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Trends in scientific research on coastal lagoon ecosystem services: A bibliometric analysis

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ABSTRACT

Description of the subject. Coastal lagoons, vital for human wellbeing, are highly threatened ecosystems. Their ecosystem services (ES) have recently gained scientific and policy attention.
Objective. This study aims to identify global trends in scientific research on coastal lagoon ecosystem services (CLES) over time.
Method. Publications from 1999 to 2022 were aggregated from the Scopus database. A bibliometric analysis of 304 documents was conducted using the Bibliometrix package in R Studio.
Results. Analysis revealed an increasing trend in both publications and citations related to CLES from 1999 to 2022. Schernewski G. and Lillebø A. were the most published authors, while Pérez-Ruzafa A. and Newton A. were the most cited. "Estuarine, Coastal and Shelf Science" was a key journal, with Newton *et al*. (2014) as the most cited document. Europe was the most productive region, and the USA led in CLES publications. Keywords like ecosystem services, coastal lagoons, and climate change were prominent. Thematic evolution showed coastal lagoons as a central theme across all periods.
Conclusion. Future CLES research should focus on the impacts of land use and cover changes, local community perceptions, and participatory mapping of ecosystem services.

Keywords: Coastal lagoon, Ecosystem services, Bibliometric analysis, Scopus, Temporal trend.

RÉSUMÉ

Tendances de la recherche scientifique sur les services écosystémiques des lagunes côtières : une analyse bibliométrique
Description du sujet. Les lagunes côtières, écosystèmes parmi les plus productifs, fournissent des biens et services essentiels au bien-être humain, mais sont menacées. Les services écosystémiques (SE) des lagunes côtières ont récemment attiré une attention accrue dans la recherche scientifique et la politique environnementale.
Objectif. Cette étude vise à identifier les tendances mondiales dans la recherche sur les services écosystémiques des lagunes côtières (SELC) au fil du temps.
Méthodes. Les publications de 1999 à 2022 ont été collectées via la base de données Scopus. Une analyse bibliométrique de 304 documents a été effectuée avec le package Bibliometrix dans R Studio.
Résultats. L'analyse des tendances temporelles révèle une augmentation des publications et des citations sur les SELC. Schernewski G. et Lillebø A. sont les auteurs les plus publiés, tandis que Pérez-Ruzafa A. et Newton A. sont les plus cités. "Estuarine, Coastal and Shelf Science" est un journal clé, et Newton *et al*. (2014) est le document le plus cité. L'Europe est la région la plus productive, et les États-Unis sont le pays leader en publications. Les mots-clés fréquents incluent services écosystémiques, lagunes côtières, et changement climatique. Les lagunes côtières sont le thème dominant.
Conclusion : Les recherches futures devraient explorer les impacts de l'utilisation des sols, la perception des communautés locales et la cartographie participative des services écosystémiques.

Mots-clés : Lagune côtière, services écosystémiques, analyse bibliométrique, Scopus, tendance temporelle

1. INTRODUCTION

It is well known that coastal lagoon landscapes (CLL) represent one of the highly productive ecosystems providing essential ecosystem services (ES) to life on the planet earth like climate regulation, nutrient cycle, control timber, habitat provision, recreation, and food security (Ghermandi *et al*., 2010; Soorae *et al*., 2020). Defined as the direct or indirect contributions and capacity of ecosystems to provide goods and services to satisfy human needs and promote human well-being (MEA, 2005; Burkhard *et al.*, 2012), ES assessment has recently become a crucial scientific framework for addressing the challenges inherent in environmental management and biodiversity conservation (Cuni-Sanchez *et al*., 2016; Pascual *et al*., 2017; Kolosz *et al*., 2018; Esse *et al*., 2019; Yohannes *et al*., 2021).

Globally, the four common categories of ES are provisioning, regulating, cultural and supporting services (MEA, 2005). Since ES have become key indicators of human well-being, supporting global economic prosperity and well-being (MEA, 2005), this concept is now incorporated into the Sustainable Development Goals (SGDs) which include clean water and sanitation, climate action, life below water, and life on land (Wood *et al*., 2018; Yang *et al*., 2020). In this way, the well-being of present and future generations depends on the continuous flow of ecosystem services, which are the benefits people obtain from ecosystems (Daily, 1997).

Coastal ecosystems including coastal lagoon landscapes are key habitats that shelter important part of the planet's biodiversity, playing a crucial ecological role, but these ecosystems have suffered a serious decline worldwide due to human influence (González-De Zayas *et al*., 2018; Orth *et al*., 2020) and their proximity to urban areas (Aponte and Cano, 2013), often resulting in decreased biodiversity and degraded ES. They are among the most valuable socio-ecological systems (Costanza *et al*., 1997; Sy *et al*., 2018). Due to their high biological productivity and ability to provide harbor and navigation facilities, coastal lagoons have historically been of great interest to humans (Pérez-Ruzafa *et al*., 2011; Newton *et al*., 2018). In the last two decades, the research interest in coastal lagoon ecosystems and their services has increased. Numerous studies have been carried out on ecosystem services linked to coastal lagoons (Pérez-Ruzafa *et al*., 2011; Basset *et al*., 2013; Inácio *et al*., 2018; Newton *et al*., 2018), highlighting the need for studies that quantitatively and analytically summarize findings and provide helpful information about their current state, future trends, and gaps.

In order to synthesize Coastal Lagoon Ecosystem Services (CLES) publications globally and know how to orient new research efforts and where research efforts are most needed on the topic, a bibliometric study was performed using bibliometrix R-tool (Aria and Cuccurullo, 2017) to assess CLES research. The study seeks to provide insights into the development, impact, and current status of CLES research, helping to understand past progress, current trends, and future directions in this area of environmental science.

Recently, bibliometric analysis has gained significant popularity in scientific research (Donthu *et al*., 2021; Khanra *et al*., 2021; Mustak *et al*., 2021). It is an internationally recognized methodology for systematically and qualitatively evaluating research trends and networks of researchers (Martinez *et al*., 2015; Donthu *et al*., 2021). Bibliometric analysis can also encourage and challenge researchers to conduct further studies (Estoque *et al*., 2018). Compared to systematic literature reviews, which use classic methods requiring a narrow scope of study and thus tend to include fewer papers for review, bibliometric analysis can handle large amounts of literature and provide a nuanced summary of a given field. Based on existing literatures, the techniques for bibliometric analysis manifest across two categories: performance analysis and science mapping (Köseoglu *et al*., 2015; Donthu *et al*., 2021). Performance analysis examines the contributions of research constituents to a given field (Cobo *et al*., 2011) whereas science mapping examines the relationships between research constituents (Cobo *et al*., 2011; Baker *et al*., 2021).

The general objective of this study is to examine the global trends and coastal lagoon ecosystem services (CLES) research through a bibliometric analysis of highly cited articles from 1999 to 2022 found in the Scopus database. Specifically, the study aims to (i) assess the trends of articles and citations in CLES research, (ii) identify the highly referenced authors and most relevant sources and country as well as collaboration in this field, and (iii) assess the primary research topics of interest within this field

2. MATERIALS AND METHODS

2.1. Data collection

In this study, we explored the global scientific literature on coastal ecosystem services over the last twenty years. The Scopus database was used to aggregate publications from 1999 to 2022. Scopus is the largest bibliographic database of scientific, multidisciplinary and international literature created by Elsevier to help researchers develop search

strings with accurate results, especially in broad areas (Aznar-Sánchez *et al*., 2019; Abbas *et al*., 2020; Khatib *et al*., 2022). The term "coastal lagoon ecosystem services," "coastal lagoon environmental services," "coastal lagoon ecological services," were used as search queries. In addition, to obtain relevant results on the dataset, Boolean logic operations, including "OR" and "AND", were applied in the search query. Publications not focused on the coastal lagoon context were removed. The "Title" field and document types such as "articles" "book chapter" "conference paper" "editorial" and "review" were filtered to limit the search for English only (Table1). The data were downloaded in the comma-delimited text (CSV) format.

Table 1. Document types

Document types	Search results	
	Number	Proportion (%)
Article	216	71.05
Book chapter	34	11.18
Conference paper	28	9.21
Editorial	3	0.99
Review	23	7.57
Total	304	100.00

2.2. Bibliometric analysis

Bibliometric analysis was performed based on the two main techniques known as performance analysis and sciences mapping techniques. Performance analysis examines the contributions of research constituents to a given field while science mapping examines the relationships between research constituents (Cobo *et al*., 2011; Baker *et al*., 2021; Donthu *et al*., 2021). Science mapping techniques were used for bibliometric analysis since it is a powerful tool for studying the structure and the dynamics of scientific fields. We used R package "bibliometric" to assess the data that had been retrieved (Aria and Cuccurullo, 2017).

In this study, performance analyses included temporal trend in scientific publication (number of annual scientific publications and citation), highly cited authors and most productive and cited journals were assessed using Microsoft Excel (version 2019). Through science mapping technique, we performed (i) co-authorship analyses (countries' scientific production, international collaboration and most productive authors), (ii) co-word analyses (identification of the most frequent author's keywords), (iii) co-citation analyses (relation among cited publications, foundational themes) were performed. Countries' scientific production related to coastal lagoon ecosystem services was assessed and mapped using QGIS 3.32. All authors' nationality who make up the collection is considered. The construction of a conceptual map of co-authorship analyses, co-word analyses, co-citations and a network was done using "biblioshiny", a web-based interface of bibliometrix under the R software (R Core Team, 2022).

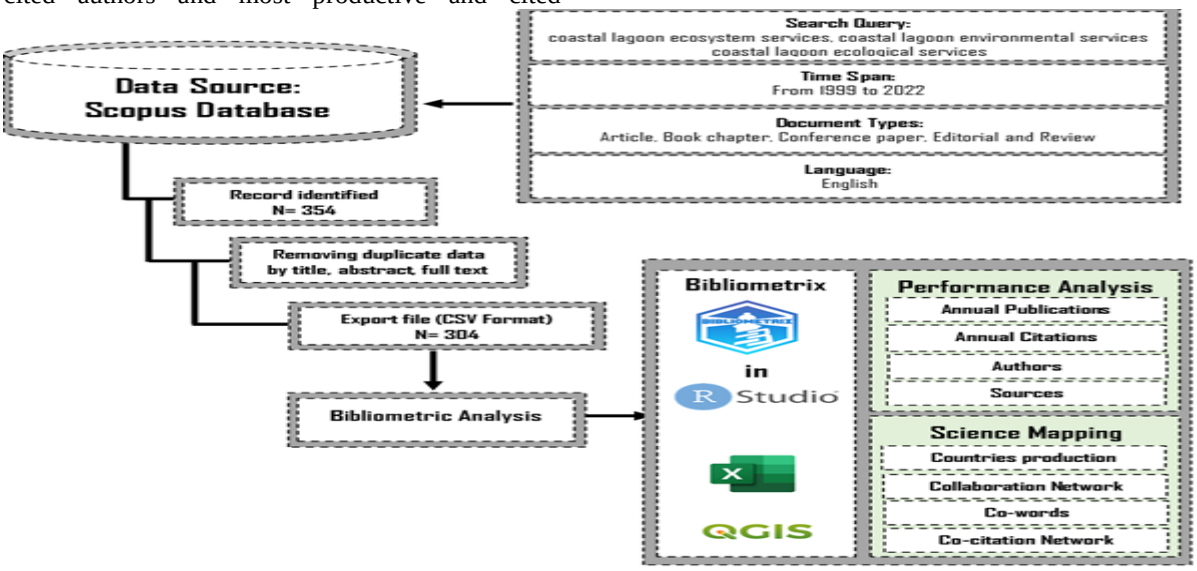

Figure 1. Research design and workflow

3. RESULTS AND DISCUSSION

3.1. Main information on selected documents

The bibliometric analysis of the articles found in this process after filtering revealed 304 review studies belonging to 172 sources with an annual growth publication rate of 18.64%. The findings showed that the average document age was 5.2, while average citation per document was 19.73. A total of 1382 authors were involved in the field study related to CLES during these 23 past years (1999-2022). In this research dataset, 1063 author keywords were recorded. Single author documents were 13, while Internationally co-authored papers were about 43.09%. Figure 2 presents the main Information on coastal lagoon ecosystem services (CLES) scientific research from 1999 to 2022.

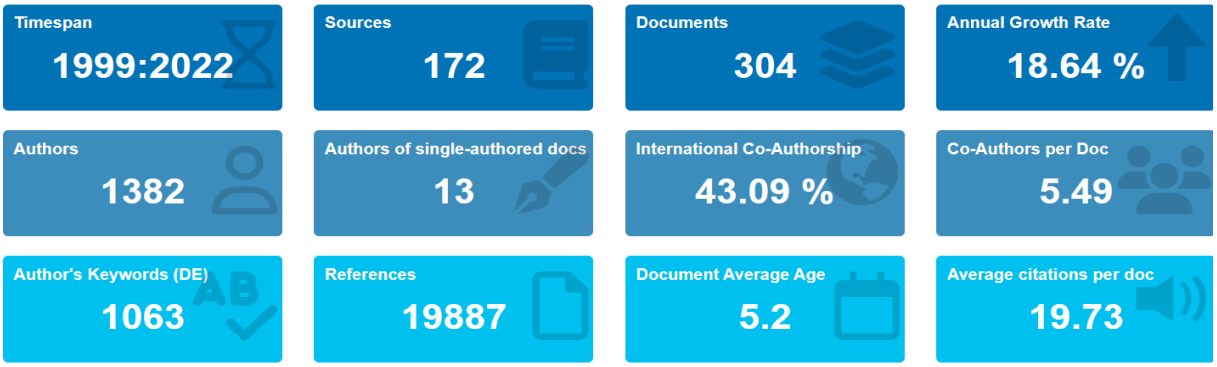

Figure 2. Main Information on coastal lagoon ecosystem services scientific research from 1999 to 2022.

3.2. Performance Analyses

Temporal trend in scientific publication of coastal lagoon ecosystem services

Temporal trend analysis across the study period (1999-2022) indicated the dynamics of publications and citations related to coastal lagoon ecosystem services (CLES). The number of publications has shown an increasing trend over the years, with small fluctuations between individual years. During the 1999-2005 period, the number of publications and mean citations related to CLES remained minimal, with less than 5 publications and 80 citations respectively. Between 2005 and 2012, the number of scientific publications has shown an increase trend, while the mean citations showed a two-modal pattern (Figure 3). From 2012 to 2022, the number scientific articles published increased rapidly from 7 in 2012 to 51 in 2022. During this period, the mean citations decreased significantly (Figure 3).

The trend analysis of CLES research showed that the number of publications slowly increased from 1999 to 2004 and substantially increased after 2005 and 2010. This increased trend of scientific publication revealed that 2005 is a turning point in this research field, mostly due to the global-scale study carried out by Millennium Ecosystem Services Assessment (MEA, 2005). Since the publication of the Millennium Ecosystem Assessment reports in 2005, the concept of ES has drawn increasing attention among researchers and policymakers due to its significance and relevance to practical management of diverse ecosystems (Costanza, 2014; Chen *et al*., 2020; Salata *et al*., 2020). In addition, the Economics of Ecosystems and Biodiversity (TEEB, 2010) which fundamental goal is to integrate environmental services and biodiversity values into all levels of decision-making has substantially contributed to move the discussion forward in this field (Jiang, 2017; Gangahagedara *et al*., 2021).

Influential authors, journals and highly cited publications

The results showed that a total of 1382 authors were involved in the field study related to CLES during these 23 past years (Figure 2). Consequently, 10 highly referenced authors were retrieved and the characteristics of each of them were presented in the Table 1. Among these top 10 influential authors in the field of in CLES research, Schernewski and Lillebø stand out with 11 articles each (Table 2). Schernewski has accumulated 614 citations with a citation h-index of at least 7, while Lillebø has accumulated 395 citations with a citation h-index of at least 8 in those publications. Perez- Ruzafa was found to be the first most highly cited author with 741 total citation. The total papers published by Perez- Ruzafa have at least citation *h-index* of 6. This author is followed by Newton and Marcos with 646 and 614 total citation respectively and at least citation *h-index* of 6 each (Table 2).

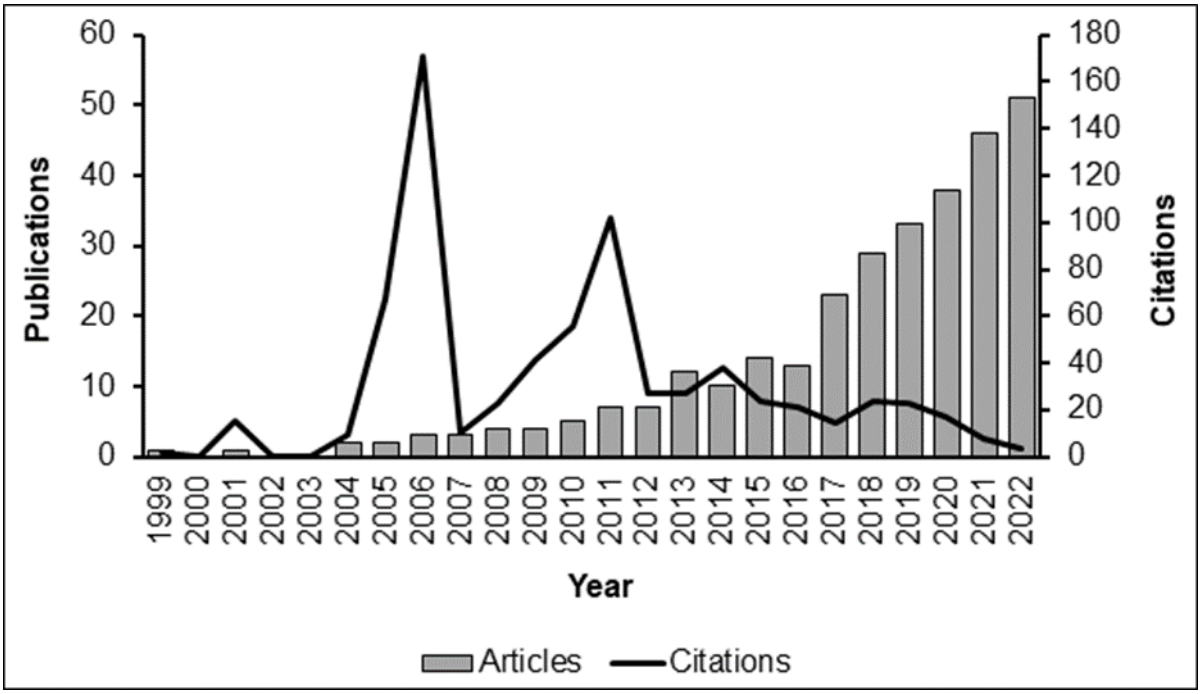

Figure 3. Temporal trends of number scientific publications and citations between the period 1999 - 2022

Table 2. Top 10 influential authors in the field of in coastal lagoon ecosystem services research based on total citation

Author	h_index	g_index	m_index	TC	NP	PY_start
Pérez-Ruzafa A	6	6	0,462	741	6	2011
Newton A	6	8	0,5	646	8	2012
Schernewski G	7	11	0,538	614	11	2011
Marcos C	6	6	0,462	532	6	2011
Reizopoulou S	3	3	0,188	480	3	2008
Solidoro C	3	3	0,214	468	3	2010
Cristina S	2	3	0,2	444	3	2014
Lillebø AI	8	11	0,727	395	11	2013
Orth RJ	3	3	0,167	335	3	2006
Bernard G	3	3	0,2	299	3	2009

Regarding the most relevant sources, which contain the highest number of articles related to CLES, analysis revealed that *Estuarine, Coastal and Shelf Science* is the most effective journal on the list (Figure 4). *Estuarine, Coastal and Shelf Science* is an international multidisciplinary journal devoted to the analysis of saline water phenomena ranging from the outer edge of the continental shelf to the upper limits of the tidal zone. The journal provides a unique forum, unifying the multidisciplinary approaches to the study of the oceanography of estuaries, coastal zones, and continental shelf seas. It bears an impact factor of 3.229 in 2022. (Newton et al., 2014) are the most global cited document in this journal (258 global citations) (Table 3) with a global citation per year of 25.80. Among the top ten locally cited documents related to CLES, 40% are published in *Estuarine, Coastal and Shelf Science* Journal (Chapman, 2012; Basset *et al*., 2013; Sousa *et al*., 2013; Newton *et al*., 2014).

Consequently, this clearly explains why this journal is included in the top ten list. The next leading journal is *Water (Switzerland)* accounting for 14 articles (i.e., 16.27% of the total) and holds an impact factor of 3.53 in 2022. *Science of The Total Environment* journals established in 2012 contributed 9 articles with an Impact IF of 10.75 in 2022. *Frontiers in Marine Science* and *Ocean and Coastal Management* journal each account for 8 articles with an Impact IF of 5.247 and 4.29 respectively. *Ocean & Coastal Management* is the leading international journal dedicated to the study of all aspects of ocean and coastal management from the global to local levels whereas *Frontiers in Marine Science* is an interdisciplinary journal that advances our understanding of marine species,

ecosystems, and processes as well as human interactions with, and impacts on, ocean environments. Table 3 highlighted the top 10 local articles in term of highly cited journal related to CLES research in Scopus database from 1999 to 2022.

Among these highly cited papers in *Estuarine, Coastal and Shelf Science* Journal, studies with various aims are performed. For instance (Newton *et al*., 2014) study deals with an overview of ecological status, vulnerability and future perspectives of European large shallow, semi-enclosed coastal systems, lagoons and transitional waters. Sousa *et al*. (2013) study aims to include the population knowledge in the identification of ecosystem services of Ria de Aveiro coastal lagoon. Authors used a deliberative and participatory approach (Focus Groups) as a first step for engaging local and regional end-users. They concluded that the incorporation of community knowledge and concerns in this coastal lagoon management strategies are very important, since it has a pedagogical role and if people identify themselves with the decision, they will accept them and enforce the compliance by the various users. Brito *et al*. (2012) explored how will shallow coastal lagoons respond to climate change and reported that climate change, especially sea level rise and global warming, are likely to affect shallow coastal lagoons and to increase their vulnerability to eutrophication. Basset *et al*. (2013) study is related to estuarine and lagoon biodiversity and their natural goods and services. Authors reported that the mechanistic relationships and responses of ecosystem functions and biodiversity to contrasting/changing environmental conditions with human activities as key drivers affecting both biodiversity conservation and the provision of ecosystem services. Results indicate that *Estuarine, Coastal and Shelf Science* journal was influential journals in coastal lagoon ecosystem services (CLES) research.

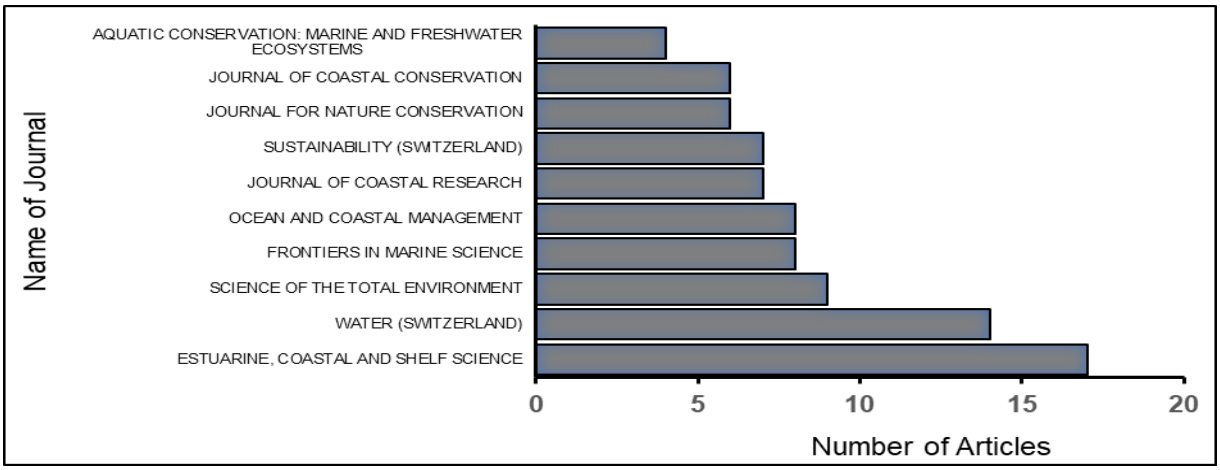

Figure 4. The top 10 journal in term of the number of articles related to CLES research in Scopus database from 1999 to 2022

Table 3. Top 10 local cited articles related to CLES research in Scopus database from 1999 to 2022

Articles	Journal	DOI	Local Citations	Global Citations	LC/GC Ratio (%)
Newton *et al*., 2018	Journal for Nature Conservation	10.1016/j.jnc.2018.02.009	22	184	11,96
Newton *et al*., 2014	Estuarine, Coastal and Shelf Science	10.1016/j.ecss.2013.05.023	22	258	8,53
Chapman, 2012	Estuarine, Coastal and Shelf Science	10.1016/j.ecss.2012.01.010	8	66	12,12
Sousa, 2013	Journal of Coastal Research	10.2112/SI65-178.1	6	29	20,69
Brito *et al*., 2012	Estuarine, Coastal and Shelf Science	10.1016/j.ecss.2011.09.002	6	55	10,91

Basset *et al*., 2013	Estuarine, Coastal and Shelf Science	10.1016/j.ecss.2013.05.018	6	56	10,71
Sy *et al*., 2018	Ecological Economics	10.1016/j.ecolecon.2018.07.018	5	31	16,13
De Wit *et al*., 2017	Aquatic Conservation: Marine and Freshwater Ecosystems	10.1002/aqc.2601	5	30	16,67
Marcos *et al*., 2015	Reviews in Fish Biology and Fisheries	10.1007/s11160-015-9397-7	5	27	18,52
Khomalli *et al*., 2020	Wetlands	10.1007/s13157-020-01386-2	4	8	50,00

Table 5 presents the top 10 globally cited documents related to CLES research. Analyzing the objectives of these articles (Newton *et al*., 2014) ranks first with 258 global citations, averaging 25.80 citations per year, focusing on the ecological status, vulnerability, and future perspectives of European large shallow, semi-enclosed coastal systems, lagoons and transitional waters. Anthony *et al*. (2009) follows with 193 global citations, addressing coastal lagoons and climate change. Newton *et al*. (2018) quantifies and values ecosystem services of coastal lagoons globally. Orth *et al*. (2006) examines the natural recovery of *Z. marina* in coastal bays of the mid-Atlantic region of the United States. Dahdouh-Guebas *et al*. (2005) assesses quantitatively and qualitatively the biological impact of the transitions in ancient inland freshwater resource management on biota and human population in and around coastal lagoons. Pérez-Ruzafa *et al*. (2011) examined the problems involved in understanding the definition and management of coastal lagoons. The main objective of (Orth *et al*., 2020) study was to report outcomes from a unique and very successful seagrass restoration project of seagrass habitat leads to rapid recovery of coastal ecosystem services.

The aim of the study by *(Trombetta et al*., 2019) was to investigate spring bloom dynamics and the associated phytoplankton diversity in a typical shallow coastal system to identify the environmental factors triggering the blooms. Finally, the goal of (Chapman *et al*., 2013) research was to provide a review of methods for assessing sediment contamination in estuaries, extending this to all transitional waters, including information on integrative assessments and on management decision-making. Regarding the literature analysis of the of the top ten publications mentioned in Table 5, greater attention is drawn to the impacts of climate change on coastal lagoon ecosystems and services. Some of them deal with ecosystem services assessment and quantification. The topics such as eutrophication, restauration and management measures of coastal lagoons were comparatively less focused at the top 10 ES publications. Nevertheless, the impacts of land use/land cover change (LU/LC) on coastal lagoon ecosystem services, community perception on ecosystem provided by these areas and their dependency, carbon sequestration as well provisioning and cultural ecosystem services are missing from the literature discussed in the top 10 global cited documents.

Table 5. Top 10 global cited documents related to CLES research in Scopus database from 1999 to 2022.

Paper	**Journal**	**DOI**	**Total Citations**	**TC per Year**
Newton *et al*., 2014	Estuarine, Coastal and Shelf Science	10.1016/j.ecss.2013.05.023	258	25,80
Anthony *et al*., 2009	Ecology and Society	10.5751/ES-02719-140108	193	12,87
Newton *et al*., 2018	Journal for Nature Conservation	10.1016/j.jnc.2018.02.009	184	30,67
Kennish, 2010	Coastal Lagoons: Critical Habitats of Environmental Change	10.1201/EBK1420088304	172	12,29
Orth *et al*., 2006,	Aquatic Botany	10.1016/j.aquabot.2005.07.007	171	9,50
Dahdouh-Guebas *et al*., 2005	Current Biology	10.1016/j.cub.2005.01.053	130	6,84
Pérez-Ruzafa *et al*., 2011	Physics and Chemistry of the Earth	10.1016/j.pce.2010.04.013	123	9,46
Orth *et al*., 2020	Science Advances	10.1126/sciadv.abc6434	114	28,50
Trombetta *et al*., 2019	PLoS ONE |	10.1371/journal.pone.0214933	102	20.40
Chapman *et al*., 2013	Environment International	10.1016/j.envint.2013.02.009	96	8.73

3.3. Science Mapping

Countries'/regions' scientific production and international collaboration

Based on the retrieved results, 66 different countries were covered by the publications related to CLES from 1999 to 2022. Figure 4 shows countries' scientific production (Figure 4 A) and top 10 countries in term of scientific production (Figure 4 B). The findings revealed that countries' scientific production ranged from 0 to 191 publications related to CLES (Figure 4 A). Most of the publications were produced in Europe (53.23%), America (29.36%) followed by Asia (8.73%) and Oceania (4.82%). Very few research projects came from Africa (3.84%). Regarding African countries' scientific production pertaining to CLES findings showed that North Africa was the most productive African region with 32 publications. It was followed by West Africa (21 publications), South Africa (5 publications), Central Africa (2 publications) and East Africa (1 publication). With respect to the top 10 countries in term of scientific production related to CLES, the United States of America (USA) ranked first with a dominant output of 191 papers. France (183 papers) and Italy (155 papers) both from Europe, ranking second and third, respectively (Figure 4 B). Other top-ranked countries were Mexico (141 papers), Portugal (124 papers), Spain (103 papers) Australia (68 papers), Germany (66 papers), United Kingdom (65 papers) and Brazil (59 papers) (Figure 4 B). In this study, no African country ranked among the top 10 countries in term of scientific production related to CLES. This list of the ten most productive countries in CLES is similar with that of Zhang *et al.* (2016) and Aznar-Sánchez *et al.* (2019). In general, several studies reported that the USA is leading in ecosystem services research (McDonough *et al.*, 2017a; Aznar-Sánchez *et al.*, 2019; Zhang *et al.*, 2019, 2016). This might be explained by the fact that the concept of ecosystem service originated in the anglophone scientific literature (Costanza *et al.*, 1997; Daily, 1997) and was early integrated and implemented in US policy with the 2008 Farm Bill, which called for the valuation of ecosystem services and their application to environmental markets (Schaefer *et al.*, 2015; McDonough *et al.*, 2017b;).

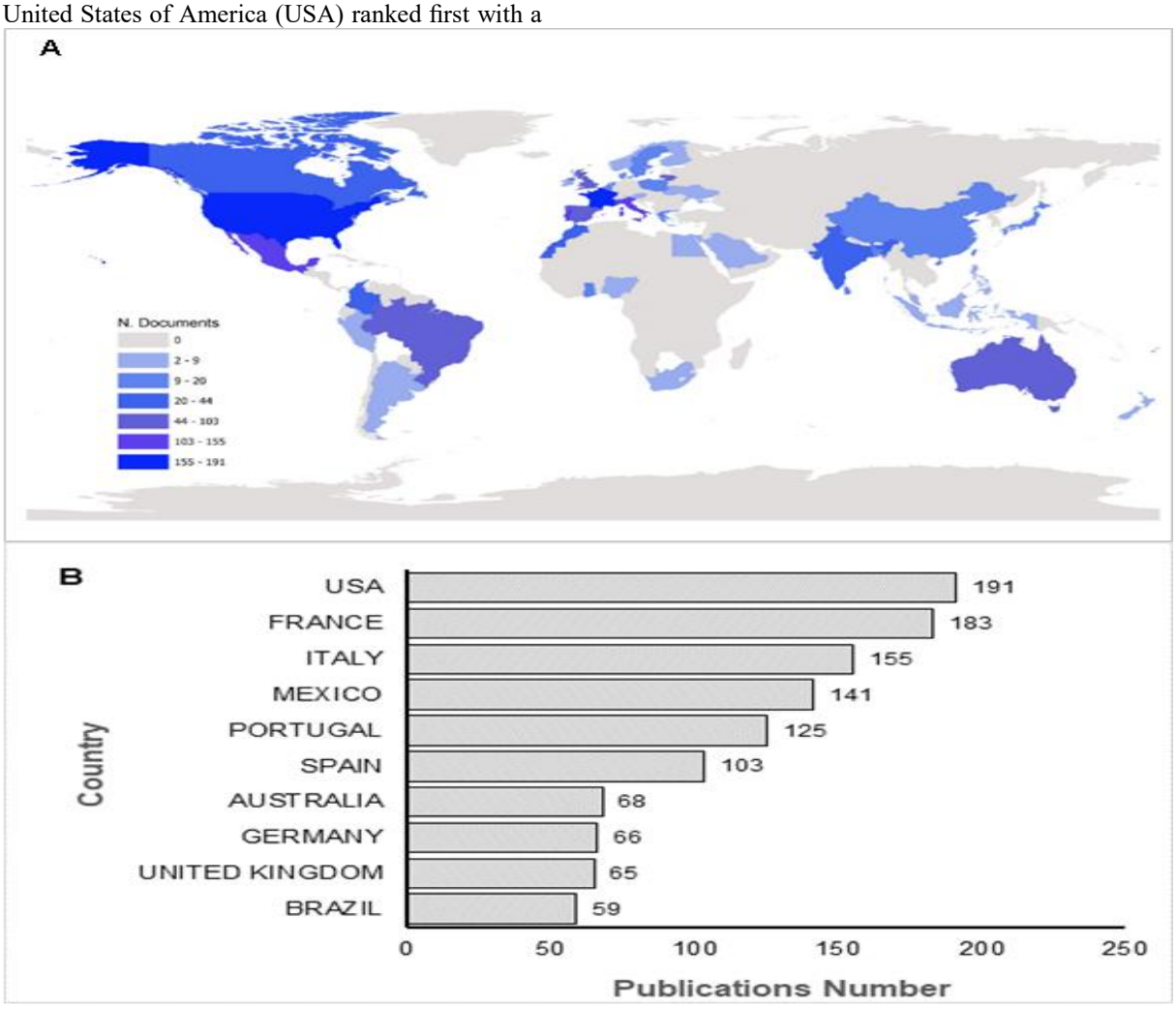

Figure 4. A: Countries'/regions' scientific production related to CLES from 1999 to 2022 **B**: Top 10 country in term of scientific production.

The co-authorship analysis showed the state of collaboration (Network) between the most productive countries (Donthu *et al*., 2021). The co-authorship map (Figure 5) showed five clusters in network. The first cluster (red color) was led by USA, followed by the United Kingdom, Portugal, Spain, Norway, Sweden, Ghana and Poland. The second and the largest cluster (blue color) was led by Germany and including Italy, Japan, Lithuania, France, Greece, Denmark, Belgium, China, Morocco and other countries. Mexico followed by Netherland composed the third and smallest cluster (green color). The fourth cluster (violet color) was led by Australia and including Saudi Arabia, India, Sri Lanka and Egypt. The lead of the last cluster (Yellow color) was taken by Canada, Columbia, Brazil, Argentina and Uruguay.

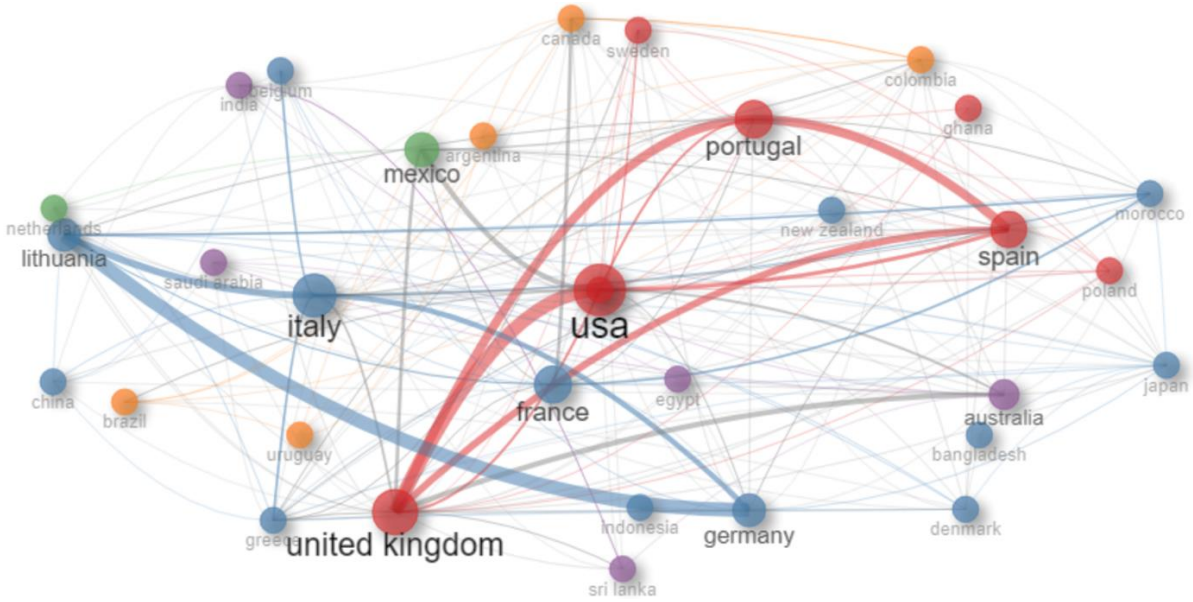

Figure 5. Co-authorship cooperation between productive countries related to CLES. Each node represents a country. The size of the nodes reveals the citations of the countries, while the thickness of the lines between them shows the strength of collaboration

Common interests in the field of coastal lagoon ecosystem services

A total of 1063 author keywords were recorded in this research dataset (Figure 1). Keywords, a key component of articles, provide a very simplified version of the contents (Lu *et al*., 2020). To understand the focal areas and development patterns of CLES topic, it is required to conduct a thorough analysis of the keyword selection in relevant research. In order to effectively organize information and knowledge resources, Author keywords are a vital source of information for both automatic and human indexing systems to organizing information and knowledge resources more effectively (Fadlalla and Amani, 2015; Raamkumar *et al*., 2018; Lu *et al*., 2020). Keywords analysis in the field of coastal lagoon ecosystem services (CLES) was presented in figure 6. The most frequently appeared keywords involved in CLES were ecosystem services (18%), coastal lagoons (10%), coastal lagoon (9%), climate change (9%) ecosystems (6%), eutrophication (5%). These words were followed by wetland, biodiversity, lagoon, water quality, transitional water and restauration, accounting for 4% each (Figure 6A). The findings suggested that there is an increase trend in scientific research related to CLES with regard to these topics.

Some of the studies have addressed the impact of climate change on coastal lagoon and ecosystem services for proactive management (Figure 6B). For instance, the most frequently chosen keywords by authors in relation to CLES studies were “coastal lagoons”, “management”, “climate change”, “ecosystem services” (Chapman, 2012); “climate change”, “coastal lagoon”, “ecosystems” (Anthony *et al*., 2009); “climatic change”, “coastal lagoon” (Fichez *et al*., 2017). This result suggests a research interest in the effects of climate change in coastal lagoon and ecosystem services.

Asmus *et al*. (2019) assessed the environmental risk generated by climate threats in coastal ecosystems on the Southern coast of Brazil – Estuary of Patos Lagoon. The research involved the development of a model that estimates the risk of losing ecosystem services used by various stakeholder groups as a function of the climate threat, the value of the service defined by stakeholder perception, and the vulnerability of each group in relation to a possible service loss. Chapman (2012) reported in his study titled “Management of coastal lagoons under climate change” that to sustain ecosystem services

before uncontrolled, negative changes occur, management would go beyond the bounds of current management efforts and could include, for example, introduction of species, bioengineering, and physical engineering. Authors suggested that this approach be implemented first to coastal lagoons since these are unique ecosystems where this strategy can be proved, allowing it to be applied more widely once accepted. In coastal ecosystems, particularly coastal lagoon landscapes, climate change is not the only threat to ecosystem services but other great pressure such as anthropogenic activities (agricultural activities, settlements, built up areas), coastal population growth, coastal erosion, marine submersion, pollution, and invasive species should also be considered (de Groot *et al*., 2010; Kindu *et al*., 2016; Tolessa *et al*., 2017; Díaz *et al*., 2019).

Based on our results, keywords analysis also implied that work on coastal lagoon ecosystem services has also focused on biodiversity (Figure 6 A & B). This is important because biodiversity is a key factor of ecosystem health and plays a vital role in delivering ecological services that are necessary for economic growth and social well-being (MEA, 2005; Mertz *et al*., 2007; Quijas and Balvanera, 2013; Harrison *et al*., 2014; Balvanera *et al*., 2016; Casal and McCarthy, 2023). Nevertheless, the result of this literature review showed that keywords such as ‘‘land use’’, ‘‘land use/land cover change (LU/CC)’’ to assess impact of land use or LU/LC on CLES. Likewise, “mapping’’, “participatory mapping’’ did not appear as relevant keywords in the papers related to CLES study found in Scopus data base. This fact may indicate a possible lack of connection between the research conducted in this field. Many empirical studies have stressed the relevance of including the concept of LU/LC (Cabral *et al*., 2016; Kindu *et al*., 2016; Tolessa *et al*., 2017; Paudyal *et al*., 2019) and participatory mapping (Muhamad *et al*., 2014; Malinga *et al*., 2015; Scholte *et al*., 2015; Kolosz *et al*., 2018; Zulian *et al*., 2018) in ecosystem services research. Furthermore, the result of this literature review also showed that terms such as “community perception” “local population” or “community livelihood” did not appear as relevant keywords in the CLES analysis. This finding may imply a probable lack of link between the research undertaken in these fields. According to Tadesse *et al*. (2014) and Laterra *et al*. (2016), understanding local communities' perceptions of ecosystem services might be used as a critical decision support tool to enhance ecosystem services supply while minimizing natural ecosystem destruction.

Figure 6. Word TreeMap (A) and WordCloud (B) of high-frequency keywords in the field of coastal lagoon ecosystem services

Thematic evolution of coastal lagoon ecosystem services research

This section presents the results of the thematic evolution analysis in coastal lagoon ecosystem services. The thematic evolution analysis of the CLES field gives an interesting broad picture of the field's development. The figure 7 shows the thematic evolution of the CLES research field in the period 1999–2022 by dividing it into five subperiods. As a result, we examine the evolution of keywords over three distinct time periods (1999-2012; 2013-2015; 2017-2017; 2018-2020 and 2021-2022). The reason for selecting these time intervals was because the number of researches related to CLES started to increase after 2010 with the publication of the Economics of Ecosystems and Biodiversity (TEEB, 2010). From the time period of 1999-2012, the dominant theme was coastal lagoons which can be explained by the fact that researchers have pooled their knowledge to define and explain this concept. During the period spanning from 2013 to 2015, the concept of coastal lagoons remained dominant but with the emergence of new themes such as ecosystems services and climate change. Since research highlighted that coastal lagoons count among the marine habitats with an important part of the planet's biodiversity, playing an important ecological role (Anthony *et al*., 2009; Basset *et al*., 2013; Costanza, 2014) but are also some of the most threatened ecosystems in the world (MEA, 2005), it is clear that research on the concept splits up into these themes. This made the research more accurate during this time period. Between 2016 and 2017, we observe the continuance of existing themes, such as ecosystems

services, but also the emergence of additional themes such as wetlands, seagrass, water quality and estuaries. During the 2018-2020 period, coastal management is the additional theme whereas, restoration, eutrophication, transitional water and coastal wetlands emerged as new thematic from 2021 to 2022. The concept of ecosystem services, which has been described as the benefits that people obtain from ecosystems such as coastal lagoon (MEA, 2005), appears appropriate for evaluating how society may benefit from ecosystem conservation and restoration activities (Orth *et al*., 2020). Coastal wetlands including coastal lagoons are areas of limited exchange that are prone to anthropogenic influences that cause issues such as eutrophication (Brito *et al*., 2012; González-De Zayas *et al*., 2018; Orth *et al*., 2020). The influence of eutrophication on ecosystem structure and functioning in coastal lagoons is characterized by regime shifts that are extensively documented in the scientific literature (McGlathery *et al*., 2007; Lloret *et al*., 2008; Del Barrio Fernández *et al*., 2012; Glibert *et al*., 2014; Domingues *et al*., 2017; Rodríguez-Gallego *et al*., 2017; Pereira-Ibarra and López-Monroy, 2021).

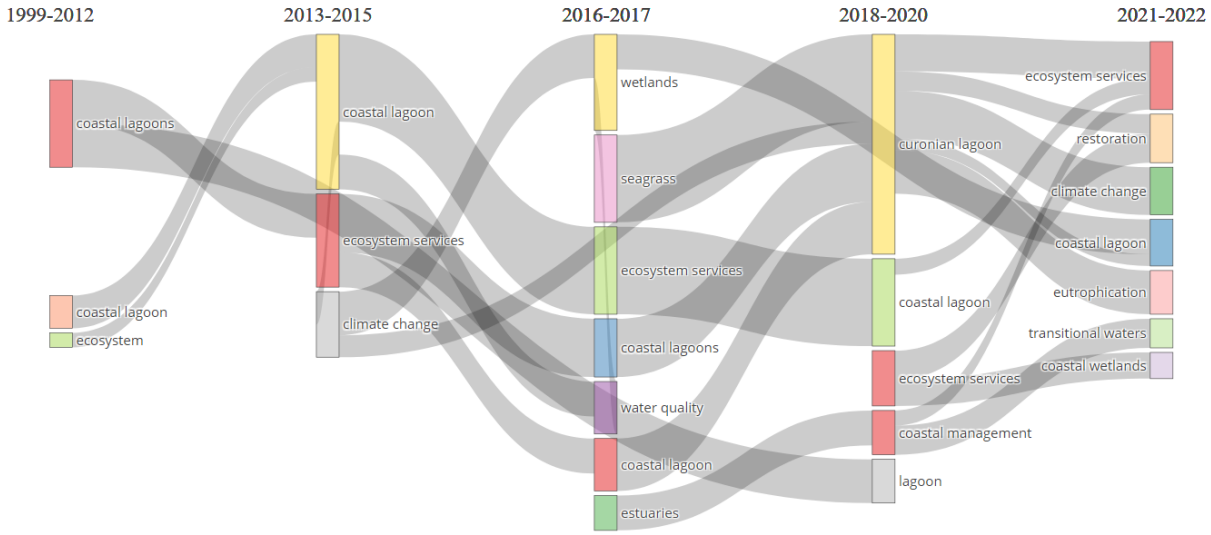

Figure 7. Thematic evolution of Coastal Lagoon Ecosystem Service (CLES) research (1999–2022).

Limitation and future research opportunities

Like any research endeavor, this study has its limitations. The bibliometric analysis relied exclusively on the Scopus database, which may not comprehensively cover all fields related to CLES. Therefore, future studies could benefit from using additional databases such as Web of Science (WoS) or Google Scholar, as database selection can influence results. Moreover, various bibliometric software tools are available, each with distinct advantages and disadvantages (Tiberius *et al*., 2020). Our study used bibliometrix (Aria and Cuccurullo, 2017) under the R software (R Core Team, 2022). Although, bibliometrix software provided relevant findings for our analyses, it is possible that different software might have produced better results. Therefore, future studies might also use other bibliometric software programs such as VoSviewer or CitNetExplorer (Van Eck and Waltman, 2010), CiteSpace (Chen, 2006), Pajek (Batagelj and Mrvar, 2008; Mrvar and Batagelj, 2016). Despite these limitations of this study, this systematic mapping has provided interesting insights into coastal lagoon ecosystem services research trend over the last twenty-three years.

4. CONCLUSION

This study reviewed scientific papers extracted from the Scopus database from 1999 to 2022 related to coastal lagoon ecosystem services (CLES) research. A bibliometric analysis of the scientific publication trends, relevant authors and publications, source journals, geographic distribution map and international collaboration network, most frequent and temporal evolution of keywords usage was performed. In total, 304 scientific papers written exclusively in English were included in the analysis. The topic of coastal lagoon ecosystem services received increased attention in research from 2012. Among the 1382 authors recorded in this research dataset, Schernewski and Lillebø were the most productive, while the most highly cited author was Perez- Ruzafa. *Estuarine, Coastal and Shelf Science* journal is influential source in CLES research. Newton *et al*. (2014) ranked first on the list of globally cited documents related to CLES research.

When analyzing countries/regions scientific production, Europe was found to be the main region, while the US was ranked first country in publishing articles. Regarding African regions' scientific production pertaining to CLES, North Africa was the most productive. Keywords analysis identified the themes such as ecosystem services, coastal lagoons, climate change ecosystems, eutrophication as the most frequently appeared keywords involved in CLES. Thematic evolution analysis highlighted that coastal lagoons was the dominant theme in all five subperiods, followed by the appearance of ecosystem services, climate change in four and two subperiods respectively. Through this bibliometric review, analysis revealed that greater attention is drawn to the impacts of climate change on coastal lagoon ecosystems and services. Based on systematic mapping, the authors suggest that future research on CLES should focus on the impacts of land use and land cover change on the value of these ecosystem services, local community perceptions, and participatory mapping of ecosystem services.

Reference

Abbas A.F., Jusoh A.B., Masod A. & Ali J., 2020. Market maven and mavenism: a bibliometrics analysis using Scopus database. *International Journal of Management*, 11, 31–45. https://doi.org/10.34218/IJM.11.11.2020.004

Anthony A., Atwood J., August P., Byron C., Cobb S., Foster C., Fry C., Gold A., Hagos K., Heffner L., Kellogg D.Q., Lellis-Dibble K., Opaluch J.J., Oviatt C., Pfeiffer-Herbert A., Rohr N., Smith L., Smythe T., Swift J. & Vinhateiro N., 2009. Coastal lagoons and climate change: Ecological and social ramifications in U.S. A*tlantic and Gulf coast ecosystems. Ecol. Soc*., 14 (1): 8. https://doi.org/10.5751/ES-02719-140108

Aponte H. & Cano A., 2013. *Estudio florístico comparativo de seis humedales de la costa de lima (perú) : actualización y nuevos retos para su conservación*, *Latin American Journal of Conservation*, 3 (2), 15 - 27

Aria M. & Cuccurullo C., 2017. bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11, 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Asmus M.L., Nicolodi J., Anello L.S. & Gianuca K., 2019. The risk to lose ecosystem services due to climate change: A South American case. *Ecol. Eng*., 130, 233–241. https://doi.org/10.1016/j.ecoleng.2017.12.030

Aznar-Sánchez J.A., Velasco-Muñoz J.F., Belmonte-Ureña L.J. & Manzano-Agugliaro F., 2019. The worldwide research trends on water ecosystem services. *Ecological Indicators*, 99, 310–323. https://doi.org/10.1016/j.ecolind.2018.12.045

Baker H.K., Kumar S. & Pandey N., 2021. Thirty years of Small Business Economics: a bibliometric overview. *Small Bus Econ*., 56, 487–517. https://doi.org/10.1007/s11187-020-00342-y

Baker J., Dupont D. & Vasseur L., 2021. Exploring Canadian Ramsar Sites Ecosystem Governance and Sustainability. *Wetlands*, 41. https://doi.org/10.1007/s13157-021-01417-6

Balvanera P., Quijas S., Martín-López B., Barrios E., Dee L., Isbell F., Durance I., White P., Blanchard R. & Groot R.D., 2016. The Links Between Biodiversity and Ecosystem Services, in: *Potschin M., Haines-Young R., Fish R., Turner R.K. (Eds.), Routledge Handbook of Ecosystem Services. Routledge, New York, NY: Routledge*, pp. 45–61. https://doi.org/10.4324/9781315775302-5

Basset A., Elliott M., West R.J. & Wilson J.G., 2013. *Estuarine and lagoon biodiversity and their natural goods and services.* Estuarine, Coastal and Shelf Science. https://doi.org/10.1016/j.ecss.2013.05.018

Batagelj V. & Mrvar A., 2008. Analysis of Kinship Relations With Pajek. *Social Science Computer Review*, 26, 224–246. https://doi.org/10.1177/0894439307299587

Brito A.C., Newton A., Tett P. & Fernandes T.F., 2012. How will shallow coastal lagoons respond to climate change? A modelling investigation. Estuar. *Coast. Shelf Sci*., 112, 98–104. https://doi.org/10.1016/j.ecss.2011.09.002

Burkhard B., Kroll F., Nedkov S. & Müller F., 2012. Mapping ecosystem service supply, demand and budgets. *Ecological Indicators*, 21, 17–29. https://doi.org/10.1016/j.ecolind.2011.06.019

Cabral P., Feger C., Levrel H., Chambolle M. & Basque D., 2016. Assessing the impact of land-cover changes on ecosystem services: A first step toward integrative planning in Bordeaux, France. *Ecosystem Services*, 22, 318–327. https://doi.org/10.1016/j.ecoser.2016.08.005

Casal G. & McCarthy T., 2023. Marine coastal biodiversity and services in Ireland in a three-dimensional context: Scientific, news media, and legislative. *Ocean & Coastal Management*, 244, 106796. https://doi.org/10.1016/j.ocecoaman.2023.106796

Chapman P.M., 2012. Management of coastal lagoons under climate change. *Estuar Coast Shelf Sci.*, 110, 32–35. https://doi.org/10.1016/j.ecss.2012.01.010

Chapman P.M., Wang F. & Caeiro S.S., 2013. Assessing and managing sediment contamination in transitional waters. *Environ. Int*. 55, 71–91. https://doi.org/10.1016/j.envint.2013.02.009

Chen, P., 2006. Evaluation on service value of wetland ecosystem in Xiamen City. *Wetland Sci*. 4, 101–107.

Chen Y., Caesemaecker C., Rahman H.T. & Sherren K., 2020. Comparing cultural ecosystem service delivery in dykelands and marshes using Instagram: A case of the Cornwallis (Jijuktu'kwejk) River, Nova Scotia, Canada. *Ocean Coast Manage*. 193. 105254. 9 pages https://doi.org/10.1016/j.ocecoaman.2020.105254

Cobo M.J., López-Herrera A.G., Herrera-Viedma E. & Herrera F., 2011. An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the Fuzzy Sets Theory field.

Journal of Informetrics, 5, 146–166. https://doi.org/10.1016/j.joi.2010.10.002

Costanza R., 2014. *Changes in the global value of ecosystem services*. *Global Environmental Change*, 26, 152–158. https://doi.org/10.1016/j.gloenvcha.2014.04.002

Costanza R., Hannon B., Limburg K., Naeem S., O'Neill R.V., Raskin R.G. & Sutton P., 1997. The Value of the World's Ecosystem Services and Natural Capital, *Nature*, 387, 253–260. https://doi.org/10.1038/387253a0

Cuni-Sanchez A., Pfeifer M., Marchant R. & Burgess N.D., 2016. Ethnic and locational differences in ecosystem service values: Insights from the communities in forest islands in the desert. *Ecosystem Services*, 19, 42–50. https://doi.org/10.1016/j.ecoser.2016.04.004

Dahdouh-Guebas F., Hettiarachchi S., Lo Seen D., Batelaan O., Sooriyarachchi S., Jayatissa L.P. & Koedam N., 2005. Transitions in ancient inland freshwater resource management in Sri Lanka affect biota and human populations in and around coastal lagoons. *Curr. Biol.*, 15, 579–586. https://doi.org/10.1016/j.cub.2005.01.053

Daily G.C., 1997. In*troduction: What Are Ecosystem Services? In: Daily, G.C., Ed., Nature's Services: Societal Dependence on Natural Ecosystems.* Island Press, Washington DC, 10 pages

de Groot R.S., Alkemade R., Braat L., Hein L. & Willemen L., 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity*, 7, 260–272. https://doi.org/10.1016/j.ecocom.2009.10.006

Del Barrio Fernández P., Gómez A.G., Alba J.G., Díaz C.Á. & Revilla Cortezón J.A., 2012. A model for describing the eutrophication in a heavily regulated coastal lagoon. Application to the Albufera of Valencia (Spain). J*ournal of Environmental Management*, 112, 340–352. https://doi.org/10.1016/j.jenvman.2012.08.019

Díaz S., Settele J., Brondízio *et al*.., 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science*, 366, eaax3100. https://doi.org/10.1126/science.aax3100

Domingues R.B., Guerra C.C., Barbosa A.B. & Galvão H.M., 2017. Will nutrient and light limitation prevent eutrophication in an anthropogenically-impacted coastal lagoon? *Continental Shelf Research*, 141, 11–25. https://doi.org/10.1016/j.csr.2017.05.003

Donthu N., Kumar S., Mukherjee D., Pandey N. & Lim W.M., 2021. How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Esse C., Santander-Massa R., Encina-Montoya F., De Los Ríos P., Fonseca D. & Saavedra P., 2019. Multicriteria spatial analysis applied to identifying ecosystem services in mixed-use river catchment areas in south central Chile. *For. Ecosyst.*, 6 (25), 1–13. https://doi.org/10.1186/s40663-019-0183-1

Estoque R.C., Myint S.W., Wang C., Ishtiaque A., Aung T.T., Emerton L., Ooba M., Hijioka Y., Mon M.S., Wang Z. & Fan C., 2018. Assessing environmental impacts and change in Myanmar's mangrove ecosystem service value due to deforestation (2000–2014). *Global Change Biol.*, 24, 5391–5410. https://doi.org/10.1111/gcb.14409

Fadlalla, A., Amani, F., 2015. A keyword-based organizing framework for ERP intellectual contributions. *Journal of Enterprise Information Management* 28, 637–657. https://doi.org/10.1108/JEIM-09-2014-0090

Fichez R., Archundia D., Grenz C., Douillet P., Gutiérrez Mendieta F., Origel Moreno M., Denis L., Contreras Ruiz Esparza A. & Zavala-Hidalgo J., 2017. Global climate change and local watershed management as potential drivers of salinity variation in a tropical coastal lagoon (Laguna de Terminos, Mexico). *Aquatic Sciences*, 79(2), 219–230 https://doi.org/10.1007/s00027-016-0492-1

Gangahagedara R., Subasinghe S., Lankathilake M., Athukorala W. & Gamage I., 2021. Ecosystem Services Research Trends: A Bibliometric Analysis from 2000–2020. *Ecologies*, 2, 366–379. https://doi.org/10.3390/ecologies2040021

Ghermandi A., Van Den Bergh J.C.J.M., Brander L.M., De Groot H.L.F. & Nunes P.A.L.D., 2010. Values of natural and human-made wetlands: A meta-analysis. *Water Resour. Res.*, 46 (12), 1–12. https://doi.org/10.1029/2010WR009071

Glibert P.M., Hinkle D.C., Sturgis B. & Jesien R.V., 2014. Eutrophication of a Maryland/Virginia Coastal Lagoon: a Tipping Point, Ecosystem Changes, and Potential Causes. *Estuaries and Coasts*, 37, 128–146. https://doi.org/10.1007/s12237-013-9630-3

González-De Zayas R., Merino-Ibarra M., Valdespino-Castillo P.M., Olivera Y. & Castillo-Sandoval S.F., 2018. Coexisting ecosystem states in a tropical coastal lagoon under progressive eutrophication in the northern Cuban keys. *Sci. Mar.*, 82(3), 139–146. https://doi.org/10.3989/scimar.04682.22A

Harrison P.A., Berry P.M., Simpson G., Haslett J.R., Blicharska M., Bucur M., Dunford, R., Egoh, B., Garcia-Llorente, M., Geamănă, N., Geertsema, W., Lommelen, E., Meiresonne, L., Turkelboom, F., 2014. Linkages between biodiversity attributes and ecosystem services: A systematic review. *Ecosystem Services* 9, 191–203. https://doi.org/10.1016/j.ecoser.2014.05.006

Inácio M., Schernewski G., Nazemtseva Y., Baltranaitė E., Friedland R. & Benz J., 2018. Ecosystem services provision today and in the past: a comparative study in two Baltic lagoons. *Ecol. Res.*, 33, 1255–1274. https://doi.org/10.1007/s11284-018-1643-8

Jiang W., 2017. Ecosystem services research in China: A critical review. *Ecosystem Services*, 26, 10–16. https://doi.org/10.1016/j.ecoser.2017.05.012

Khanra S., Dhir A., Kaur P. & Mäntymäki M., 2021. Bibliometric analysis and literature review of ecotourism: Toward sustainable development. T*ourism Management Perspectives*, 37, 100777. https://doi.org/10.1016/j.tmp.2020.100777

Khatib S.F.A., Abdullah D.F., Hendrawaty E. & Elamer A.A., 2022. A bibliometric analysis of cash holdings literature: current status, development, and agenda for future research. *Manag. Rev. Q*, 72, 707–744. https://doi.org/10.1007/s11301-021-00213-0

Kindu M., Schneider T., Teketay D. & Knoke T., 2016. Changes of ecosystem service values in response to land use/land cover dynamics in Munessa–Shashemene landscape of the Ethiopian highlands. Sc*ience of The Total Environment*, 547, 137–147. https://doi.org/10.1016/j.scitotenv.2015.12.127

Kolosz B.W., Athanasiadis I.N., Cadisch G., Dawson T.P., Giupponi C., Honzák M., Martinez-Lopez J., Marvuglia A., Mojtahed V., Ogutu K.B.Z., Van Delden H., Villa F. & Balbi S., 2018. Conceptual advancement of socio-ecological modelling of ecosystem services for re-evaluating Brownfield land. *Ecosystem Services*, 33, 29–39. https://doi.org/10.1016/j.ecoser.2018.08.003

Köseoglu M.A., Sehitoglu Y. & Craft J., 2015. Academic foundations of hospitality management research with an emerging country focus: A citation and co-citation analysis. *International Journal of Hospitality Management*, 45, 130–144. https://doi.org/10.1016/j.ijhm.2014.12.004

Laterra P., Barral P., Carmona A. & Nahuelhual L., 2016. Focusing Conservation Efforts on Ecosystem Service Supply May Increase Vulnerability of Socio-Ecological Systems. *PLoS ONE* 11, e0155019. https://doi.org/10.1371/journal.pone.0155019

Lloret J., Marín A. & Marín-Guirao L., 2008. Is coastal lagoon eutrophication likely to be aggravated by global climate change? *Estuarine, Coastal and Shelf Science*, 78, 403–412. https://doi.org/10.1016/j.ecss.2008.01.003

Lu W., Liu Z., Huang Y., Bu Y., Li X. & Cheng Q., 2020. How do authors select keywords? A preliminary study of author keyword selection behavior. *Journal of Informetrics*, 14, 101066. https://doi.org/10.1016/j.joi.2020.101066

Malinga R., Gordon L.J., Jewitt G. & Lindborg R., 2015. Mapping ecosystem services across scales and continents – A review. *Ecosystem Services*, 13, 57–63. https://doi.org/10.1016/j.ecoser.2015.01.006

Martinez M.A., Cobo M.J., Herrera M. & Herrera-Viedma E., 2015. Analyzing the scientific evolution of social work using science mapping. *Research on Social Work Practice*, 25, 257–277.

McDonough K., Hutchinson S., Moore T. & Hutchinson J.M.S., 2017a. Analysis of publication trends in ecosystem services research. *Ecosystem Services*, 25, 82–88. https://doi.org/10.1016/j.ecoser.2017.03.022

McDonough K., Hutchinson S., Moore T. & Hutchinson J.M.S., 2017b. Analysis of publication trends in ecosystem services research. *Ecosystem Services*, 25, 82–88. https://doi.org/10.1016/j.ecoser.2017.03.022

McGlathery K., Sundbäck K. & Anderson I., 2007. Eutrophication in shallow coastal bays and lagoons: the role of plants in the coastal filter. *Mar. Ecol. Prog. Ser.*, 348, 1–18. https://doi.org/10.3354/meps07132

MEA, 2005. (*Millennium Ecosystem Assessment) Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC, 80 p.

Mertz O., Ravnborg H.M., Lövei G.L., Nielsen I. & Konijnendijk C.C., 2007. Ecosystem services and biodiversity in developing countries. *Biodivers Conserv.*, 16, 2729–2737. https://doi.org/10.1007/s10531-007-9216-0

Mrvar A. & Batagelj V., 2016. Analysis and visualization of large networks with program package Pajek. C*omplex Adapt Syst Model*, 4(6) 2–8. https://doi.org/10.1186/s40294-016-0017-8

Muhamad D., Okubo S., Harashina K., Parikesit, Gunawan B. & Takeuchi K., 2014. Living close to forests enhances people's perception of ecosystem services in a forest–agricultural landscape of West Java, Indonesia. *Ecosystem Services*, 8, 197–206. https://doi.org/10.1016/j.ecoser.2014.04.003

Mustak M., Salminen J., Plé, L. & Wirtz J., 2021. Artificial intelligence in marketing: Topic modeling, scientometric analysis, and research agenda. *Journal of Business Research*, 124, 389–404. https://doi.org/10.1016/j.jbusres.2020.10.044

Newton A., Brito A.C., Icely J.D. *et al.*, 2018. Assessing, quantifying and valuing the ecosystem services of coastal lagoons. *J. Nat. Conserv.*, 44, 50–65. https://doi.org/10.1016/j.jnc.2018.02.009

Newton A., Icely J., Cristina S. *et al.*, 2014. An overview of ecological status, vulnerability and future perspectives of European large shallow, semi-enclosed coastal systems, lagoons and transitional waters. Estuar. *Coast. Shelf Sci.*, 140, 95–122. https://doi.org/10.1016/j.ecss.2013.05.023

Orth R.J., Lefcheck J.S., McGlathery K.S., Aoki L., Luckenbach M.W., Moore K.A., Oreska M.P.J., Snyder R., Wilcox D.J. & Lusk B., 2020. Restoration of seagrass habitat leads to rapid recovery of coastal ecosystem services. *Sci. Adv.*, 6. https://doi.org/10.1126/sciadv.abc6434

Orth R.J., Luckenbach M.L., Marion S.R., Moore K.A. & Wilcox D.J., 2006. Seagrass recovery in the Delmarva Coastal Bays, USA. *Aquatic Botany*, 84, 26–36. https://doi.org/10.1016/j.aquabot.2005.07.007

Pascual U., Balvanera P., Díaz S. *et al*., 2017. Valuing nature's contributions to people: the IPBES approach. Current Opinion. *Environmental Sustainability*, 26–27, 7–16.
https://doi.org/10.1016/j.cosust.2016.12.006

Paudyal K., Baral H., Bhandari S.P., Bhandari A. & Keenan R.J., 2019. Spatial assessment of the impact of land use and land cover change on supply of ecosystem services in Phewa watershed, Nepal. *Ecosystem Services*, 36, 100895.
https://doi.org/10.1016/j.ecoser.2019.100895

Pereira-Ibarra C.J. & López-Monroy F., 2021. T*rophic status of a tropical coastal lagoon in margarita island, venezuela*. RICA. https://doi.org/10.20937/RICA.54083

Pérez-Ruzafa Á., Marcos C. & Pérez-Ruzafa I.M., 2011. Recent advances in coastal lagoons ecology: Evolving old ideas and assumptions. *Transitional Waters Bull.*, 5, 50–74. https://doi.org/10.1285/i1825229Xv5n1p50

Quijas S., Balvanera P., 2013. Biodiversity and Ecosystem Services, in: Encyclopedia of Biodiversity. *Elsevier*, pp. 341–356. https://doi.org/10.1016/B978-0-12-384719-5.00349-X

R Core Team, 2022. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna.

Raamkumar A.S., Erdt M., Vijayakumar H., Rasmussen E. & Theng Y., 2018. Understanding the Twitter usage of humanities and social sciences academic journals. *Proc. Assoc. Info. Sci. Tech.*, 55, 430–439. https://doi.org/10.1002/pra2.2018.14505501047

Rodríguez-Gallego L., Achkar M., Defeo O., Vidal L., Meerhoff E. & Conde D., 2017. Effects of land use changes on eutrophication indicators in five coastal lagoons of the Southwestern Atlantic Ocean. E*stuarine, Coastal and Shelf Science*, 188, 116–126. https://doi.org/10.1016/j.ecss.2017.02.010

Salata S., Giaimo C., Alberto Barbieri C. & Garnero G., 2020. The utilization of ecosystem services mapping in land use planning: the experience of LIFE SAM4CP project. *Journal of Environmental Planning and Management*, 63, 523–545. https://doi.org/10.1080/09640568.2019.1598341

Schaefer M., Goldman E., Bartuska A.M., Sutton-Grier A. & Lubchenco J., 2015. Nature as capital: Advancing and incorporating ecosystem services in United States federal policies and programs. *Proc. Natl. Acad. Sci.*, 112, 7383–7389. https://doi.org/10.1073/pnas.1420500112

Scholte S.S.K., van Teeffelen A.J.A. & Verburg P.H., 2015. Integrating socio-cultural perspectives into ecosystem service valuation: A review of concepts and methods. *Ecological Economics*, 114, 67–78. https://doi.org/10.1016/j.ecolecon.2015.03.007

Soorae P., Sakkir S., Saji A., Khan S.B., Zaabi R.A., Shah J.N., Ali A., Al Omari K., Al Dhaheri A., Javed S., Tubati S.R., Ahmed S., Alrashdi Z.A. & Al Dhaheri S., 2020. A Review of the Flora and Fauna in the Al Wathba Wetland Reserve in Abu Dhabi, United Arab Emirates. *Wetlands*, 40, 1505–1512. https://doi.org/10.1007/s13157-019-01235-x

Sousa L.P., Lillebø A.I., Gooch G.D., Soares J.A. & Alves F.L., 2013. Incorporation of local knowledge in the identification of Ria de Aveiro lagoon ecosystem services (Portugal). *J. Coast. Res.*, 1051–1056. https://doi.org/10.2112/SI65-178

Sy M.M., Rey-Valette H., Simier M., Pasqualini V., Figuières C. & De Wit R., 2018. Identifying Consensus on Coastal Lagoons Ecosystem Services and Conservation Priorities for an Effective Decision Making: A Q Approach. *Ecological Economics*, 154, 1–13. https://doi.org/10.1016/j.ecolecon.2018.07.018

Tadesse G., Zavaleta E., Shennan C. & FitzSimmons M., 2014. Local Ecosystem Service Use and Assessment Vary with Socio-ecological Conditions: A Case of Native Coffee-Forests in Southwestern Ethiopia. *Hum. Ecol.*, 42, 873–883. https://doi.org/10.1007/s10745-014-9704-2

TEEB, 2010. *The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations*, 422 p.

Tiberius V., Rietz M. & Bouncken R., 2020. Performance Analysis and Science Mapping of Institutional Entrepreneurship Research. *Administrative Sciences*, 10, 69. https://doi.org/10.3390/admsci10030069

Tolessa T., Senbeta F. & Kidane M., 2017. The impact of land use/land cover change on ecosystem services in the central highlands of Ethiopia. *Ecosystem Services*, 23, 47–54. https://doi.org/10.1016/j.ecoser.2016.11.010

Trombetta T., Vidussi F., Mas S., Parin D., Simier M. & Mostajir B., 2019. Water temperature drives phytoplankton blooms in coastal waters. *PLoS ONE* 14(4): e0214933 https://doi.org/10.1371/journal.pone.0214933

Van Eck N.J. & Waltman L., 2010. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84, 523–538. https://doi.org/10.1007/s11192-009-0146-3

Wood A., Sutcliffe J.P. & Dixon A., 2018. Baro-Akobo river basin wetlands: Livelihoods and sustainable regional land management (Ethiopia), in: The Wetl. Book II: Distrib., Descr., and Conserv. *Springer Nature*, pp. 1261–1267. https://doi.org/10.1007/978-94-007-4001-3_226

Yang Y., Song G. & Lu S., 2020. Study on the ecological protection redline (EPR) demarcation process and the ecosystem service value (ESV) of the EPR zone: A case study on the city of Qiqihaer in China. *Ecol. Indic.*, 109. https://doi.org/10.1016/j.ecolind.2019.105754

Yohannes H., Soromessa T., Argaw M. & Warkineh B., 2021. Spatio-temporal changes in ecosystem service bundles and hotspots in Beressa watershed of the Ethiopian highlands: Implications for landscape management. *Environmental Challenges*, 5, 100324. https://doi.org/10.1016/j.envc.2021.100324

Zhang L.L., Gong J. & Zhang Y., 2016. A review of ecosystem services: a bibliometric analysis based on web of sciences. *Acta Ecol. Sinica*, 36, 5967–5977.

Zhang H., Pang Q., Long H., Zhu H., Gao X., Li X., Jiang X. & Liu K., 2019. Local Residents' Perceptions for Ecosystem Services: A Case Study of Fenghe River Watershed. *I.J.E.R.PH.*, 16, 3602. https://doi.org/10.3390/ijerph16193602

Zulian G., Stange E., Woods H. *et al.*, 2018. Practical application of spatial ecosystem service models to aid decision support. *Ecosystem Services* 29, 465–480. https://doi.org/10.1016/j.ecoser.2017.11.005