# Exploring global dynamics of sustainable environmental sciences in climate change mitigation for sustainable development

*Hasan Nuurul* Hidaayatullaah[1], *Eko* Hariyono[2*], *Deni* Hadiana[3], *Hiroki* Fujii[4], *Muhammad* Satriawan[2]

[1]Postgraduate Science Education Program, Universitas Negeri Surabaya, 60231 East Java, Indonesia
[2]Physics Education Program, Universitas Negeri Surabaya, 60231 East Java, Indonesia
[3]Education Research Center Program, National Research and Innovation Agency, Indonesia
[4]Faculty of Education, Okayama University 3-1-1 Tsushima-naka, Kita-ku Okayama 700-8530 Japan

**Abstract.** Sustainable Environmental Sciences (SES) and climate change have emerged as relatively new subjects in sustainability that have garnered increasing attention from academics in recent years. This study aims to delve deeper into the implications of SES in climate change mitigation to support the achievement of Sustainable Development Goals (SDGs). A systematic review method combined with bibliometric analysis was employed to comprehensively uncover the evolution of scientific studies. Data utilized encompassed publications from 2019 to 2023 sourced from three databases: Dimensions, Lens, and Scopus. Findings reveal a significant increase in research on SES over the past five years. The most prolific authors in SES research were identified as Horton, R.C. in the Dimensions database, Ciais, P. in the Lens database, and Meena, R.S. in the Scopus database. The United States and China emerged as the countries with the highest contributions to SES research. The most significant contributions from SES and Climate Change research to SDGs in the past five years were observed in SDG-13, SDG-7, and SDG-15 indicators. This study highlights the emerging domain of SES and its crucial involvement in mitigating climate change, emphasizing its essential role in advancing SDGs.

## 1 Introduction

The imperative to address global environmental challenges has become increasingly urgent in recent years. With escalating concerns over climate change and the imperative to achieve Sustainable Development Goals (SDGs), understanding the intricate dynamics of Sustainable Environmental Sciences (SES) has garnered significant attention [1–3]. SES is an interdisciplinary field that focuses on the interaction between humans and the environment, with a special emphasis on sustainability[4, 5]. It involves the study of environmental science, ecology [6], climate science [7], geology [8], economics [9], politics [10], and social factors that drive human impacts on the planet. The goal of sustainability is to maintain the Earth's

* Corresponding author: ekohariyono@unesa.ac.id

natural capital, which is made up of the natural resources and ecosystem services that sustain life on Earth [11, 12].

The implications of SES for the SDGs and climate change mitigation are significant [13], [14]. Climate change mitigation measures, such as reducing CO2 emissions from land use and non-CO2 emissions from agriculture, livestock, and waste, are critical for achieving the SDGs, particularly SDG 13, which aims to combat climate change and its impacts [15–17] These measures also affect other SDGs, including energy security, air quality, human health, land management, food security, water scarcity, and biodiversity. Education also plays a crucial role in achieving SDG-13 [18–22], as improved Climate Change Education (CCE) raises awareness and promotes mechanisms for effective climate change-related planning [23, 24]. Therefore, integrating environmental sustainability into the SDGs is essential for addressing climate change and achieving sustainable development [25, 26].

This study aims to delve deeper into the implications of SES in climate change mitigation to support the achievement of SDGs in education. By engaging stakeholders in the field of education, this research also seeks to compare emerging research trends related to SES and climate change through three databases: Dimensions, Lens, and Scopus. The novelty of this research lies in its exploration of global dynamics within sustainable environmental sciences, offering insights into their implications for achieving Sustainable Development Goals (SDGs) and mitigating climate change. It is hoped that this study will provide valuable insights into the concrete development of research related to SES implications in climate change mitigation that can support the achievement of SDGs and have a positive impact on providing quality education.

## 2 Methodology

This research employs a systematic review approach combined with bibliometric analysis to comprehensively unveil the evolution of scientific studies. The integration of these methods provides quantitative understanding through bibliometric analysis while also offering qualitative insights through a systematic review of the topic and content under investigation [27–29]. Bibliometric analysis is a scientific method utilized for exploring and analysing large volumes of scientific data [30–32]. It serves to identify core research areas, authors, and their relationships, as well as to track the evolution of research priorities [31, 33].

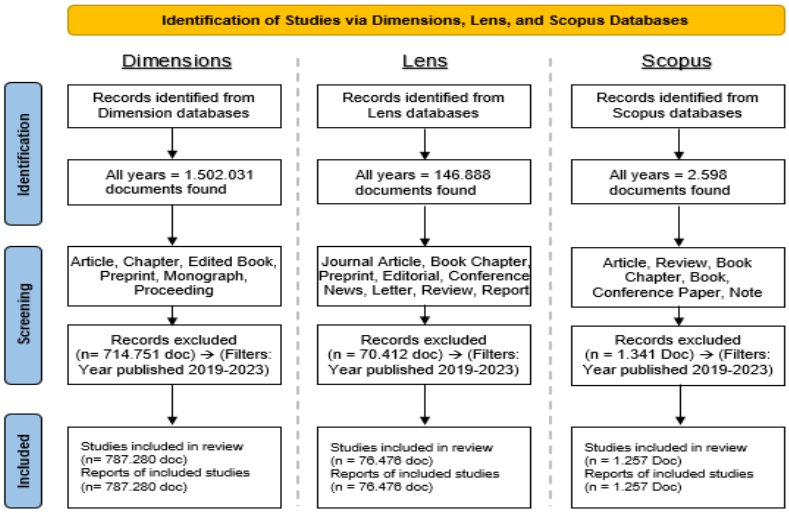



**Fig. 1.** Flowchart of research

Additionally, this study employs a systematic review method following the PRISMA guidelines for literature search. Evaluation of these articles is conducted to ensure they meet the desired characteristics outlined by the researchers (**Fig 1**). The metadata search was conducted online in February 2024 through the Dimension, Lens, and Scopus databases. The keywords used in searching for data in the three databases are the same "sustainable AND environmental AND science AND climate AND change". The data was then exported in (.csv) formats. After downloading, the data is processed through Ms. Excel and VOSviewer to produce graphs and tables that provide visualization of research patterns [34]. The exploration of global dynamics not only highlights the impact and contribution of scientific work to the development of SES in the field but also explains its impact and contribution to the advancement of science in the field.

# 3 Results and Discussions

## 3.1 Trends publication in SES over the last 5 years

Based on data filtering and analysis through Dimensions, Lens, and Scopus metadata, the research trend on SES in all research fields is presented in Table 1. It can be seen that the trend of research on SES has increased significantly. Publications on SES implications in climate change mitigation have consistently increased, reflecting the important growth and development of this field as a significant research topic.

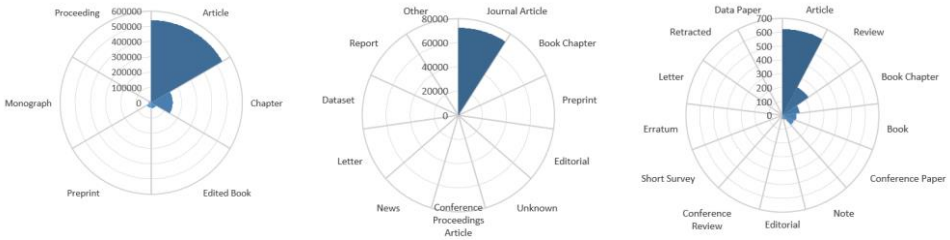
**Table 1.** Number of Publications Using SES Research in the Last 5 Years

| Year Publications | Dimensions | Lens | Scopus |
|---|---|---|---|
| 2023 | 198.368 | 21.987 | 314 |
| 2022 | 187.193 | 18.791 | 307 |
| 2021 | 164.685 | 16.275 | 237 |
| 2020 | 132.575 | 11.457 | 215 |
| 2019 | 104.459 | 8.972 | 131 |

Over the last five years (2019-2023), there has been a significant increase in the number of publications and coverage of SES research on its implications for climate change, with the number of publications increasing from 104,459 in 2019 to 198,368 in 2023. Likewise, the Lens and Scopus databases experienced a significant increase. The surge in publications in the SES field, as evidenced by databases such as Dimensions, Lens, and Scopus, reflects a growing global awareness of environmental issues and the urgency to find sustainable solutions. This increase in research output underscores the interdisciplinary nature of environmental science, which attracts contributions from a wide range of fields. SES-related research trends continue to increase as global awareness of the importance of environmental conservation grows, such as research on sustainable waste management [35], climate change adaptation [36], and renewable energy development [37].

**Fig. 2** illustrates the distribution of publications in Sustainable Environmental Sciences (SES) based on document types. Articles emerge as the most dominant document type across all three databases. In Dimensions, besides articles, chapters also constitute a significant portion of SES-related research documents. Conversely, in Scopus, the distribution of SES research over the past 5 years ranks document types from second to fifth as Review, Book Chapter, Book, Conference Paper, and Note, respectively. The presence of various document types signifies the diversity of research approaches and publication avenues within SES and Climate Change studies. This diversity reflects the multifaceted nature of the field, encompassing not only traditional scholarly articles but also contributions from reviews,

chapters, books, conference papers, and notes, indicating a rich tapestry of perspectives and methodologies employed in addressing sustainability and climate change challenges.




(a) Dimensions Database (b) Lens Database (c) Scopus Database

**Fig. 2.** Types of Document Distribution in SES Research Over the Last 5 Years

## 3.2 Authors and Sources & Countries in SES over the last 5 years

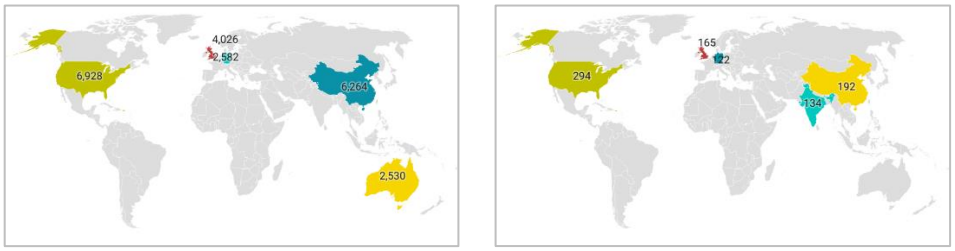
The metadata results from all three databases can indicate the authors involved in research on the implications of SES in mitigating climate change over the past 5 years. Information regarding the Top 5 Authors who have contributed the most and the Sources most frequently utilized in SES-related research is presented in Table 2.

**Table 2.** Top 5 Authors and Sources Distribution in SES Research Over the Last 5 Years

| **Author** | | | | | |
|---|---|---|---|---|---|
| **Dimension** | **Freq** | **Lens** | **Freq** | **Scopus** | **Freq** |
| Horton, Richard C. | 336 | Ciais, Philippe | 112 | Meena, R.S. | 9 |
| Sahni, Peyush | 329 | Kumar, Pankaj | 63 | Jhariya, M.K. | 5 |
| Laurie L.L. | 321 | Filho, W.L. | 61 | Dhyani, Shalini | 5 |
| Benfield, T.L. | 312 | Smith, Pete | 55 | De Andrade Guerra, J.B.S.O. | 3 |
| Hancocks, Stephen | 311 | Zhang, Wei | 43 | Webb, P. | 3 |
| **Sources** | | | | | |
| Sustainability | 23.717 | Environmental science and pollution research international | 4.654 | Sustainability Switzerland | 71 |
| SSRN Electronic Journal | 11.231 | Scientific reports | 2.115 | Nature | 25 |
| Research Square | 10.603 | Environmental Research Letters | 1.780 | Science of The Total Environment | 24 |
| Journal of Cleaner Production | 9.136 | Journal of Cleaner Production | 1.632 | Environmental Science and Pollution Research | 20 |
| The Science of The Total Environment | 8.736 | Environment, Development and Sustainability | 1.600 | IOP Conference Series Earth and Environmental Science | 16 |

The top author in the Dimensions database regarding SES research is Richard C. Horton (Scopus ID: 26643541300) with an h-index of 62. This author from London, United

Kingdom, focuses on research topics related to the integrated assessment model; Carbon and global temperature increase. Philippe Ciais (Scopus ID: 55399842300) has emerged as the foremost contributing author in SES research over the last 5 years. Hailing from Gif-sur-Yvette, France, Ciais boasts an h-index of 178, delving into research topics such as carbon dioxide and atmospheric Inversion. Meanwhile, the top author in SES research according to the Scopus database is Meena, Ram Swaroop (Scopus ID: 54583928000) with an h-index of 41. The most researched topics under Meena's purview include soil organic carbon; Carbon sinks; and greenhouse gas emissions.



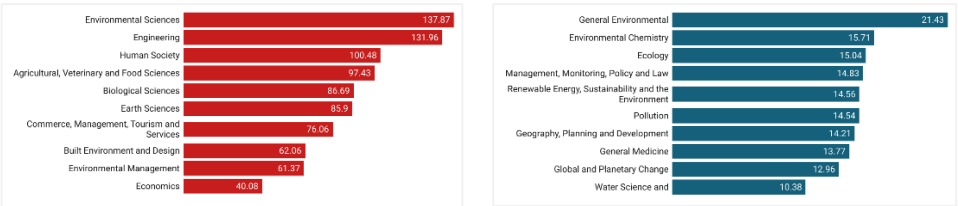

(a) Lens Database (b) Scopus Database

**Fig. 3.** Types of Document Distribution in SES Research Over the Last 5 Years

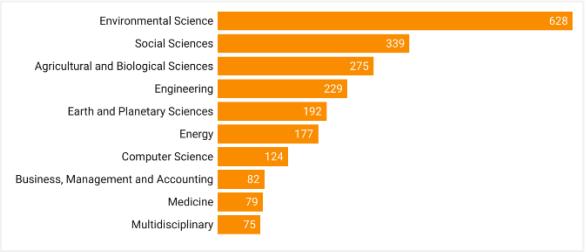
**Fig. 3** shows the countries that contributed most significantly to SES and Climate Change research aligned with their contribution to the SDGs. According to Scopus, the leading countries in SES research over the past five years are the United States, China, the United Kingdom, India, and Germany, while the Lens database reveals the prominent roles of the United States, China, the United Kingdom, and Australia, with India ranked sixth. The differences between the two databases may arise from variations in coverage, inclusion criteria, and attribution methodology. Despite these differences, the consistent presence of countries such as the United States, China, the United Kingdom, and India underscores their important role in advancing research efforts in the field of SES and Climate Change, emphasizing the global collaborative nature of environmental research efforts.

## 3.3 Subject Area and Sustainable Development Goals in SES Research over the last 5 years

Subject areas related to SES research in the past five years are presented in **Fig. 4**. The Dimensions database highlights Environmental Sciences, Engineering, and Human Society as the top three subject areas, while Lens emphasizes General Environmental, Environmental Chemistry, and Ecology. In contrast, the Scopus database indicates Environmental Science, Social Sciences, and Agricultural and Biological Sciences as the primary subject areas in SES research. These variations likely stem from differences in database categorization schemes and disciplinary focus. Nevertheless, Environmental Sciences consistently emerge as a central focus across all databases, highlighting the interdisciplinary nature of SES research.




(a) Dimensions Database (b) Lens Database




(c) Scopus Database

**Fig. 4.** Subject Area in SES Research Over the Last 5 Years

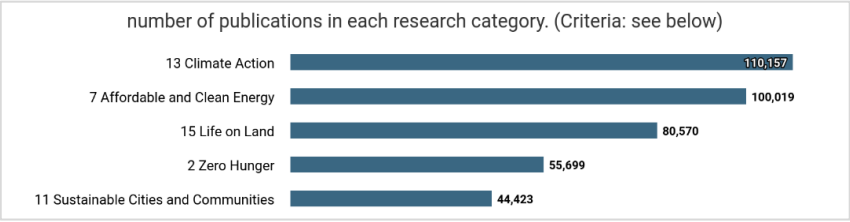
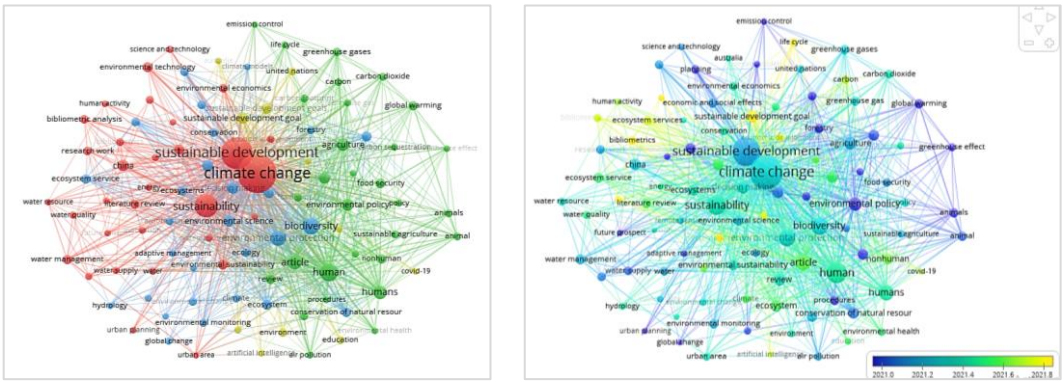



**Fig. 5.** Top 5 Sustainable Development Goals in SES Research Over the Last 5 Years

**Fig. 5** illustrates the implications of SES and climate change research subject areas on the SDGs. The contributions of SES and climate change research over the past five years towards the SDGs are most pronounced in indicator 13, climate action. Following closely is SDGs-7, affordable and clean energy, occupying the second position. The third to fifth rankings, in descending order of significance, are attributed to SDGs-15, life on land; SDGs-2, zero hunger; and SDGs-11, sustainable cities and communities. This distribution highlights the crucial role of SES research in addressing key environmental and societal challenges outlined in the SDGs. Notably, the emphasis on climate action underscores the urgency of mitigating climate change impacts, while affordable and clean energy reflects the importance of transitioning towards sustainable energy sources [38]. Additionally, the inclusion of indicators related to biodiversity conservation, food security, and urban sustainability underscores the interdisciplinary nature of SES research and its potential to contribute to a wide range of sustainable development objectives. Overall, these findings emphasize the need for continued investment and collaboration in SES and climate change research to achieve the SDGs and foster a more sustainable future.

## 3.4 Mapping the Evolution & Top 10 Papers of SES Research

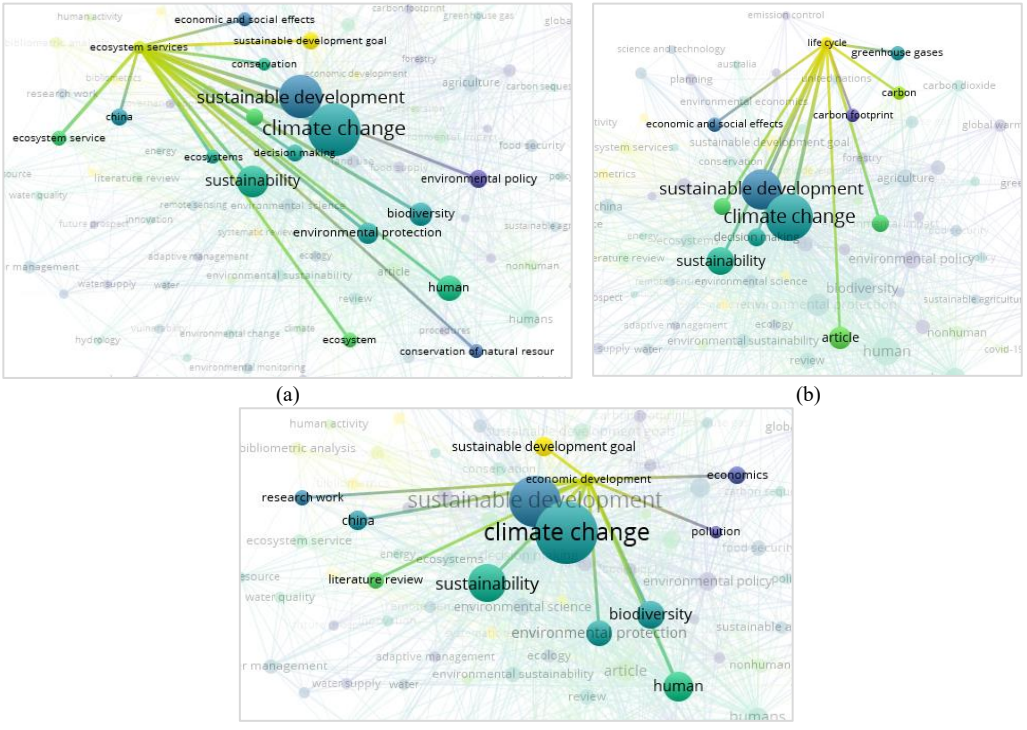
The results of network visualization related to SES and climate change research and its implications for SDGs using bibliometric analysis are presented in **Fig. 6**. There are 4 clusters with 3665 links related to keyword trends in SES research. The first cluster (red color, 32 items) focuses on climate change, sustainable development, environmental sustainability, and human activity. The second cluster (green, 30 items) focuses on humans, global warming, and the greenhouse effect. The third cluster (blue, 28 items) pays attention to the climate model, conservation, ecosystem, and ecology. The last cluster, the fourth (yellow, 11 items), focuses on education, knowledge, deforestation, and policy making.




(a) (b)

**Fig. 6.** Visualization of Keywords Used in SES Research Over the Last 5 Years

Keywords with the largest number of spherical occurrences and the highest strength of association to a topic indicate researchers' interest in that topic [32]. Overlay visualization shows the evolving research trends by year range (**Fig. 6**b). Meanwhile, other clusters show more occurrences of minor keywords [39], indicating a more specific research focus in the sub-topic of SES implications in climate change mitigation. Through this mapping, there are new findings that enrich our understanding of SES research trends in climate change mitigation over the past 5 years. In finding novelty from the mapping results, that is by looking at the relationship between fewer or smaller keys [40]. From the results of the mapping, new and specific aspects can be seen in **Fig. 7**.




(a) (b)

(c)

**Fig. 7.** Detailed Keyword Analysing: a) Ecosystem Services, b) Life Cycle, and c) Sustainable Development Goal

The results of the bibliometric analysis show a close relationship between SES and ecosystem services, life cycle, and economic development. This aligns with prior research emphasizing SES's crucial role in supporting ecosystem services essential for human well-being [41, 42]. This underscores the significance of integrating environmental concerns into economic development efforts. Recognizing the life cycle of products or services is vital for understanding their environmental impact, affirming the necessity of integrating environmental, economic, and social aspects for sustainable development within the SES framework. Strengthening this understanding can enhance the effectiveness of policies and practices in preserving natural resources and the environment for future generations.

**Table 3.** Overview of Highly Cited Papers in SES Publications Over the Last 5 Years

| Author | Sources; Citation | Research Findings and Recommendations |
|---|---|---|
| Roth, Gregory A. et al [43] (Dimensions) | Journal of the American College of Cardiology (Q1); 4500 | This paper reviews the global burden of cardiovascular diseases (CVDs), including ischemic heart disease (IHD) and stroke, using data from the Global Burden of Disease (GBD) Study 2019. It highlights a significant increase in CVD prevalence and mortality rates since 1990, emphasizing the urgent need for cost-effective policies and interventions to address this escalating burden and meet targets set by SDGs 3. |
| Gössling, Stefan et al [44] (Dimensions) | Journal of Sustainable Tourism (Q1); 3000 | The COVID-19 pandemic has led to widespread implementation of nonpharmaceutical interventions to contain the virus, severely disrupting the global economy and tourism industry. With international travel bans affecting over 90% of the world's population, tourism has plummeted, prompting the need to reassess growth models advocated by tourism organizations such as UNWTO, ICAO, CLIA, and WTTC. |
| Willett, Walter et al [45] (Lens) | The Lancet (Q1); 5200 | The study highlights the urgent need for a global transition to healthy diets and sustainable food systems to address food insecurity, malnutrition, and environmental degradation. It emphasizes dietary shifts towards plant-based foods and reduced consumption of unhealthy items like red meat and sugar. These changes could prevent millions of deaths annually and reduce the burden of non-communicable diseases. Sustainable food production practices must also be adapted to operate within planetary boundaries, requiring significant reductions in yield gaps, fertilizer use, water consumption, and greenhouse gas emissions. Strong global partnerships and actions across all sectors are necessary to achieve these targets and ensure a sustainable and equitable food future for all. |
| Reichstein, Markus et al [46] (Lens) | Nature (Q1); 2000 | The study recommends incorporating contextual cues into deep learning frameworks for a better understanding of Earth system science problems. By integrating spatial and temporal context into deep learning models, predictive abilities in seasonal forecasting and modeling long-range spatial connections can be improved. The next step involves adopting a hybrid modeling approach, combining physical process models with data-driven machine learning techniques, to enhance predictive capabilities and gain deeper insights into Earth system dynamics. |
| Dulvy, Nicholas K. et al [47] (Scopus) | Current Biology (Q1); 320 | The global reassessment of Chondrichthyes species by the IUCN Red List reveals a concerning increase in the percentage of threatened species, now at 32.6%. Overfishing emerges as the primary threat, affecting all 391 threatened species, with urgent measures needed to prevent further extinctions and safeguard ecosystem functions. |
| Babaeian, Ebrahim et al [48] (Scopus) | Reviews of Geophysics (Q1); 279 | The review underscores the critical importance of soil moisture (SM) in various Earth and environmental applications, such as weather forecasting, drought monitoring, and agricultural production. Recent advancements in SM measurement techniques have led to significant progress, but further improvements are needed, especially in remote sensing methods, to address challenges in water resource management and environmental sustainability. |

Based on Table 3, these publications provide an important foundation for future research on SES and its implications for climate change mitigation. These publications exhibit highly

favorable features, such as high citation counts, Q1 journal rankings, and the highest citations from each database. The papers cited in these publications also have high SJR values, indicating that the journals receiving citations wield significant influence in the SES discipline and their contributions to climate change in SDGs. In other words, citations from these publications not only originate from diverse sources but also stem from journals considered significant within the scientific community. Journals with high rankings and reputations tend to influence research developments in this field. Thus, these publications not only contribute to the context of research and the application of SES and climate change in their contribution to SDGs but also reflect credibility and strong influence within the academic community. As a result, future research can leverage the findings and methodologies in these publications as a robust basis.

## 4 Conclusion

Based on bibliometric analysis and literature review, this study produced significant findings. The research trend of SES and climate change contribution in SDGs increased significantly in the last 5 years, this will be a challenge for future research and has potential topics for further research. The most published document type is articles from all three databases. The most productive top Authors in SES research are Horton, R.C. in the Dimensions database, Ciais, P. in the Lens database, and Meena, R.S. in the Scopus database. The most relevant sources across all three databases, Dimensions, Lens, and Scopus, respectively, are Sustainability, Environmental Science and Pollution Research International, and Sustainability Switzerland. The United States and China are the countries with the highest contributions to SES research. By subject area, Environmental Science consistently emerges as the main focus across all databases, highlighting the interdisciplinary nature of SES research. The most significant contributions of SES and Climate Change research to SDGs in the last five years are observed in SDG-13, SDG-7, and SDG-15 indicators. The mapping visualization shows that there is a strong relationship between SES and ecosystem services, life cycle, and economic development, which emphasizes the need to integrate environmental concerns into economic development for the preservation of natural resources and a sustainable environment. These findings highlight the importance of continuing to advance research related to SES and climate change in their contribution to the SDGs. Future research is recommended to be more exploratory, particularly in exploring SES and climate change as supporters of sustainable learning. The potential for developing innovative and interactive learning to achieve SDG-oriented education is also a primary focus. This research provides profound insights and contributes to the development of sustainable education strategies in the current era.

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