research landscapes. *Biblioshiny* by R and VOS Viewer were used for this study to analyze data from the Scopus database. *Biblioshiny* by R provides a user-friendly interface for conducting bibliometric analysis, while VOS Viewer offers network visualization for academic materials. The study adhered to a standard bibliometric workflow consisting of five stages: study design, data collection, analysis, visualization, and interpretation. The study aims to identify the most impactful authors and countries in environmental communication; analyse keyword co-occurrences to track research trends over time; and explore thematic evolution in the field. Data extraction followed the PRISMA framework, ensuring rigorous review and adherence to inclusion criteria such as English-language original research articles published between 2004 and July 2024, with a focus on communication processes, media involvement, and interdisciplinarity. The researchers employed Scopus as their primary data source due to its strict article curation standards and filtered the articles using relevant keywords like "Environmental Communication," "Social media," and "Sustainability." After an initial export of 1,436 articles, data cleaning and screening yielded 604 articles for detailed analysis. Bibliometric analysis is particularly suitable for processing large datasets, as it helps identify meaningful insights through visualization and statistical mapping. Data analysis involved performance metrics and Scientific Mapping Analysis (SMA). Performance Analysis examines contributions from researchers and countries, while SMA offers spatial and temporal representations of research activities. Both methods provide valuable insights into publication and citation trends. This study underscores bibliometrics as a reliable method for uncovering the evolution and trends in research.

3. Data Analysis

3.1 Descriptive analysis using R *biblioshiny*

The bibliometric data analysis of environmental communication research using R *biblioshiny* provides valuable insights. Covering a timespan from 2004 to 2024, the study analysed 604 documents sourced from 268 journals. This significant body of work highlights a steadily growing field, with an impressive annual growth rate of 16.58%, emphasizing the increasing importance of environmental communication research. On average, each document received 14.71 citations, reflecting moderate engagement and influence within the academic community. Collectively, the documents referenced a vast body of work, totalling 31,086 references. A wide variety of topics are explored, as indicated by 1,719 unique author keywords. The analysis involved 1,450 authors, showcasing the collaborative nature of the field. While 183 documents were authored by a single researcher, most studies involved teamwork, with an average of 2.71 co-authors per document. International collaborations accounted for 15.89% of the total, highlighting global partnerships in addressing environmental challenges. The findings reflect the dynamic and interdisciplinary character of environmental communication research. They underline its growing prominence and collaborative spirit, driven by contributions from diverse authors and institutions worldwide. Such data-driven insights are vital in advancing research, enhancing global engagement, and fostering innovative strategies to tackle pressing environmental issues. The years 2016 & 2022 have seen a rapid increase in the production of scientific articles than their previous years. The year 2022 marked the highest production of scientific articles (n=67), yet there has been a slight decrease in the years 2023 (n=61) & 2024 (till July) (n=43). The descriptive analysis shows that the extracted 604 articles comprised 1719 author keywords and 183 single-authored docs with an average citation of about 14.71 per article. Speaking of the International co-authorship, about 15.89% of articles have been co-authored by authors from different countries. The line graph tracks trends in research output from 2004 to 2024. Between 2004 and 2010, the number of scientific articles published remained stable with minor fluctuations. Growth of annual articles in the domain of environmental communication became evident from 2011 to 2014, followed by a sharp surge during 2014-2016, reflecting a period of rapid expansion in production. From 2016 to 2022, the trend continued upward consistently, peaking in 2022 with the highest annual output recorded. However, a decline is noticeable after 2022, extending to 2024, which could be attributed to factors like economic challenges or global disruptions such as pandemics. This pattern showcases key moments of progress and slowdown in scientific productivity. Peaks might correlate with increased investments, breakthroughs in specific fields, or major global scientific initiatives, while declines could result from external constraints. Researchers have enlisted the authors with the most impact as an indicator that relies on evaluative bibliometrics [33] by assessing the authors with the highest h-index score. Fig. 2 depicts the top 10 authors with a higher h-index score and a higher impact in the domain of environmental communication. Hart P S is the most impactful author with an h-index of 6 followed by Feldman L and Van Der Wal R with an h-index of 4.

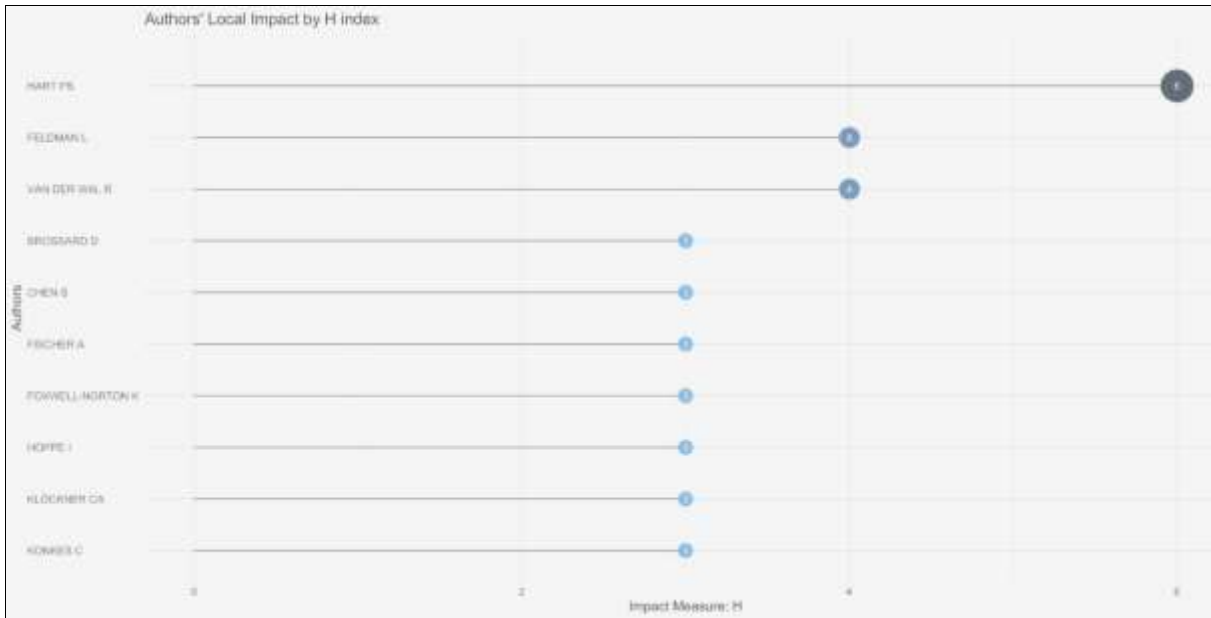


Fig 1: Author’s local impact by R biblioshiny.

3.2 Three-field plot analysis

The progression of a data flow and the relationship between the data can be appropriately represented using a Sankey diagram. This Sankey diagram provides valuable insights into the geographical distribution of research topics and the key contributors in the field of environmental communication and related areas. The contribution of research papers from different countries, the author keywords extracted from the dataset and the cited sources from the articles have been precisely represented using a three-field plot analysis through a Sankey diagram as shown in Figure 3. The left column represents the corresponding

authors’ countries, the middle column represents the author keywords and the right column represents the cited sources from the articles. The dominant keyword of the research is ‘Environmental Communication’, followed by ‘Climate Change’ and ‘Social Media’.The relationship and the connectivity rely on the height of the boxes along with the thickness of the lines [34]. From the left column, it is evident that Boykoff M T is the highest cited source in the articles with the keywords ‘Environmental Communication’ and ‘Climate Change’ followed by Nisbet M C, Hansen A, and O’Neill S.

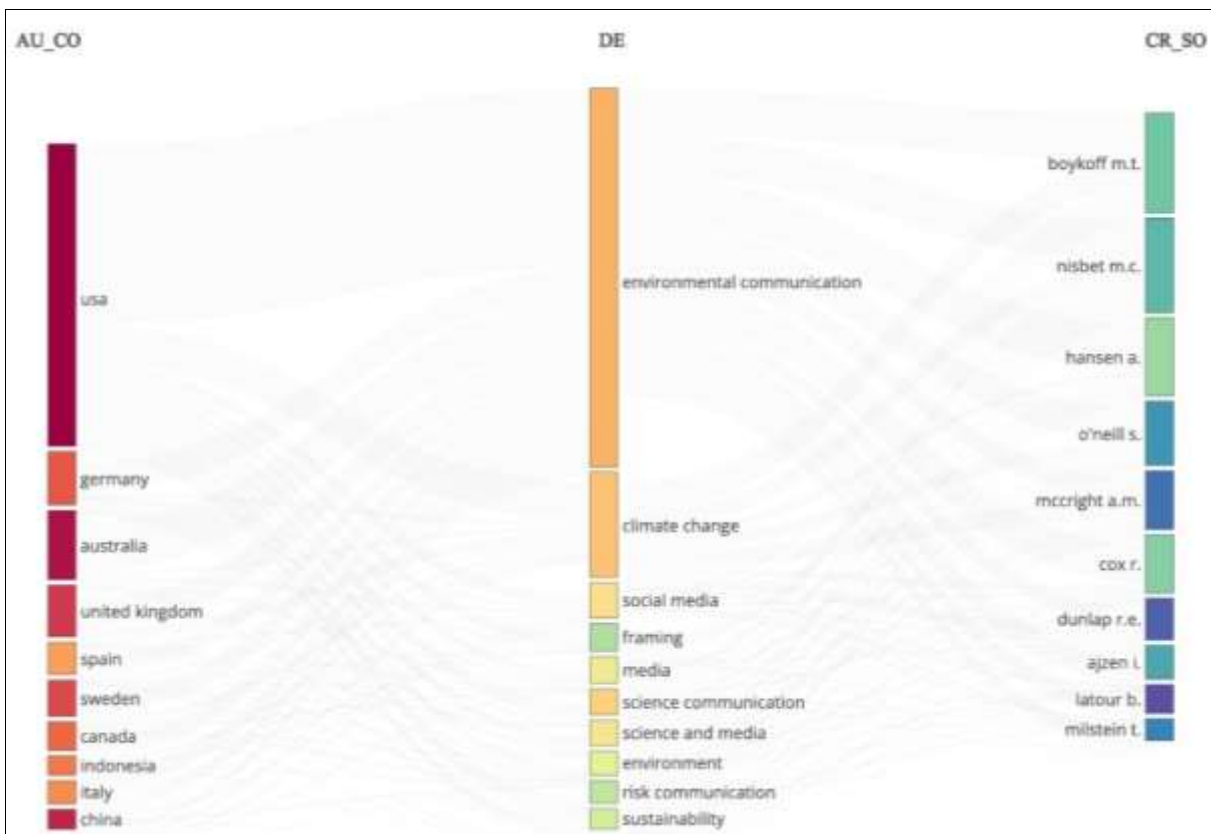


Fig 2: Three field-plot representing the Author countries, Keywords and Corresponding authors using biblioshiny.

The countries that made the most contributions towards the field of environmental communication are the USA, Australia and the UK. While the USA and Spain have contributed greatly to the field of Climate Change. USA has strong links with topics like Climate Change and Environmental Communication and has key contributors such as Boykoff M.T. Germany is connected to topics like Science Communication and has contributors like Nisbet M.C. Australia shows connections with topics like social media and is represented by authors like Hansen A. United Kingdom has links with Environmental Communication and is represented by authors like O'Neill S.

3.3 Keyword co-occurrence analysis

Keyword Co-occurrence Analysis highlights the thematic evolution of research. Co-occurrence analysis is used to identify frequently appearing terms to create a network, where the nodes and connections represent the co-occurrence relationship as a cluster, that represents a theme

[35, 36]. Researchers have performed a co-occurrence analysis using VOS Viewer with the author’s keywords. The analysis depicted three clusters that have been dominant over the years, ‘Environmental Communication’ with a link strength of 153 and 318 occurrences followed by ‘Climate Change’ with a link strength of 153 and 74 occurrences, and ‘Science Communication’ with a link strength of 64 and 26 occurrences. The analysis underscores shift in focus toward ‘participatory science communication’ and ‘climate change communication’. The study suggests interconnectedness among topics like social media, sustainability, public engagement, and risk communication. Stronger links indicate closer relationships, such as between social media and public engagement. A timeline of keywords (2016-2022) reveals older discussions in blue nodes, while yellow nodes highlight recent trends like citizen science and visual communication. Niche areas like corporate social responsibility and environmental justice also emerge.

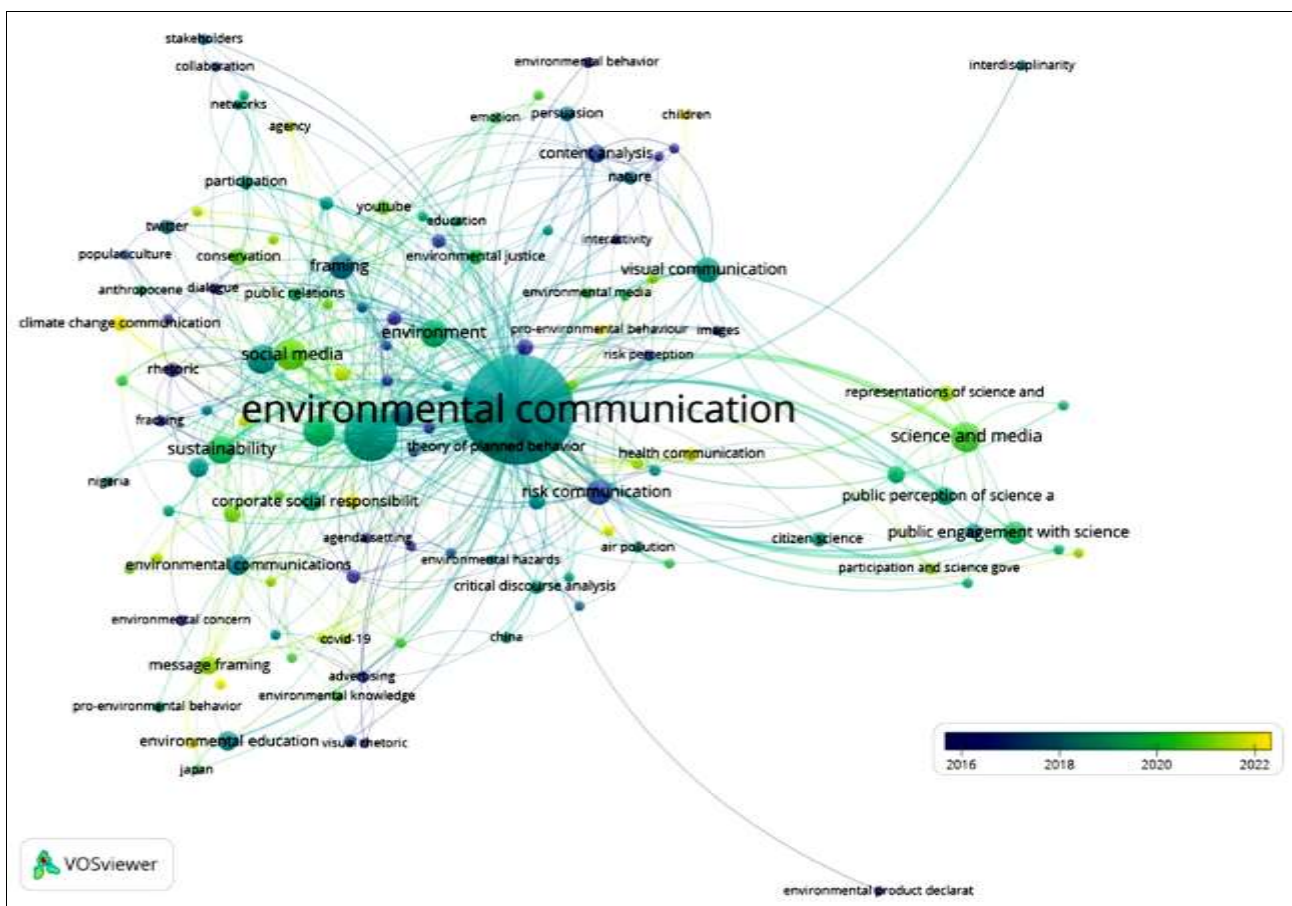


Fig 3: Co-occurrence analysis of author keywords using VOS Viewer.

3.4 Thematic mapping

The thematic analysis is used to form clusters to obtain themes from authors’ keywords and the association between them which are characterised by their attributes (density and centrality)³⁴. These attributes are used to analyse the importance of a theme. Higher centrality and density, it is considered to be highly important. The upper right quadrant (Q1) represents the motor themes, the upper left quadrant (Q2) represents the Niche themes, the lower left quadrant (Q3) represents the emerging or declining themes and the lower right quadrant (Q4) represents the basic themes. It is observed from Fig. 5 that the Q4 cluster containing media,

environment and communication are of more importance for the development of the field. The cluster in Q1 with critical discourse analysis and environmental sustainability lies in an essential position in the network. The rhetoric cluster in the Q2 marks a significant position with a higher centrality and density. The thematic map categorizes based on development degree (density) and relevance degree (centrality). It is better represented in the table 2. This categorization, explained in Figure 4 and Table 2, reflects development degree (density) and relevance degree (centrality). The analysis underscores the interconnectedness of themes and their contributions to

advancing research, offering insights into key topics and their roles in shaping the domain of environmental communication and related fields.

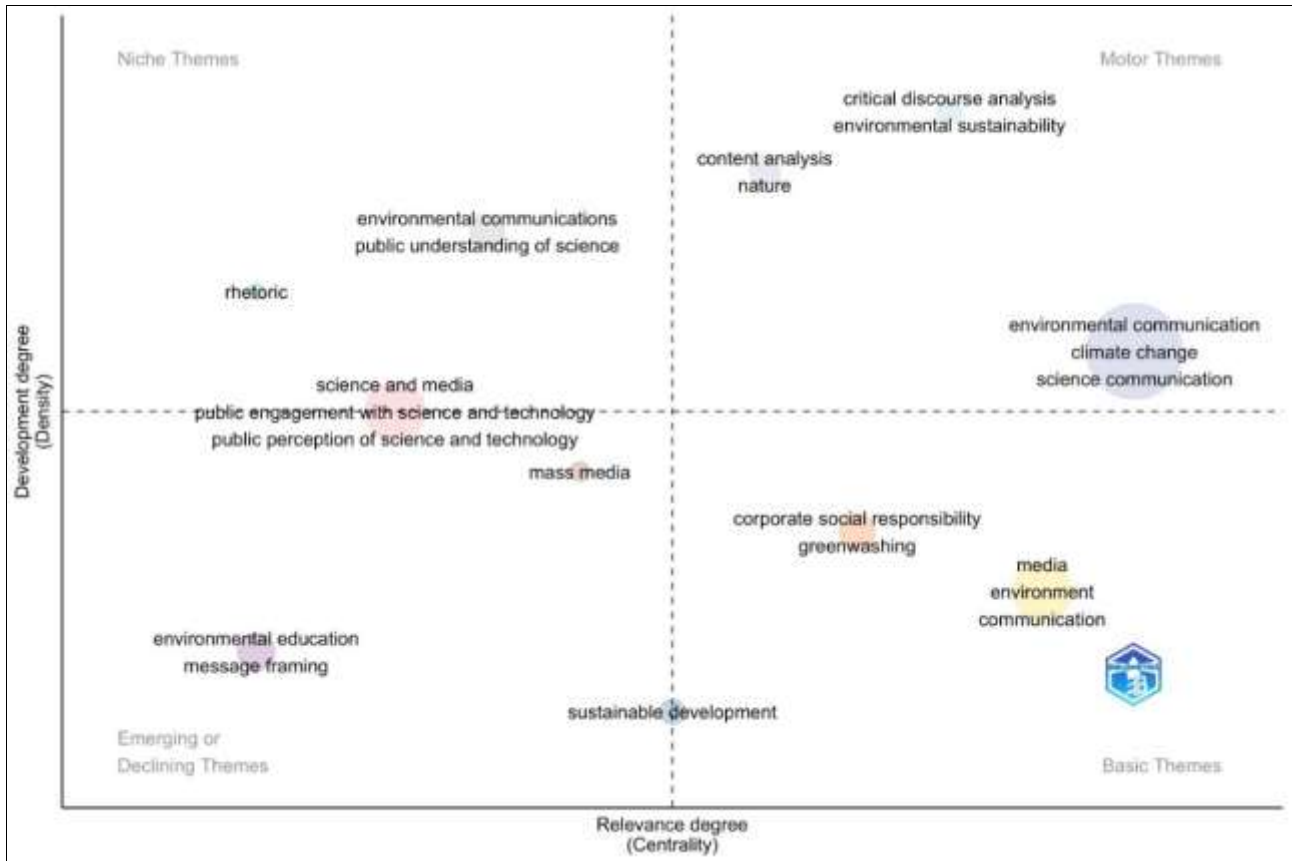


Fig 4: Thematic mapping of the author keywords using *biblioshiny*.

Table 1: Categorisation of themes based on Thematic mapping of keywords

Categorization of Themes	Density & Centrality	Themes
Motor Themes (Q1)	High density and centrality	Critical discourse analysis, Environmental sustainability, Content analysis, Nature
Niche Themes (Q2)	High density but Low centrality	Environmental communications, Public understanding of science, Rhetoric
Emerging or Declining Themes (Q3)	Low density and centrality	Environmental education, Message framing
Basic Themes (Q4)	High centrality but Low density	Environmental communication, Climate change, Science communication, Corporate social responsibility, Greenwashing, Media, Environment, Communication, Sustainable development

3.5 Bibliographic coupling

Bibliographic coupling identifies relationships between documents through shared references, offering insights into research collaborations, trends, and author influence. This approach is particularly useful for assessing the research landscape and identifying potential areas for international collaboration [37, 38]. Using VOS Viewer, researchers mapped three author clusters within a bibliometric network. Nodes

represented authors, edges indicated connections, and node sizes reflected influence. Cluster 2 emerged as the most impactful, led by Hart (link strength: 615, six documents, 16 connections) and Feldman (link strength: 566, four documents, 16 connections). Cluster 1 featured Van Der Wal (link strength: 139, five documents) and Olausson (link strength: 60, six documents).

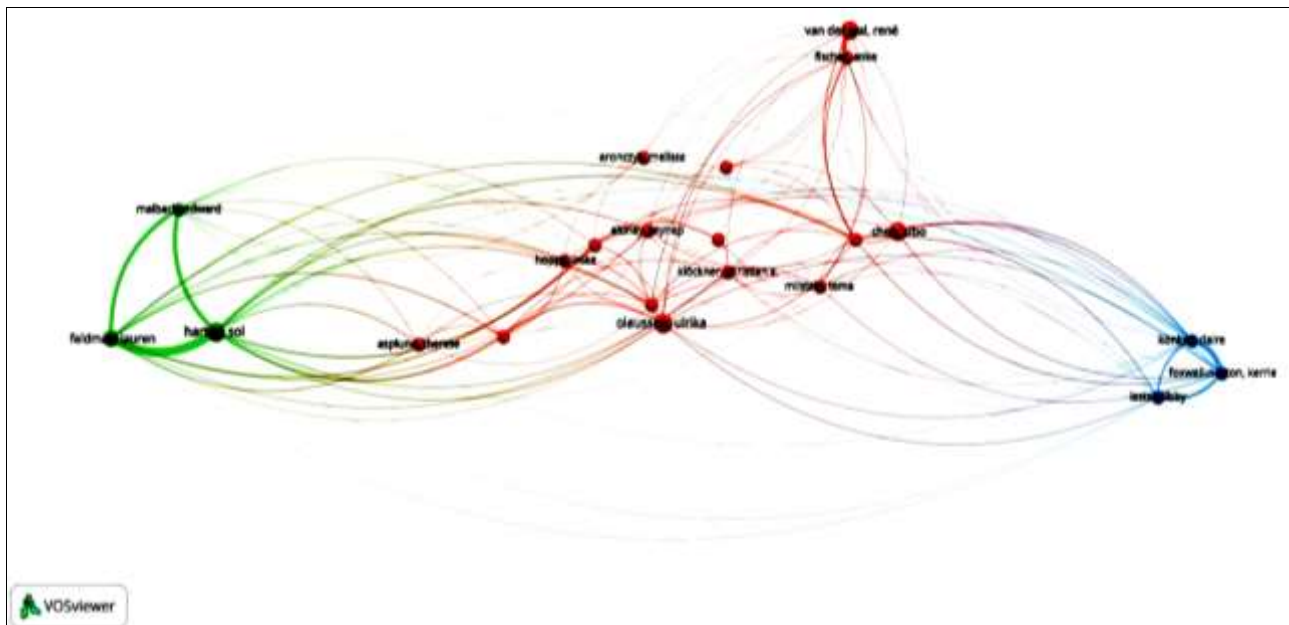


Fig 5: Bibliographic coupling of authors using VOS Viewer.

Cluster 3 included Foxwell and Konkes, each contributing three documents with link strengths of 273 and 243, respectively. Thematic distinctions among clusters highlight the field's diversity. The red cluster focuses on critical discourse analysis and environmental sustainability, the green cluster emphasizes environmental communication and public understanding of science, and the blue cluster concentrates on content analysis and media studies. This analysis showcases collaboration dynamics and thematic priorities in environmental communication research.

4. Discussion and Conclusion

The study aimed to explore three key objectives: identifying influential authors and countries, examining thematic evolution, and uncovering research trends in environmental communication. Using bibliometric tools like R *biblioshiny*, the analysis showcased the contributions of prominent authors such as Hart P. S., whose work spans media polarization, public perception of environmental issues, climate activism, and framing techniques in climate change communication. The USA emerged as the leading contributor, followed by Australia and China. However, India's limited research output underscores the need to strengthen communication strategies addressing environmental challenges. India faces significant environmental challenges, including air and water pollution, deforestation, waste management issues, and the impacts of climate change. These issues have far-reaching consequences for public health, agriculture, and biodiversity. Environmental communication plays a crucial role in addressing these challenges. It helps raise public awareness, shape opinions, drive behaviour change, and promote policy reforms [39]. However, research in this domain often remains underexplored, particularly in creating actionable strategies that engage communities and policymakers effectively. Expanding research in environmental communication can bridge this gap and contribute to sustainable solutions [40]. Critical discourse and content methods have been gathering attention in the recent time. Co-occurrence analysis using VOS Viewer identified thematic clusters, revealing a transition toward participatory

communication and the framing of environmental messages on social media platforms. The field is moving toward a more participatory, interdisciplinary, and technology-driven approach, with a strong focus on fostering public engagement and addressing misinformation. These trends underscore the importance of innovative communication strategies in shaping perceptions and driving action on critical environmental issues.

4.1 Limitations and scope for future research

Despite the study's comprehensive insights, its reliance on the Scopus database restricted the scope, excluding other databases like Web of Science and non-journal materials. This limitation calls for expanding data sources in future research, including a focus on misinformation's impact on public perception and the development of tools to enhance message credibility. The findings underscore the importance of interdisciplinary collaboration among researchers, policymakers, and communicators. Effective strategies must be developed to foster public engagement and address global environmental concerns. By analyzing trends and thematic evolution, the study highlights the growing emphasis on climate communication and participatory approaches. Collaboration is essential for advancing research and crafting sustainable solutions to pressing environmental issues.

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