RESEARCH ARTICLE

Batticaloa Lagoon: A Bibliometric analysis of publications from 1954 to 2024

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Abstract: The Batticaloa Lagoon in Eastern Province is Sri Lanka's one of the largest brackish water bodies. A bibliometric study of publications on Batticaloa Lagoon provides key insights into diverse research approaches and critical knowledge gaps. This study explored two scholarly databases and a search engine, namely Scopus, Web of Science, and Google Scholar to find published literature on Batticaloa Lagoon. The search was conducted in January 2025 using the keyword "Batticaloa Lagoon" as the search query yielded 16 records in Scopus, 15 in Web of Science, and 547 in Google Scholar. Preliminary screening identified 180 documents directly relevant to the search query. Among those 180 publications, approximately 43% were journal articles, 28% were from conference proceedings and,12% were theses and dissertations. The highest number of documents were published in year 2017 which accounts for 13. The relationship between age of the articles, and the number of articles indicated increase in research activity. The highest contribution of 36% was from single authors, followed by 28% from two-author publications. Authors with 10 or more publications on Batticaloa Lagoon were affiliated to Eastern University, Sri Lanka, South Eastern University of Sri Lanka and University of Peradeniya. The relative growth rate was notably higher during 1997 (0.241), 2012 (0.183) and 2005 (0.157), suggesting increased number of publications during those periods. Tropical Agricultural Research, Journal of Science-EUSL, and AGRIEAST were the three journals to include most articles on Batticaloa Lagoon. A book on lagoons of Sri Lanka receiving 94 citations recorded the highest number of citations per year. The distribution of keywords indicates that the studies related to traditional ecological knowledge, cultural, religious and educational values, spiritual values, sense of place, or health benefits are limited.

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INTRODUCTION

Coastal lagoons are transitional ecosystems within the terrestrial and marine interface, covering approximately 13% of coastal areas worldwide (Perez-Ruzafa et al., 2011). They provide a range of resources and highly productive ecosystem services (Barbier et al., 2011). Listed among 36 global biodiversity hotspots, Sri Lanka is blessed with scenic lagoons and notable fauna and flora (IFAW, 2024).

Batticaloa Lagoon (Figure 1) is considered to be the third-largest brackish water body in Sri Lanka (Harris et al., 2023) and it is the largest among the three lagoons (Batticaloa, Vakarai and Valaichchenai) located in the Batticaloa District (Shanmugaratnam, 1995). The lagoon reaches a maximum depth of approximately four meters (Scot, 1989) and it covers an area of 11500 hectares according to the National Wetland Directory and stretches 56 Km in length from Pankudaweli to Kalmunai (IUCN Sri Lanka & The Central Environmental Authority, 2006). Therefore, 10 % of the lagoon, which is the southern end in Kalmunai falls into the Ampara district (Santharooban & Manobavan, 2005).

This broad lagoon leads to the sea by two bar mouths in Batticaloa, namely Paalameenmadu Bar, and Koddaikallar. The wetlands associated with the lagoon are rich in biodiversity, with extensive mangroves and seagrass beds in the estuary (IUCN Sri Lanka, 2004). Numerous areas of freshwater swamps are also found along with dry scrubland. More than 10,000 families depend on the lagoon fishery for livelihoods and food security (IUCN Sri Lanka & The Central Environmental Authority, 2006). There are many islands and islets in the lagoon where Manthevu was used as an isolation centre for leprosy patients for many years. The lagoon also served as an important seaport for trade during the 19th century. The Batticaloa lagoon comprises several islands within it, namely Puliyantheevu, Mantheevu, Erumaitheevu, Sirayatheevu, Bone Island. In these islands, the Puliyantheevu is important as it holds the central city of Batticaloa. The population is mainly concentrated on this

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island, and a bridges across the Batticaloa lagoon was constructed to connect the island with the mainland (Santharooban & Manobavan, 2005).

The Batticaloa Lagoon is also renowned for its "singing fish," which produces mysterious sounds like music at night during certain seasons. This distinct attraction features an unusual noise that many have described as "the sweetest trouble mingling with the lowest bass" and "the twang of the G string on a violin" (Lang, 1954). There are various explanations attributing the sound to different species of fish and shellfish or to tides flowing through empty mollusk shells or fretted rocks on the lagoon's bed (Stoker, 2002). Another suggests that the sounds originate from the Topsail Catfish, which gather in large numbers in the lagoon during specific seasons, yet only a few local residents acknowledge these occurrences. Historical evidence supports this phenomenon as a reality rather than mere fiction (Priyatharshini & Premakumar, 2013). It provides a home for many endemic species due to the unique ecosystem with mangroves, seagrass beds, and coral reefs (Kularatne et al., 2017). It contributes to a diverse and critical estuarine ecosystem that has become the lifeblood of the Eastern Province. As such, Batticaloa has been named as 'Land of lagoons and paddy fields' and 'Land of milk and honey'. However, as visitors increase in numbers since the cessation of the ethnic conflict in 2009, the Batticaloa lagoon has been subjected to significant degradation from various unplanned activities. Habitat degradation, pollution and land reclamation are threatening the biodiversity and hydrological functions of the estuary (Harris et al., 2016). Such adverse effects can be minimized if neighboring communities have an understanding on the importance of this sensitive ecosystem and a shared knowledge of conservation benefits, and coordinated action based on reliable data (Ostrom, 1990).

Bibliometric analysis offers a systematic method for quantitatively assessing scientific literature within a specific domain (Hood & Wilson 2001). This approach is beneficial for tracking research outputs and monitoring academic contributions as well as identifying gaps in natural resource management. It can also analyze the impact and breadth of research while highlighting key contributions and influential works in the fields of biodiversity and conservation research. Bibliometrics may empower stakeholders to make informed decisions regarding the prioritization of funding and policy based on evidence-driven insights. Bibliometric analysis of coastal ecosystems has effectively revealed and described available scientific literature (Adam et al., 2022; Barbosa & Lanari, 2022; Jayawardena & Seneviratne, 2023). Therefore, a bibliometric analysis on the Batticaloa Lagoon has been conducted to enhance our understanding of existing research trends, scope, and impacts while identifying areas of knowledge that require further exploration. By analyzing publication volumes, prominent authors, affiliated institutions, and

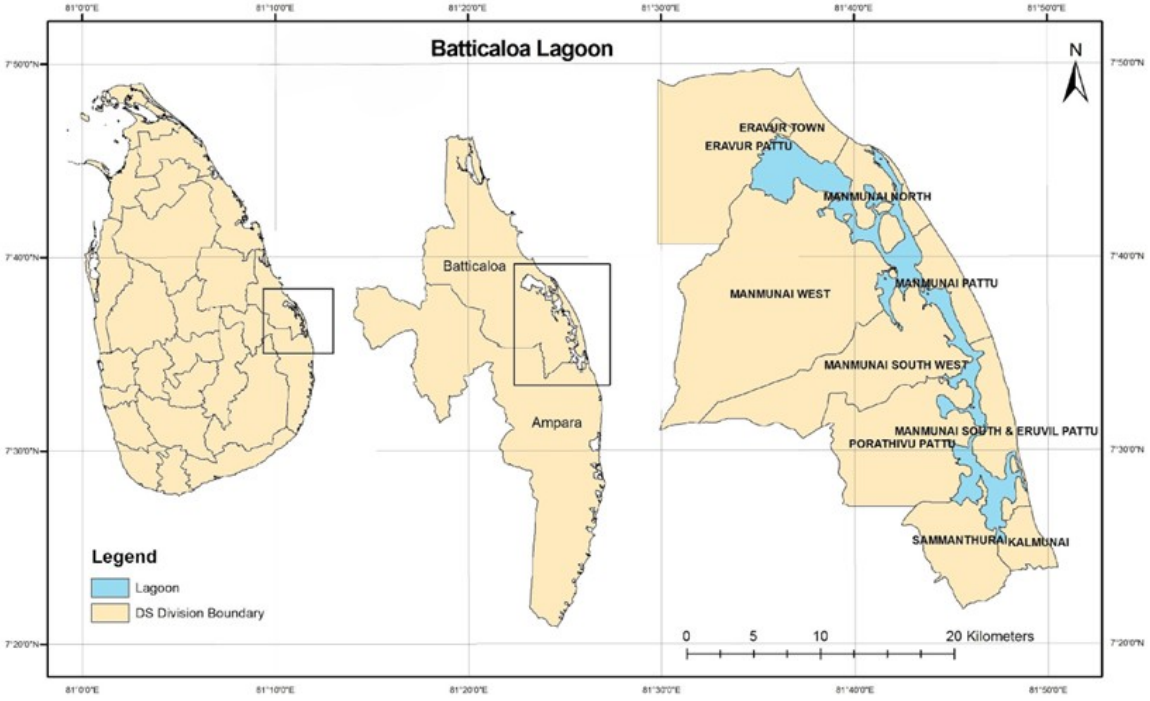

Figure 1: Batticaloa lagoon (Illustration by PJE Delina)

citation trends, this analysis has illustrated the degree of scientific contributions and partnerships within this area.

General Objective

To conduct a bibliometric analysis of scientific publications on Batticaloa Lagoon in Sri Lanka from 1954 to 2024.

Specific Objectives

1. To study the authorship patterns and publication appearance in journals
2. To identify relevant publications, research trends, types and years of publications
3. To evaluate research impact made by publications and highly cited articles
4. To find out knowledge gaps using keyword analysis

LITERATURE REVIEW

Potts (2020) concluded that 'waterbodies and rivers' were the most discussed natural resource type when compared to natural resources such as 'landscapes/catchments', 'marine/coastal area', fisheries', forestry', national parks/conservation areas', 'extractive sources', 'agriculture' and 'general natural resources'. Analysing 6608 Web of Science publications published between 2003 and 2022 on emergency information resource management, Zhang et al (2023) found that Water Resources has been listed as 4th among the top 20 disciplinary direction rankings. Further, there were 460 (7%) publications on emergency information resource management of water resources (Zhang et al., 2023). Martinez-Harms et al. (2025) have used bibliometric analysis to study ecosystem services recently. A bibliometric analysis of research by Yetein et al (2024) on the ecosystem services of coastal lagoons from 1999 to 2022 available in the Scopus database indicated a growing trend in the number of publications and citations related to the ecosystem services of coastal lagoons. It emphasized the necessity of conducting further research on the effects of land use and the perceptions of the community. This literature review aims to explore the existing body of knowledge related to coastal lagoons, with a focus on bibliometric studies.

A bibliometric analysis of 360 peer-reviewed articles on the Patos Lagoon have identified information gaps for future study. Their findings indicated an increase in research due to national collaborative efforts, and that long-term ecological studies. However, there has been little research into how subtropical coastal lagoons function (Barbosa & Lanari, 2022). Similar study used bibliometric analysis, to look into trends in international research on marine and coastal tourism, Harzing's Publish and Perish software was used to analyze the extracted articles' citation metrics. The study highlighted key journals, keywords, and publication regions in order to identify trends in the research on marine and coastal tourism. However, the study pointed out flaws in the methods used for analysis (Adam et al., 2022).

Navaneethakrishnan and Sivakumar (2015) have conducted several bibliometric studies on water resource development and utilisation-based research in Sri Lanka. An update on different document categories containing information about the Bolgoda ecosystem are available through the selected bibliography compiled by Jayawardena and Seneviratne (2023), which has enabled further analysis of grey literature and research complying with Millennium Ecosystem Services (MES) to reveal valuable insights for a variety of stakeholders. A bibliometric analysis by Rubini et al (2023) on publications during 1969–2021 listed in four electronic databases; Scopus, PubMed, Web of Science, and Google Scholar on water quality in Northern Province of Sri Lanka has resulted 118 records. The attempt discovered implications on scientific output in terms of its quality, peer review process, and usefulness of the work in the local context policy making. Nevertheless, there has been limited research on the bibliometric analysis of coastal lagoons, both internationally and locally. This study is important as this is the first bibliometric analysis on the Batticaloa Lagoon, which can help us understand research landscape in the context of Batticaloa Lagoon.

RESEARCH METHODS

The effort to assess the published research on Batticaloa Lagoon concentrated on two academic databases, specifically Scopus and Web of Science, and the search engine Google Scholar. Scopus and Web of Science offer high-quality, organized information that can be utilized for systematic bibliometric analyses in the fields of environmental sciences and related areas (Cascajares et al., 2021). Google Scholar plays a vital role in comprehending the research concerning Batticaloa Lagoon, as it frequently includes unpublished works (Grey literature) or regionally available content that is absent from well-known international databases. This is especially important for a subject that is

localized, where findings from local studies may not be featured in globally esteemed journals (Adriaanse & Rensleigh, 2011).

To find relevant records, title, abstract, and keyword search in Scopus and Web of Science was performed to retrieve scholarly publications related to Batticaloa Lagoon. Publish or Perish (PoP) software was used to perform systematic and reproducible searches in Google Scholar search engine. The literature search conducted in January 2025 using the keyword "Batticaloa Lagoon" as the search query yielded 16 records in Scopus, 15 in Web of Science, and 547 in Google Scholar. Eventually, 180 documents were manually sorted as directly relevant to the search query by excluding publications in other languages and news items. The selected documents were further analyzed to obtain information on publication type, year, number of authors per publication, number of citations, institutions with the most prolific authors, collaborations, and keywords etc. (Figure 2).

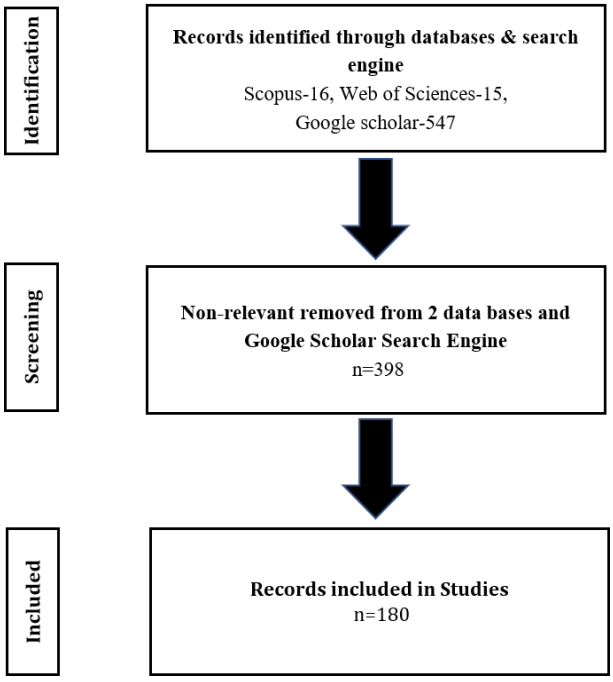

Figure 2: Selection procedure of documents

RESULTS AND DISCUSSION

Types, years and relative growth rate of publications from 1954 to 2024

In this study, journal articles, conference papers in proceedings, dissertations and books/book chapters related to Batticaloa Lagoon, are collectively referred to as scholarly publications. The percentage distribution among different types of publications are shown in Table 1. Among those 180 publications, approximately 43% were journal articles, 28% were articles from conference proceedings, and 12% were theses and dissertations.

According to the results, the year 1954 records the first publication on the Batticaloa lagoon. The publications over the years are shown in Figure 3, and minimal activity can be observed from 1954 to 2000, averaging less than two to three per year. There is dynamic growth afterwards. The highest number of documents was published in 2017, which accounts for 13, followed by 12 articles each during 2012, 2019, and 2021.

Table 1: Types of publications

Types of publication	Count	Percentage (%)
Journals	77	43
Conference papers	51	28
Theses and dissertations	21	12
Books and Book chapters	14	08
Others (Reports)	11	06
Not specified	6	03
Total	180	100

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The Batticaloa Lagoon may have received little scholarly attention, possibly due to a lack of interest, funding or environmental urgency. The ecological and social relevance of Batticaloa Lagoon may becoming widely understood, with the increase in publications over the last two decades. Given the developing trends, future research may focus on interdisciplinary efforts including sustainable management of ecosystems and community engagement. underscoring the necessity for more contemporary research in this area.

Figure 4 displays the Relative Growth Rate (RGR) in bibliometrics. The RGR value variations reflect changes in growth dynamics which are notably higher during 1997 (0.241), 2012 (0.183) and 2005 (0.157), suggesting increased number of publications during those periods.

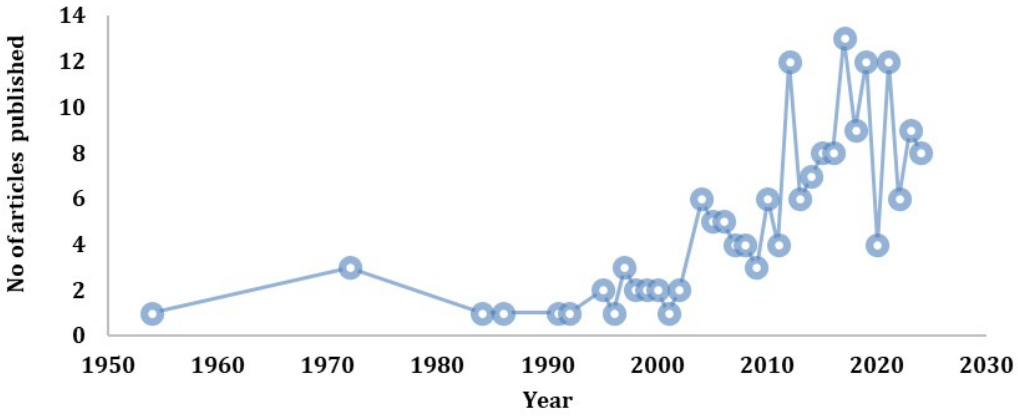

Figure 3: Number of publications by year from 1954 to 2024

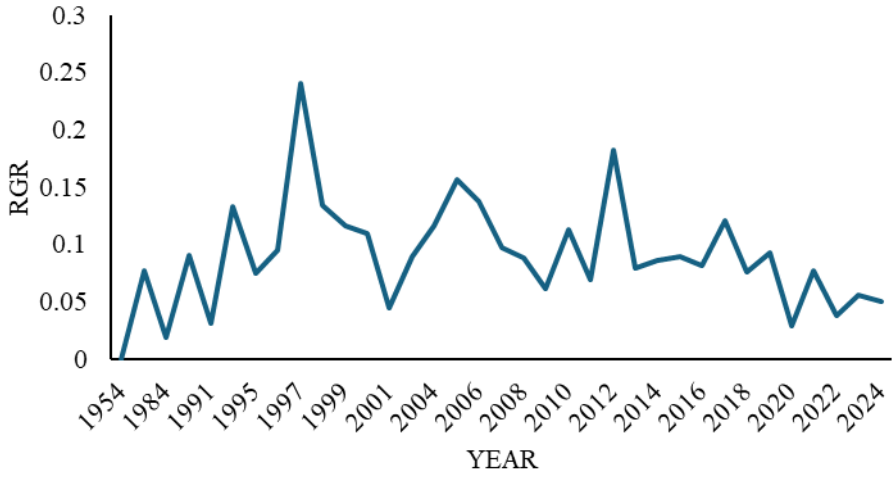

Figure 4: Relative Growth Rate (RGR) between 1954 to 2024

Most popular journals, conferences and highly cited articles between 1954 to 2024

Based on Table 1, over 40% of the publications are from journal articles and the top 10 source titles are shown in Table 2. An examination of the sources reveals that 'Tropical Agricultural Research' published by the University of Peradeniya is the leading journal, featuring five articles. The two journals published by the Eastern University of Sri Lanka, 'Journal of Science' has four articles followed by 'AGRIEAST' having three articles. These highlights the significance of agricultural viewpoints in lagoon and estuarine research and also indicates contributions from local researchers. Furthermore, 'Bulletin of Environment', 'Pharmacology and Life Sciences', 'Environmental Science and Pollution Research', 'Regional Studies in Marine Sciences', 'Thalassas: An International Journal of Marine Sciences' are recorded as the international journals with two articles each on Batticaloa Lagoon.

Fifty-one conference papers from 36 conferences are also recorded in which only four events were held in overseas. 'Workshop on Strategies for the Management of Fisheries and Aquaculture in Mangrove Ecosystems, Bangkok, Thailand, 1986'; 'First Session of the APFIC Working Party on Marine Fisheries, Bangkok, Thailand, 1997'; 'International Conference on Disaster Management, Japan, 2012' and 'Proceedings and a Call for Action from an MFF Regional Colloquium, India 2012' are the overseas events that mentions about Batticaloa Lagoon. Table 3 presents the most popular locally held conferences where publications related to the Batticaloa Lagoon were made.

The Annual Conferences at Eastern University, Sri Lanka seems the most dominant forum for sharing research on Batticaloa Lagoon and related topics. Conferences at Southeastern

University of Sri Lanka has also made a significant contribution promoting research related to Batticaloa Lagoon. Publications from The International Conference: Meeting on Mangrove Ecology, Functioning, and Management (MMM3), held in Galle, Sri Lanka, has been cited four times, indicating the importance of mangrove-related research. The International Symposium at Sabaragamuwa University of Sri Lanka also reflects its role in advancing academic dialogue on this subject. In summary, these four conferences have been consistent platforms for showcasing research on Batticaloa Lagoon over the years considered in this study.

Table 4 displays the most referenced publications on lagoons, estuaries, and socio-environmental research in Sri Lanka, especially in relation to the Batticaloa Lagoon. 'Lagoons of Sri Lanka: from the Origins to the Present' ranks as the most cited work among those listed, indicating a significant scholarly engagement with 94 citations. An article titled as *"Carbon sequestration capacity of mangrove soils in micro tidal estuaries and lagoons: A case study from Sri Lanka"* (64 citations) and a book titled *"Lagoons and Estuaries"* (58 citations) also show strong academic attention. The quantity of environmental studies is significant, indicating an increasing focus on ecological conservation and climate research. However, studies that are exclusively on Batticaloa are less often cited, even if they are still quite important locally.

Table 2: Most popular journals during 1954 to 2024

Journal name	Publisher type	Article count
Tropical Agricultural Research	Local	5
Journal of Science, EUSL	Local	4
AGRIEAST	Local	3
Bulletin of Environment, Pharmacology and Life Sciences	International	2
Ceylon Journal of Science	Local	2
Environmental Science and Pollution Research	International	2
OUSL Journal	Local	2
Regional Studies in Marine Science	International	2
Thalassas: An International Journal of Marine Sciences	International	2
Trends in Biosciences	International	2

Table 3: Conferences in Sri Lanka from 1954 to 2024 with papers on Batticaloa Lagoon

No	Name of conference	Occurrence
1	Annual conferences at Eastern University, Sri Lanka	9
2	Conferences at South Eastern University of Sri Lanka	5
3	International Conference: Meeting on Mangrove Ecology, functioning and Management, (MMM3), Galle, Sri Lanka	4
4	International Symposium, Sabaragamuwa University of Sri Lanka	3

Author count, degree of collaboration and most prolific authors during 1954 to 2024

Authorship pattern in bibliometric study reflects the authors' characteristics, authorship of articles and degree of collaboration among the researchers in specific studies (Manikumar & Chandrasekar, 2020). Single authorship constitutes 36% of the total contribution, followed by 28% two-author publication as shown in Figure 5. Single-authored publications gaining attention in Batticaloa Lagoon studies may imply challenges in collaboration or limited access to scientific networks with similar interests. There are only a limited number of papers with more than five authors, and the highest number of authors have been recorded as twelve only in one instance. It is essential to promote interdisciplinary and

Table 4: The most cited works

Title	ECC/ Cites	Authors	Source
Lagoons of Sri Lanka: from the origins to the present	94	E.I.L. Silva, J. Katupotha, O. Amarasinghe, H. Manthrithilake, R. Ariyaratna	Book
Carbon sequestration capacity of mangrove soils in micro tidal estuaries and lagoons: A case study from Sri Lanka	64	K Perera, M.D. Amarasinghe	Journal
Lagoons and estuaries	58	S. Miththapala	Book
Impact of water quality on species composition and seasonal fluctuation of planktons of Batticaloa lagoon, Sri Lanka	40	J.M. Harris, P. Vinobaba	Journal
Development of water and energy Budget-based Rainfall-Runoff-Inundation model (WEB-RRI) and its verification in the Kalu and Mundeni River Basins, Sri Lanka	37	M. Rasmy, T. Sayama, T. Koike	Journal

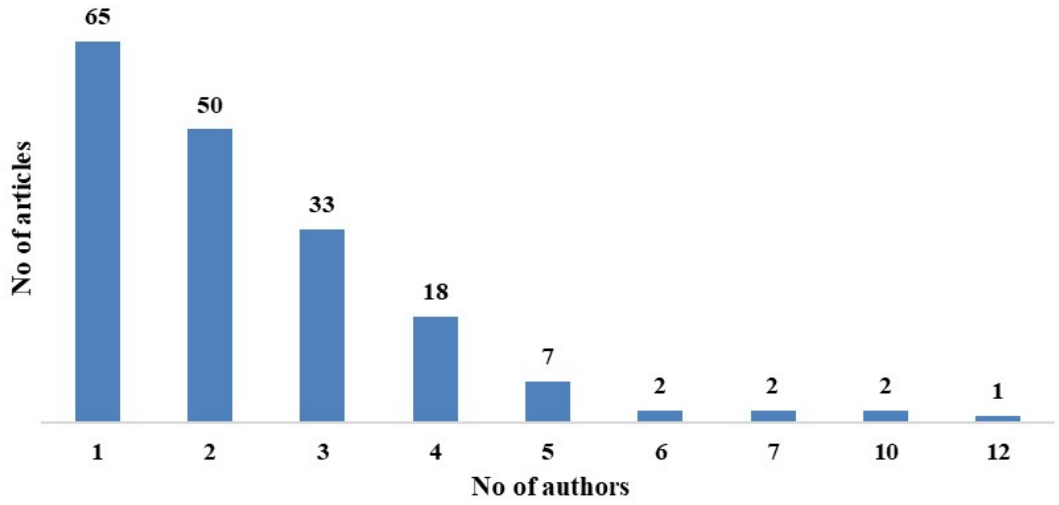

Figure 5: Authorship patterns from 1954 to 2024 on Batticaloa Lagoon

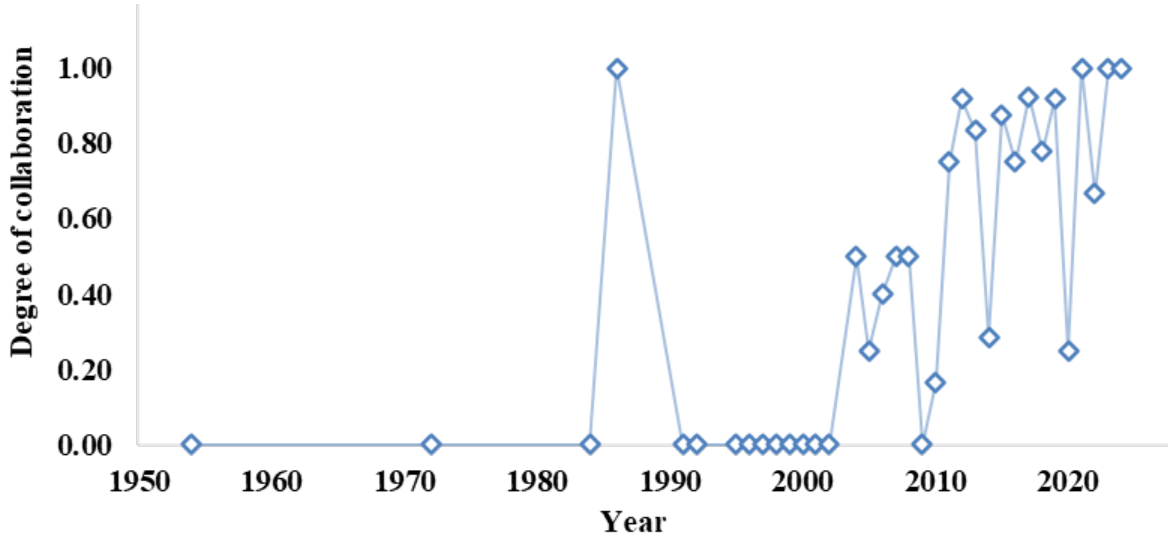

Figure 6: Degree of collaboration

institutional partnerships to promote a wider range of research on Batticaloa Lagoon.

The degree of collaboration computed according to Subramanyan (1983) ranges from 0 to 1 and the highest value of 1 (higher level of collaborations) was recorded in 1986, 2021, 2023, and 2024 (Figure 6). Table 5 depicts the details of the most prolific authors and Eastern University, Sri Lanka, has 6 of the top 14 authors. Notably, P. Vinobaba and A.J.M. Harris authored the highest number of publications (23 and 21, respectively), showing consistent contributions to this research area. Researchers with ten or more publications on Batticaloa Lagoon are also recorded from South Eastern University of Sri Lanka, and the University of Peradeniya. The Eastern University may have a higher attention for research on the Batticaloa Lagoon, due to its close geographic location and academic emphasis on local environmental matters. Academics from University of Colombo, University of Kelaniya, and University of Sri Jayewardenepura are also

Table 5: Most prolific authors on Batticaloa Lagoon and their contributions with affiliations for the duration of 1954 to 2024

Author name	No of contribu-tions	Affiliation
P. Vinobaba	23	Eastern University, Sri Lanka
A.J.M. Harris	21	Eastern University, Sri Lanka
M. Adikaram	13	South Eastern University of Sri Lanka
H.M.T.G.A. Pitawala	10	University of Peradeniya
A.M. Riyas Ahamed	10	Eastern University, Sri Lanka
H. Ishiga	9	Shimane University
M. Manobavan	8	Eastern University, Sri Lanka
M. Sugirtharan	7	Eastern University, Sri Lanka
M. Dharmaretnam	7	Eastern University, Sri Lanka
S. Pathmarajah	7	University of Peradeniya
R.K.A. Kularatne	7	University of Colombo
D.T. Jayawardana	7	University of Sri Jayewardenepura
M.D. Amaransinghe	7	University of Kelaniya
S. Santharooban	6	Eastern University, Sri Lanka

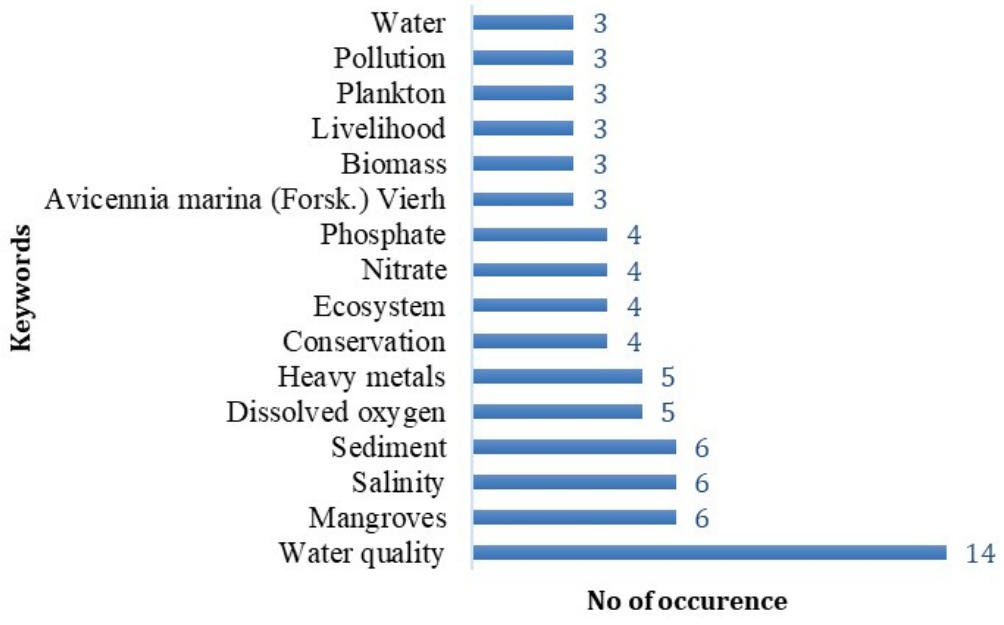

Figure 7: Prominent keywords in publications during 1954 to 2024

among the leading contributors, reflecting interest in Batticaloa Lagoon research as a nationally important scholarly involvement. H. Ishiga from Shimane University (Japan) appears with 9 publications, showing evidence of international contributions.

Dominant keywords

Analysing keywords would help in identifying the predominant themes within literature. Figure 7 illustrates the occurrence of specific keywords out of 478 keywords found in selected 180 publications on Batticaloa Lagoon. The prominent keywords were Water quality, Mangroves, Salinity, Sediments, Dissolved oxygen, and Heavy metals. Water Quality appearing 14 times indicates that considerable research focuses on the water quality of the lagoon. *Avicennia marina* (Forsk.) Vierh (a species of mangrove), Livelihood, and Pollution are fewer occurring keywords, and appear 3 times each.

When 478 keywords are analysed according to the Millennium Ecosystem Assessment (2005); 39.5% (189 keywords) represent regulating services such as climate regulation, flood regulation, disease regulation and water purification; 21.5% (103 keywords) represent supporting services such as nutrient cycling, soil formation and primary production; 8.8% (42 keywords) represent provisioning services such as food, freshwater, wood and fibre fuel, and 1.7% (8 keywords) represent cultural services such as aesthetic, spiritual, educational and recreational services. Further, 136 keywords (28.5%) represented mixed themes.

The distribution of keywords indicates that the studies related to traditional ecological knowledge, cultural, religious and educational values, spiritual values, sense of place, or health benefits are limited.

CONCLUSIONS AND RECOMMENDATIONS

Promoting interdisciplinary and institutional collaborations is vital for advancing the research on Batticaloa Lagoon. The ecological and social importance of Batticaloa Lagoon is gaining wider attention, as indicated by the increase in publications. The volume of environmental research is notable, reflecting a growing focus on ecological preservation and climate studies. However, articles that exclusively address Batticaloa tend to garner fewer citations despite their significant local relevance. Most of the current scientific literature on Batticaloa Lagoon primarily addresses the regulation, provisioning, and supporting services of ecosystems, with relatively little focus on cultural ecosystem services.

This study provides important insights into the historical evolution and thematic concentration of research conducted on the Batticaloa Lagoon for the period of 1954 to 2024. By emphasizing influential studies, the research offers direction to local scholars and funding agencies. The findings also uncover important research networks, enhancing collaboration trends in the area. Future inquiries should fill the gap concerning cultural ecosystem services to ensure a comprehensive understanding of the ecological and social importance of the Batticaloa Lagoon. Fortifying interdisciplinary partnerships and expanding research networks can contribute to more thorough and sustainable management of the lagoon ecosystem.

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