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Education and the Sustainable Development Goals: A Comparative Bibliometric Analysis of SDG 3 and SDG 13 Research Outputs from the Global North and Global South

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Abstract: This study investigates the integration of education within global research at the convergence of Sustainable Development Goal 3 (Good Health and Well-being) and Sustainable Development Goal 13 (Climate Action), focusing on thematic evolution, collaboration patterns, and disparities between knowledge systems of the Global North and Global South. Methodology a thorough bibliometric study was performed utilizing 1,625 publications indexed in Scopus from 2015 to 2025. In accordance with PRISMA requirements, VOS viewer was utilized to delineate co-authorship, institutional collaboration, keyword co-occurrence, and citation networks, with a specific emphasis on education as a pervasive analytical framework. The results indicate a disjointed incorporation of education in research related to SDG 3 through SDG 13, a significant concentration of authorship and institutional authority, and a marked predominance of the Global North. Climate-health knowledge is structured into concurrent methodological, applied, and policy-oriented areas, with insufficient cross-institutional collaboration hindering equitable educational capacity development. The study influences education policy, curriculum management, and leadership practices by pinpointing deficiencies in the dissemination of climate-health knowledge. It facilitates evidence-based curricular integration, bolstered research supervision, and inter-university collaborations to improve climate literacy, health literacy, and educational capacity linked with the Sustainable Development Goals (SDGs). Novelty this study enhances current bibliometric analyses by investigating the representation of educational dimensions in research on SDG 3 and SDG 13, providing insights into the influence of education on the development of climate-health knowledge systems and SDG-focused learning and leadership.

Keywords: *Health education, sustainable, development literacy, education, leadership*

A. Introduction

Sustainable development is based on the principle of fulfilling current needs without jeopardizing the ability of future generations to satisfy their own, a concept formalized through the Sustainable Development Goals (SDGs) established by the United Nations in 2015 (Sama et al., 2020; Saxena et al., 2021). The successful implementation of the

seventeen SDGs, which focus on various development priorities, relies on cross-sectoral coordination, institutional capacity, and integrated knowledge systems(Allen et al., 2023; Breuer et al., 2023; Marín-González et al., 2022). Sustainable Development Goal 3 (Good Health and Well-being) and Sustainable Development Goal 13 (Climate Action) have gained prominence as human health outcomes are inextricably linked to planetary systems (Henderson & Loreau, 2023).

Climate change, first perceived mainly as an environmental concern, is today acknowledged as one of the foremost public health challenges of the twenty-first century. Increasing temperatures, severe weather phenomena, and ecological disturbances exacerbate health risks via mechanisms including heat-related fatalities, vector-borne illnesses, food insecurity, and psychological stresses (Rocha et al., 2022; Romanello et al., 2021; WHO, 2025). The effects disproportionately burden low- and middle-income nations, where healthcare systems encounter enduring structural limitations (Okereke et al., 2021; Pedersen et al., 2022). Despite the inherent connection between climate and health, research on SDG 3 and SDG 13 has predominantly progressed independently, resulting in disjointed bodies of knowledge that hinder cohesive policy responses and coordinated execution.

The growing corpus of research recognizes education as a vital tool for mitigating this fragmentation. In addition to its official title as Sustainable Development Goal 4 (Quality Education), education serves as a fundamental facilitator of sustainable development by cultivating human capabilities, enhancing leadership capacity, improving institutional governance, and influencing societal behavior (de Assumpção & Neto, 2020; Price et al., 2024; UNESCO, 2021). Empirical data indicates that Education for Sustainable Development enhances health and climate action results by cultivating sustainability competencies, civic participation, and institutional capacity (Abera, 2023; Chiba et al., 2021; Franco & Tracey, 2019). Thus, health literacy, climate literacy, and sustainability competencies are increasingly acknowledged as vital educational outcomes that must be intentionally integrated into curricula, supervisory frameworks, and learning governance structures (Ahmad et al., 2023; Zanobini et al., 2024).

From an educational leadership standpoint, theoretical frameworks such as instructional leadership, transformational leadership, and distributed leadership underscore the significance of leaders in influencing curriculum priorities, professional development, and organizational culture (Kwan, 2020; Leithwood et al., 2020; Torres, 2022). These frameworks are especially significant for enhancing climate and health education, as they emphasize leadership agency in synchronizing institutional vision, pedagogical practices, and resource distribution with intricate social issues like climate resilience and public health. In the realm of SDG implementation, educational leaders serve as boundary spanners, converting global sustainability mandates into regional curricula, staff development programs, and organizational practices.

Nonetheless, current research indicates significant deficiencies in the implementation of these functions within education systems. Higher education institutions, despite their strategic role as centers of knowledge generation and leadership cultivation, frequently demonstrate a disjointed incorporation of sustainability, health, and climate goals within

their curricula and governance structures (Kioupi & Voulvoulis, 2020). Although leadership and governance are critical, especially when sustainability goals are integrated into institutional strategy, curriculum, research, and public engagement, climate education often stays peripheral within core curricula (Kittipongvises & Salathong, 2024). In Global South contexts, these issues are exacerbated by structural restrictions such as resource inequities, restricted institutional autonomy, and prevailing human capital paradigms (Chankseliani & McCowan, 2021).

Comparable disparities are apparent after tertiary education. Research underscores a continuous disparity between institutional sustainability pledges and students' educational experiences, indicating predominantly symbolic incorporation into the curriculum (Elsayed et al., 2025) Student research, while a substantial yet underappreciated contribution to SDG 3, is profoundly influenced by supervision frameworks, faculty configurations, and institutional research governance (Garnita et al., 2024). In basic education, climate action is inconsistently and implicitly integrated into national curricula, indicating a poor alignment between educational policy and climate goals, as well as inadequate teacher training (Ahovi, 2025; Robles-Moral, 2021).

Concurrently with these educational problems, bibliometric analyses frequently reveal significant regional disparities in research output relevant to the SDGs. High-income nations dominate climate action research, whereas low-income nations prioritize health equality, leading to imbalanced knowledge production and partnership dynamics (Qi et al., 2022; Sweileh, 2020). Additional data highlights the ongoing underrepresentation of Global South institutions in climate–health research (Faraji et al., 2022; Klarin, 2024; Rojas-Rueda et al., 2019; Zhao et al., 2022). Importantly, prior bibliometric studies have predominantly focused on health and climate research in isolation and seldom integrate education, leadership, or supervision as explicit analytical frameworks.

This omission represents a significant research deficiency. Although education is widely acknowledged as pivotal for the advancement of SDG 3 and SDG 13, there exists a paucity of systematic evidence regarding the representation of education within the global research framework that connects health and climate action, the involvement of educational institutions in knowledge production and collaborative networks, and the variations of these dynamics between the Global North and Global South. Rectifying this deficiency is imperative, considering the intensifying effects of climate change on health systems and the crucial function of education in influencing enduring social reactions.

This study conducts a comparative bibliometric analysis of global research outputs concerning SDG 3 and SDG 13, specifically highlighting education as a primary analytical subject. The study's originality resides in its comprehensive analysis of health, climate action, and education within a unified bibliometric framework, facilitating the identification of thematic development, collaborative structures, and institutional impact across many geographies. This work positions education at the core of the SDG 3–SDG 13 research nexus, enhancing a more inclusive and policy-relevant comprehension of how knowledge systems can facilitate coordinated, education-focused approaches to sustainable development.

B. Methods

This study adopts a systematic quantitative review combined with bibliometric analysis to examine the scholarly landscape at the intersection of Sustainable Development Goal 3 (Good Health and Well-being) and Sustainable Development Goal 13 (Climate Action), explicitly incorporating education as a cross-cutting analytical dimension. The study is designed to identify, map, and analyze the intellectual structure, thematic patterns, and collaboration networks of research addressing the health–climate nexus, while also assessing how educational institutions, educational concepts, and learning-oriented interventions are embedded within this body of knowledge.

The inclusion of education is methodologically justified on both conceptual and empirical grounds. Conceptually, education is recognized as a foundational enabler of sustainable development through its role in shaping human capabilities, institutional capacity, leadership development, and policy implementation across SDGs. Empirically, education systems particularly higher education institutions function as primary sites of knowledge production, research collaboration, and human capital formation related to health and climate action. Accordingly, this study treats education not as a separate thematic outcome, but as a structural lens through which the production, dissemination, and organization of health–climate research can be systematically examined.

Specifically, the study aims to: (1) map the thematic evolution and intellectual structure of SDG 3–SDG 13 research;(2) analyze co-authorship and institutional collaboration patterns, with particular attention to the role of educational institutions across Global North and Global South contexts; and (3) assess regional disparities in research production and knowledge networks where education serves as a mediating institutional platform;(4) highlight areas of inquiry that can inform policy and practice at the health–climate interface and those in supervision and leadership of education.

The Scopus database was selected as the primary data source due to its extensive multidisciplinary coverage of peer-reviewed literature and its strong citation indexing and affiliation metadata, which are essential for institution-level and collaboration-based bibliometric analysis (Baas et al., 2020). Scopus is particularly well suited for this study because it comprehensively indexes journals spanning public health, environmental science, sustainability, education, and social sciences, thereby enabling systematic identification of education-linked research within the broader health–climate discourse. Importantly, Scopus provides standardized institutional affiliation data, allowing for robust analysis of the contribution of universities, research institutes, and education-oriented organizations to SDG 3 and SDG 13 scholarship. This feature is critical for examining the role of education as an institutional driver of research production and cross-regional collaboration.

To ensure methodological rigor and transparency, the review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The PRISMA framework facilitated a clear, replicable process for identification, screening, eligibility assessment, and inclusion of studies, as illustrated in Figure 1. This approach is widely adopted in bibliometric analyses examining SDG-related research,

health equity, and climate action, and is particularly appropriate for studies seeking to systematically map interdisciplinary and cross-sectoral research domains (Chen et al., 2022).

The comprehensive keyword search was conducted on May 18, 2025 within the Scopus database. The Boolean search string was constructed to identify publications that directly address SDG 3 and SDG 13:
TITLE-ABS-KEY "sdg 3" OR "sustainable development goal 3" OR "good health and well-being" OR "global health" OR "world health" and "sdg 13" OR "sustainable development goal 13" OR "climate action" OR "climate change" OR "global warming". The search was restricted to publications from 2015 to 2025, corresponding with the implementation period of the SDGs. Only English-language documents were included. Eligible document types comprised research articles, review papers, book chapters, and conference proceedings.

From an initial yield of 4,908 records, the screening process was guided by PRISMA standards. The steps were as follows: 1. Year filter (2015–2025): 4,002 records retained, 2. Document type filter: 1,689 documents retained after excluding non-research articles, 3. Language filter: 1,625 English-language publications included for analysis. The final dataset of 1,625 documents was deemed suitable for bibliometric analysis. The PRISMA flow diagram (Figure 1) provides a visual summary of the selection process.

Bibliographic data were exported in CSV format from Scopus. The bibliometric analysis was conducted using VOS viewer software, a recognized tool for visualizing co-authorship, co-occurrence, and citation networks. In this study, the emphasis was placed on keyword co-occurrence analysis, which facilitates the detection of conceptual linkages, thematic clusters, and emerging trends within the health–climate literature.
By mapping the frequency and co-occurrence of keywords, this technique enables the identification of dominant research streams and knowledge gaps. The analytical process provides critical insights into the structure and evolution of interdisciplinary discourse on SDG 3 and SDG 13.

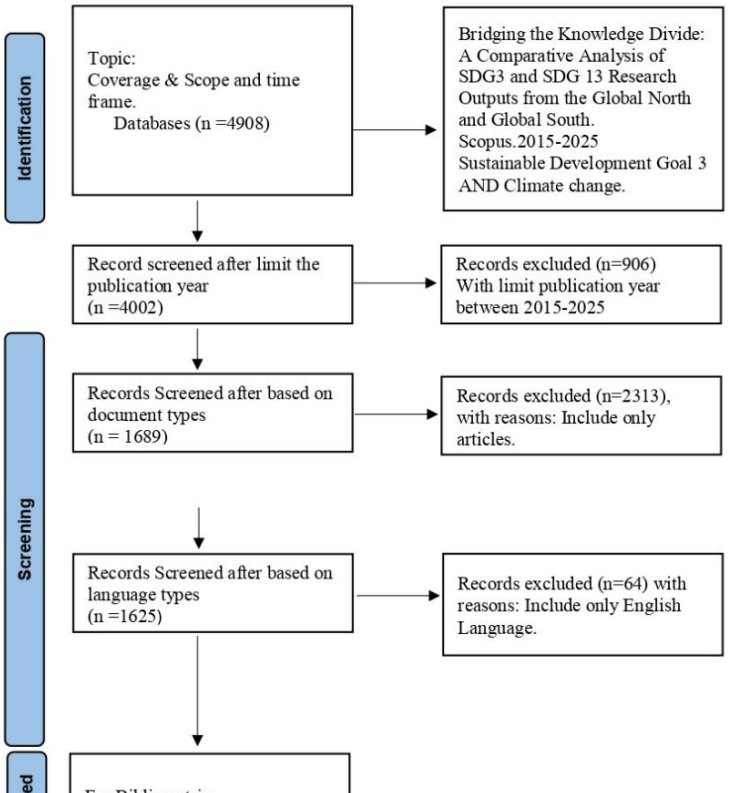

Figure 1. Source: (Page et al., 2021)

C. Results and discussion

The Co-authorship Network on Health and Climate Research illustrates patterns of scientific collaboration among researchers examining the relationship between health issues and climate change. This network highlights how cross-disciplinary collaboration such as between public health, environmental science, and policy studies plays a crucial role in enhancing research quality and impact. Co-authorship analysis reveals key actors, dominant institutions, and levels of global connectivity that reflect the intensity of scholarly cooperation. Through this network, it is evident that health and climate research is increasingly multidisciplinary and international, enabling more comprehensive findings to support evidence-based policymaking.

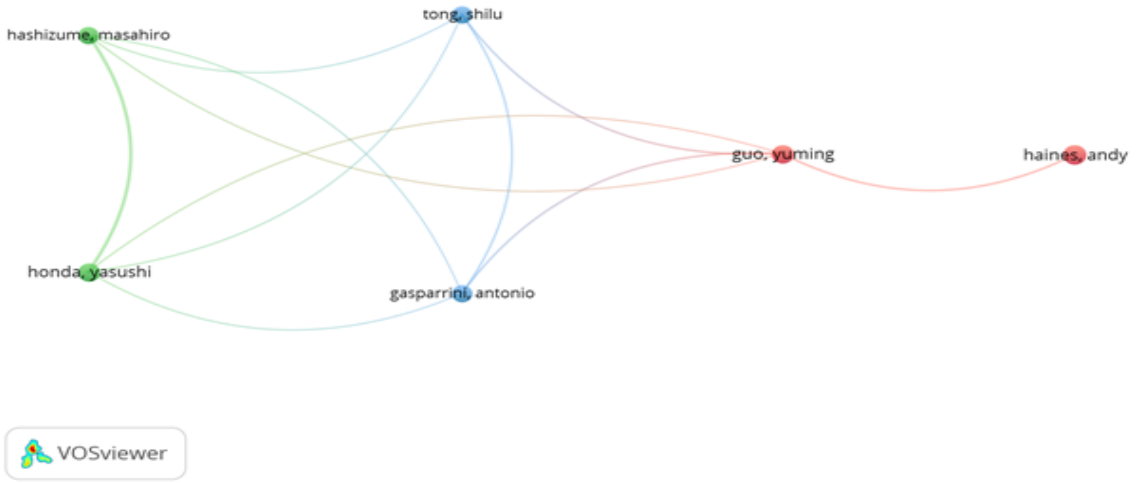

Figure 2. Co-authorship network

Figure 2 illustrates a concentrated co-authorship network at the convergence of SDG 3 (Good Health and Well-being) and SDG 13 (Climate Action), organized around three principal author clusters that jointly influence the production, diffusion, and pedagogical integration of climate–health information. These clusters represent distinct yet complementary educational functions: regional applied learning, methodological capacity enhancement, and policy-focused leadership, highlighting the pivotal role of academic networks in promoting climate-health education and SDG literacy. The initial cluster emphasizes regionally focused research on climate-related health concerns, specifically heat stress and air pollution in highly populated areas. This pattern corroborates previous studies indicating that place-based evidence enhances professional training, public health

education, and contextually pertinent adaption measures (de Assumpção & Neto, 2020; Rocha et al., 2022). This research directly enhances practical learning and institutional capacity building within national education and health systems by informing early warning systems and climate-sensitive surveillance instruments (Abera, 2023; Hanemann & Robinson, 2022).

The second cluster signifies methodological leadership in climate–health epidemiology, characterized by the integration of standardized analytical frameworks in postgraduate education and interdisciplinary programs. This concentration of methodological knowledge enhances higher education's function in standardizing research procedures and disseminating sustainability capabilities across institutions, in alignment with previous studies on Education for Sustainable Development and institutional learning systems (Kioupi & Voulvoulis, 2020; UNESCO, 2021).

The third cluster occupies a knowledge translation and leadership role, linking empirical research to global policy and educational agendas. Its strong international connectivity illustrates how academic leadership shapes curriculum priorities, executive education, and interdisciplinary teaching on planetary health and sustainable development (Leithwood et al., 2020; Torres, 2022). This cluster exemplifies the function of educational leaders as boundary spanners who align institutional strategies with integrated SDG objectives (Allen et al., 2023).

Taken together, the network confirms persistent fragmentation between health, climate, and education domains, despite their conceptual interdependence(Breuer et al., 2023; Henderson & Loreau, 2023). The dominance of high-income country institutions further reflects documented regional inequalities in SDG knowledge production (Faraji et al., 2022; Sweileh, 2020). These findings reinforce the need for educational policies and leadership strategies that deliberately integrate climate and health literacy across curricula, supervision systems, and professional training to strengthen educational capacity, strategic leadership, and overall SDG literacy (Elsayed et al., 2025; Robles-Moral, 2021).

Author Co-citation Analysis in Health-Climate Research

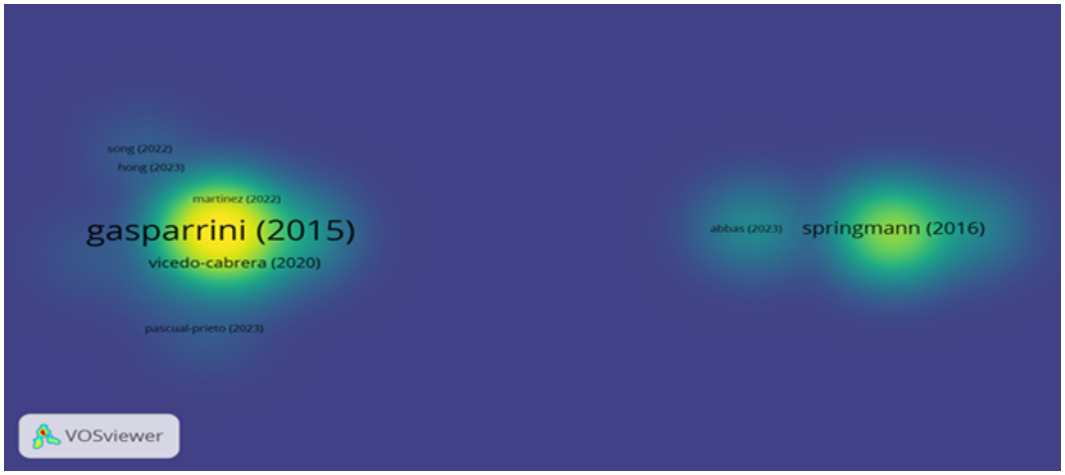

Figure 3. Author co-citation network

Citation Network, Educational Knowledge Domains, and Implications for SDG Literacy

Figure 3 illustrates two predominant knowledge clusters influencing research at the nexus of climate change and health, with significant ramifications for climate–health education, educational capacity enhancement, and SDG literacy. These clusters signify complementary educational domains: methodological training and systems-oriented transdisciplinary education. The initial cluster, focused on climate epidemiology and sophisticated modeling, signifies the establishment of unified analytical frameworks that currently support postgraduate education and doctorate mentorship in climate-health research. The prevalence of standardized methodologies and their recent incorporation with spatial analysis and machine learning indicate the advancement of technical skills necessary to tackle intricate, climate-related health threats. This pattern underscores the significance of higher education institutions as pivotal venues for methodological capacity enhancement and the dissemination of climate-health literacy, along with previous studies on Education for Sustainable Development and institutional learning frameworks (Kioupi & Voulvoulis, 2020; Price et al., 2024; UNESCO, 2021).

The second cluster, centered on planetary health, food systems, and sustainability transitions, embodies a systems-oriented knowledge area that amalgamates climate mitigation, nutrition, and public health. This cluster supports multidisciplinary curriculum and sustainability education, coinciding with demands for integrated SDG implementation that crosses disciplinary boundaries and connects scientific evidence to societal change (Breuer et al., 2023; de Assumpção & Neto, 2020; Henderson & Loreau, 2023).
All these clusters demonstrate the strengths and weaknesses of the existing climate–health knowledge ecosystem. Although they exhibit intellectual consistency and pedagogical depth, they also reveal ongoing fragmentation between technical research and overarching educational governance and leadership processes (Allen et al., 2023; Marín-González et al., 2022). Bridging this gap necessitates strategic educational leadership and policy frameworks that intentionally incorporate climate and health capabilities throughout curricula, supervision, and professional development, thereby enhancing institutional capacity and promoting complete SDG literacy (Elsayed et al., 2025; Leithwood et al., 2020; Torres, 2022).

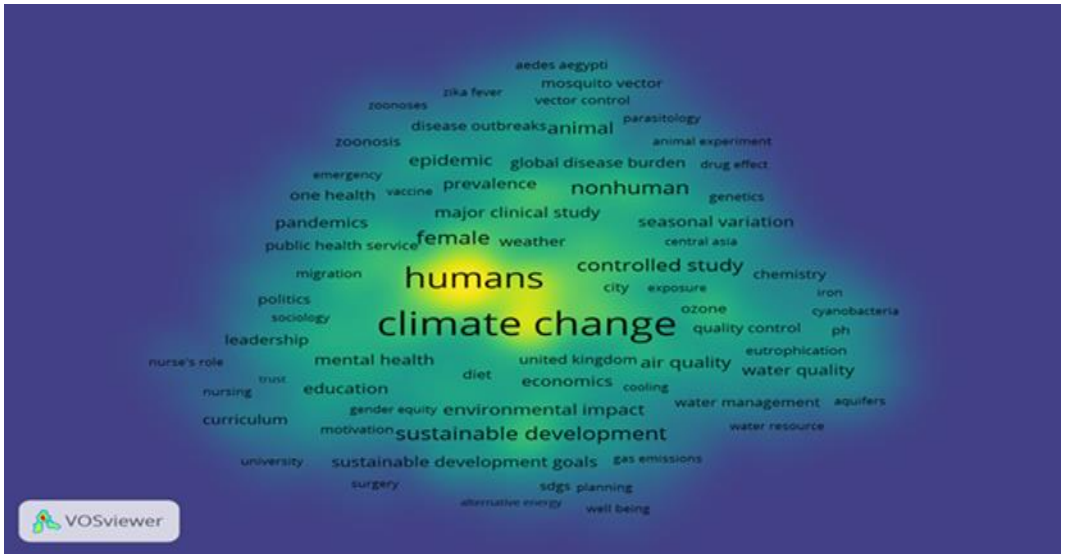

Figure 4. Co-occurrence Map of Keywords

Keyword Co-occurrence Structure and Implications for Climate–Health Education

Figure 4 delineates four interrelated keyword clusters that organize research at the convergence of SDG 3 (Good Health and Well-being) and SDG 13 (Climate Action), illustrating separate yet intertwined realms of knowledge within climate–health studies. Collectively, these clusters elucidate the organization of climate-health education and capacity building, as well as the areas where integration deficiencies remain. The initial cluster signifies the fundamental climate–health connection, highlighting epidemiological insights about climate change, illness burden, mental health, and One Health frameworks. This area supports fundamental education in public and environmental health, emphasizing the importance of surveillance, risk assessment, and evidence-based decision-making for the resilience of health systems (Henderson & Loreau, 2023; Rocha et al., 2022; Romanello et al., 2021).

The second cluster pertains to a technical education sector centered on environmental quality, exposure assessment, and monitoring. The focus on air and water quality and ecosystem degradation underscores the significance of scientific and laboratory-based training in connecting climate dynamics to health effects, in alignment with Education for Sustainable Development literature (Hanemann & Robinson, 2022; Hays & Reinders, 2020). Also, cluster emphasizes education, leadership, and socioeconomic governance, highlighting the importance of curriculum design, professional training, and institutional leadership in converting climate–health evidence into policy and practice. This corresponds with research highlighting leadership capacity and governance literacy as essential facilitators of integrated SDG implementation (Kwan, 2020; Leithwood et al., 2020; Torres, 2022).

This cluster focuses on strategic planning and the implementation of Sustainable Development Goals (SDGs), facilitating policy-oriented learning in public administration and executive education. The emphasis on planning and well-being underscores the necessity for systems thinking and cross-sectoral coordination in promoting SDG coherence (Breuer et al., 2023; UNESCO, 2021). The data suggest that climate-health education is allocated across interconnected yet distinct areas. In alignment with previous

studies, successful SDG literacy necessitates enhanced curriculum integration encompassing epidemiology training, technical skills, leadership development, and policy education, underpinned by cohesive educational policy and strategic leadership (de Assumpção & Neto, 2020; Elsayed et al., 2025).

Figure 5. Institutional co-authorship network

Figure 5 depicts a disjointed institutional collaboration network in research at the convergence of Sustainable Development Goal 3 (Good Health and Well-being) and Sustainable Development Goal 13 (Climate Action). The prevalence of isolated or poorly connected institutional nodes signifies restricted cross-institutional and international collaboration, implying that climate–health knowledge production, research training, and educational capacity development remain confined to individual institutions. This pattern aligns with previous bibliometric findings indicating uneven collaboration and the concentration of SDG-related research among a limited number of well-funded universities (Faraji et al., 2022; Qi et al., 2022; Sweileh, 2020).

From an educational standpoint, this dispersion hinders the dissemination of sustainable capabilities and SDG literacy. Education for Sustainable Development prioritizes integrative learning and inter-institutional information exchange as essential components for enhancing climate and health capability (Abera, 2023; UNESCO, 2021). The weakly connected network observed here reinforces earlier findings that education systems struggle to operationalize the integrative role required to align SDG 3 and SDG 13 in practice (Kioupi & Voulvoulis, 2020).

Prominent organizations such as the Institute for Global Health at University College London, the World Health Organization, and the Institute for Health Metrics and Evaluation appear as significant but predominantly isolated entities. Their responsibilities signify distinct contributions to research excellence, policy direction, and methodological leadership, respectively. Nevertheless, restricted collaborative integration indicates that educational impact is frequently achieved via internal training initiatives, data distribution, and policy direction rather than co-developed curricula, shared oversight, or enduring academic collaborations(Qi et al., 2022; Sweileh, 2020).

Likewise, regional institutions like the University of the Chinese Academy of Sciences and the University of Sydney exhibit substantial national or regional capabilities but exhibit limited transcontinental integration, thereby perpetuating patterns of geographically constrained knowledge production and disparate educational capacities among regions (Faraji et al., 2022; Zhao et al., 2022). The results suggest that enhancing climate and health education necessitates improved institutional coordination, leadership-oriented collaboration, and cohesive curricular governance. Strategic educational leadership and inter-university collaborations are crucial for transforming climate-health research into equitable educational capacity development, cohesive policy creation, and improved SDG literacy, especially in Global South settings (Chankseliani & McCowan, 2021; Leithwood et al., 2020).

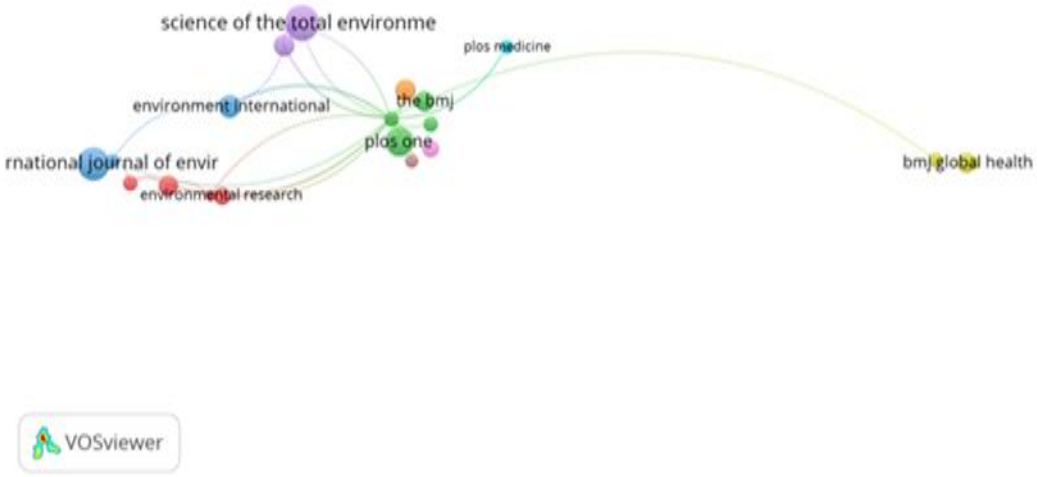

Figure 6. Journal co-citation network

Figure 6 illustrates that climate–health research is communicated through diverse but interconnected journal clusters that serve as primary educational knowledge conduits within the SDG 3–SDG 13 research framework. Environmental science publications, such as Science of the Total Environment, Environmental International, Environmental Research, and IJERPH, furnish the empirical foundation for climate–health education through the provision of exposure research, environmental monitoring, and risk modeling evidence. This pattern aligns with previous studies highlighting that a strong scientific foundation is crucial for analytical proficiency and methodological precision in sustainability and environmental health education (Hanemann & Robinson, 2022; Rocha et al., 2022; Romanello et al., 2021).

Public and global health journals, including BMJ Global Health, The BMJ, PLOS Medicine, and PLOS ONE, represent a complementary stream of translational and policy-oriented knowledge. These institutions influence medical education, public health training, and SDG-focused learning by connecting environmental exposures to health system efficacy, equity, and population welfare. Their pivotal role illustrates how education converts scientific facts into policy-relevant information, essential for comprehensive SDG literacy and successful implementation (Breuer et al., 2023; Henderson & Loreau, 2023). PLOS ONE and The BMJ serve as pivotal journals that promote interdisciplinary integration by linking

environmental research with clinical and population health viewpoints. This integrative function facilitates problem-based pedagogy, interdisciplinary curriculum, and systems thinking, which are recognized as fundamental elements of Education for Sustainable Development (de Assumpção & Neto, 2020; UNESCO, 2021).

The co-citation structure reveals that climate–health education presently relies on parallel scientific and policy-oriented information streams that are only partially connected. In accordance with previous research on SDG governance and education, enhancing educational capacity and SDG literacy necessitates strategic leadership, cohesive educational management, and policy frameworks that intentionally integrate environmental science, public health, and interdisciplinary pedagogy within cohesive learning pathways (Allen et al., 2023; Elsayed et al., 2025; Marín-González et al., 2022).

Country Collaboration Network in Health-Climate Research

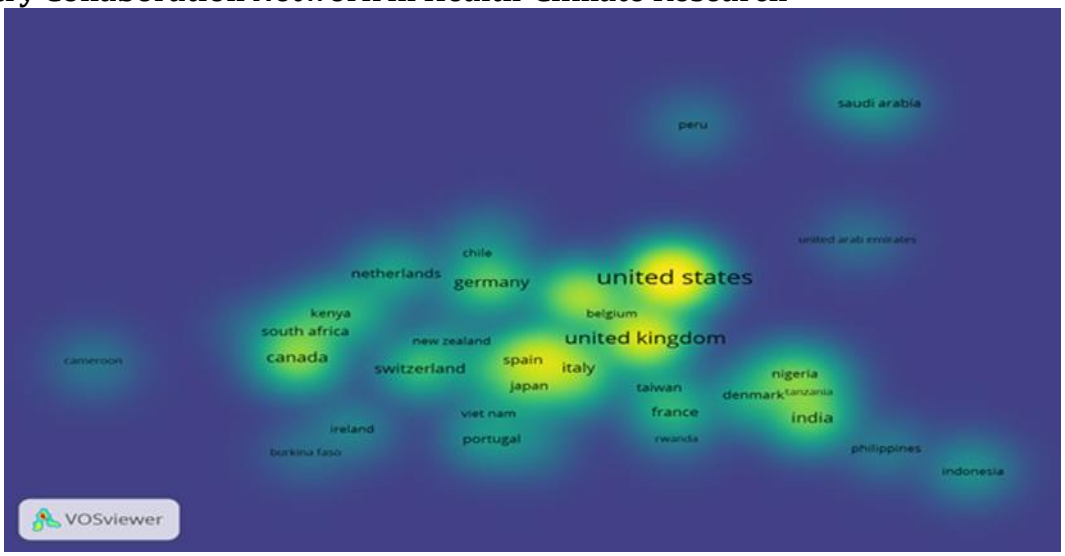

Figure 7. Country collaboration network

Geographic Distribution of Research and Educational Capacity

Figure 7 illustrates significant geographic variations in climate–health research output and collaboration, reflecting inequalities in educational resources, institutional leadership, and access to advanced training facilities. The United States and the United Kingdom serve as primary centers, indicative of their aggregation of research-intensive institutions, global health institutes, and robust PhD training frameworks. These countries serve as global knowledge exporters, establishing methodological standards and curriculum in climate-health education, in alignment with evidence connecting SDG-related knowledge creation to enhanced higher education capacity and research funding (Allen et al., 2023; Breuer et al., 2023).

The secondary group of European nations gains advantages from synchronized public health education systems and EU-funded collaborations that facilitate cross-border PhD training and collective curriculum creation. This regional integration enhances methodological consistency and promotes policy-driven learning, demonstrating how interconnected educational institutions institutionalize sustainability education and bolster capacity development (Marín-González et al., 2022; UNESCO, 2021). The increasing involvement of nations such as India, Japan, Taiwan, Indonesia, and the Philippines in the Asia–Pacific area signifies the advancement of higher education and public health training

concerning climate-sensitive health concerns. India's growing significance underscores the incorporation of climate vulnerability and equity factors into global Sustainable Development Goal (SDG) knowledge, in accordance with demands for context-specific climate-health education (Okereke et al., 2021; Rocha et al., 2022).

In contrast, sub-Saharan Africa remains marginal despite incremental growth, indicating restricted access to global research training networks rather than a deficiency in relevance or skill. This pattern highlights the established underrepresentation of the Global South in climate-health scholarship and emphasizes the influence of educational systems and leadership capacity on involvement in SDG knowledge networks (Chankseliani & McCowan, 2021; Faraji et al., 2022; Sweileh, 2020). The results demonstrate that enhancing SDG literacy necessitates more than merely augmenting research output. Strategic educational leadership, curriculum integration, and enduring cross-regional training collaborations are vital for enhancing inclusive educational capacity and converting climate-health research into cohesive learning paths that facilitate integrated advancement towards SDG 3 and SDG 13 (de Assumpção & Neto, 2020; Elsayed et al., 2025; Hanemann & Robinson, 2022).

D. Conclusions

This study's findings highlight the crucial importance of educational leadership and supervision in promoting climate-health education and enhancing Sustainable Development Goal (SDG) literacy. The concentration of climate-health information within a restricted number of epistemic communities indicates that leaders must proactively manage the translation of global research into inclusive curricula and professional learning practices. Strategic educational leadership is crucial for integrating climate and health concerns into institutional vision, curriculum frameworks, and resource allocation, rather than considering them as ancillary projects. Educational supervision serves as a crucial instrument for converting policy and curriculum objectives into effective practices at the classroom and program levels. Supervisors influence curricular fidelity, pedagogical excellence, and assessment coherence, guaranteeing that climate–health competencies are substantively cultivated rather than only nominally embraced. By utilizing reflective supervision and focused professional development, supervisors can facilitate problem-oriented, context-specific teaching methods that link scientific findings to local climate and health issues.

The research emphasizes leadership and supervision as essential mechanisms for mitigating disparities in educational competence among institutions and regions. Leaders and supervisors must cultivate cross-institutional relationships, mentoring programs, and collaborative learning networks that enhance access to climate-health knowledge and research training. By integrating systems thinking, policy literacy, and evidence-to-action competencies into teaching and assessment, educational leaders and supervisors are pivotal in promoting comprehensive SDG literacy. Enhancing leadership and supervisory capabilities is crucial for maintaining climate-health education and facilitating synchronized advancement towards SDG 3 and SDG 13.

This study's findings underscore the necessity for educational systems to progress beyond superficial or disjointed approaches to climate and health challenges, advocating for the comprehensive incorporation of climate–health competences throughout curriculum. Educational institutions, including schools, universities, and teacher training programs, ought to integrate climate literacy, health literacy, systems thinking, and risk awareness into core curricula through problem-based and multidisciplinary pedagogies that relate scientific knowledge to local contexts. The findings emphasize the need of capacity enhancement via ongoing professional development. Educators, academic personnel, and supervisors necessitate continuous training and organized support to properly execute climate-health education, hence rendering enhanced supervision and mentorship systems crucial for maintaining curriculum fidelity and pedagogical excellence.

Education authorities should implement clear climate-health education frameworks that align with SDG 3 and SDG 13 to direct curricular standards, learning outcomes, and assessment methods. Policies that promote multidisciplinary programs, cross-institutional collaboration, and North–South and South–South training collaborations are essential for mitigating disparities in educational ability. The study underscores that strategic educational leadership is crucial for institutionalizing climate-health education and enhancing SDG literacy. Leadership development, curriculum governance, and evidence-based decision-making should be prioritized in education policy to ensure that education systems significantly contribute to sustainable development and long-term social resilience.

This study's findings identify key areas for enhancing Sustainable Development Goal (SDG) literacy, especially at the convergence of SDG 3 (Good Health and Well-being) and SDG 13 (Climate Action). First and foremost, SDG literacy must be integrated as a fundamental educational capacity throughout all educational tiers, with a specific focus on systems thinking, the interconnections between climate and health, and the translation of knowledge into policy. Incorporating SDG-related education across several disciplines through problem-based and context-sensitive teaching methods is crucial for developing a comprehensive awareness of sustainability issues. Secondly, proficient SDG literacy necessitates robust educational leadership and oversight to guarantee alignment across curriculum development, instructional methods, and evaluation. Leadership development and professional training must encompass sustainability governance, policy literacy, and change-management competencies to facilitate substantive implementation rather than mere symbolic adoption.

Third, mitigating global disparities in SDG literacy requires inclusive capacity building methods, encompassing cross-institutional collaboration, collaborative supervision, and North–South and South–South learning networks that enhance access to climate–health information and training. Future research should look at empirical research evaluating learning outcomes, pedagogical efficacy, and the influence of leadership and supervision in the integration of SDGs would yield significant evidence for policy and curriculum reform. Comparative and longitudinal studies in Global North and Global South contexts are essential to evaluate the enduring effects of educational interventions on SDG literacy, leadership capability, and sustainability-focused decision-making.

E. Acknowledgement

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