WATER CONSERVATION AND BUSINESS RESEARCH: THEMES AND GLOBAL COLLABORATION, 1916–2025

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Abstract: *This study utilizes bibliometrics to examine global water conservation and business studies from 1916 to 2025. We investigated 3,083 Scopus publications on water conservation and business. The Bibliometric package in R, Biblioshiny for visualization. Annual publishing growth, significant nations, co-authorship networks, theme changes, and keyword trajectories are examined. The US leads in citations and international collaboration with 22.12% of documents, indicating a consistent increase in scientific production since the early 2000s. Thematic mapping shows established themes like environmental protection and sustainable development alongside underdeveloped but crucial ones like water supply and management. This field is globally as shown by important research in agroecology, hydrology, and environmental economics. Keyword analysis shows that business-related water research is using terms connected to sustainability. Research on scholarly trends and global collaborations over a century informs sustainable business practices and policymakers with evidence-based ideas.*

INTRODUCTION

Over the last century, water conservation has moved from technical solutions like reservoir capacity and irrigation efficiency (Asdak, Yulizar and Subiyanto, 2023) to integrated management strategies involving diverse stakeholders (Mulyanti et al., 2024). At the same time, sustainability has become an important part of how businesses work, and more people are aware of this, thus companies are working to meet environmental goals, such as conserving water (Aslam et al., 2021). Water is becoming increasingly important not just for the environment but also for the economy. This makes it more relevant to sustainable business models that improve both the landscape and business goals (Erskine et al., 2023) (Fuerst, Sanchez-Dominguez and Rodriguez-Montes, 2023).

As water scarcity intensifies globally, the integration of conservation strategies into business operations becomes more critical (Wen, Li and Meseretchanie, 2023). Despite the relevance of this nexus, research on its evolution and collaborative dynamics remains limited. It is possible to use bibliometric research to find out how water conservation and business

practices have changed over time and across different places (Ergashova, Kasymbetova and Matyakubov, 2023). Previous research has identified water recycling and soil-water conservation frameworks in corporate settings (Arias-Navarro et al., 2023) (Chen and Huang, 2024) but lacks in-depth mapping of interdisciplinary interactions. Global research from 1916 to 2025 was analyzed to identify thematic trends and collaborative patterns at the interface of water conservation and business. This study could help policymakers, industry practitioners, and researchers build better water conservation strategies for sustainable business models.

LITERATURE REVIEW

The intersection of water conservation and business research has gained prominence amid increasing global challenges related to water scarcity, climate change, and the need for sustainable development. A crucial theme that emerges from the literature is the role of corporate water stewardship in promoting sustainable business practices. Yu et al. highlight that enhancing corporate water disclosure is vital for improving transparency and fostering responsible water management within firms, as engagement in water stewardship can significantly impact company performance and sustainability efforts (Yu et al., 2020). Similarly, Farooq et al. explore corporate water management disclosures in water-stressed regions, suggesting that these practices not only advance responsible water use but also align corporate actions with broader sustainability goals (Farooq et al., 2025). This coupling of corporate responsibility and water stewardship highlights a shifting paradigm in business practices, where companies are increasingly accountable for their water impact, thus contributing to both social equity and environmental sustainability.

Moreover, the literature demonstrates the importance of adopting cohesive systems approaches across sectors to integrate water management more effectively within business operations. Knai et al. argue for the necessity of forming alliances with various stakeholders, which amplifies the industry's position and creates broader support for water stewardship initiatives (Knai et al., 2021). This perspective resonates with D'Amore et al.'s research on employing artificial intelligence to build holistic business models for water management, underscoring the need for innovative frameworks that engage diverse viewpoints and methodologies from engineering to policy (D'Amore et al., 2022). Such interdisciplinary approaches not only enhance the efficiency of water use in businesses but also foster collaboration, driving collective action towards sustainable development goals a critical requirement for addressing the multifaceted nature of water management challenges.

Finally, the literature evidence indicates that commercial success is increasingly tied to sustainable water practices, implicating a need for rigorous academic inquiry into this critical nexus. For instance, Miguel emphasizes the role of corporate social responsibility (CSR) in ensuring responsible water use, which aligns with financial performance metrics (Miguel, 2024). In the context of emerging markets, while Wyrwoll et al. do discuss the importance of reforms in governance related to water management, their emphasis is more on hydropower and resilience rather than directly linking sustainable water management practices to better business performance, leading to a weaker support for this specific claim (Wyrwoll & Grafton, 2021). Companies must not only comply with water governance standards but also redefine their business strategies to incorporate sustainability as a central

pillar an evolving trend that speaks to the interconnectedness of ecological health, community welfare, and economic viability around water conservation initiatives.

RESEARCH METHOD

Analysis of global water conservation and business publication patterns from 1916 to 2025 is carried out by means of a quantitative bibliometric technique, which makes use of the R Bibliometrix package. An analysis of theme developments, commonly used terms, and keywords across time reveals how the field has progressed (Cobo et al., 2011). The study is based on objective measures to make sure that scholarly material is evaluated in a systematic and consistent way (Derviş, 2020). Scopus is the major database for data collecting since it covers a lot of ground and is well-known for indexing peer-reviewed research, which makes it a good source for bibliometric study (Huang and Yang, 2022).

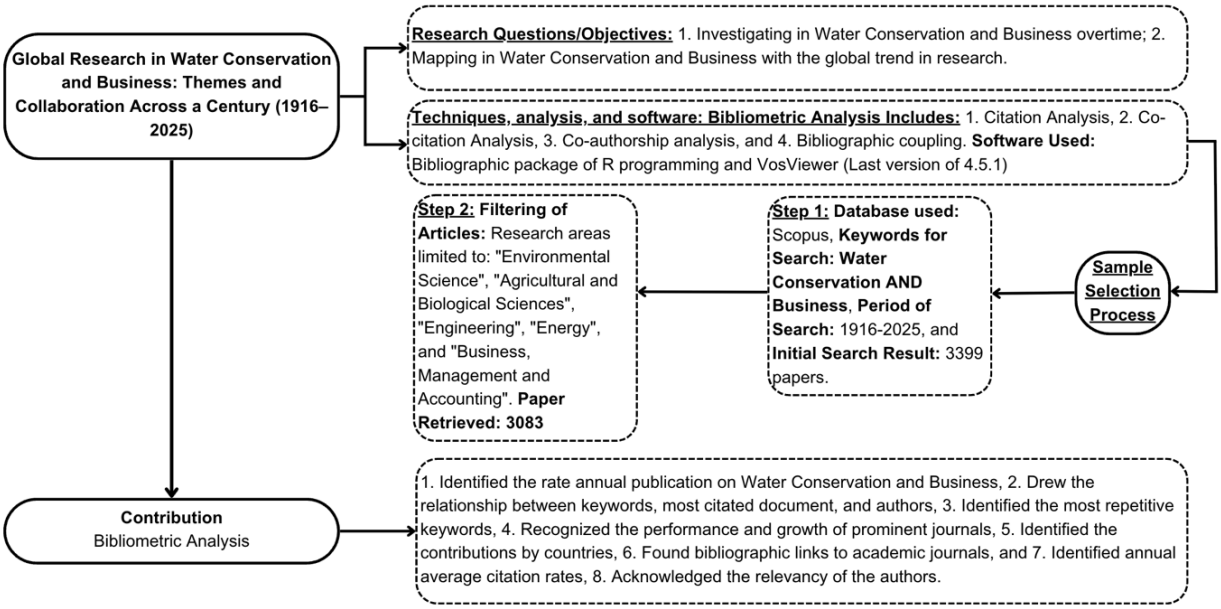

Figure 1. Outline of The Methodology

The Scopus database encompasses a wide array of disciplines, enabling detailed examination of citation trends and emerging research across topics such as Environmental Science, Agricultural and Biological Sciences, Engineering, Energy, Business, Management, and Accounting. This analysis concentrated on publications containing the terms "Water Conservation" and "Business". The CSV data were processed for visualization using R's Biblioshiny interface, and Microsoft Excel was employed for fundamental statistical analysis. Biblioshiny produces the Main Information Table, Annual Scientific Production, Most Cited Countries, Collaboration Network, Thematic Map, Most Globally Cited Documents, and Words' Frequency Over Time to emphasize prevailing literature themes. A regulated validation procedure was employed to ensure the data's accuracy. This assisted academics in identifying significant trends, collaborative patterns, and novel areas where business intersects with water conservation. The publication's appendix contains the complete dataset utilized for this inquiry.

RESULT
Summary Statistics

Table 1. Summary Statistics

Description	Results
Main Information About Data	
Timespan	1916:2025
Sources (Journals, Books, etc)	831
Documents	3083
Annual Growth Rate %	3.17
Document Average Age	12.09
Average Citations per Doc	33.25.00
References	127223
Document Contents	
Keywords Plus (ID)	20096
Author's Keywords (DE)	9132
Authors	
Authors	10403
Authors of single-authored docs	399
Authors Collaboration	
Single-authored docs	463
Co-Authors per Doc	0,174306
International co-authorships %	22.12

Description	Results
Document Types	
article	2366
book	21
book chapter	128
conference paper	344
conference review	13
editorial	3
erratum	1
letter	1
note	7
report	7
review	185
short survey	7

Source: Bibliometrix

This section highlights key findings derived from a comprehensive bibliometric analysis covering the period from 1916 to 2025. A total of 3,083 documents were examined, originating from 831 distinct academic sources. The annual publication growth rate is 3.17%, with an average document age of 12.9 years and 33.25 citations per document, underscoring the enduring relevance and scholarly impact of research in this domain. The dataset comprises 127,223 references, along with 20,096 Keywords Plus and 9,132 author-defined keywords.

A total of 10,403 authors contributed to the publications, although only 399 produced single-authored documents. In all, 463 papers were written by a single author, while the average number of co-authors per document is 3.71, and 22.12% involved international collaboration. Regarding document types, journal articles make up the majority (2,366), followed by conference papers (344), reviews (185), and book chapters (128), illustrating the multidisciplinary nature and broad scholarly engagement in the intersection of water

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conservation and business. This century-long bibliometric analysis reveals key trends in water conservation and business, reaffirming (Raman et al., 2022) view on the role of bibliometric mapping in shaping strategic research and stakeholder engagement.

Performance Analysis

Building on the summary statistics, Figure 2 illustrates a significant rise in annual scientific production on water conservation and business, particularly from the early 2000s onward. The publication volume peaked between 2010 and 2012, reaching over 300 articles per year, reflecting a surge in global academic attention likely driven by the growing urgency of environmental issues and the integration of sustainability into business practices. Although a decline followed the peak, the output remained substantially higher than in earlier decades, with a steady resurgence observed from 2018 to 2023. This sustained publication trend not only reflects ongoing academic interest but also reinforces the strategic importance of this research area in shaping environmental policy, driving business innovation, and fostering interdisciplinary collaboration, highlighting the global momentum and relevance of research in water conservation and business across a century.

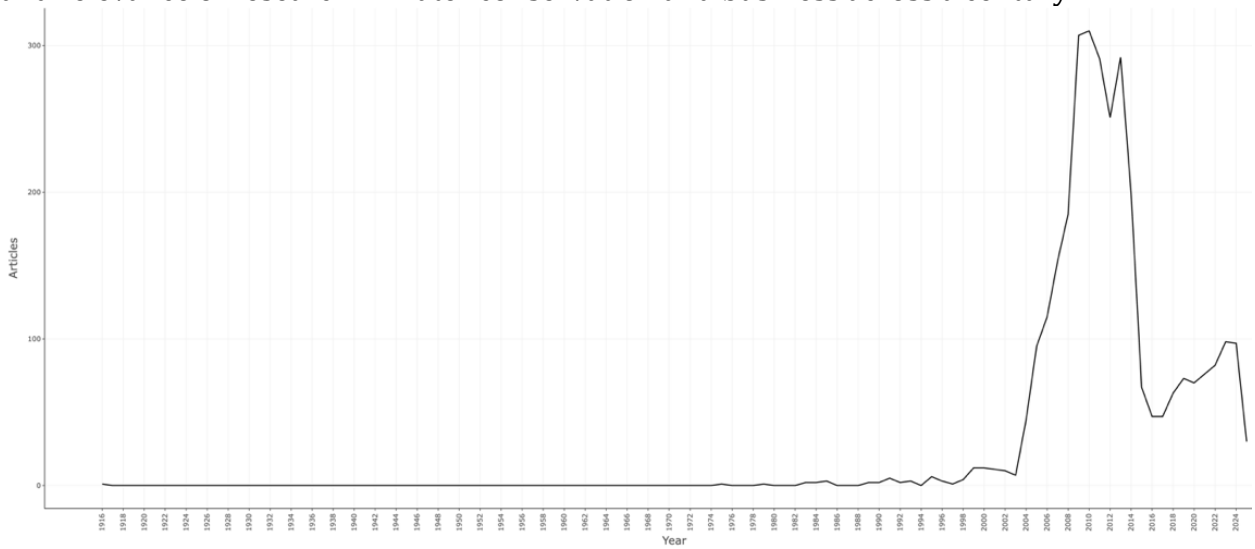

Figure 2. Annual Scientific Production

Global Citation Distribution

Figure 3 shows the countries that have been mentioned the most in business research and water conservation. The United States is clearly the most cited country, with 26.117 citations, far more than any other country. China is in second place with 11439 mentions, followed by the UK with 5258, then Germany with 4968, and finally India with 4926. This distribution reflects the central role of Western and emerging economies in shaping the academic discourse around sustainability and business practices. The presence of countries such as Spain, Australia, Canada, France, and Brazil also indicate a geographically diverse contribution, reinforcing the global nature of research collaboration and influence in this field. These findings align with the overarching theme of the study, emphasizing the worldwide engagement and cross-border knowledge exchange that have characterized a century of research on water conservation and business.

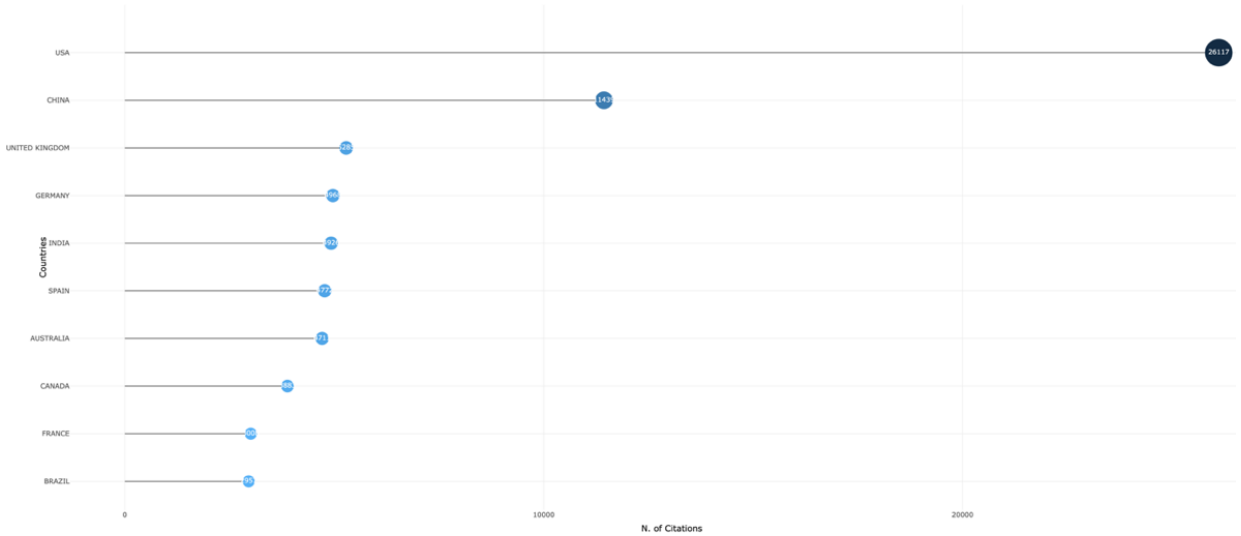

Figure 3. Most Cited Countries

Collaboration Network Among Leading Authors

Figure 4 visualizes the co-authorship network among the most active and connected researchers in the field of water conservation and business. The visualization reveals small but distinct clusters, indicating focused collaborative efforts rather than large, centralized research groups. Notable author pairs such as Lakra, W.S. and Sarkar, U.K., Sen, L. and Lodhi, A., as well as Sayre, K.D. and Govaerts, B., reflect consistent partnerships that may have shaped niche areas of inquiry within this interdisciplinary domain. The presence of various geographically and thematically diverse nodes, ranging from technical environmental expertise to water reuse and policy, suggests that collaboration in this field is both specialized and globally distributed. This pattern supports the paper's central thesis that research in water conservation and business has evolved through sustained global engagement and decentralized scholarly interaction across a century.

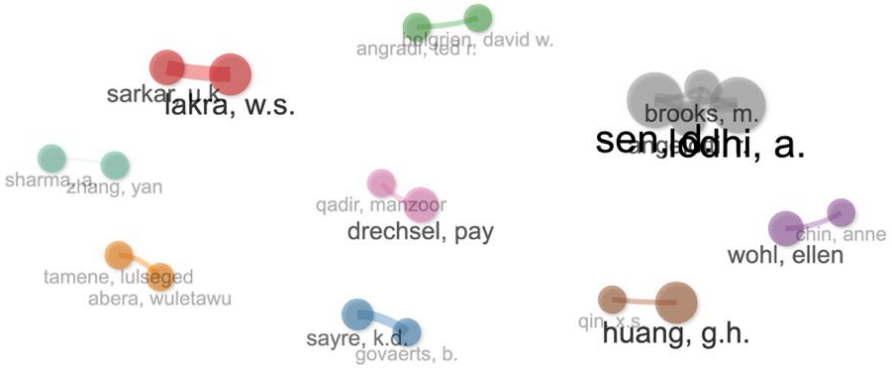

Figure 4. Collaboration Network

Thematic Evolution: Strategic Positioning of Research Themes

Figure 5 displays a thematic map that categorizes research themes based on their centrality (relevance) and density (development), offering insights into the structural landscape of the field. The upper-right quadrant, which hosts "article," "water quality," and "environmental protection," represents motor themes well-developed and crucial to the field, indicating that environmental protection remains a driving force in water-related research

with strong links to publication output and policy discourse. The upper-left quadrant includes themes like "conservation of natural resources," "environmental monitoring," and "United States," suggesting niche but well-developed clusters, likely tied to region-specific or technical expertise. In contrast, the lower-left quadrant shows themes such as "water conservation," "water management," and "water supply," which are positioned as emerging or declining themes with relatively low development and relevance.

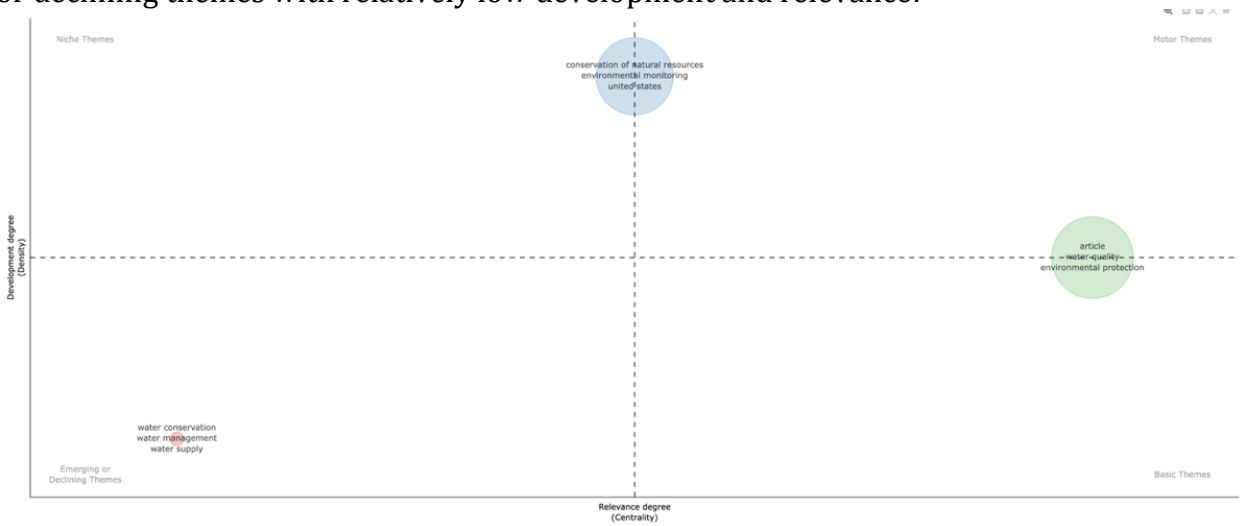

Figure 5. Thematic Map

This positioning signals a critical insight: while water conservation remains central in name, its scholarly depth and integration into broader interdisciplinary systems may be lagging, suggesting untapped potential. These thematic dynamics reinforce the importance of this study's longitudinal perspective, which maps not only the growth of research across a century but also the shifting focus and maturity of core themes in the intersection of water and business.

Influential Publications: Most Globally Cited Documents

Figure 6 highlights the top globally cited documents in the field of water conservation and business, offering insight into the foundational literature that has shaped scholarly thought over the past century. The most cited article, Jose (2009) in Agroforestry Systems, has amassed 1,180 citations, reflecting the strong influence of agroecological approaches in sustainability research. Other highly cited works, such as Qin (2010), Thomaz (2007), and Freibauer (2004), published in Environmental Management, Hydrobiologia, and Geoderma respectively, further reveal the interdisciplinary nature of impactful contributions, spanning ecology, land use, and environmental economics.

These citation patterns confirm that globally recognized research in this domain often bridges scientific rigor with applied relevance, addressing real-world environmental challenges. This reinforces the central argument of the study that the field of water conservation and business is not only globally engaged but also shaped by enduring scholarly contributions that continue to influence policy, practice, and future research directions.

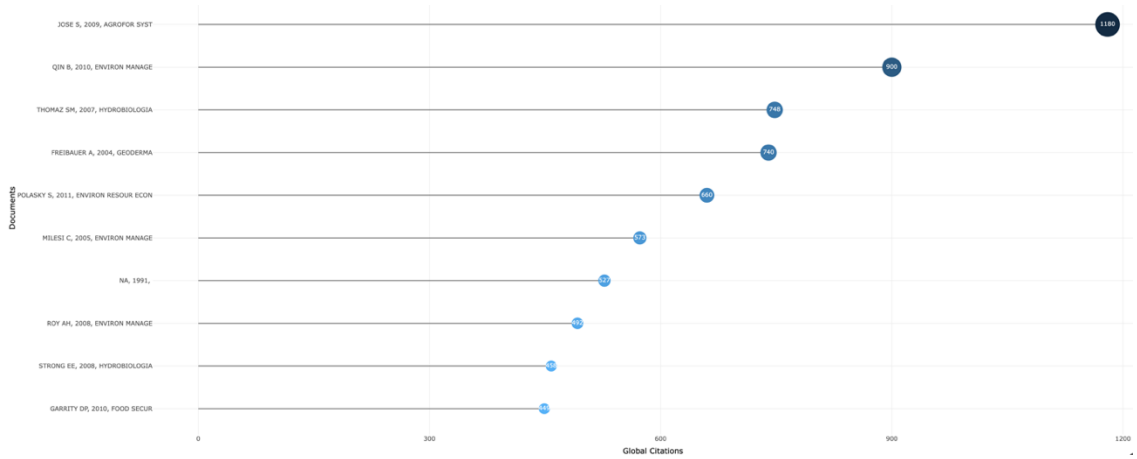

Figure 6. Most Global Cited Documents

Thematic Trajectories: Keyword Frequency Over Time

Figure 7 illustrates the cumulative frequency of key terms used in publications related to water conservation and business from 1970 to 2025. The data shows a steep rise in the use of terms such as “article,” “United States,” “conservation of natural resources,” and “water conservation” beginning in the early 2000s, peaking between 2010 and 2015. Terms like “sustainable development,” “environmental protection,” and “water management” also gained significant traction during this period, reflecting a growing alignment between environmental themes and strategic business concerns. Although some terms, such as “water quality” and “environmental monitoring,” show slower but consistent growth, their presence indicates a broadening of research focus over time.

The prominence and trajectory of these keywords underscore the evolving nature of the field and affirm that sustainability-related terminology has become deeply embedded in scholarly discourse. These longitudinal trends strengthen the study’s central argument that the intersection of water conservation and business has matured through dynamic thematic shifts, reflecting both global environmental priorities and collaborative academic development across a century.

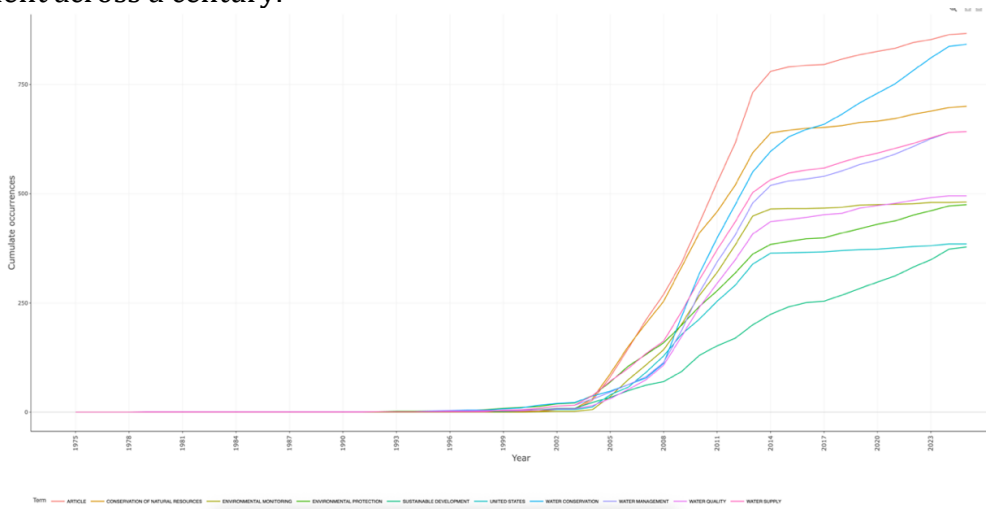

Figure 7. Words' Frequency over Time

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CONCLUTION

This study concludes that research on water conservation and business has significantly evolved over the past century, demonstrating substantial growth in scholarly output, thematic diversification, and international collaboration. Employing a bibliometric analysis using the Bibliometrix package in R, supported by the Biblioshiny interface and Microsoft Excel, allowed for systematic identification of dominant trends, co-authorship structures, and the development of core and emerging themes from 3,083 Scopus-indexed documents. Scopus was selected for its comprehensive interdisciplinary coverage and its reliability in indexing peer-reviewed literature.

The analysis reveals that the United States leads in global citations, and that themes such as environmental protection and sustainable development have gained prominence, while critical concepts like water management and water conservation remain underdeveloped. These findings contribute to the body of knowledge by providing a century-spanning overview of scholarly progress, inform sustainable business and entrepreneurship practices, and support evidence-based policymaking. The study also reinforces the global diffusion of knowledge and interdisciplinary exchange in water-related business innovation. A key limitation of this research lies in its exclusive reliance on Scopus-indexed publications, which may exclude important regional studies and non-English language sources.

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Author Contributorship

Riefky Prabowo: Conceptualization, Methodology, Data Curation, Resources, Validation, Formal Analysis, Visualization, Writing, Review and Editing, and Project Administration.

Data Availability

Prabowo, Riefky, 2025, "Publication Dataset Global Research in Water Conservation and Business Themes and Collaboration Across a Century (1916–2025)", https://doi.org/10.7910/DVN/2SFXS5, Harvard Dataverse, V1.

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