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Bibliometric analysis of water quality assessment of Coastal Lagoons based on Water Quality Indices

Babadjide R.[1*], Lingofo R.B.[2]**

[1]*Water-Energy-Environment-Agriculture Expertise Office, P.O.Box 2175, Abomey-Calavi, Benin*
[2]*Department of Hydrobiology and Aquaculture, University of Kisangani, P.O.Box 2012, Kisangani, DRC*

**Corresponding author, Email address: reginarojanvier@gmail.com*
***Corresponding author, Email address: rlingofo@gmail.com*

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Abstract: Coastal lagoons are subjected to environmental pressures mainly of anthropogenic origin, which significantly impact the quality of their waters. The use of water quality indices is an essential tool that provides multiple pieces of information simultaneously about water quality. The present study aims to analyze the evolution of scientific publications on the assessment of water quality in coastal lagoons based on Water Quality Indices (WQI). To this end, a review was conducted using the keywords "Water Quality Index" AND "Coastal Lagoon" limited to publications written in English and indexed in the Scopus database between 2000 and August 2025. In total, 16 documents were identified. Bibliometric analysis was performed using Biblioshiny, a feature of the Bibliometrix package in the R 4.2.3 software. The results reveal a relatively small number of publications explicitly addressing the topic indexed in Scopus database. These publications cover the period from 2007 to 2025, with a predominance of articles less than five years old. The number of citations per publication ranges from 0 to 71. Among the journals, only Marine Pollution Bulletin has 3 articles on this subject. On the African continent, the mentioned research comes exclusively from Egypt and Ghana. The main keywords used in these studies notably include water quality, environmental monitoring, coastal lagoon, and eutrophication. This bibliometric analysis explicitly highlights the need to develop research on this topic in Benin as well as in other African countries, in order to assess the usability quality waters of coastal lagoon.

1. Introduction

Coastal lagoons are aquatic ecosystems located at the interface of freshwater, marine, and terrestrial environments (Rodrigues-Filho *et al.*, 2023). Globally, these lagoons are recognized as among the aquatic ecosystems with the highest biological productivity (Pérez-Ruzafa *et al.*, 2024). Besides their high productivity, they provide numerous essential ecosystem services for societal well-being (Rodrigues-Filho *et al.*, 2023; Han *et al.*, 2024). Nevertheless, these ecosystems are subject to various anthropogenic pressures that increase their vulnerability (Pérez-Ruzafa *et al.*, 2024; Lingofo *et al.*, 2024 & 2025).

To date, a notable degradation of water quality has been observed (Zandagba *et al.*, 2016; Lingofo *et al.*, 2024 & 2025), accompanied by a significant decline in biodiversity within these hydrosystems (Jennings *et al.*, 2012). Indeed, water quality is a determining factor for the health of both living organisms and human populations (Tibebe *et al.*, 2023; Agbaje *et al.*, 2024). These authors indicated that access to potable water is a fundamental element for the socio-economic development of communities. Furthermore, water is essential for various activities such as agriculture, industry, tourism, leisure, and navigation. The assessment of water quality in accordance with established standards is a fundamental element in the sustainable management of water resources (Tibebe *et al.*, 2023). Lingofo *et al.* (2024) noted that regular monitoring of water quality is indispensable for the conservation of ecosystem services as well as the biodiversity of aquatic systems. Various methodological tools are used to assess water quality, including principal component analysis, discriminant analysis, factor analysis, multiple linear regression, correlation matrices, etc., as well as different indices such as the Water Quality Index (WQI), the Organic Pollution Index (OPI), and the Trophic State Index (TSI) (Yéo *et al.*, 2023).

Among these tools, the Water Quality Index (WQI) is one of the most frequently used to assess water quality (Lukhabi *et al.*, 2023). These authors highlight its major advantage, which lies in its ability to provide multiple pieces of information in a single representative numerical value. Moreover, this index facilitates spatio-temporal comparisons related to water quality. Nevertheless, despite its recognized strengths, its specific application to the assessment of coastal lagoon water quality remains relatively limited compared to other aquatic environments such as rivers, lakes, etc.

In recent years, the number of studies on bibliometric analysis in various fields has experienced continuous growth (Moral-Muñoz *et al.*, 2020; Büyükkidik, 2022; Kachbou *et al.*, 2025). The bibliometric analysis is a discipline that applies quantitative and statistical methods to the study of scientific production, primarily through the analysis of publications, citations, and collaboration networks (Hammouti *et al.*, 2025). It enables the identification of research trends, the evaluation of scholarly impact, the mapping of knowledge domains, and the measurement of the dynamics of idea diffusion. By providing objective indicators of scientific activity (such as the number of publications, impact factors, the h-index, or co-authorship networks), bibliometrics plays a central role in understanding and evaluating research systems. Beyond its evaluative function, it also contributes to shaping science policies, informing strategic decision-making, and supporting the cumulative advancement of knowledge by integrating its findings with those of prior research (Byiringiro *et al.*, 2025). Furthermore, Büyükkidik, (2022) emphasized that synthesizing results from bibliometric data combined with those from previous research represents a crucial step for the cumulative progress of scientific knowledge.

This study aims to conduct a bibliometric review of works dedicated to the assessment of the water quality of coastal lagoons based on Water Quality Indices (WQI) in order to understand the current state of research on this topic in Africa and to initiate this type of research to evaluate the usability quality of the waters of the coastal lagoons of Benin.

2. Methodology

2.1 Sourcing and preparation

Within the framework of this study, the bibliometric analysis method used has been adopted by several researchers, notably Moral-Muñoz *et al.* (2020), Büyükkidik (2022), Nikiema *et al.* (2023) and Ab Rashid (2023).

The metadata used to conduct the bibliometric analysis of the present research were extracted from the Scopus database. This choice is explained by the fact that the Scopus database is one of the main databases containing a large number of high-quality publications. Moral-Muñoz *et al.* (2020) indicated that the first step of a bibliometric analysis consists of selecting the most appropriate data source for the scientific coverage of the studied field. According to Boulanger (2023), the choice of the Scopus database is based on its reputation for indexing peer-reviewed articles recognized for their quality, as well as its thematic breadth. Furthermore, Suhaimi and Mahmud (2022) reported that documents extracted from the Scopus database are filtered according to titles, abstracts, and keywords.

In the context of the present study, a literature review was conducted using various keywords relevant to the studied topic. Initially, 8,368 documents were identified using the keyword "Water Quality Index." Subsequently, the combined use of the keywords "Water Quality Index" and "Lagoon" allowed for the identification of 75 documents. Finally, the association of the terms "Water Quality Index" and "Coastal Lagoon" led to the selection of 17 documents. According to Nikiema *et al.* (2023), the Boolean operators "AND" and "OR" are commonly used in advanced bibliographic searches. **Table 1** illustrates the bibliographic search strategy on the Scopus database for this bibliometric analysis.

Table 1. Bibliographic search strategy on the Scopus database for bibliometric analysis

Query Wording	Details	Number of documents
"Water Quality Index"	In Title, Abstract, Keywords	8368 (after refining)
"Water Quality Index" AND "Lagoon"	In Title, Abstract, Keywords	75 (after refinng)
"Water Quality Index" AND "Coastal lagoon"	In Title, Abstract, Keywords	17 (after refining)

The metadata used for the bibliometric analysis cover the period from 2000 to August 2025 and concern exclusively publications in English. The PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was employed to perform a rigorous filtering of the information (see **Figure 1**). This methodological approach is commonly adopted in bibliometric research, as evidenced by the works of Malapane *et al.* (2022) and Büyükkidik (2022).

2.2 Bibliometric analysis

Details of experiments are exactly the bibliographic metadata extracted in this study includes 16 documents containing data related to the authors, the journals in which these contributions were published, the institutional affiliations of the authors, the number of citations received, the countries of origin of the publications, as well as the keywords used by the authors (Lrhoul *et al.*, 2023).

To conduct the analysis of the bibliographic metadata, the Excel file containing the data was imported into Biblioshiny via the Bibliometrix package of R software version 4.2.3. Furthermore, the names of the water quality indices, the parameters used, and the specific objectives of each study were taken into account. Büyükkidik (2022) indicated that the Biblioshiny interface of the Bibliometrix package of R software is a commonly used tool for conducting bibliometric analyses. According to Malapane *et al.* (2022), this interface highlights major trends, influential authors, high-impact journals, emerging research themes, etc.

2.3 Visualization data

Apart from the geolocation map and graphs related to keywords obtained directly via the Biblioshiny interface, all other graphical visualizations were produced using the ggplot2 package of R software version 4.2.3.

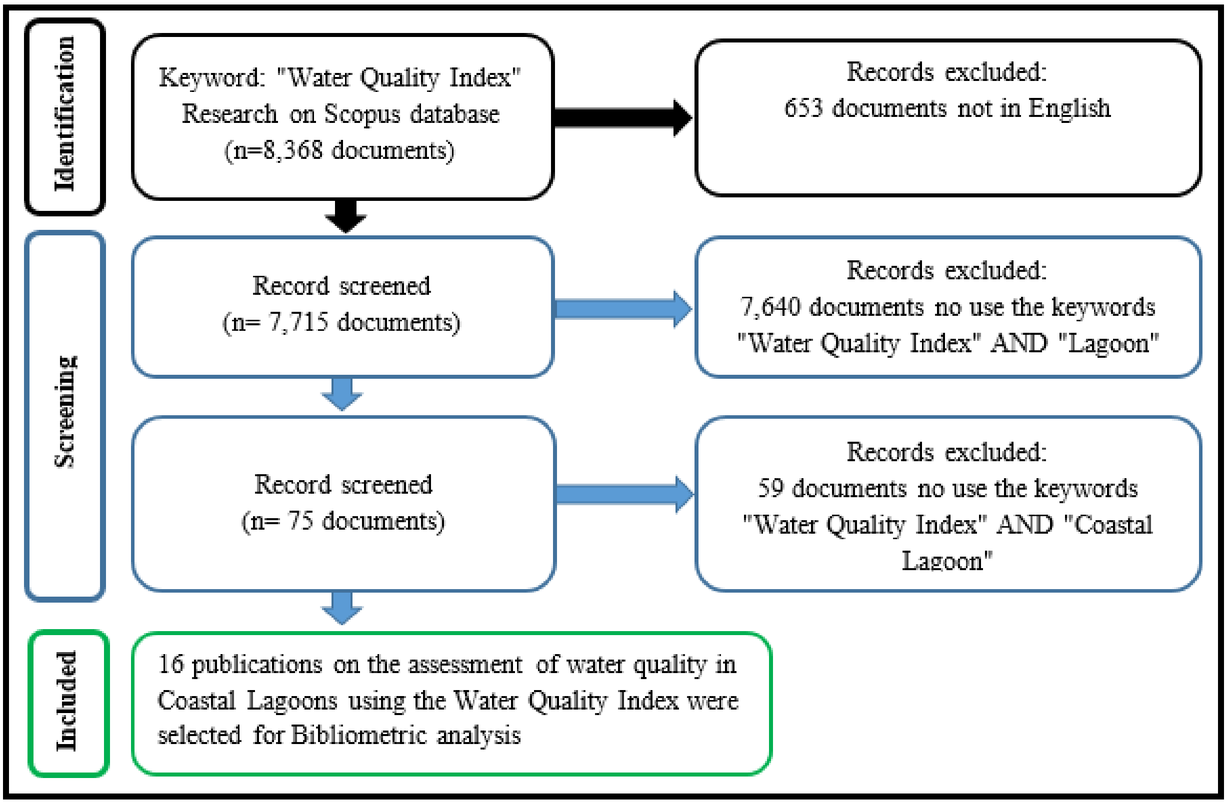

Figure 1. Diagram of the selection process of publications for Scopus based on PRISMA.

3. Results and Discussion

Bibliometric analysis reveals a limited number of publications indexed in the Scopus database devoted to assessing the water quality of coastal lagoons using Water Quality Indices (WQI). **Table 2** compiles the various publications examined in this study.

Table 2. List of 16 publications indexed in the Scopus database and analysed in this study.

N°	Authors and Year	Title	Journal
1	Wazniak C.E., Hall M.R., Carruthers T.J.B., Sturgis B., *et al*. (2007)	Linking water quality to living resources in a mid-Atlantic Lagoon system, USA	*Ecological Applications*
2	Badosa A., Boix D., Brucet S., López-Flores R., Quintana X.D. (2008)	Short-term variation in the ecological status of a Mediterranean coastal lagoon (NE Iberian Peninsula) after a man-made change of hydrological regime	*Marine and Freshwater Ecosystems*
3	Tay C., Asmah R., Biney C.A. (2010)	A comparative study of the pollution status of Sakumo II and Muni Lagoons in Ghana	Water Science and Technology
4	Taner M.Ü., Üstün B., Erdinçler A. (2011)	A simple tool for the assessment of water quality in polluted lagoon systems: A case study for Küçükçekmece Lagoon, Turkey.	Ecological Indicators
5	Cañedo-Argüelles M., Rieradevall M., *et al.* (2012)	Annual characterisation of four Mediterranean coastal lagoons subjected to intense human activity	Estuarine, Coastal and Shelf Science

6	Christia C., Giordani G., Papastergiadou E. (2014)	Assessment of ecological quality of coastal lagoons with a combination of phytobenthic and water quality indices	Marine Pollution Bulletin
7	Ruiz-Ruiz T.M., Arreola-Lizárraga J.A., Morquecho L., Mendez-Rodríguez L.C., *et al*. (2017)	Detecting eutrophication symptoms in a subtropical semi-Arid Coastal Lagoon by means of three different methods	*Wetlands*
8	Kulshreshtha A., Shanmugam P. (2018)	Assessment of trophic state and water quality of coastal-inland lakes based on Fuzzy Inference System	*Journal of Great Lakes Research*
9	Alprol A.E., Heneash A.M.M., Soliman A.M., Ashour M., *et al*. (2021)	Assessment of Water Quality, Eutrophication, and Zooplankton Community in Lake Burullus, Egypt	*Diversity*
10	Al-Afify A.D.G., Abdo M.H., Othman A.A., Abdel-Satar A.M. (2023)	Water Quality and Microbiological Assessment of Burullus Lake and Its Surrounding Drains	*Water, Air, & Soil Pollution*
11	Muhtadi A., Yulianda F., Boer M., Krisanti M., Riani E., Leidonald R., Hasani Q., Cordova M.R. (2023)	Assessment of pollution status of tropical coastal lakes using modified Water Quality Index (WQI) based on physio-chemical parameters	*AACL Bioflux*
12	Zaghloul Et Al. F.A. (2023)	Modified Water Quality Index and Multivariate Analysis for Water Quality Assessment in El-Mex Bay, Alexandria, Egypt: A Study of the Largest Drain in the Southeastern Mediterranean Sea	*Egyptian Journal of Aquatic Biology and Fisheries*
13	Ayitey S., Nijamdeen T.W.G.F.M., Peiris H., Arachchilage S.K., George I., *et al*. (2024)	Human health risk attributed to consumption of seafood and recreation swimming in Negombo Lagoon, Sri Lanka: An assessment on lagoon water and inhabitant oysters (Crassostrea cucullata Born, 1778)	*Marine Pollution Bulletin*
14	Özdemir N., Dokuyucu A., Ceviz N.A., Döndü M., Demirak A., Keskin F. (2024)	A comparative assessment of the lagoons with water quality indexes and based on GIS: A study on the Aegean Sea and Mediterranean Sea	*Environmental Forensics*
15	Cravo A., Barbosa A.B., Lima M.J., Ferreira C., Correia C., Matos A., Jacob J., Caetano S. (2025)	Water quality for bivalve molluscs and consumer safety: Application of novel and adapted multimetric indices in a coastal lagoon system exposed to wastewater discharges	*Marine Pollution Bulletin*
16	De Oliveira Muniz Cunha P.M., De Sousa J.S.D., Da Cruz M.C.S., Coutinho R., Domingos P., *et al*. (2025)	Environmental risk assessment methodology for urban tropical lagoons based on feasible lines of evidence under limited resources conditions: Jacarepaguá Lagoon/Brazil	*Ecotoxicology*

Figure 2 shows that publications related to the topic covered were identified from 2007 to August 2025. Before 2023, scientific output remained low, characterised by years with no publications or with only one annual contribution. From 2023 onwards, a minimum of two publications per year were systematically recorded. This increase can be attributed to the growing importance attached by the international community to the sustainable management of coastal lagoons in recent years.

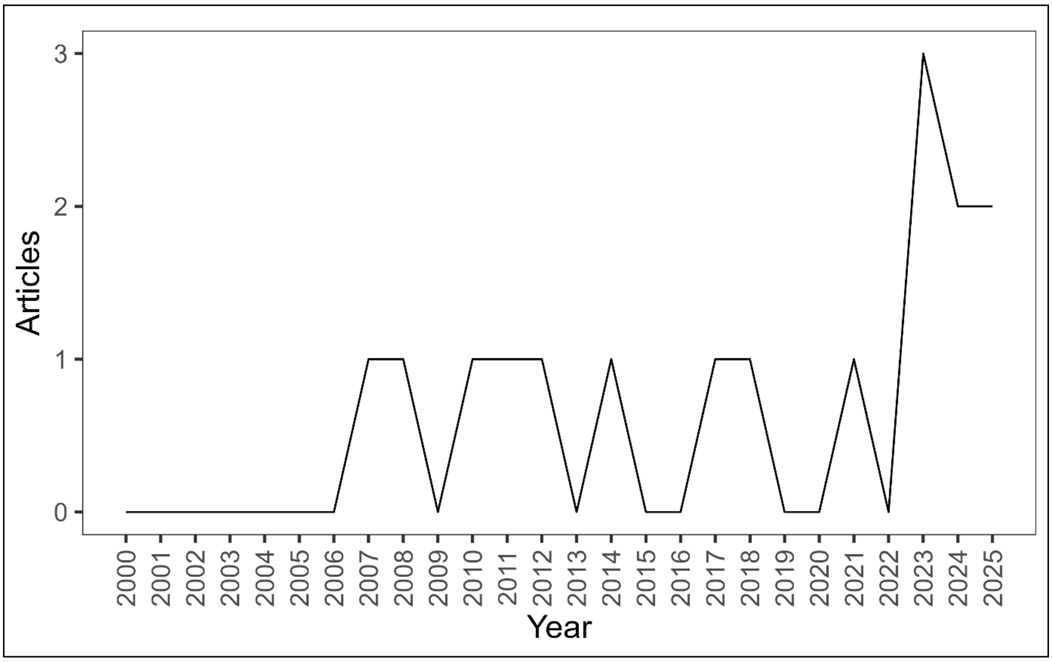

Figure 2. Annual evolution of scientific output on the assessment of coastal lagoon water quality based on Water Quality Indices between 2000 and 2025.

Figure 3 shows that the study conducted by Alprol *et al.* (2021) is the most cited publication, with a total of 71 citations, followed by the work of Wazniak *et al.* (2007) with 54 citations, Christia *et al.* (2014) with 46 citations, Taner *et al.* (2011) with 42 citations, and Cañedo-Argüelles *et al.* (2012) with 37 citations. In contrast, the articles recently published by De Oliveira Muniz Cunha *et al.* (2025) and Cravo *et al.* (2025) have not been cited to date.

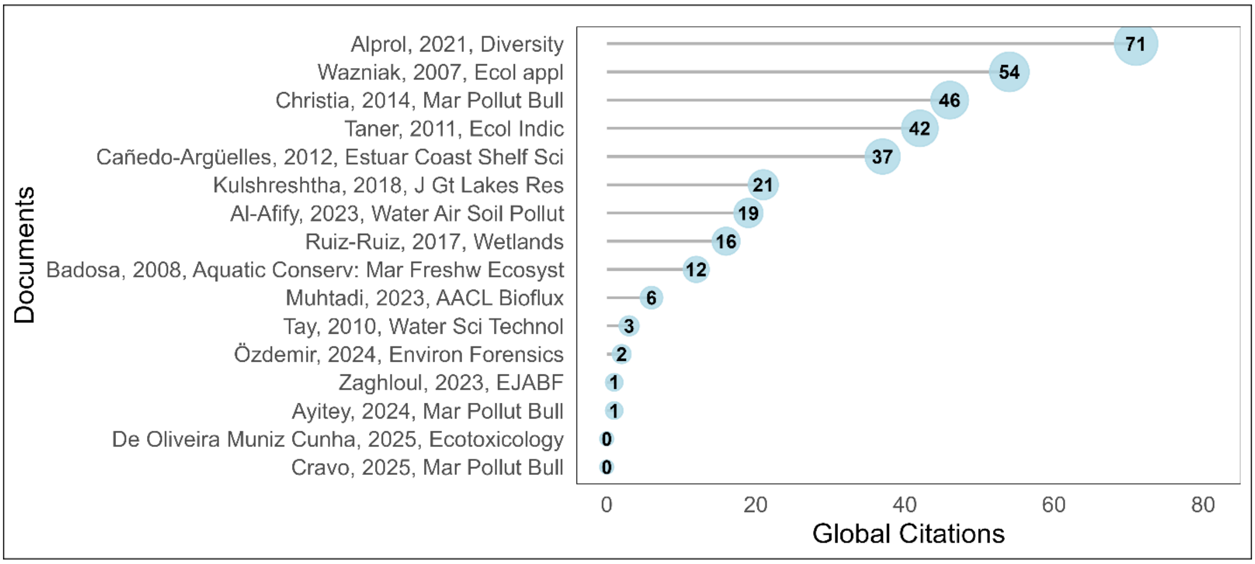

Figure 3. Number of citations of the documents analyzed

Analysis of **Figure 4** reveals that the average annual number of citations varies between 0 and 14.20 citations per year. The maximum average is obtained in 2021. The following years also stand out with a significant number of citations: 2007 with 54 citations, 2014 with 46 citations, 2011 with 42 citations, and finally 2012 with 37 citations.

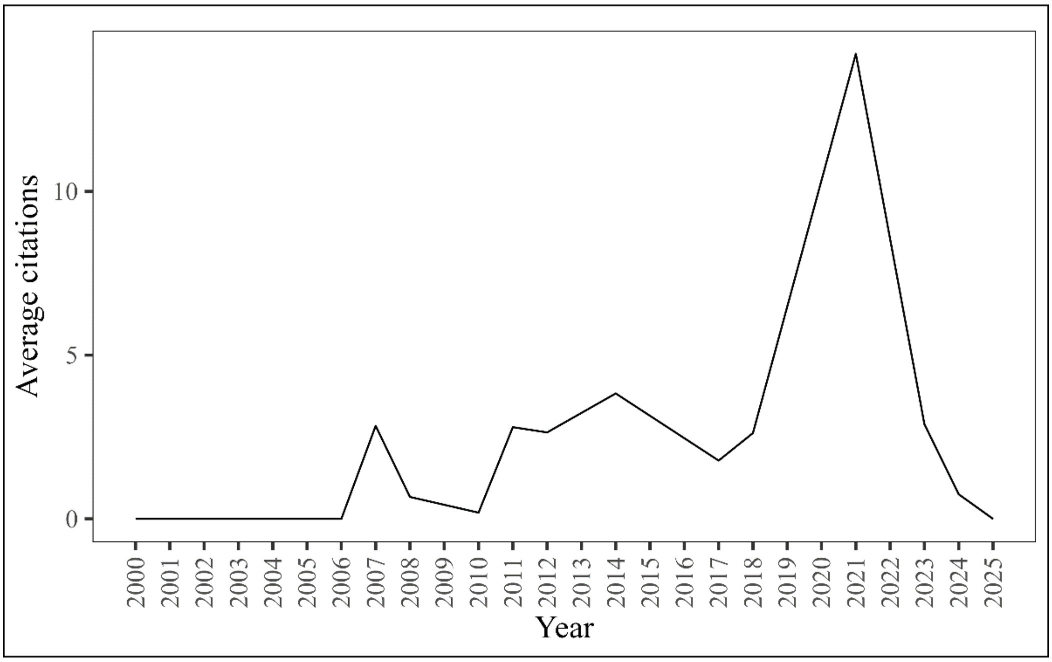

Figure 4. Average annual number of citations of the documents examined.

Figure 5 shows that the 16 documents analysed were published in 14 different journals. Among these, Marine Pollution Bulletin stands out with three publications, while each of the other journals published only one article.

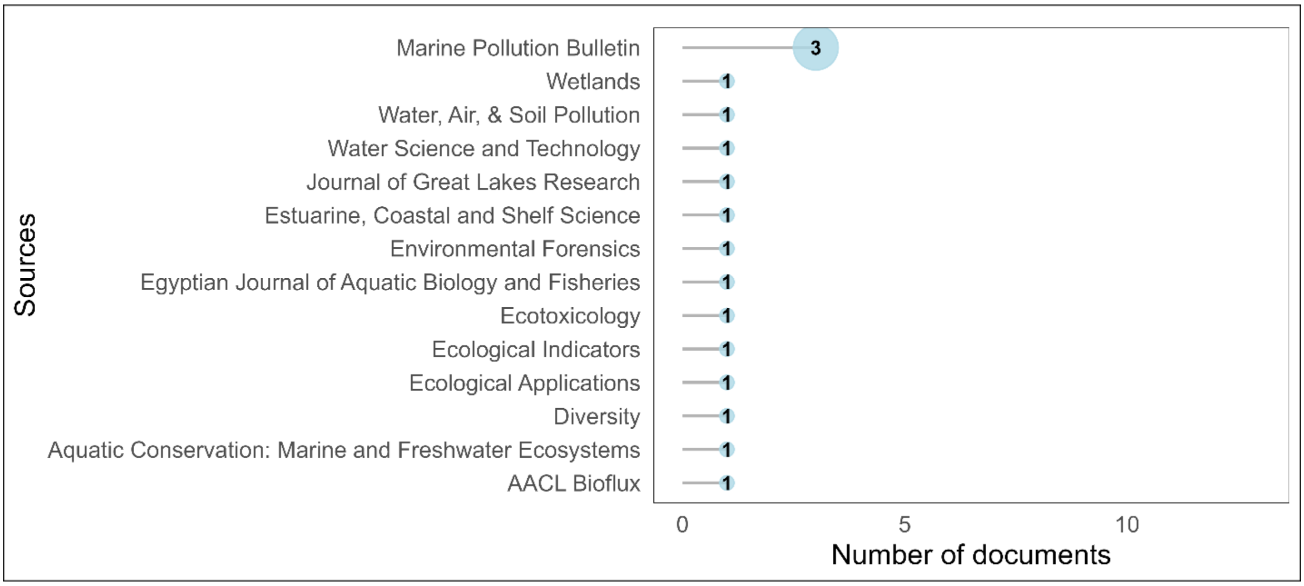

Figure 5. Number of publications per journal during the period 2000 to 2025

Figure 6 reveals that the authors of the various publications analysed are affiliated with 37 different international institutions. The National Institute of Oceanography and Fisheries stands out as the most prolific institution with three publications. It is followed by Bogazici University and the Centro de Investigaciones Biologicas del Noroeste, each with two publications. The other institutions each contributed a single publication.

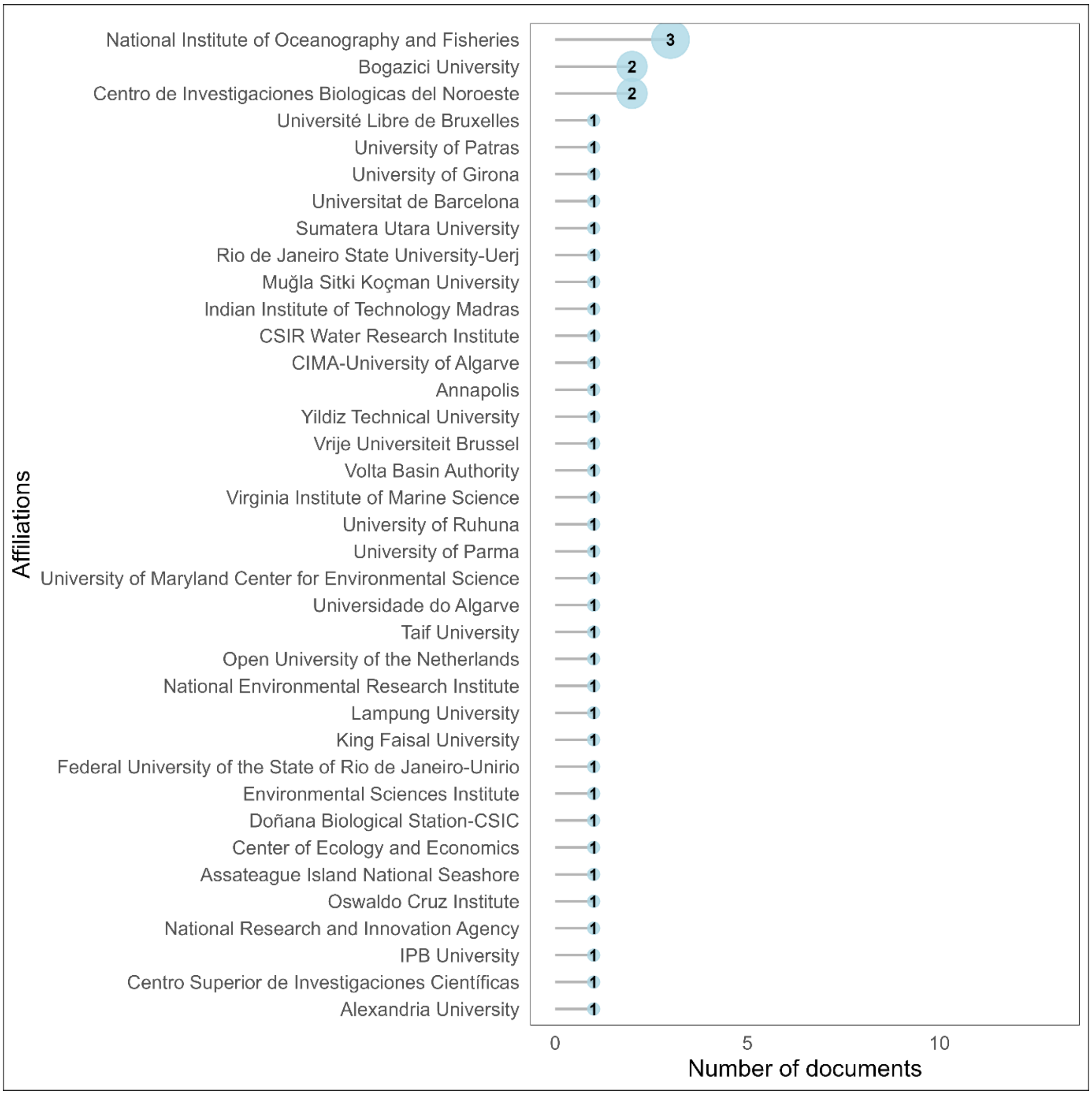

Figure 6. Institutional affiliations of the authors of the publications analysed

The map shows the geolocation of the publications examined on the assessment of coastal lagoon water quality using Water Quality Indices (Figure 7). The majority of the researchers involved are affiliated with institutions located in various countries such as the United States, Brazil, Spain, Turkey, Italy, Egypt and Indonesia. With regard to the African continent, only research conducted in Egypt and Ghana is included. Nikiema *et al.* (2023) also noted the marginal contribution of African countries in the field of agroecology research.

Analysis of Figure 8 shows that studies were conducted in 12 different countries. Egypt stands out with the highest number of citations, totalling 91. It is followed by the United States with 54 citations, Greece with 46 citations, Turkey with 44 citations and Spain with 37 citations. In contrast, no citations were recorded for Portugal and Brazil.

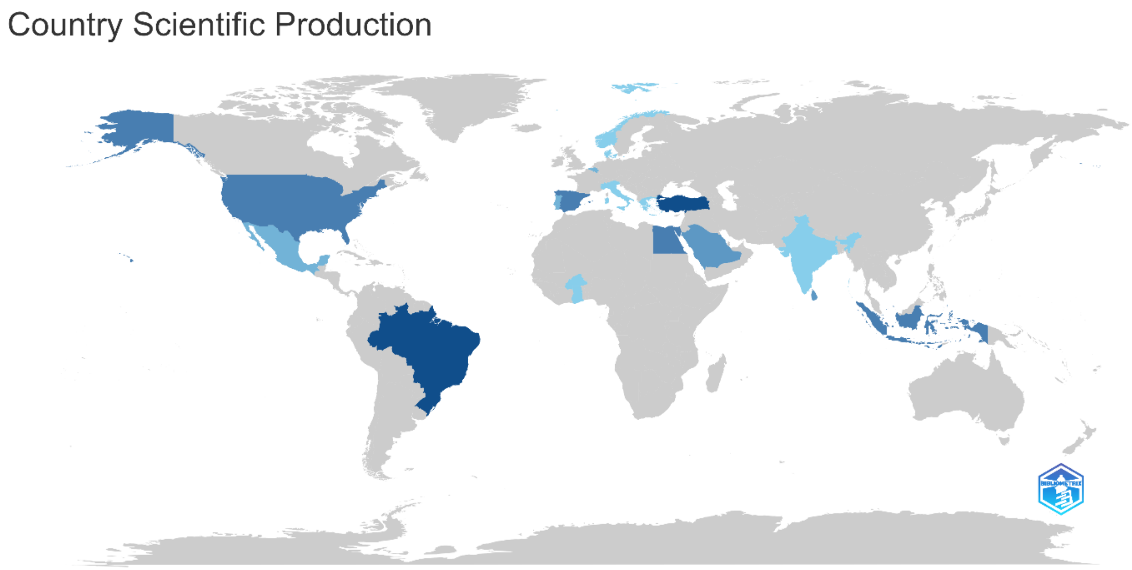

Figure 7. Geographical distribution of publications on the assessment of coastal lagoon water quality based on water quality indices between 2000 and 2025.

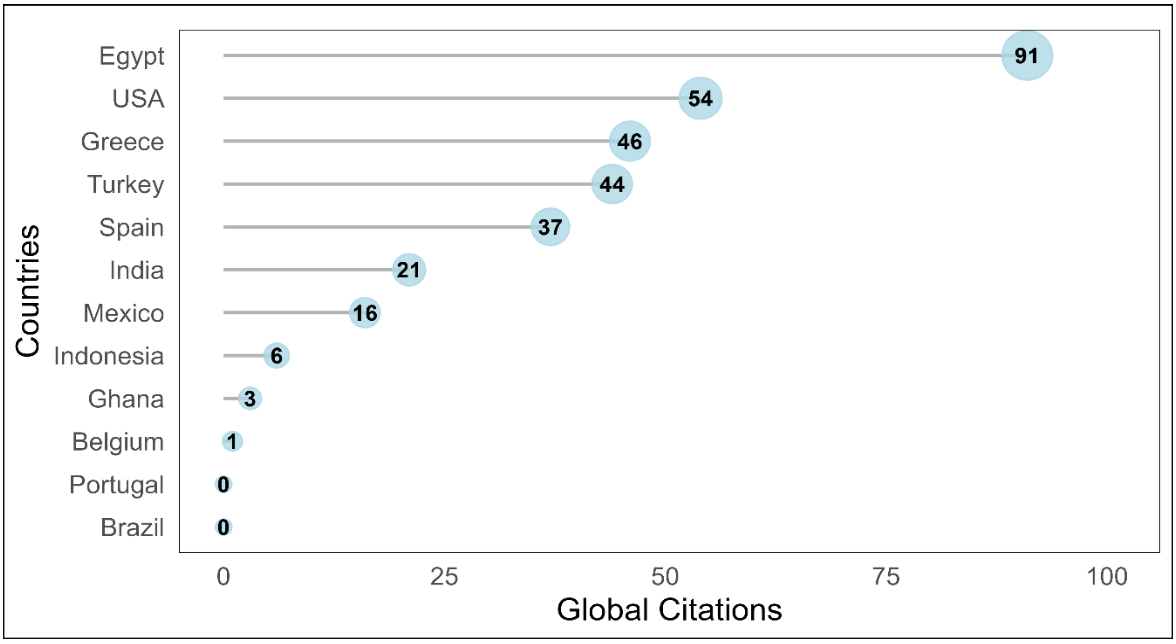

Figure 8. Number of citations by country of origin of authors

In the context of the present research, the authors used 9 distinct water quality indices to assess the quality of coastal lagoon waters from the perspective of pollution status, ecological status, trophic status, and eutrophication processes. These indices notably include the Water Quality Index, the Lagoon Water Quality Index (L-WQI), the Arid Zone Coastal Water Quality Index (AZCI), the Trophic Water Quality Index (TWQI), the Siombak Water Quality Index (SWQI), the Modified Water Quality Index, the Canadian Council of Ministers of the Environment Water Quality Index (CCME-WQI), the Water Quality Risk Index (WQRI), and the Water Quality Index for Bivalves (WQIB).

More than19,000 authors gathered 8,368 documents identified using the keyword "Water Quality Index" can be visualized by VOS viewer. Figures 9 & 10 present the Network and Overlay visualizations of the 384 authors having at least 5 articles. The most published author is Egbueri J.C.

(Ojukwu University, Uli, Nigeria), shown by a grew node, having 34 articles in this topic and a total of 121 articles, an H-index 43 and over 5000 citations. The second rank is the Indian Das A. (31 articles), the third and fourth are Uddin and Islam reaching aver 25 articles. Figure 10 linked the production against time. The authors shown by dark blue nodes contributed around 2000 and those by yellow color indicates that the articles appear recently (Bazzi *et al.*, 2023; Laita *et al.*, 2024; ; Saiz-Alvarez *et al.*, 2024Hammouti *et al.*, 2025).

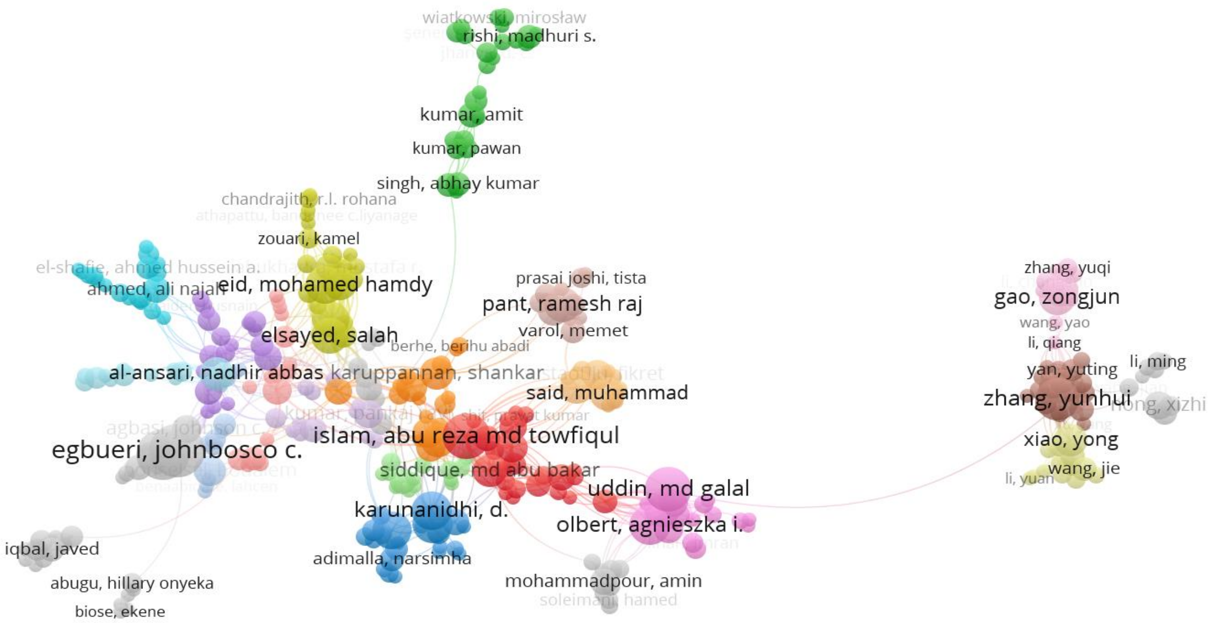

Figure 9: Network visualization on VOS viewer of nanoparticles green synthesis authors

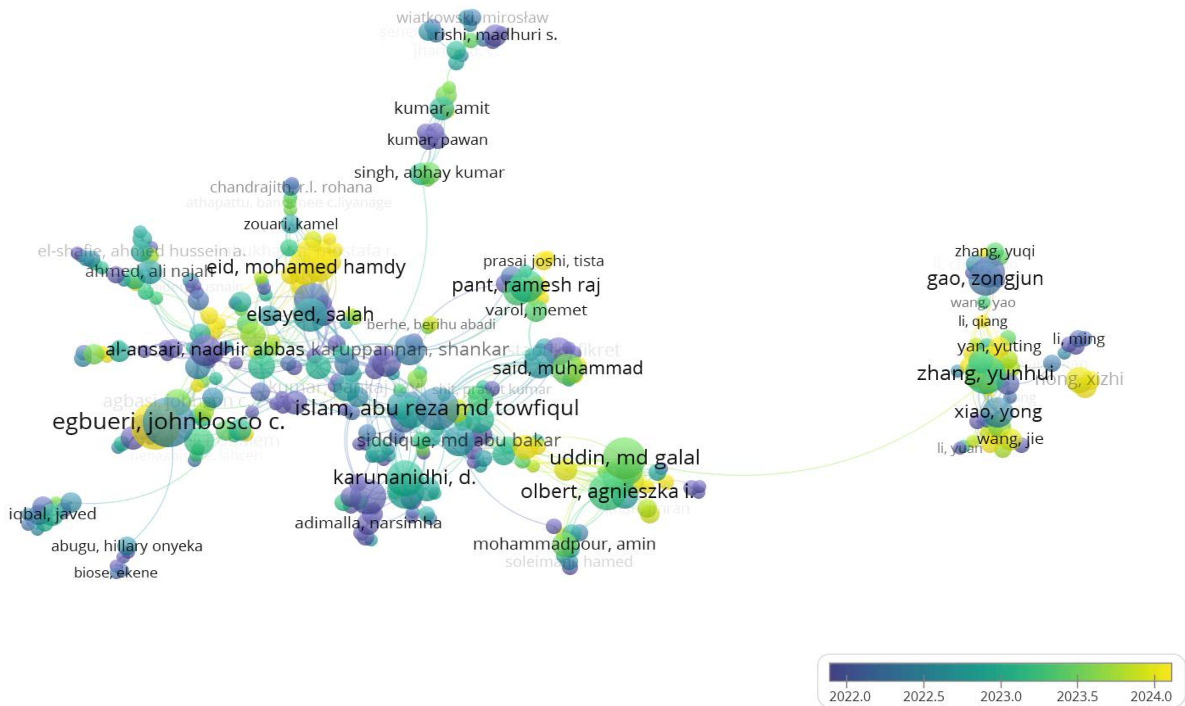

Figure 10: Overlay visualization on VOS viewer of nanoparticles green synthesis authors

Furthermore, **Figures 11, 12** and **13** indicate that the authors used various keywords, the main ones being water quality, environmental monitoring, coastal lagoon and eutrophication.

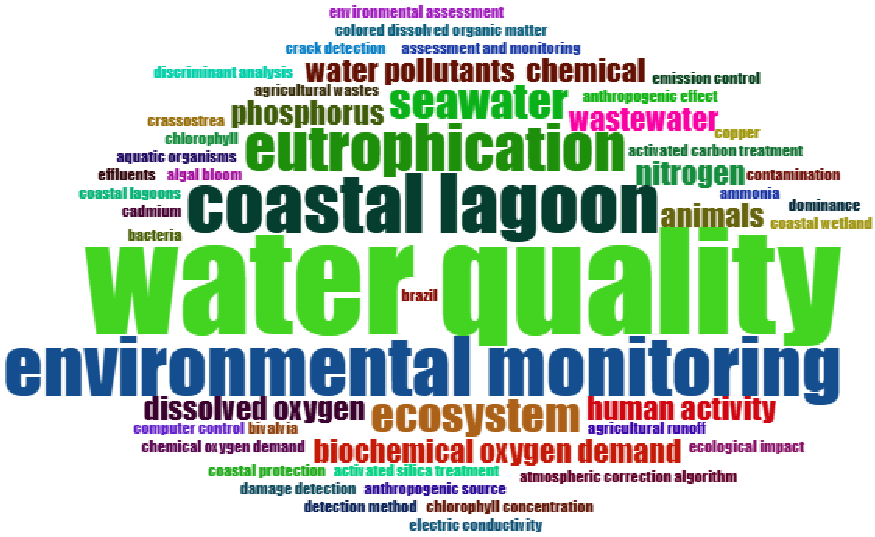

Figure 11. Keywords used by authors

Figure 12. Keyword co-occurrence network

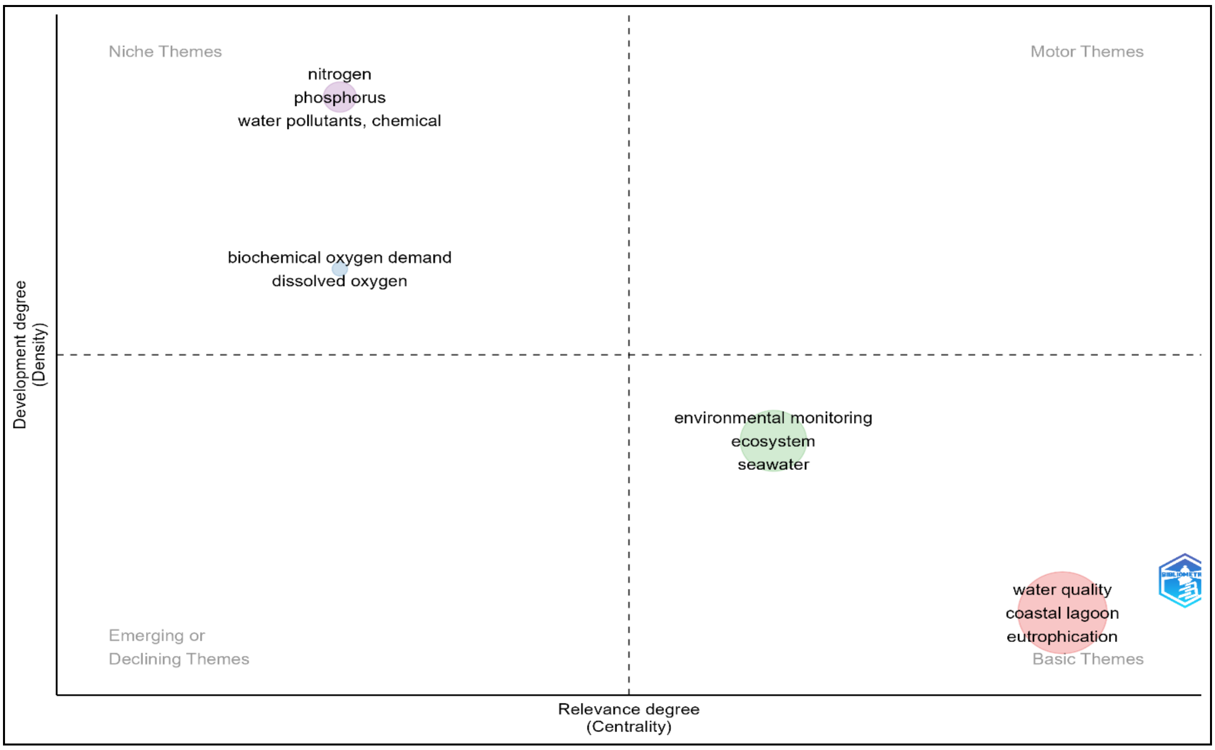

Figure 13. Thematic map of keywords

In total, 32 physicochemical parameters and 7 biological parameters were taken into account for the calculation of the aforementioned indices. Among the physicochemical parameters are Water temperature, Dissolved Oxygen, pH, Water transparency, Colored dissolved organic matter, Turbidity, Suspended Solid Matter, Water discharge, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Salinity, Electrical conductivity, Total Dissolved Solids, Ammonium, ammonium nitrogen, Ammonia, Nitrite, Nitrite nitrogen, Nitrate, Nitrate nitrogen, Orthophosphate, Orthophosphate phosphorus, Total Nitrogen, Total Phosphorus,Copper, Cadmium, Fe, Zn, Cr and SiO4-Si. Regarding the selected biological parameters, notably Chlorophyll-a, Fecal coliform, Macroalgae, Fecal streptococci, ThermoTolerant coliforms (CTE), Escherichia coli and Toxigenic phytoplankton are noted. **Table 3** provides information on the different water quality indices used by different authors and their different measured physicochemical and biological parameters.

Table 3. Different water quality indices used by different authors and their different measured physicochemical and biological parameters.

N°	Sources	Countries	Water Quality Index types	Used parameters	Objective
1	Wazniak *et al.* (2007)	USA	Water Quality Index	Dissolved Oxygen (DO), Chlorophyll-a, Total Nitrogen (TN) and Total Phosphorus (TP)	Linking water quality to living resources
2	Badosa *et al.* (2008)	Spain	No using of Water Quality Index		Short-term variation in the ecological status
3	Tay *et al.* (2010)	Ghana	water Quality Index (WQI)	Water temperature (WT), DO, pH, Biochemical Oxygen Demand (BOD), ammonium nitrogen (NH_4-N), Nitrate nitrogen (NO_3-N), Orthophosphate phosphorus (PO_4-P), Total Suspended Solids (TSS), Electrical conductivity (EC) and Feacal coliform	Study of the pollution status
4	Taner *et al.* (2011)	Turkey	Lagoon Water Quality Index (L-WQI)	DO, TN, TP, Nitrate (NO_3^-), Orthophosphate (PO_4^{-3}), Chlorophyll-a, Chemical Oxygen Demand (COD), pH, Turbidity and Electrical conductivity	Assessment of water quality in polluted lagoon systems
5	Cañedo-Argüelles *et al.* (2012)	Spain	No using of Water Quality Index		Annual characterisation of coastal lagoons subjected to intense human activity
6	Ruiz-Ruiz *et al.* (2017)	USA	Arid Zone Coastal Water Quality Index (AZCI)	NO_3^-, Nitrite (NO_2^-), Ammonium (NH_4^+) and PO_4^{-3}	Detecting Eutrophication Symptoms
7	Christia *et al.* (2014)	Italy	Trophic Water Quality Index (TWQI)	DO, Chlorophyll-a, Inorganic or Total Nitrogen, Phosphorus and macroalgae	Assessment of ecological quality
8	Kulshreshtha and Shanmugam (2018)	India	Water Quality Index (WQI)	Turbidity, chlorophyll-a and Colored dissolved organic matter (aCDOM).	Assessment of trophic state and water quality

9	Alprol *et al.* (2021)	Egypt	water quality index (WQI).	pH, Ammonia (NH_3), DO, NO_3^-, COD, Fe, Zn, Cu, Cr	Assessment of Water Quality and Eutrophication
10	Muhtadi *et al.* (2023)	Indonesia	Siombak Water Quality Index (SWQI)	WT, TSS, DO, BOD, COD, Salinity, EC, Total Dissolved Solids (TDS), Turbidity, NO_3^-, PO_4^{-3}, Water discharge and Water transparency	Assessment of pollution status
11	Zaghloul Et.Al. (2023)	Egypt	Modified Water Quality Index	Temperature, Salinity, DO, OOM, NH4-N, NO2-N, NO3-N, PO4-P, SiO4-Si	Assessment of Water quality
12	Al-Afify *et al.* (2023)	Turkey	water quality index (WQI).	Dissolved oxygen, ammonia, copper, cadmium, Fecal coliform and Fecal streptococci	Water Quality and Microbiological Assessment
13	Ayitey *et al.* (2024)	Sri Lanka	Canadian Council of Ministers of the Environment Water Quality Index (CCME-WQI)	Water temperature, Orthophosphate, pH, Total Dissolved Solids (TDS), Electrical conductivity, Biological oxygen demand, and Fecal coliforms	An assessment on lagoon water and Human health risk
14	Özdemir *et al.* (2024)	Turkey	Water Quality Index	WT, pH, DO, BOD, Suspended Solid Matter (SSM), TP, NO_2-N, NO_3-N and (NH_4-N)	Assessment of Water quality
15	De Oliveira Muniz Cunha *et al.* (2025)	Brazil	Water Quality Risk Index (WQRI)	DO, pH, BOD, WT, TN, TP, Turbidity, TDS and ThermoTolerant coliforms (CTE)	Environmental risk assessment
16	Cravo *et al.* (2025)	Portugal	Water Quality Index for Bivalves (WQIB)	Salinity, NH_4^+, DO, TSS, Chlorophyll-a, *Escherichia coli* and Toxigenic phytoplankton	Water quality for bivalve molluscs and consumer safety

Conclusion

The bibliometric analysis conducted on publications related to the evaluation of the water quality of coastal lagoons using water quality indices reveals a limited number of studies indexed in the Scopus database. The majority of these works are recent, dating back less than a decade. In Africa, only three publications have been recorded, two in Egypt and one in Ghana. This bibliometric review clearly highlights the need to intensify research on this subject in Benin as well as in other African countries, in order to assess the usability quality of coastal lagoon waters. Finally, the development of a Water Quality Index specifically adapted to the coastal lagoons of Benin would constitute an essential tool for a more reliable assessment of the usability quality of their waters.

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Compliance with Ethical Standards: This article does not contain any studies involving human or animal subjects.

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