ZIBELINE INTERNATIONAL™ PUBLISHING

Water Conservation and Management (WCM)

DOI: http://doi.org/10.26480/wcm.01.2026.210.219

ISSN: 2523-5664 (Print)
ISSN: 2523-5672 (Online)
CODEN: WCMABD

REVIEW ARTICLE

SEDIMENT FLUSHING STRATEGIES FOR SUSTAINABLE RESERVOIR MANAGEMENT: A REVIEW

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Article History:

Received 11 January 2026
Revised 18 February 2026
Accepted 15 March 2026
Available online 12 May 2026

ABSTRACT

Reservoir sedimentation is continuing to be an essential obstacle to the long-term performance of dams and water infrastructure, with consequences for hydropower generation, flood control, and environmental integrity. This bibliometric study analyzes 118 peer-reviewed publications from 2014 to 2024, retrieved from Scopus, focusing on sediment flushing and reservoir sedimentation. Using Excel, VOSviewer, RStudio, and MapChart, the study maps publication trends, methodological diversity, co-authorship networks, and institutional contributions. The dataset reveals a marked increase in publication activity over the study period, with numerical modeling consistently leading in frequency and application. This upward trend reflects growing global attention to sediment-related challenges and the expanding role of computational strategies in addressing complex hydraulic phenomena. Further efforts could emphasize integrating field-based validation with existing models to enhance reliability. Expanding comparative studies across diverse regions may also improve the adaptability of sediment management strategies.

KEYWORDS

reservoir sedimentation, flushing sediment, sedimentation and review.

1. INTRODUCTION

Reservoir sedimentation has emerged as a critical challenge in water resource management, particularly in regions dependent on hydropower, irrigation, and flood control infrastructure. Sediment accumulation reduces storage capacity, disrupts operational efficiency, and accelerates structural degradation of dams and reservoirs (Tohidloo and Abbasi, 2025). As global water demands rise and climate variability intensifies, the need for sustainable sediment management strategies becomes increasingly urgent (Xu and Cao 2024). This trend is evident in the increasing number of peer-reviewed publications addressing sediment transport dynamics, ecological consequences, and modeling techniques (Xu and Cao 2024; Guillén Ludeña et al., 2022; Lee et al., 2024; Naderi et al., 2022; Xu et al., 2023). A bibliometric approach offers a structured lens through which to assess global research trends, highlight influential contributors, and inform future directions in sediment management.

The persistence of reservoir sedimentation is driven by a combination of natural and anthropogenic factors. In mountainous and tropical regions, intense rainfall events exacerbate erosion, accelerating sediment delivery to reservoirs (Narwal and Gupta, 2019; Takahashi, 2013). Simultaneously, aging infrastructure and limited sediment evacuation capacity hinder effective flushing operations.Many reservoirs were designed without long-term management plans, resulting in rapid capacity loss, reduced hydropower output (Beiramipour et al., 2021) and an increase in filtration rate (Samiev et al., 2024). Moreover, sediment flushing techniques often face ecological constraints, flow control, and sediment concentration thresholds further complicate flushing efficiency. The lack of standardized design criteria and predictive tools for sediment behavior under varying hydraulic conditions adds to the complexity. Several international organizations have recognized the urgency of reservoir sedimentation and have published influential reports to guide mitigation efforts. The International Commission on Large Dams (ICOLD) released Bulletin 178 titled *Management of Reservoir Sedimentation* , emphasizing coordinated flushing and bypassing strategies (International Commission on Large Dams. 2023). The World Bank addressed sediment risks in its report *Sustainable Hydropower and Sediment Risk*, advocating for integrated sediment control in dam planning. Similarly, the Central Board of Irrigation and Power (CBIP) highlighted sedimentation challenges in its 2024 technical review (World Bank. 2022; Central Board of Irrigation and Power. 2024).

In the academic sphere, Yin proposed reservoir operation methods for sediment control and ecosystem protection, while Cao developed double-layered models for turbidity current simulation (Yin, 2014; Cao, 2015). Espa and Costa investigated controlled flushing and sediment export in Alpine catchments (Costa, 2018; Espa, 2016). Pandey applied remote sensing for sediment assessment, and Kondolf explored dam renovation strategies to prolong reservoir life (Kondolf, 2022; Pandey, 2016). Recent contributions by Reisenbüchler and Cattanéo have focused on ecological impacts and artificial intelligence applications in sediment management (Cattanéo, 2021; Reisenbüchler, 2021). These works collectively form the foundation for advancing sustainable reservoir operations. Bibliometric analysis is widely used across disciplines to evaluate research trends, identify influential works, and map thematic developments. It offers a quantitative approach to studying scholarly output through metadata such as co-authorship, keyword patterns, and citation networks (Tranfield et al., 2003).Bibliometric methods have been applied across various fields,

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Cite The Article: Aybek Arifjanov, Farrukhbek Babajanov, Jumaniyoz Donoboev, Samandar Arifjanov, Abdulaziz Turdaliyev (2026). Sediment Flushing Strategies for Sustainable Reservoir Management: A Review. *Water Conservation and Management*, 10(1)210-219.

e.g. sedimentation , groundwater, hydrological modeling, rehabilitation robotics, machine learning and deep learning, modeling of breathing crack, English linguistics, root harvester machine for agriculture food, marginal lands (Jumaniyazov, et al., 2023), and landslides (Khasanov et al., 2021, our study examines publications indexed in Scopus between 2014 and 2024, categorizing them by methodological approach, including numerical modeling, field studies, and hybrid techniques to assess research diversity and international collaboration in sediment management (De Asis, 2020; Petkovsek, 2023: Kannazarova et al., 2024; Kannazarova et al., 2024; Scientific Research Institute of Irrigation and Water Problems, Tashkent, Uzbekistan, 2025; Oo and Humphries, 2025; Karasheva et al., 2025; Tande and Suryawanshi, 2025; Ganguly, 2023; Xaliqulov, et al., 2023; Mardieva, et al., 2024).

This study aims to analyze and systematically classify advanced scientific strategies for managing sediment accumulation and removal in reservoirs. The findings are expected to be broadly applicable not only within hydraulic engineering and reservoir operations, but also in related fields such as environmental monitoring, watershed planning, sediment transport modeling, and long-term sustainability of water infrastructure. Furthermore, the methodological insights presented herein may serve as a valuable reference for future academic research, as well as a decision-support tool for policymakers and engineering practitioners engaged in sediment management and water resource planning.

2. Methods and Materials

In this review, we focused on gathering regional knowledge from existing research. The research was conducted using the Scopus data-base, the most widely utilized bibliographic online database, for the period from 2014 to 2024. We used “water and reservoir”, “sedimentation” and “dam” as keywords. Following a bibliometric analysis was carried out in January 2025, 118 pertinent scientific publications from all across the world were selected for a more thorough examination.

These articles offered important insights into the current status of research in this field worldwide and specifically addressed a number of issues related to flushing sedimentation, design optimization, and reservoir sedimentation performance. For the analysis, we utilized a CSV file, Microsoft Excel 2021, RIS, VOSviewer, BibTex, RStudio and Map chart, each serving a specific function in the data processing and visualization process.

2.1. Eligibility criteria for article selection and review

In order to simplify the search, relevant information was entered into a spreadsheet, including the keywords "reservoir sedimentation," "flushing sediment," and all English-language articles. Subject area: Environmental Science, Agricultural and Biological Sciences; deadline: January 2025; article = ("Reservoir sedimentation"), document type = "article," timespan = "2014–2024." The figure illustrates the flow of the selected research approach (Figure 1).

((TITLE-ABS-KEY(reservoir sedimentation) AND TITLE-ABS-KEY(flushing sediment)) AND (LIMIT-TO (PUBYEAR,2014) OR LIMIT-TO (PUBYEAR,2015) OR LIMIT-TO (PUBYEAR,2016) OR LIMIT-TO (PUBYEAR,2017) OR LIMIT-TO (PUBYEAR,2018) OR LIMIT-TO (PUBYEAR,2019) OR LIMIT-TO (PUBYEAR,2020) OR LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2022) OR LIMIT-TO (PUBYEAR,2023) OR LIMIT-TO (PUBYEAR,2024)) AND (LIMIT-TO (SUBJAREA,"AGRI") OR LIMIT-TO (SUBJAREA,"ENVI")) AND (LIMIT-TO (LANGUAGE,"English")) AND (LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE,"cp") OR LIMIT-TO (DOCTYPE,"re") OR LIMIT-TO (DOCTYPE,"cr")))

2.2. Bibliometric analysis

In order to do a bibliometric analysis, the CSV data was imported into Excel. To guarantee the accuracy of the findings, the dataset was carefully examined for inconsistencies or mistakes before the research began. The most pertinent papers were found after a careful analysis of the reviewed articles. In addition to these papers, the authors who produced the greatest number of publications on the subject were acknowledged and listed, offering information on the most significant scholars in the area (Figure 1).

3. Results

3.1. Publication trend on reservoir sedimentation in different countries of the world.

The figure shows how many scientific publications there were on the subject between 2014 and 2024 (Figure 2). The data indicates that the number of research publications has been steadily rising. The number of publications increased slightly each year between 2014 and 2017, but stayed relatively low overall. Interest in the field of study grew during that time, as evidenced by a discernible increase that started in 2018 and a sharp increase in publications in 2019. The publication rate peaked in 2022 after a sharp rise in 2020 and 2021. This could be the result of new strategies or technologies being introduced in the field, or it could be a result of a renewed academic focus. The high publication counts in 2023 and 2024 indicate ongoing scholarly interest. All things considered, the pattern indicates that the subject has become very popular recently and is still a topic that is being studied and is relevant.

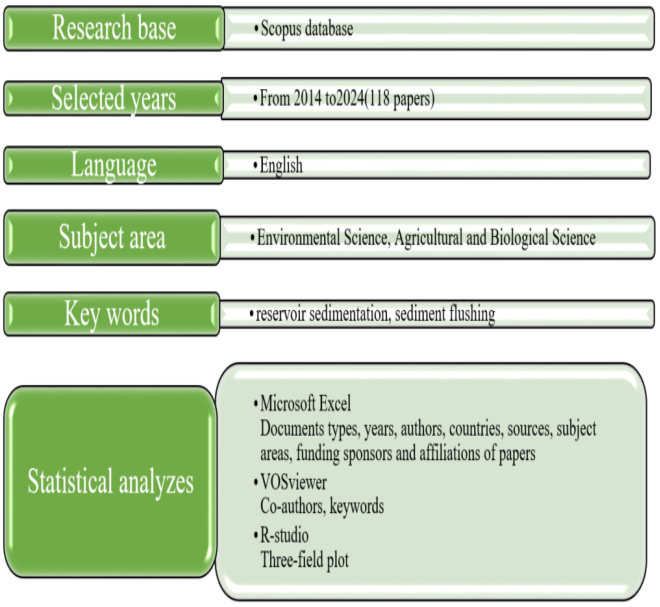

Figure 1: Methodology flowchart for research

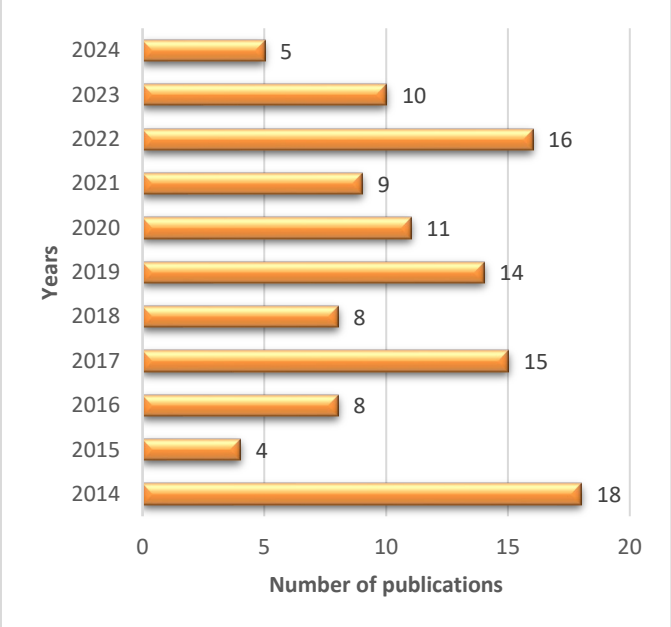

Figure 2: Annual production of articles on sedimentation during the period 2014-2024

3.2. Document types on reservoir sedimentation

The analysis of the publication dataset revealed a clear dominance of research articles, which account for 60% of the total. Conference papers represent 38%, reflecting the active role of scientific meetings in disseminating preliminary findings and ongoing research. In contrast, review papers constitute only 2%, suggesting that comprehensive state-of-the-art evaluations are relatively scarce in this field (Figure 3).

This distribution highlights that the majority of contributions are based on original research, while reviews remain underrepresented. Such an imbalance underscores the need for more systematic review studies to consolidate the existing body of knowledge and to provide a broader understanding of current trends and research gaps.

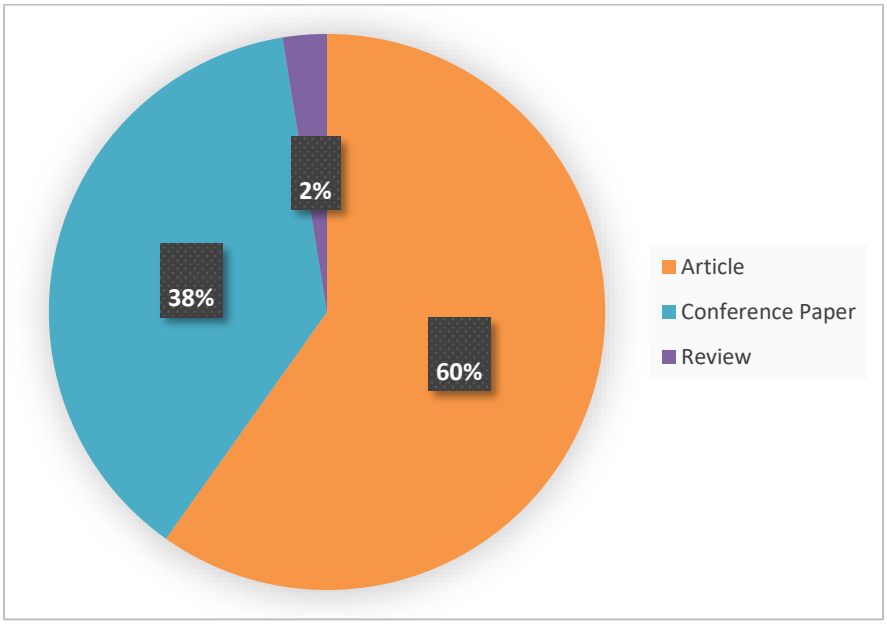

Figure 3: Publication type

3.3. Top journals on reservoir sedimentation

The distribution of research output in the fields of hydraulics, water, and related engineering disciplines is shown in the table, which counts the number of articles published in various journals. With 10 articles, Water (Switzerland) is in the lead, demonstrating its status as a major publication for these kinds of studies. With 8 articles, Proceedings of The IAHR World Congress comes next, emphasizing its function in sharing conference-based research. Water Resources Research and Environmental Earth Sciences each contribute ten articles, demonstrating a balanced emphasis on hydraulic engineering and environmental issues. There are 23 articles in the Journal of Hydrology and 21 in the Iop Conference Series Earth and Environmental Science. Finally, the Journal of Hydrologic Engineering and Water Resources Management have added four and nine articles, respectively. With other journals offering specialized platforms for hydraulic, environmental, and energy-related research, this distribution, as of May 2025, highlights Water's (Switzerland) leadership in the field (Table 1).

Table 1: List of journals

Source title	Number of articles
Water (Switzerland)	10
Proceedings Of The IAHR World Congress	8
IOP Conference Series Earth and Environmental Science	5
Journal of Hydraulic Engineering	5
Ish Journal of Hydraulic Engineering	4
Journal of Environmental Management	4
International Journal of River Basin Management	3
Journal Of Hydraulic Engineering	3
Proceedings of the Institution of Civil Engineers Water Management	3
River Research and Applications	3
Hydrological Sciences Journal	2
Journal of Hydrology	2

3.4. Co-authorship network, organizations, and funding sponsors

The visualization illustrates the co-authorship network of researchers in the field, generated using VOSviewer. Each node represents an author, while the size of the node reflects the relative number of publications or citations associated with that researcher. The links between nodes indicate co-authorship relations, with stronger connections shown by thicker lines. The color coding corresponds to the average year of publication, ranging from dark blue (2018) to yellow (2021), as indicated by the gradient bar.

The network reveals several clusters of collaboration. On the left side, a group of researchers including Hauer C., Habersack H., and Holzapfel P. forms a dense cluster, reflecting close cooperation. Toward the center, Haun S. acts as a bridging author, connecting this cluster with another network of researchers. To the right, another collaboration cluster is visible, centered around Kantoush S.A. and including co-authors such as Rahimpour M. and Qaderi K.. This structure highlights the presence of interconnected yet distinct research groups, with bridging authors facilitating knowledge exchange across clusters (Figure 4).

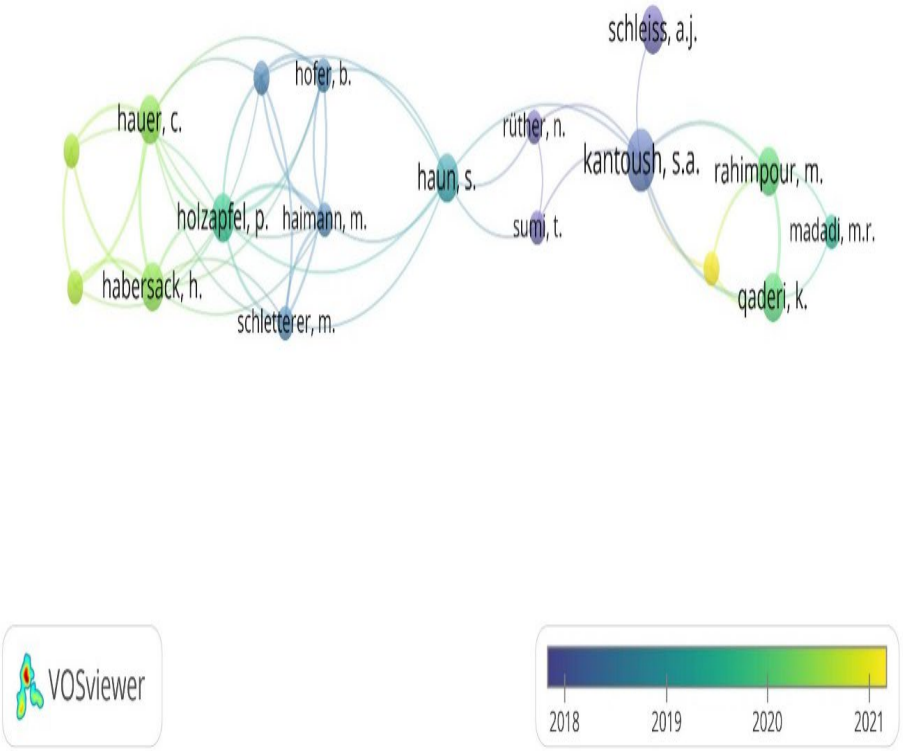

Figure 4: Co-authorship network of researchers in the field

The figure illustrates the number of publications produced by different research organizations between 2017 and 2020 (Figure 5). The institutions listed include Central Water and Power Research Station, Kyoto University, INRAE, Brawijaya University, École Polytechnique Fédérale de Lausanne, BOKU University, Universidad Politécnica de Cartagena, Indian Institute of Technology Bombay, Università degli Studi dell'Insubria, and Norges Teknisk-Naturvitenskapelige Universitet (NTNU). The length of each bar represents the number of publications, with the scale ranging from 0 to 5. Central Water and Power Research Station and Kyoto University lead with the highest number of publications,both exceeding 4.5, followed closely by INRAE and Brawijaya University, each with approximately 4 publications. The remaining institutions, including École Polytechnique Fédérale de Lausanne, BOKU University, Universidad Politécnica de Cartagena, Indian Institute of Technology Bombay, Università degli Studi dell'Insubria, and NTNU, each have between 3 and 4 publications. This chart highlights the significant contributions of these institutions to the research field, with Central Water and Power Research Station and Kyoto University showing the most prolific output.

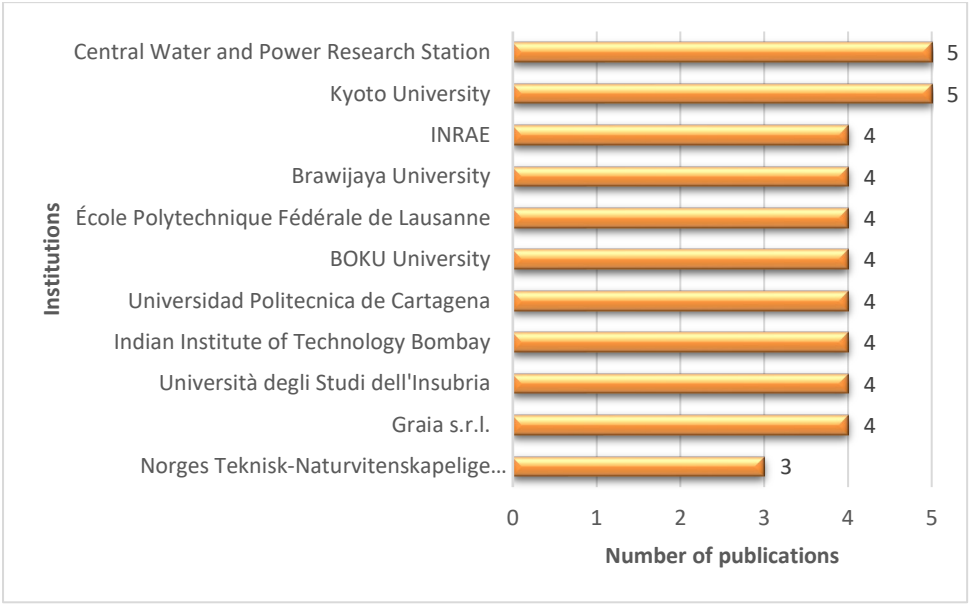

Figure 5: List of Institutions

The funding analysis highlights the number of publications supported by various funding organizations from 2017 to 2020. The y-axis lists the funding sponsors, while the x-axis represents the number of publications, ranging from 0 to 8. The National Natural Science Foundation of China leads with the highest number of publications, exceeding 7. Other notable sponsors include Central University Basic Scientific Research Business Expenses Special Funds (approximately 2 publications), Consiglio Nazionale delle Ricerche (around 2 publications), Ministry of Science and Technology, Taiwan (about 2 publications), National Key Research and Development Program of China (approximately 1 publication), Agència Catalana de l'Aigua (around 1 publication), Austrian Federal Ministry of Economy, Family and Youth (about 1 publication), Baden-Württemberg Stiftung (approximately 1 publication), Bundesministerium für Bildung und Forschung (around 1 publication), and Bundesministerium für Digitalisierung und Wirtschaftsstandort (about 1 publication). The chart highlights the dominant role of the National Natural Science Foundation of China in funding research, with other sponsors contributing more modestly to the publication output (Figure 6).

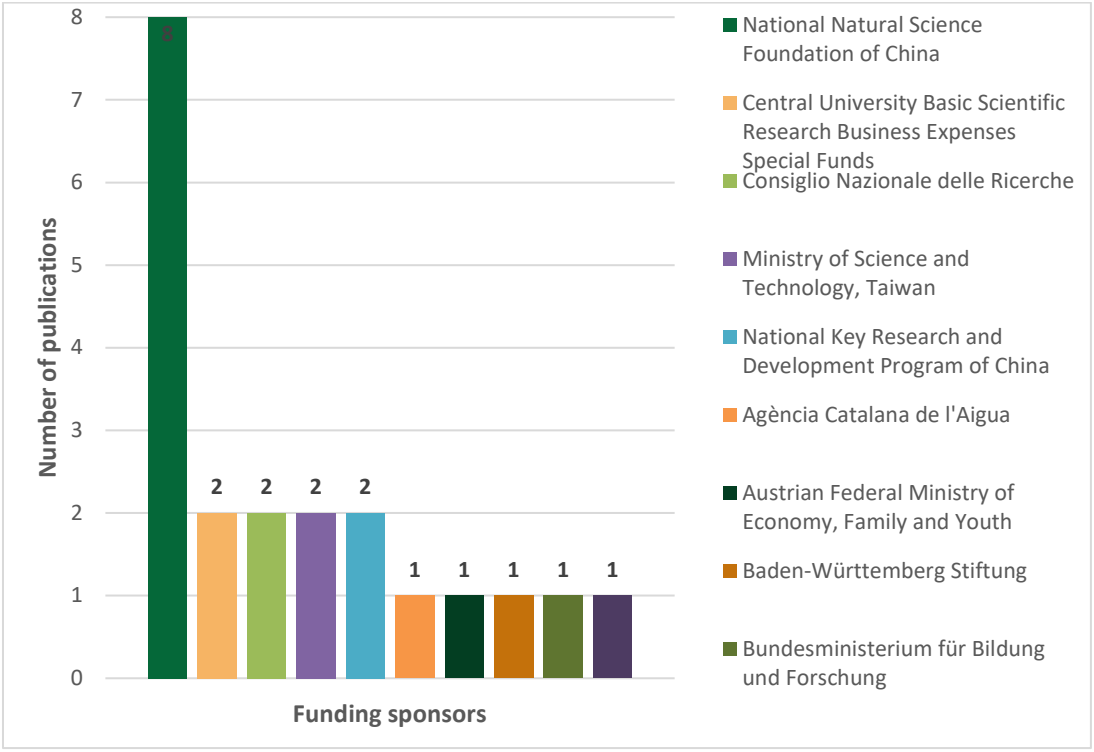

Figure 6: List of funding sponsors

3.5. Top countries on reservoir sedimentation in the world.

The global map highlights nations active in reservoir sedimentation studies, with a ranked list of the top publishing countries (Figure 7). The United States leads with 19 publications, followed by China (13), and then India and Iran (11 each). European nations such as Germany, Switzerland, Austria, France, and the United Kingdom also feature prominently in the top rankings. The list concludes with Pakistan and the Russian Federation, which have 4 and 3 publications, respectively. Countries like Canada, Brazil, and Australia are indicated on the map but do not appear in the ranked list of top contributors.

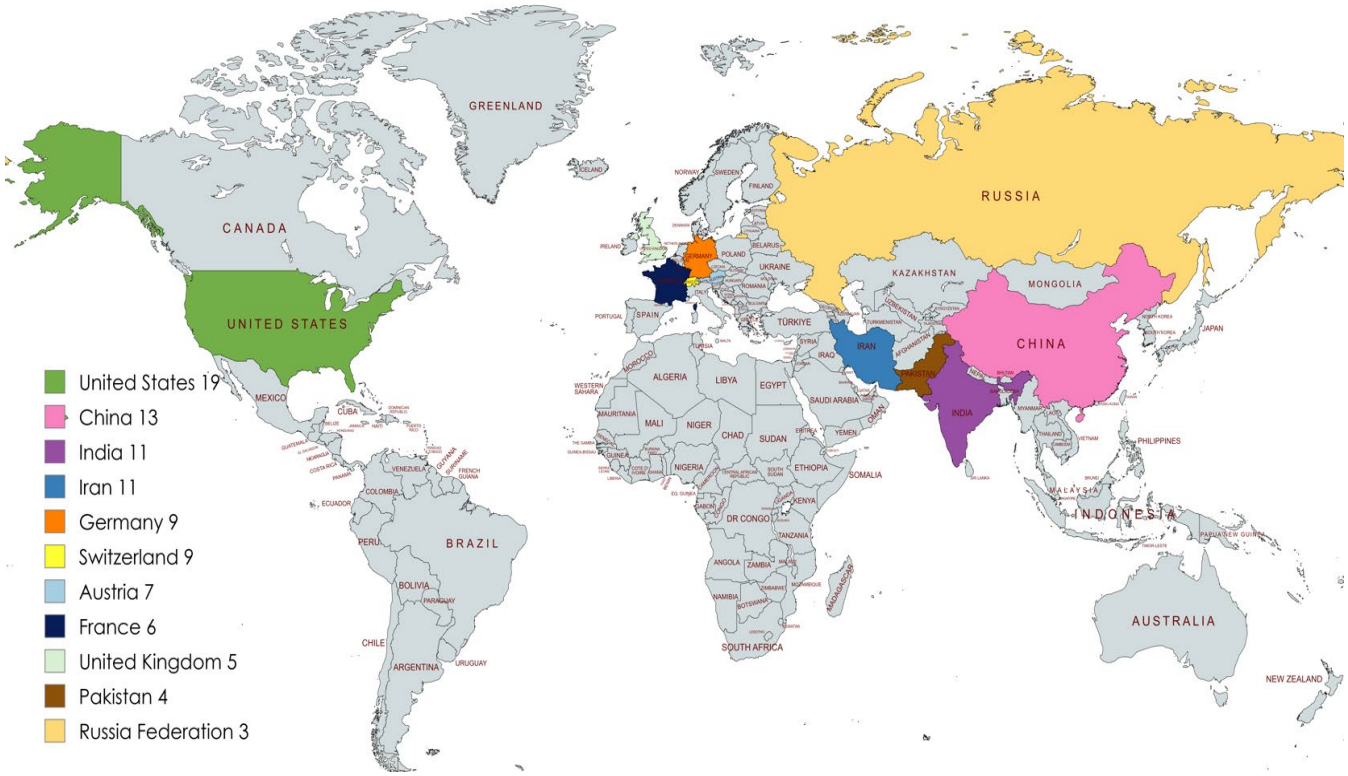

Figure 7: List of top countries on reservoir sedimentation

3.6 Top cited papers on reservoir sedimentation in the world.

There has been significant advancement in the measurement and management of reservoir sedimentation, as evidenced by an analysis of eleven important research published between 2014 and 2024 (Table 2). While suggested modeling techniques for sediment control and turbidity current simulation, investigated temperature effects and controlled flushing in Alpine catchments (Yin, 2014; Cao, 2015; Costa, 2018; Espa, 2016). The study examined integrated techniques for sediment flushing, and Pandey (2016) used remote sensing to assess sedimentation (Castillo,2015). With studies examining the ecological effects of flushing on fish habitats, environmental effects have been a primary emphasis by (Baoligao, 2016; Quadroni, 2016; Cattanéo, 2021). The analysis illustrated the use of artificial neural networks for sediment control, while examined dam rehabilitation techniques to prolong reservoir life (Reisenbüchler, 2021; Kondolf, 2022).

All things considered, these studies highlight sustainable, integrated methods for managing reservoir sediments in the present period that include ecological factors, monitoring technology, and hydraulic models.

Table 2: List of top cited publications on reservoir sedimentation

No.	Title	Journal	Corresponding authors	PY	TC 2014-2024	Doc.type
1.	Temperature signal in suspended sediment export from an Alpine catchment	Hydrology and Earth System Sciences	A.Costa	2018	65	Article
2.	Controlled sediment flushing at the Cancano Reservoir (Italian Alps): Management of the operation and downstream environmental impact	Journal of Environmental Management	P.Espa	2016	60	Article
3.	A reservoir operating method for riverine ecosystem protection, reservoir sedimentation control and water supply	Journal of Hydrology	X.Yin	2014	57	Article
4.	Whole-process modeling of reservoir turbidity currents by a double layer-averaged model	Journal of Hydraulic Engineering	Z.Cao	2015	48	Article
5.	Assessment of reservoir sedimentation using remote sensing and recommendations for desilting Patratu Reservoir, India	Hydrological Sciences Journal	A.C. Pandey	2016	47	Article
6.	Complementary methods for determining the sedimentation and flushing in a reservoir	Journal of Hydraulic Engineering	L.G.Castillo	2015	39	Article
7.	Acute impacts of reservoir sediment flushing on fishes in the Yellow River	Journal of Hydro-Environment Research	B.Baoligao	2016	38	Article
8.	Dam Renovation to Prolong Reservoir Life and Mitigate Dam Impacts	Water (Switzerland)	M.G.Kondolf	2022	34	Review
9.	Mitigation of ecological impacts on fish of large reservoir sediment management through controlled flushing – The case of the Verbois dam (Rhône River, Switzerland)	Science of the Total Environment	F.Cattanéo	2021	31	Article
10.	Effects of sediment flushing from a small Alpine reservoir on downstream aquatic fauna	Ecohydrology	S.Quadroni	2016	31	Article
11.	Reservoir sediment management using artificial neural networks: A case study of the lower section of the alpine saalach river	Water (Switzerland)	M.Reisenbüchler	2021	24	Article

* PY – Published year, * TC – Total citation

This case is widely recognized, as an analysis of the productivity and impact of the articles was conducted. The top journals with the greatest number of published papers are listed (Figure 8). In light of this, we choose to look into the groundwater journals with the highest citation counts. The source names from the 118 documents in the Excel file were first arranged alphabetically. The number of papers and their citations for each journal were then compiled in the following phase.

It's interesting to note that the research produced a revised list of possible journal names. The top 10 journals were selected and illustrated (Figure 8). Water (Switzerland) was the most cited publication with 141 citations, followed by the publication of Hydraulic Engineering (131 citations), the Journal of Environmental Management (98 citations), and the Journal of Hydrology (74 citations), according to the citation analysis.

3.7. Interrelationship analysis

The provided image is a network visualization created using VOSviewer, depicting the co-occurrence of keywords related to sediment management and hydroelectric power from 2017 to 2020. The nodes represent key terms such as "sedimentation," "sediment transport," "reservoir management," "dams," "hydroelectric power plants," "rivers," "floods," "sustainability," "efficiency," "flushing," "hydraulics," "stream flow," "suspended sediments," "sediment concentration," "numerical model," and "digital storage." The size of each node indicates the frequency of the term's appearance, with larger nodes representing more frequent

occurrences. The links between nodes illustrate the strength of their co-occurrence, with thicker and more numerous connections indicating stronger relationships. The color gradient, ranging from blue (2017) to yellow (2020), reflects the temporal evolution of the research focus, showing a progression from topics like "sedimentation" and "sediment transport" to "sustainability" and "reservoir management" over the years. This visualization highlights the interdisciplinary nature of the field, integrating hydraulics, environmental management, and renewable energy research (Figure 9).

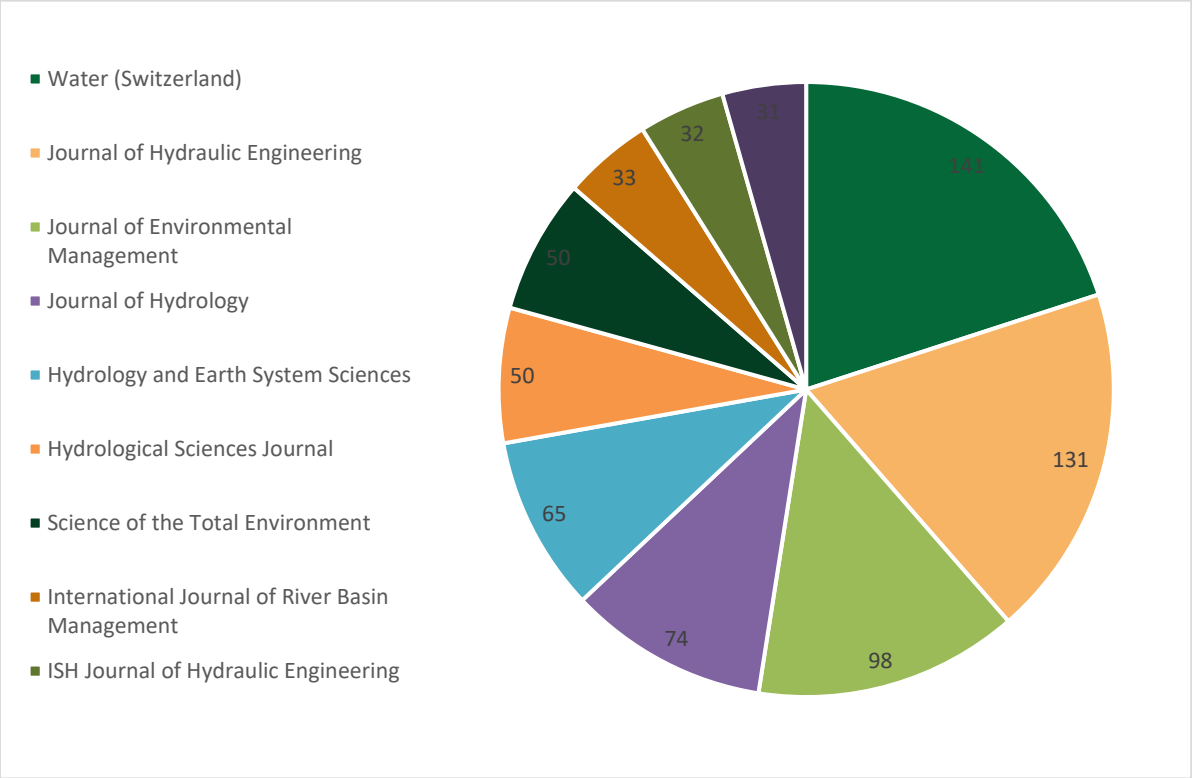

Figure 8: Top scientific journals and their total citation counts

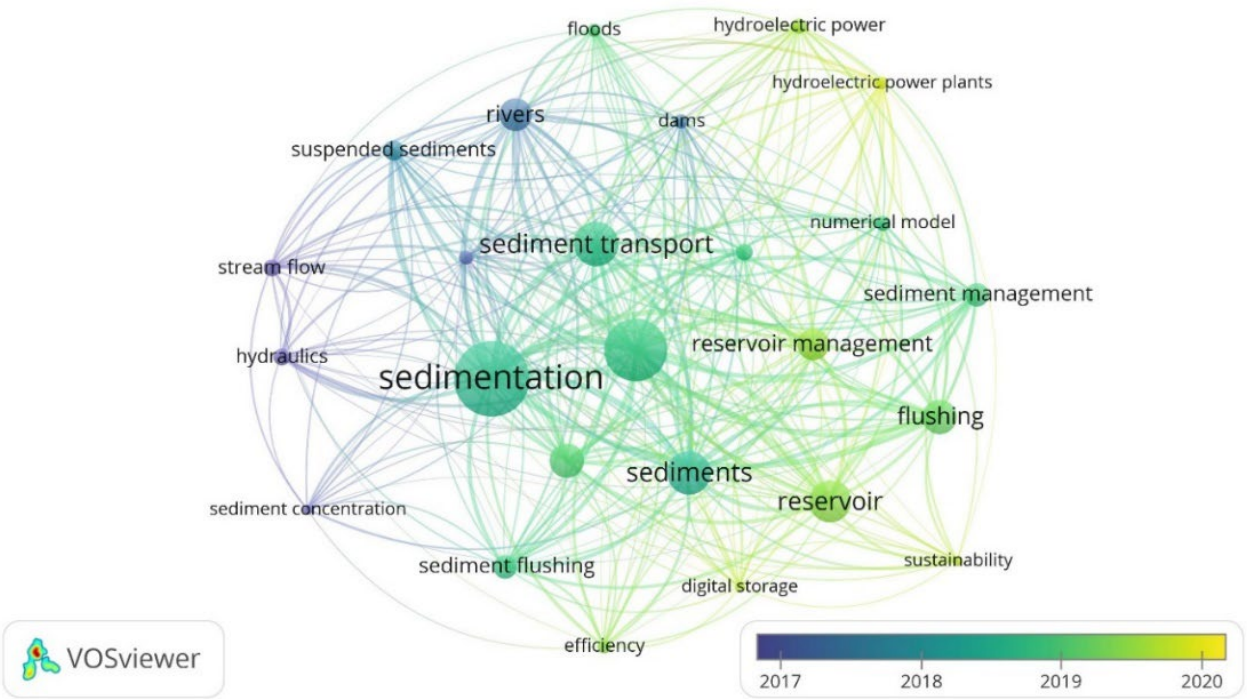

Figure 9: Most used key words

The flow diagram highlights the relationships between authors (AU), countries (AU_CO), and research domains (DE) to show patterns of international research collaboration in sedimentation and reservoir studies. Research areas like reservoir sedimentation, sediment transport, and environmental monitoring are on the right, while authors are displayed on the left, with nations like the US, China, and India in the middle. According to the diagram, significant contributors are actively engaged in a variety of research fields, especially those from the US, China,and India. This covers important subdomains such as sediment transport, erosion, and management. The diagram provides insight into global research strengths, identifies areas of collaboration, and highlights potential knowledge gaps by visualizing these connections. It is a useful tool for figuring out how research efforts are distributed among various nations and fields, which helps to direct future studies and cooperative efforts (Figure 10).

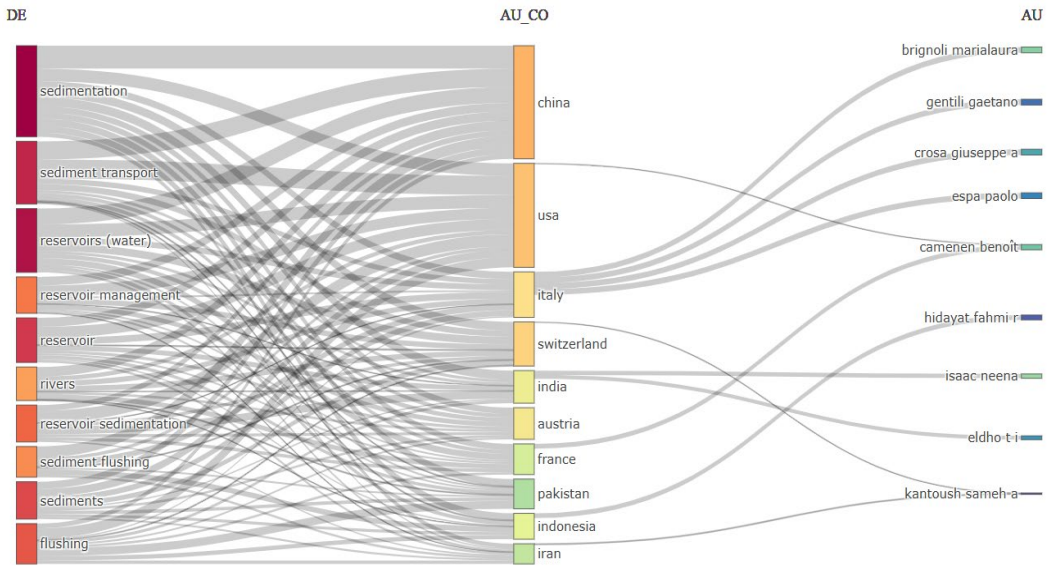

Figure 10: Three-Field plot (authors, countries and key words)

4. Discussion

The methodological classification provides a structured overview of the dominant strategies used in reservoir sedimentation and flushing studies over the past decade (Table 3). A total of 118 articles were categorized into six distinct methodological groups, each reflecting specific analytical priorities and technical depth.

Table 3: Method-based categorization of extracted articles

Methodology	Thematic Category	Number of papers
Numerical Modeling (2D/3D, SPH)	Computational simulations of sediment transport, flushing efficiency, and morphological changes.	43
Field Observations & Case Studies	Real-world reservoir performance, sedimentation rates, and flushing outcomes.	36
Empirical/Statistical Analysis	Evaluation of sedimentation trends, trap efficiency, and historical sediment data.	16
Combined Methods (Hybrid Strategies)	Integration of physical, numerical, and optimization models for comprehensive sediment management.	13
Physical Modeling	Laboratory-scale simulations of flushing tunnels, sediment transport, and erosion dynamics.	5
Optimization Techniques, Remote Sensing & GIS	Satellite-based sedimentation assessment and rule curve optimization for sediment evacuation strategies.	5

Over the past decade, scientific interest in reservoir sedimentation and flushing technologies has grown significantly. This trend reflects the increasing global need to maintain the operational efficiency of hydraulic structures, ensure ecological safety, and promote sustainable water resource management. Sediment accumulation reduces reservoir capacity and negatively affects hydropower generation and irrigation systems. Therefore, developing advanced methodologies for sediment removal and control has become a pressing scientific and practical challenge. This bibliometric analysis contributes to the field by identifying key research trends, leading authors, institutions, and funding bodies, thereby offering a structured overview of the global knowledge landscape. The findings serve as a foundation for strengthening international collaboration and guiding future research directions in sediment management.

While the results section presents annual publication counts, a deeper interpretation reveals evolving thematic complexity over time. Early publications (2014-2017) laid the groundwork by introducing fundamental concepts and initial modeling strategies. From 2018 onward, there was a noticeable shift toward more sophisticated techniques, including numerical simulations, ecological impact assessments, and integrated management strategies. The surge in publications during 2020-2022 coincides with the adoption of advanced technologies such as artificial intelligence, GIS, and rheological modeling. In the most recent years (2023–2024), research has increasingly focused on interdisciplinary strategies, international collaboration, and funding dynamics. This progression indicates not only quantitative growth but also a qualitative expansion in scope and methodological diversity.

Despite yielding valuable insights, this bibliometric study has several limitations. First, it relies solely on the Scopus database, potentially excluding relevant literature indexed in other repositories such as Web of Science or Google Scholar. Second, the inclusion criteria were restricted to English-language publications, which may have overlooked regionally significant studies published in other languages.

Third, the analysis emphasizes bibliometric indicators without assessing the scientific rigor, innovation, or practical impact of individual articles. Additionally, some visualizations and data subsets focus only on the 2017–2020 period, which may not fully represent the entire study timeframe. These constraints should be considered when interpreting the findings and planning future analyses.

To enhance future bibliometric studies in this domain, several improvements are recommended. Integrating multiple databases would provide a more comprehensive view of global research output. Evaluating not only publication quantity but also scientific quality and real-world applicability would enrich the analysis. Including non-English publications could capture valuable regional perspectives and broaden the scope. Moreover, adopting interactive visualization tools such as Tableau or Power BI could improve data presentation and accessibility. Finally, incorporating ecological and socio-economic impact indicators would enable a more holistic assessment of sediment management strategies and their implications.

This bibliometric analysis offers a structured overview of global research trends in reservoir sedimentation and flushing over the past decade. It identifies key contributors, methodologies, and thematic shifts, providing a valuable reference for scholars and practitioners. Despite certain limitations, the study lays a solid foundation for future investigations and highlights the importance of interdisciplinary collaboration and methodological innovation in addressing sediment-related challenges.

5. Conclusion

This bibliometric analysis provides a comprehensive overview of global research on reservoir sedimentation and flushing from 2014 to 2024. The

study reveals a consistent increase in scholarly output, with numerical modeling leading methodological development. Physical modeling, empirical analysis, and hybrid strategies also play significant roles in advancing sediment management. Key authors, institutions, and funding sponsors were identified, reflecting strong regional contributions and international collaboration. Thematic progression indicates a shift toward integrated, ecologically sensitive strategies.

Despite these advances, gaps remain in standardized design criteria, ecological impact assessment, and real-time sediment monitoring. Future research should prioritize interdisciplinary strategies, expand regional representation, and incorporate emerging technologies such as AI and remote sensing. By consolidating fragmented knowledge and visualizing research dynamics, this study supports evidence-based decision-making and contributes to the development of resilient reservoir sedimentation policies.

Ethics statements

No data was used in this research.

Credit author statement

All authors have contributed significantly to the preparation of this manuscript, have approved the final version, and agree to its submission to this journal.

Funding

No Funding was used in this research.

Acknowledgments

The authors express their sincere appreciation to the PhD course "Bibliometric Research and Scientific Writing," organized under the leadership of Dr. Bakhadir Mirzaev, Rector of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, National Research University. Special thanks are extended to Zulfiya Kannazarova for her valuable guidance and supervision throughout the course.

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