



Review article

Drivers in the fisheries domain: A bibliometric and text mining analysis

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ABSTRACT

Fisheries have garnered attention from researchers throughout the last several decades. This sector's contribution has been recognised globally, leading to exponential growth in the number of research studies published in this area. Among all the dimensions from which this field has been explored, a critical theme under focus has been the drivers in the fisheries domain. Therefore, this study aims to provide a wholesome view of such studies that have explored drivers in the context of fisheries using bibliometric analysis and text-mining tools. Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach, 322 studies on the theme were extracted from the Scopus and Web of Science databases. The studies extracted were analysed using VOSviewer and Orange software. The analysis uncovered the top journals and publishers in this domain and revealed the hidden patterns in the existing literature. The researchers posit that rather than judging the growth solely based on the number of citations and publications over the period, focus should be concentrated towards identifying themes that have gained immense attention from researchers over the years. The results indicate a shifting trend in recent times, centered on topics related to sustainability and climate change, among many more. The findings have important implications for researchers to make valuable contributions in this domain.

1. Introduction

For several millennia, fishing has historically supported human existence [1]. Archaeological finds indicate that fishing-related activities have existed for centuries, evident from the remnants of cichlid Tilapia and catfish alongside the remains of Homo habilis and Homo erectus at Olduvai in eastern Africa. Although early evidence of fisheries existed, it was depicted clearly in the earliest cave paintings around 40,000 years ago. Likewise, in 3500 BC, Egyptian history indicates that fishing tools such as the spear, net, line, and rod were used [2].

In today's era, fish, besides being one of the most popular elements of several cuisines across the globe, is a significant component of global trade. The sector's significance can be measured by its significant contribution to employment and import-export trade. It, therefore, plays a crucial role in providing a livelihood to millions across the globe. Data figures highlight that the sector employed about 58.5 million people across the globe in 2020 [3]. Global fish production has constantly grown over the last several decades and peaked in 2022 at 184.6 million metric tonnes [4]. The word 'fish' is widely used to refer to diverse varieties of aquatic creatures. The variability in the definitions associated with the word makes it difficult to define the same clearly; hence, several researchers have

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attempted to develop some exhaustive definitions [5] states that fishes are “aquatic vertebrates with gills and limbs in the shape of fins.” Whereas according to Berra [6], fishes are “poikilothermic, aquatic chordate(s) with appendages (when present) developed as fins, whose chief respiratory organs are gills and whose body is usually covered with scales.” However, due to the non-uniformity in the way ‘fish’ as a term has been defined, The Food and Agriculture Organisation gave a more inclusive definition of fish, stating that unless otherwise specified, the term “fish” indicates fish, crustaceans, molluscs, and other aquatic animals, but excludes aquatic mammals, reptiles, seaweeds, and other aquatic plants [7].

Due to its fragile and highly perishable nature, fish distinguishes itself from other products usually consumed. Moreover, because it is a natural product, it is all the more important to identify ways the fisheries sector could grow sustainably. Problems such as illegal fishing, depletion of fish resources due to overfishing, and highly variable catch and prices are a few of the problems plaguing the sector. Considering the grave danger of exploiting the resource beyond repair, there is a need to look at the various elements that influence this sector. Also, since the sector is not just limited to the fishermen or those who catch the fish, it becomes essential to look at the sector from a broader perspective. It is essential to understand the interrelationships between elements of the work environment, technology, aspects of the society and culture of fishermen before making any fishery-related decisions [8]. The fisheries literature highlights critical assumptions about fisher attitudes and motivations. Typical assumptions include beliefs that populations of fishermen are homogeneous in decision-making and behave in a myopic way, ignoring the implications of their activities on the fishing resources [9]. Decision analysis is a relevant tool used in fisheries management, and authors such as Peterson and Evans [10] encourage its use by fisheries biologists. These studies about fisher behaviour from various perspectives by several researchers have given rise to the need to critically view these studies and highlight the arguments put forth by these authors, thus enabling us to understand better the critical role various drivers play in fisheries management.

As the literature highlights, fisheries management is a complex system and several elements such as risk, power and status, among others, tend to have an impelling effect on it. As such, it is crucial to examine these drivers. Past literature has highlighted various factors driving the growth of the fisheries sector based on fishermen’s viewpoint. The drivers identified in the context of fisheries by researchers in the past range from social to environmental and conscious to sub-conscious. At the same time, a few studies also put forth other players’ views on a fishing supply chain. Several authors have also approached this research area using secondary sources of data. Though the literature available in this regard is vast, it must be more cohesive. A thorough exploration of research articles published in various reputed journals can illuminate studies that have discussed such aspects. An in-depth review of available literature can, therefore, highlight several research works that have used different approaches to explore the drivers in the context of fisheries. But this methodology has its own limitations due to the time-consuming process which could also be plagued with researchers biases cropping in at the stage of selection of the studies which the researcher judges to be more significant as compared to the others. Therefore, this study identified bibliometric and text mining approach to be a more suitable and relevant tool for integrating knowledge from diverse and fragmented literature which is conducive for the cognition of researchers who will delve deeper into this research domain [11]. Unlike traditional bibliometric studies which solely focus on statistical results, this study further extracted key themes and frontiers which have been studied by researchers. This study will assist experts in this domain to further investigate the key patterns identified while also providing new researchers a glimpse into the probable research areas which can be focused upon in future.

2. Literature survey

Fishermen generally fall into three archetypal groups: those who frequently comply with regulations, those who frequently violate them, and those who unintentionally break rules due to a misunderstanding of regulations [12]. Traditional models for understanding fisher compliance behaviour are typically evaluated from an economic perspective, emphasising that a rational fisherman aims to maximise personal gains and profits [13]. Aspects that pertain to but go beyond the economic variables motivate fishers’ compliance decisions, and there is a need to account for monetary and non-monetary factors while trying to have a holistic view of fisher behaviour [14]. Variables such as moral and social norms, personal values, beliefs, individual perceptions and risk tolerance, and levels of confidence in the management system are some of the integral non-monetary factors influencing fisher behaviour [12,15]. Poggie & Gersuny [16], in their study of the anglers of Galilee, noted that one of the aspects that anglers highly acknowledge is the importance of non-monetary factors influencing fisher behaviours.

Moreover, Salas and Gaertner [17] also concluded that knowledge of the social, economic and behavioural dynamics of fishing is essential for effective fisheries management. Over the last few decades, the concept of sustainability has gained limelight in various fields and has been one of the extensively discussed aspects in the fisheries sector [18–25]. Likewise, Setthasakko [26] assessed key determinants that drive corporate sustainability and barriers that hinder its development by selecting two frozen seafood-processing companies as case studies. The author highlighted that international buyers should have considered the environmental and social impact generated by their suppliers while making their purchasing decisions. The researchers argued that the two significant barriers to change are the lack of a long-term view of environmental and social sustainability and the absence of a system perspective on the seafood supply chain. However, Fulton et al. [27], using empirical evidence of unexpected resource user behaviour and reviewing current responses to unexpected management outcomes, identified different approaches that improve the prediction of human behaviour in fisheries systems and identify management measures that are more robust to the sources of uncertainty. Also, Singh [28] identified several factors responsible for coordination in the food supply chain. Moreover, several researchers have also asserted that attitude is a good criterion for measuring one’s experience in fisheries and represents a psychological construct that can be measured [29]. Likewise, several key social variables influence fisheries management [30].

Researchers over the years have also given importance to recognising the need for information sharing among fishermen and its

contribution to their survival and success. In a study conducted among fishermen from Nigeria [31] results showed that the information needs of the fishers primarily revolve around their occupation, highlighting that information is sought mainly from friends, relatives, colleagues, and neighbours. The information exchange theme was mainly related to sources of credit and modern fishing technologies.

During the literature review, it was observed that fisheries have garnered attention from scholars across several disciplines due to their significant influence on numerous global economies. Management is a critical aspect in this study area that has gained increasing importance. Many experts have stressed the significance of sound decision-making approaches at both the macro and micro levels to attain sustainability goals established by society as a whole.

A thorough search is conducted to identify the studies that have previously undertaken literature reviews in the fisheries sector. The query run to identify these studies was TITLE-ABS-KEY (“Systematic Literature Review” OR “Bibliometric analysis”) AND “Fish*”) AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (DOCTYPE, “re”) OR LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ECON”) OR LIMIT-TO (SUBJAREA, “DECI”) OR LIMIT-TO (SUBJAREA, “MULT”) OR LIMIT-TO (SUBJAREA, “ARTS”)). The query resulted in the following studies, as shown in Table 1.

The 27 results were screened, and some of those found to be closely significant are summarised in Table 2, while others were briefly explained in the succeeding section.

Moreover, many other authors have reviewed the literature on fisheries management, such as Bernal-Higueta et al. [45], who conducted a systematic literature review identifying the main elements contributing to the sustainable growth of productivity in aquaculture with a particular focus on Information and Communication Tools (ICT) tools such as Artificial Intelligence (A.I.) and Internet of Things (IoT). Along similar lines, Drury et al. [46] systematically reviewed the literature to examine the economic viability of wool rope in seaweed aquaculture and highlighted a significant gap in wool research; however, the drive to increase sustainability within the marine environment has increased manifold. Wirza & Nazir [47] presented the existing state-of-the-art literature based on different species of fish and vegetables, systems layouts and climatic conditions in urban aquaponic systems.

Elsewhere, Philips et al. [48] addressed the current state of partially protected areas in Australian Marine areas. Basurto et al. [49] refined variables adopted to study Benthic fisheries from 1980 to 2010 based on literature around experts’ discussions. Zhang & Vincent [50] comprehensively reviewed China’s approach towards bottom trawling fishing over seven decades from 1949 to 2018. He highlighted that these policies have been influenced by domestic factors such as political will and consumption demand and international drivers like international laws and globalisation. Colman et al. [51] systematically reviewed the studies that examined how innovation has emerged as a critical element in fisheries’ success from the non-technological dimension perspective. Garcia et al. [52] reviewed the mathematical models used by previous researchers to study the change. They discussed the stress factors that were relevant in affecting the quality and freshness of fish. Ferlansyah & Suhajito [53] explored studies that examined vessel anomalous behaviour at sea through the patterns identified. Wiczorek et al. [54] critically reviewed the behavioural economics mechanisms influencing fishers’ behaviour. Oliveira et al. [55] adopted a bibliometric approach to test whether there is a variance between the geographical foci of the research and examined the need for research using studies based on artisanal fisheries. The results confirmed a need to synchronise the global research networks and needs based on the place where it is required. Therefore, this study attempts to address the following research questions:

R.Q.1. What is the publication trend for research on drivers in fisheries?

R.Q.2. What are the top contributing countries, institutions, and sources for research on drivers in fisheries?

R.Q.3. What are the emerging research themes and topics for research on drivers in fisheries?

R.Q.4. What are the future research perspectives in the area of drivers in fisheries?

Hereafter, this research paper is divided into three sections. The first section explains the research methodology in the form of materials, methods used for data collection, and the tools used for data analysis. The second section presents results and discussions based on the bibliometric and text mining analysis; the third section states the conclusion of this study.

Table 1
Studies related to systematic review and bibliometric analysis in fisheries.

Query specification	No. of Studies excluded	No. of studies retained
Stage 1: Query “Systematic Literature Review” OR “Bibliometric analysis” AND “Fish*”		564
Stage 2: Studies after limiting results to English language	(26)	538
Stage 3: Studies after limiting the results to document type: Research articles and Reviews	(44)	494
Stage 4: Studies after limiting the results to Subject areas: Social sciences, Business management and accounting, economics econometrics and finance, decision sciences, multi-disciplinary, arts and humanities	(413)	81
Stage 5: Studies retained in this research paper after screening the titles and abstracts	(54)	27

Source: Authors’ compilation

Table 2
Summary of relevant review articles in the context of fisheries.

Journal Author(s) Year	Scope	Study Period	Keywords	No. of articles	Subject area	Method
British Food Journal Nicolas et al. (2023) [32]	Studied research trends that took precedence in sustainability assessment and focused on understanding the knowledge components and structure within the food sector.	1994–2021	Bibliometric; Business; Food; Keyword analysis; Management; Sustainability assessment	209	Business economics	Bibliometric techniques, a keyword co-occurrence network
Environment, Development and Sustainability Dash et al. (2023) [33]	Highlighted the benefits of using ICT in fisheries to enhance fishers' socio-economic conditions and achieve long-term sustainability.	1994–2021	Bibliometric analysis; Fishery; Information and communication technology (ICT); Socio-economic development; Sustainability; Systematic literature review	163	All	PRISMA, bibliometricvisualisation tool-VOSviewer
Sustainability (Switzerland) Akbari et al. (2023) [34]	Conducted a systematic literature review on the impact of fisheries on the economy.	2000–2020	CGE models; economic modelling; fishery management; input-output models; regional economy; sustainable development	52	Economics	Computable general equilibrium (CGE) and input-output (I-O.) methods
Pertanika Journal of Social Sciences and Humanities Sulaiman et al. (2023) [35]	Reviewed studies on fishermen's knowledge of astronomical phenomena on fishery activities and discussed how they influence fishery activities.	2000–2019	Astronomical phenomena; fishermen's knowledge; fishery; systematic literature review	15	Social Sciences, agricultural and biological sciences, and environmental sciences	Reporting Standards for Systematic Evidence Syntheses (ROSES) is the review protocol.
Sustainability (Switzerland) Rejeb et al. (2023) [36]	Examined scholarly discourse around the Food Supply Chain and COVID-19.	2019 to June 2022	Bibliometric; COVID-19; food security; food supply chain; food waste	287	All	Bibliometric analysis using VOSviewer
Environmental Science and Policy Turschwell et al. (2022) [37]	Reviewed the tools used to assess multi-sectoral interactions in the blue economy.	up to 2021	Aquaculture; Multi-use platform; Offshore; Planning; Renewable energy; Sustainability	96	All	PRISMA, Operational Maturity analysis, industry and thematic analysis
Journal of Rural Studies Szymkowiak et al. (2022) [38]	Identified the issues faced by young farmers and fishers in the U.S.	up to 2021	Ageing demographic; Beginning farmers; Capital assets; Graying of the fleet; Rural livelihood	76	All	Systematic literature review using capital assets framework and expert interviews
Sustainability (Switzerland) Edmondson et al. (2022) [39]	Reviewed adaptive management in fisheries context to compare how adaptive management was defined and applied and what was deemed necessary for implementation.	up to 2019	Adaptive management; fisheries management; PRISMA; systematic literature review	46	All	PRISMA approach, meta-synthesis
Sustainability (Switzerland) Monirul et al. (2022) [40]	Systematic literature review of the overall impacts of COVID-19 on the fisheries and aquaculture sector in developing countries using the PRISMA approach.	Jan 2020 to Aug 2021	Aquaculture; Fish-based industry; Fish-food supply chain; Small-scale fisheries	47	All	PRISMA approach
Scientometrics Teixeira et al. (2020) [41]	Conducted a bibliometric analysis to map each country's scientific production concerning its marine shrimp fishery yield and identified	1987–2018	Bibliometrics; Conservation; Management; Marine shrimp	489	All	VOSviewer Mapping & modelling

(continued on next page)

Table 2 (continued)

Journal Author(s) Year	Scope	Study Period	Keywords	No. of articles	Subject area	Method
Sustainability (Switzerland) Mele et al. (2019) [42]	socio-economic factors that influence the publication of articles on this subject. Reviewed Integrated coastal management (ICM) and economic issues within marine ecology.	1991–2018	Coastal resilience; Ecological economics; Integrated coastal management; Marine ecology; Marine/maritime economy; Network science; Socio-ecological systems; Topic modelling	6042	Ecological and economic issues within marine science	PRISMA approach
International Journal of Supply Chain Management Setiawan et al. (2019) [43]	Conducted bibliometric analysis of supply chain and sustainable fisheries to develop portable inflated solar power cold storage house technology in Indonesia.	1851–2019	Cold storage solar power; Fisheries; Portable inflated solar power; Supply chain	23321	All	Bibliometric analysis using VOSviewer
Marine Policy Villasante et al. (2016) [44]	Investigated the potential socio-economic impacts of the discard ban in European small-scale fisheries (SSF) and the critical factors for its successful implementation.	up to Feb 2016	Discarding; European union; Landing obligation; Small-scale fisheries; Stakeholders' perceptions	1004	All	Systematic review and consultation with stakeholders

Source: Authors' compilation

3. Materials and methods

This study is based upon a four stage process as proposed by FossoWamba & Mishra [56] which involves.

- Specifying the keywords and selecting the databases
- Conducting a preliminary analysis of the data
- Analyzing bibliometric networks
- Performing thematic analysis and structure analysis

3.1. Data source

This study is based upon research articles extracted from Scopus and Web of Science databases, selected because of their comprehensive and interdisciplinary coverage. Scopus database is known to have a coverage spanning more than 7000 publishers and more than 84 million records from across 240 disciplines [57]. Whereas Web of Science (WoS) is the world's leading analytical information and scientific document search platform [58]. These are some of the most widely accepted databases globally and are known for publishing quality research works [59].

3.2. Keyword selection and refinement

This paper adopts the PRISMA approach (see Fig. 1) to identify the studies that have explored various drivers in the context of fisheries. Further exploration of studies in this aspect resulted in the selection of phrases such as 'factors influencing fish', driver of fish', 'drivers of fisheries' and 'determinants of fisheries' as key terms for identifying relevant studies. Therefore, based on these cues, a search query consisting of keywords related to the topic was formulated. For this study, we chose to include research works published from 1974 till 2023. The results were then further filtered to include studies published in 4 specific subject domains including Social Sciences, Business Management and Accounting, Arts and Humanities, and Econometrics and Finance. The results were also restricted to only research articles published in research journals and thereafter a language filter was applied to limit this study to articles published only in English language. The search query used was-

TITLE-ABS-KEY (("Drivers" AND "Fisheries") OR "Driver of fish" OR "factor* influen* fish" OR "drivers of fisheries" OR "Drive* fish*" OR "determinant* of fish*") AND PUBYEAR >1973 AND PUBYEAR <2024 AND (LIMIT-TO (SUBJAREA, "SOCT") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ARTS") OR LIMIT-TO (SUBJAREA, "ECON")) AND (LIMIT-TO (DOCTYPE, "ar"))

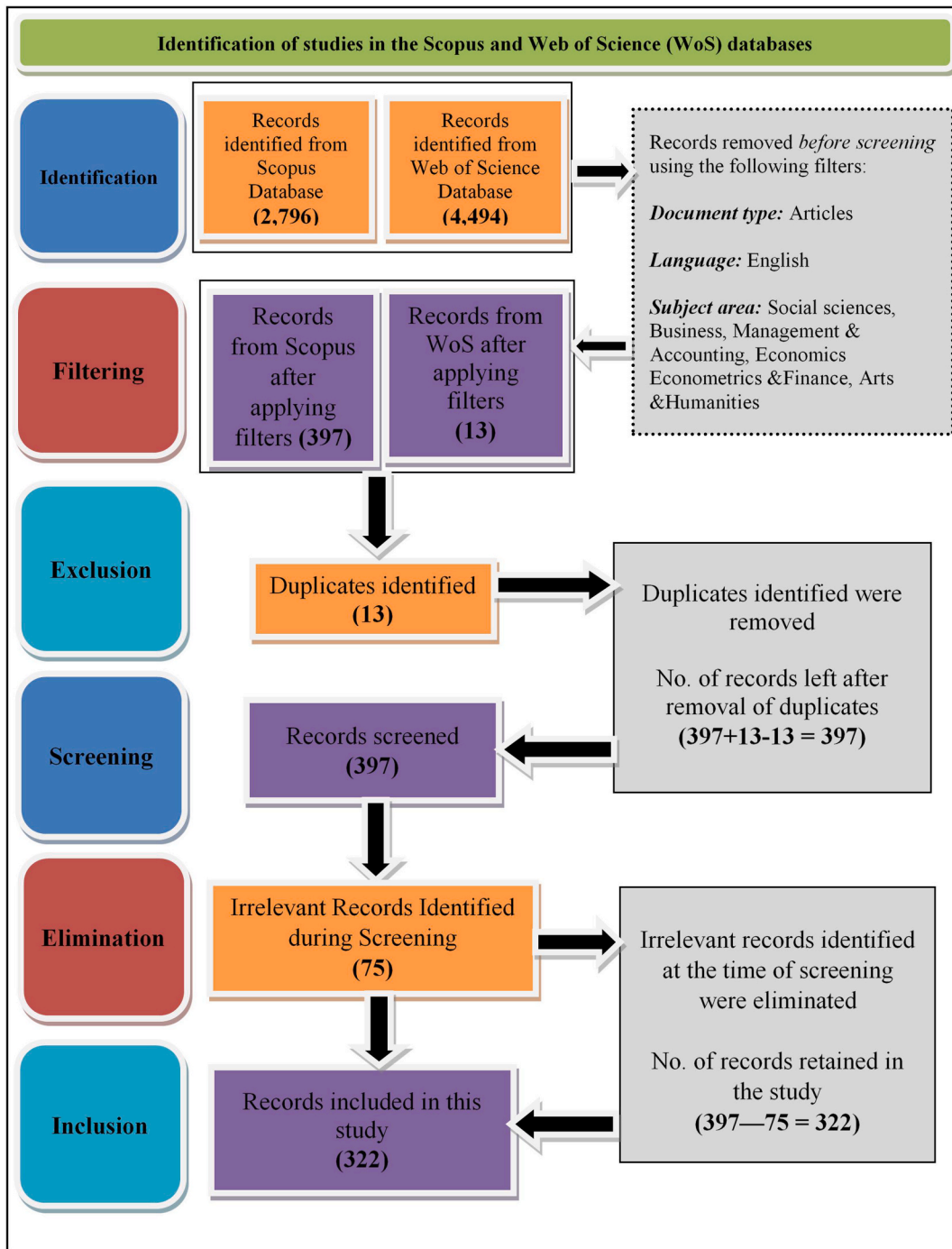


Fig. 1. Graphical representation of the PRISMA approach adopted to select the relevant studies. Source: Authors' compilation

AND (LIMIT-TO (LANGUAGE, "English"))

Keywords.

"Drivers" AND "Fisheries".

"Driver of fish".

"factor* influen* fish".

"drivers of fisheries".

"Drive* fish*"

“determinant* of fish**”

Therefore the thematic search on the Scopus database resulted in 322 research papers based on the theme of this paper.

3.3. Data analysis tools

Tranfield et al. [60] suggested that systematic reviews and meta-analysis are significant for summarising the findings of a research related to a study field. Bibliometric analysis is an essential tool for comprehending and analyzing large volumes of articles from interdisciplinary domains [61,62]. Bibliometric tools and text-mining approaches outperform subjective approaches as they objectively examine the studies, leaving out the possibility that the selection of studies may be subject to selection bias [36,63]. In this study, the researchers use graphs, tabulation, and frequencies to provide critical insights about the number of studies published, top journals, top publishers, and countries with the most significant presence in this research domain. Next, VOSviewer Software was used for bibliometric analysis, where the focus was placed on analysing the bibliometric information of the studies based on Co-authorship, Co-occurrences, Citations, Bibliographic coupling and Co-citations. Lastly, the studies extracted for this research were analysed using text mining tools such as Word Cloud and Topic Modelling using Orange Software [36,64].

4. Results and discussion

4.1. Studies published on the theme of drivers in fisheries from 1988 to 2023

Fig. 2 shows the number of studies published on the theme of drivers in fisheries from 1974 to 2023. The increasing trend shown in the graph is a clear indicator of the growing interest of researchers in this domain over the past few years. The number of publications grew from single-digit figures to five times the number from 2011 to 2021. The year 2021 witnessed the highest-ever number of publications on this theme, with 53 documents published. Comparatively, 2022 saw a dip in the number of documents, but the number of studies have increased again in 2023. Although the number of studies on the theme of drivers in fisheries has shown an upward trend, a comparative view with the growth of fisheries sector clearly indicates the need for greater number of studies in the future revealing the wide scope for research in this domain.

4.2. Top publishers in this domain

Table 3 indicates the top publishers which have published research works on the theme of drivers in fisheries. This list is topped by Elsevier, which published 40.99 % of the studies selected for this research work. Springer follows this with 13.04 % of the studies and MDPI with 7.76 % of the research studies. This table highlights that the top 3 publishers have published about 65 % of the total studies, while the contribution by other publishers has been negligible.

4.3. Top countries that have a significant research presence in this domain are arranged based on the highest number of documents

Table 4 comprises countries arranged in an order that starts from those with the highest number of documents. This table reveals that the countries with the highest number of studies accredited to themselves and those with the highest number of citations do not coincide with those with the highest number of average citations. Regarding the total number of documents and citations, the countries that achieved the highest ranks are the United States, the United Kingdom, and Australia. However, when we considered the average number of citations, which was computed by dividing the total number of citations by the total number of documents, we can see that

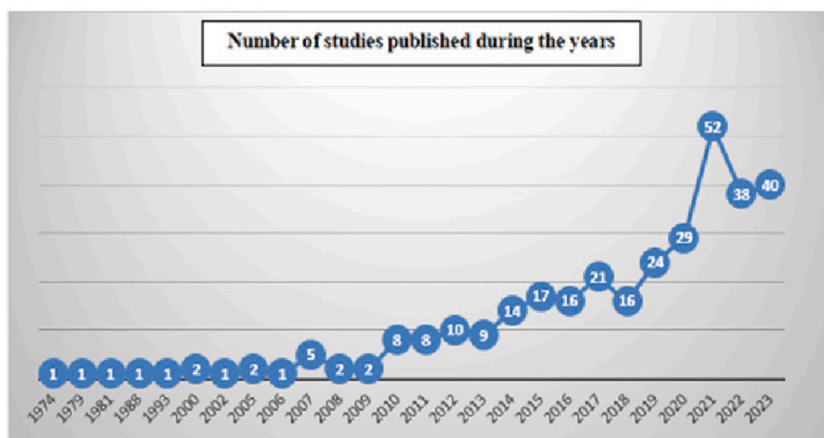


Fig. 2. Number of studies published on the theme over the years.

Source: Authors' work using Excel software

Table 3
Tabulation of the top publishers.

Top Publishers	No. of documents	%
Elsevier	132	40.99
Springer	42	13.04
MDPI	25	7.76
Routledge	11	3.42
University of Chicago Press	6	1.47
John Wiley and Sons, Inc	5	1.55
Taylor and Francis	5	1.55
Igitur, Utrecht Publishing and Archiving Services	4	1.24
Emerald Group	4	1.24
Others	88	27.33
Total	322	100.00

Source: Authors' work using Excel software

Table 4
Showing top countries based on the number of documents, citations and average citations.

Country	No. of docs	No. of citations	Average no. of citations	Rank based on total documents	Rank based on total citations
United States	98	2207	22.52	1	1
Australia	52	1179	22.67	2	3
United Kingdom	46	1358	29.52	3	2
Canada	36	732	20.33	4	5
France	20	444	22.20	5	6
Germany	19	197	10.37	6	12
Sweden	18	870	48.33	7	4
Spain	18	326	18.11	8	8
Tanzania	8	329	22.67	18	7

Source: Authors' work using Excel software

Sweden is the country which tops the list with an average citation score of 48.33 which is twice as much as any other country in the list.

Top 8 journals with maximum articles on this theme.

Table 5 highlights the top 8 journals that have published a maximum number of articles related to drivers in the context of fisheries. The journal titled 'Marine Policy' surpasses all other journals with 33.54 % of the articles selected for this paper. This reveals that 'Marine Policy' publishes more than five times the studies published by any subsequent journals. It is seconded by the journal titled 'Sustainability (Switzerland)', which has published 21 studies based on the theme of this study, constituting 6.52 % of the total studies included in this study.

4.4. Bibliometric analysis using VOSviewer

4.4.1. Co-authorship based analysis

4.4.1.1. *Co-authorship based on authors.* An analysis of the network within authors in this domain revealed significant linkages between many researchers across countries. The 426 authors of the 322 research articles included in this study were grouped into 12 clusters. Fig. 3 shows the strong and close-knitted networks which can be observed between authors working in the same domain at about the same time period. The analysis reveals a significant connection between the years of publications and the links between peers in the research worlds (see Fig. 4).

Table 5
Showing the top 8 journals.

Top 8 Journals	No. of Documents	%
Marine Policy	108	33.54
Sustainability (Switzerland)	21	6.52
Ambio	13	4.04
Maritime Studies	11	3.42
Global Environmental Change	10	3.11
Ecological Economics	8	2.48
Human Ecology	7	2.17
Marine Resource Economics	7	2.17
Others	137	42.54
Total	322	100

Source: Authors' work using Excel software

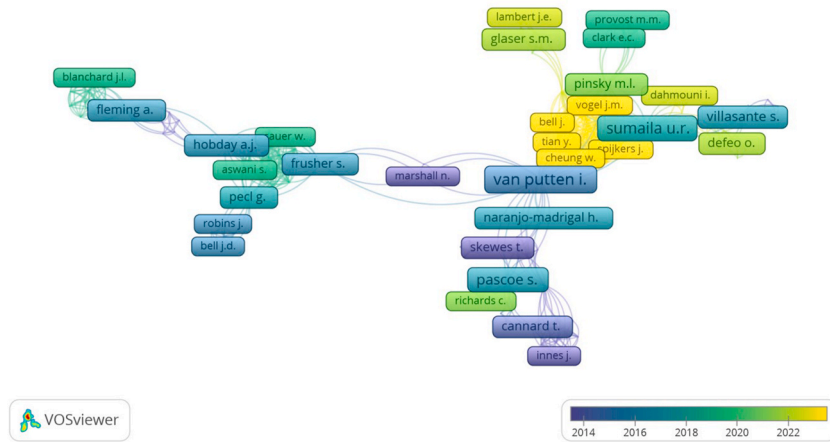


Fig. 3. Network Analysis of Co-authorship based on authors. Source: Authors’ work using VOSviewer software

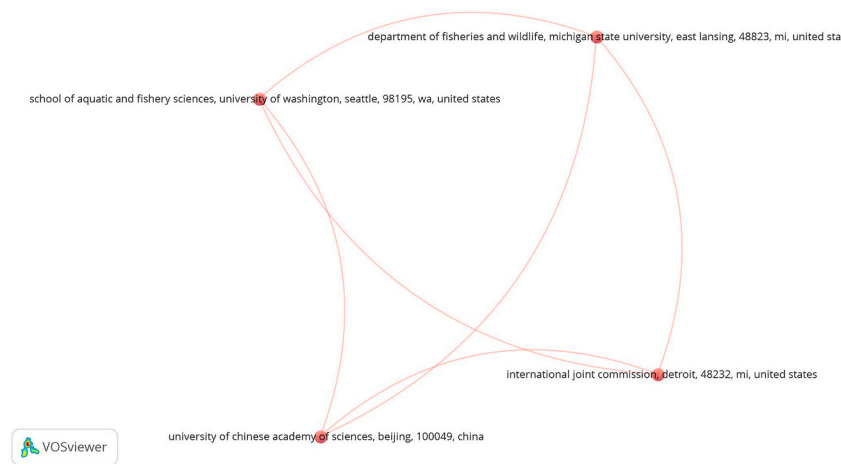


Fig. 4. Network Analysis of Co-authorship based on organisations. Source: Authors’ work using VOSviewer software

4.4.1.2. Co-authorship based on organisations. The analysis based on co-authorship between organisations revealed strong links between 4 organisations. The organisations that had two or more research articles accredited to them were only included in the results. Out of all the organisations, only 29 could meet the set threshold, while documents by any individual organisation was three. The four interlinked institutions comprised of 3 institutes from United States and one from China. This indicates low frequency of collaborations between organisations on the global front.

4.4.1.3. Co-authorship based on countries. In the next step, we conducted a co-authorship-based analysis of the countries where the studies were published. The results are shown in Fig. 5. The criteria used while analysing them was selecting only countries with at least five documents and five citations to their credit. The co-authorship-based analysis of the countries having research on the subject being studied in this paper using the LinLog/modularity normalisation method highlighted three significant clusters with 32 countries meeting the threshold. Cluster 1 consisted of 13 items, cluster 2 comprised ten items, and cluster 3 comprised nine countries. The United States, United Kingdom and Australia lie in the central part of the network, indicating that these countries have the most prominent presence and interconnected base of research on drivers in the context of fisheries. Bangladesh, Brazil, Finland, Germany, Ghana, India, Indonesia, Japan, Malaysia, Philippines, South Africa, Tanzania and Thailand form the first cluster. Meanwhile, cluster two comprises ten countries: Denmark, France, Greece, Italy, Netherlands, Norway, Peru, Portugal, Spain, and Switzerland. Cluster Three has nine countries: Australia, Canada, Chile, China, Kenya, Mexico, Sweden, the United Kingdom and the United States. The total number of documents from all these countries amounted to 552, of which 18.66 % (103) were studies based in the United States. The United Kingdom, Australia, Canada, France, Germany and Sweden followed this. A similar trend can be seen when we observed the countries based on the number of citations, with the United States leading the way with 2896 citations, followed by the United

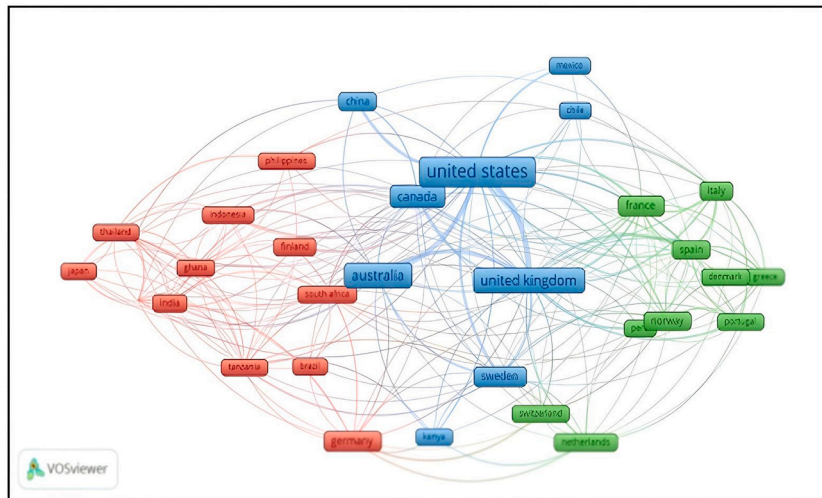


Fig. 5. Network Analysis of Co-authorship based on countries. Source: Authors' work using VOSviewer software

Kingdom with 1981 citations. Sweden stands out, though, as it has received 1315 citations with just 21 documents, resulting in the highest average citation value of 62.62. Likewise, the Netherlands is another country that outshines others with an average citation value of 54. The United States ranks 12th in this race, with the average amounting to 28.12. Comparatively, the United Kingdom does better, ranking fifth with an average citation score of 36.02.

4.4.1.4. *Time-based network analysis based on Co-authorship between countries.* As shown in Fig. 6, a time-based network map indicated that in 2017, Thailand, Tanzania, Mexico, Philippines, Denmark, and France were the countries with the most work on fisheries drivers. The United States, United Kingdom, Australia, and Sweden were countries that had a higher number of studies in 2018. Finland, Norway, Kenya, Netherlands, Spain, Peru, and Brazil saw more research studies in 2019. In 2019, countries like Germany, Brazil, Switzerland, Netherlands, China, Italy, and Spain. In 2020, countries like Ghana, China, Japan, India, Indonesia, Germany, Italy and Chile led the research.

4.4.2. *Co-occurrences based analysis*

4.4.2.1. *Co-occurrences based on all keywords.* The network analysis of co-occurrences based on all keywords, as shown in Fig. 7, revealed four clusters with interlinking connections. Cluster 1 has 23 items, cluster 2 has 18, cluster 3 has 12 and cluster 4 has 11 items.

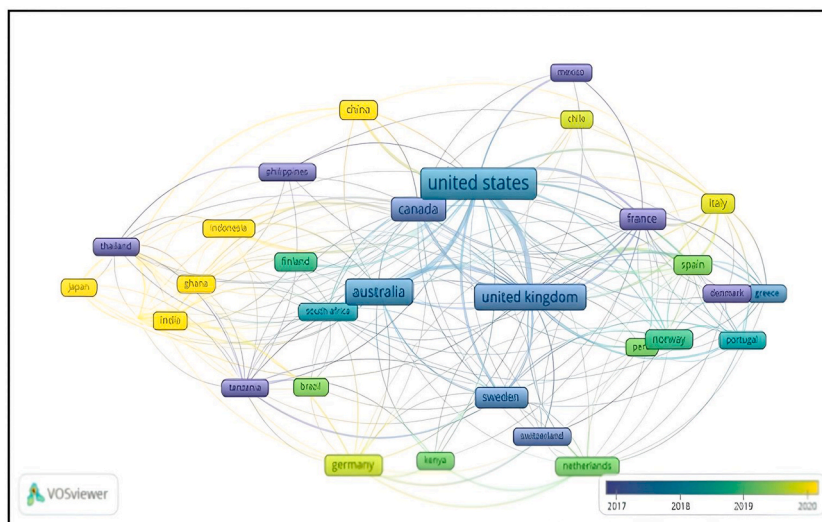


Fig. 6. Time-based network analysis based on Co-authorship between countries. Source: Authors' work using VOSviewer software

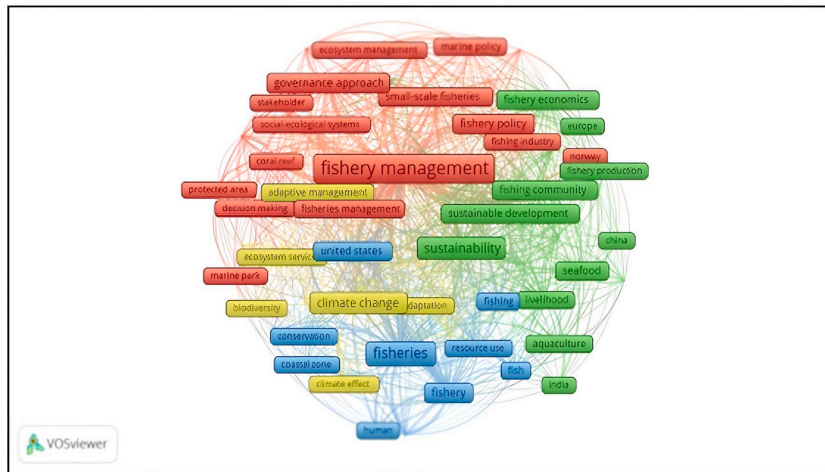


Fig. 7. Network Analysis based on Co-occurrence of keywords.
Source: Authors' work using VOSviewer software

The criteria used for selection was a minimum of 10 occurrences. The result includes 64 keywords that met the threshold out of 2481. The keyword with the largest co-occurrences is 'Fisheries Management' with 118 occurrences and the maximum total link strength of 455. Other than this, the keywords with higher occurrences were fisheries, sustainability, and climate change. The top five keywords regarding occurrences have the highest total link strengths. The network analysis highlights critical connections between fisheries management and aspects such as governance approach, fishery policy, biodiversity, socio-ecological systems, ecosystem management, and decision-making, with linkages to the small-scale fisheries and stakeholders. This cluster primarily comprises keywords that highlight the studies related to the assessment of approaches related to conversation and protection. Cluster 2 includes aspects such as strategic approach, aquaculture, and seafood, as well as dimensions of the fishing community, food security, and sustainability with links to places such as China, Europe, and India. The third cluster links fisheries and fishing to marine resources, conservation, and human dimensions. The fourth cluster associated elements of adaptive management with environmental elements such as climate effect, vulnerability, and overfishing and seems to have connections to the Atlantic Ocean.

The network highlights that authors have placed research emphasis on assessing fisheries management and governance approaches. Focus has also been on addressing issues such as climate change, and attention has been diverted towards sustainability. Focus on small-scale fisheries and themes such as livelihood, fishing communities, and stakeholders, highlighting the recognition of the need to explore the human dimension for effective management of fishery resources. Exploring socio-ecological system management, sustainable development, and environmental protection highlights the perception of adverse effects that drive resource protection. Many authors have also emphasised understanding decision-making approaches in fisheries management. The network also highlights that the research primarily concentrates on China, Europe, India, Norway, and the United States.

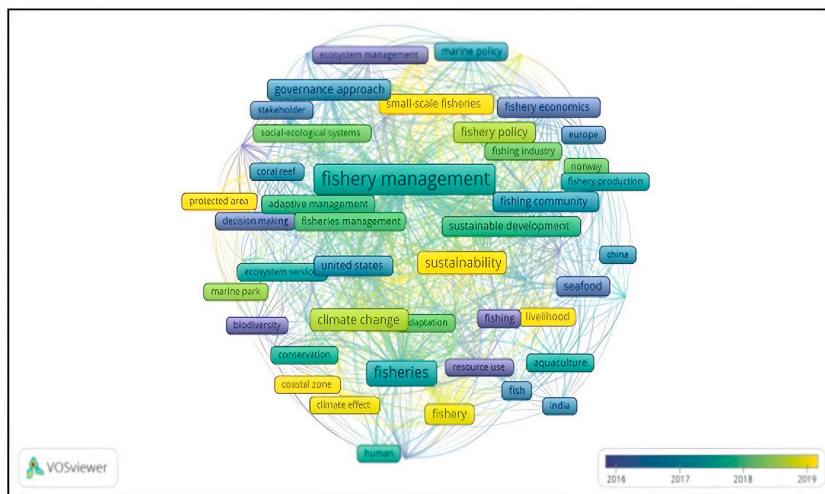


Fig. 8. Analysis showing Co-occurrence of keywords from 2016 to 2019.
Source: Authors' work using VOSviewer software

Fig. 8 shows the network analysis of co-occurrences of keywords from 2016 to 2019. In 2016, research on drivers in the fisheries context revolved around aspects such as fishing ecosystem management, biodiversity, fishery economics, decision-making, biodiversity and resource use. In 2017, keywords based on governance approaches, stakeholders, marine policy, fishery production and fishing communities gained significant attention from researchers. In 2018, it was observed that there was a transition towards focusing on elements such as fisheries management, adaptive management, conservation, and socio-ecological systems while moving towards sustainable development, fishery policy, and climate change. In 2019, we noticed that topics such as sustainability, coral zones, small-scale fisheries, and livelihood, among topics like climate effect and protected areas, have gained immense importance among researchers.

4.4.3. Citations based analysis

4.4.3.1. Citations based on documents. The analysis of the research studies based on the number of citations received by each document (see Fig. 9) revealed the picture of no interlinked studies. The criterion used to filter out the research works was the number of citations. The researchers specified a limit of 30 as the minimum number of citations, highlighting 70 studies meeting the threshold. However, no clusters were identified within the results. Even so, the point to note is that the study by Bene et al. [65], published in 2016, received the highest number of citations (455) in this domain. In this regard, there were a total of 14 studies which have received at least 100 citations. Similarly, the analysis of citations based on sources also revealed a picture without any linkages.

4.4.3.2. Citations based on sources. A citation analysis of the sources based on the number of documents depicts the Scopus-indexed Journals with the maximum number of documents on drivers in fisheries. The results were filtered to include only those sources with at least five documents published in this domain and received at least ten citations. The threshold resulted in 11 sources out of 107 (see Fig. 10). The journal titled 'Marine Policy' contains a maximum number, i.e. 108 documents, several times more than the other journals in the list. It is followed by the journal 'Sustainability (Switzerland)', which has 21 documents. Regarding the total number of citations, Marine Policy has received far more than all the other journals in the list, with 2801 citations for its publications on drivers in fisheries, followed by a journal titled 'Global Environmental Change', which has 380 citations to its credit. Therefore, 'Marine Policy' is the journal with 108, the highest number of publications in this regard. However, two other sources outperform 'Marine Policy' if we look at the average number of citations. These two include 'Global Environmental Change' with an average citation score of 38 and 'Ambio' in the second position with an average citation score of 36.38, whereas 'Marine Policy' has a score of 25.93. Likewise, 'Marine Policy' is closely followed by 'Marine Resource Economics', with an average citation score of 21. The top journals with research work published in the domain of drivers in fisheries in the order of highest number of documents include 'Marine Policy' (2801 citations); 'Sustainability (Switzerland)' (183 citations); 'Ambio' (473 citations); 'Maritime studies' (233 citations); 'Global environmental change' (380 citations); 'Water (Switzerland)' (96 citations); 'Ecological economics' (93 citations); 'Human ecology' (78 citations); and 'Marine resource economics' (147 citations) (see Fig. 11).

4.4.3.3. Citations based on authors, organisations and countries. The results were similar when we analysed the citations based on the authors. The analysis only included authors who had received at least ten citations. So, 182 met the threshold and were included in the network analysis. However, no links exist between the studies when we analysed citations based on authors. No links were found between organisations when a citation-based analysis was run with a criterion stating the inclusion of all organisations with at least two documents attributed to them. The results reported that 13 out of 1092 organisations met the threshold, but no links existed. A

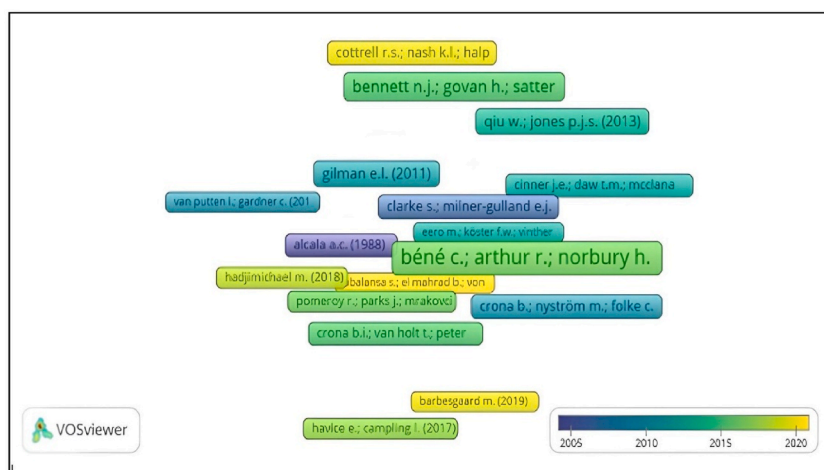


Fig. 9. Analysis showing Citations based on documents. Source: Authors' work using VOSviewer software



Fig. 10. Analysis showing Citations based on sources.
Source: Authors' work using VOSviewer software

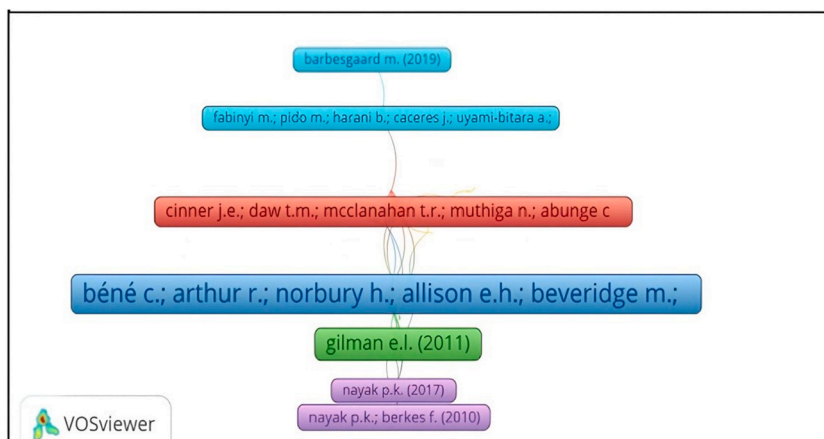


Fig. 11. Analysis showing Bibliographic coupling based on documents.
Source: Authors' work using VOSviewer software

similar picture was seen when the citation analysis was run based on the countries. The results, which were filtered with a condition to include only those countries with at least five documents accredited to themselves, reported 32 countries meeting the threshold out of a total of 93 countries. However, no links were identified.

4.4.4. Bibliographic coupling-based analysis

4.4.4.1. Bibliographic coupling based on documents. Bibliographic coupling analysis is based on shared references. If two documents have cited a common third document, it will result in bibliographic coupling. The search was limited to only those documents that have received at least 20 citations. A total of 103 documents met the threshold. From among the 103 documents, 47 items were highly connected. They were classified into 6 clusters (see Fig. 9). The analysis revealed that a study done in 2016 by Bene C. et al. [65] received the highest (455) citations. The study explored fisheries' contribution to reducing poverty and its role towards food security. However, in terms of the total link strength, the study with maximum links with a strength of 24 was done in 2015 by Trimble M. & Berkes F [66]. It was a study that evaluated the influence of adaptive co-management on small-scale fisheries in Uruguay and Brazil. The search results reported 47 documents that met the threshold with 105 links. These were categorised into 6 clusters: Clusters 1 and 2 have 12 documents each, cluster 3 has 10 items, Cluster 4 and 5 consists of 5 items each, and Cluster 6 has three items.

4.4.4.2. Bibliographic coupling based on sources. The analysis of sources based on bibliometric coupling was done by setting criteria of including only sources with at least five documents on the theme and having received at least ten citations. Based on the sources, the bibliographic coupling analysis resulted in 2 clusters with 11 items: cluster 1 with eight items and cluster 2 with three items. The analysis highlighted 35 links with a total link strength of 299. A time-based analysis (see Fig. 12) revealed that journals such as

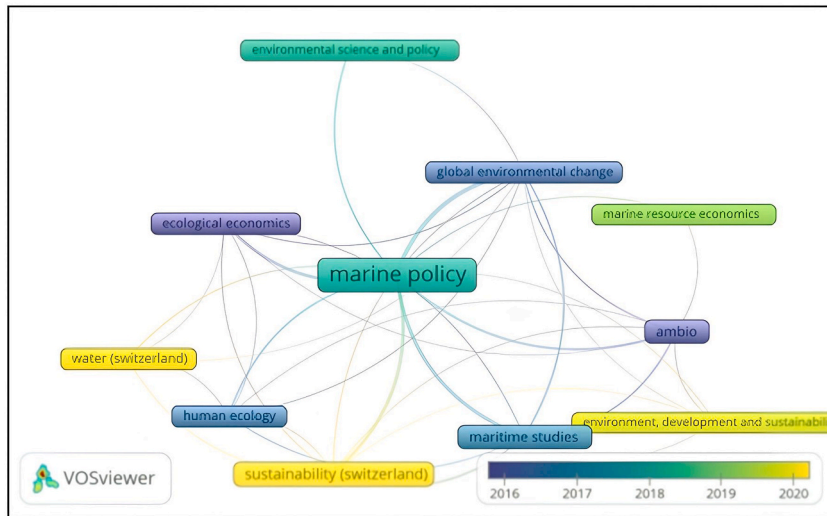


Fig. 12. Analysis showing Bibliographic coupling based on sources.
Source: Authors' work using VOSviewer software

'Ecological Economics' and 'Ambio' had a more significant presence in 2016–2017. In 2020, journals titled 'Water (Switzerland)' and 'Sustainability (Switzerland)' had higher visibility. Regarding total link strength, 'Marine Policy' has the highest weightage with a score of 206, far more than any other source.

4.4.4.3. Bibliographic coupling based on organisations. The Department of Geography at Seoul National University in South Korea and the Department of Geography at the University of the Philippines have the highest links, with a total link strength of 148 each. The analysis resulted in four clusters (see Fig. 13) having 11 items with 16 links and a total link strength of 120. The results include only those organisations that have published a minimum of two documents related to the theme of this study. 13 organisations met the threshold out of 1092 organisations. Cluster 1 has four institutions from Australia, the United States, and Canada. Cluster 2 has three organisations from Ghana, the Philippines, and South Korea. Cluster 3 and Cluster 4 comprise two organisations, each constituting organisations from Australia and the latter comprising institutions from Germany and Bangladesh, respectively.

4.4.4.4. Bibliographic coupling based on countries. Moreover, in Fig. 14, an analysis based on the bibliographic coupling between countries highlights a similar picture. The analysis of countries with criteria including only those with at least five accredited documents and receiving at least ten citations indicated that 32 of the 93 countries had met the threshold. This analysis revealed a well-

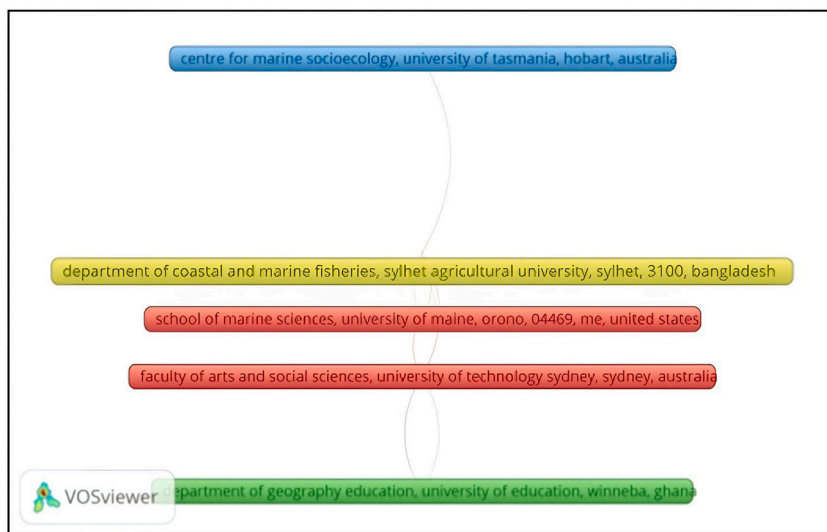


Fig. 13. Analysis showing Bibliographic coupling based on organisations.
Source: Authors' work using VOSviewer software

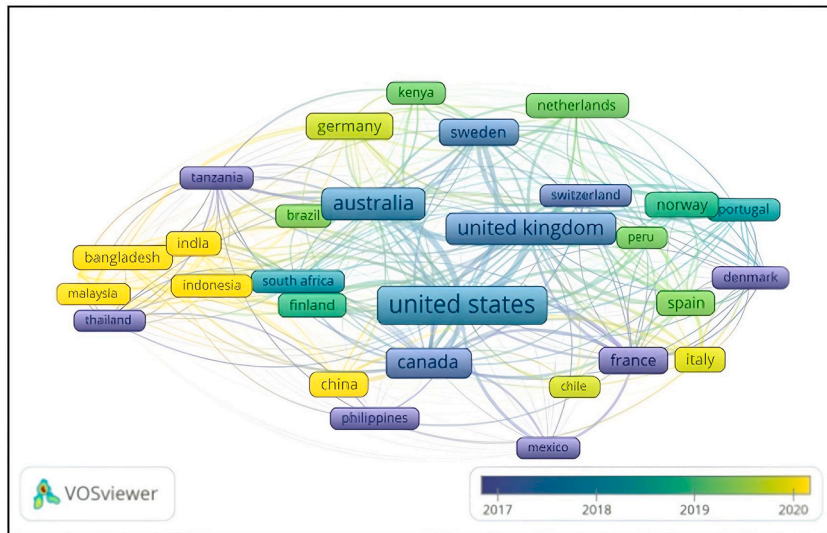


Fig. 14. Analysis showing Bibliographic coupling based on countries. Source: Authors' work using VOSviewer software

connected and highly dense picture of the countries linked to each other based on bibliographic coupling. The analysis reported 32 items grouped into three clusters with 394 links, indicating a link strength 36,128. As indicated in the earlier analysis, the United States, Australia and the United Kingdom are positioned centrally within the network, indicating their significant contribution. The network also reveals that research works from developing countries have taken the lead recently, as indicated by the representation of countries such as Bangladesh, India, Malaysia, Indonesia, and China, which are significant contributors in 2020.

4.4.5. Co-citations based analysis

4.4.5.1. Co-citations based on cited references. The analysis of co-citations based on cited references resulted in 13 items classified into three clusters (see Fig. 15). Cluster 1 comprises six items, cluster 2 has four items and cluster 3 has three items. Among these 13 items, a study by Ostrom in 1990 [67] received the highest number of citations and scored the highest total link strength.

4.4.5.2. Co-citations based on cited authors. An analysis of links between authors based on co-citations, as shown in Fig. 16, led to 5 significant clusters with 99 interrelated authors. Each of these five clusters was connected through links as well. The results were

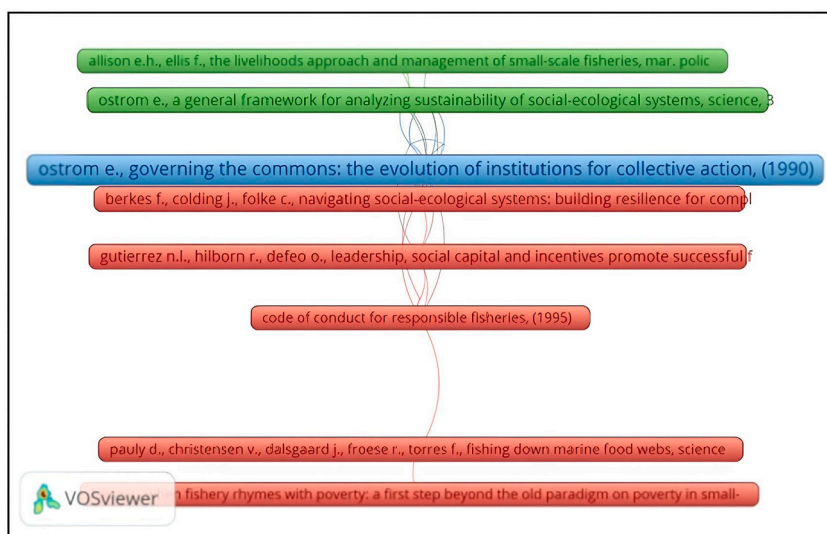


Fig. 15. Analysis showing Co-citations based on cited references. Source: Authors' work using VOSviewer software

4.6. Topic modelling

Topic modelling is an application of machine learning that helps to comprehend topics from a given cluster of words based on the frequency of the word's appearance in the text. It helps to extract key terms and identify the underlying patterns in a corpus of text if used with precaution. In this study, Topic Modelling has been used to identify such critical elements based on the abstracts of the research works selected for this paper. The researchers have selected the Latent Dirichlet Allocation method of Topic Modelling as the most widely used technique [36]. This study used topic modelling to identify hidden themes based on the text in the studies' abstracts. Abstracts are known to contain the core elements of any research study. The data extracted was pre-processed to eliminate any irrelevant elements. Additionally, stemming was used to minimise the effect of undesirable versions of words. Moreover, other elements such as stop words, punctuations, and numbers were also excluded as they do not assist in identifying core themes in a corpus of text. The result, as shown in Table 6 includes ten topics which highlight themes of various studies. Topic 1 relates to social and economic drivers related to marine fishing activity. Topic 2 highlights studies which have focused on the drivers of change related to fish catch and fishery management in the context of lakes. Topic 3 discusses studies which have explored economic drivers concerning fisher communities. Topic 4 indicates that studies have examined drivers of change in the context of marine stock by exploring resource-based management. Topic 5 highlights the studies that have discussed drivers of change in resource management, focusing on climate, livelihood and ecosystem. Topic 6 indicates research works that have studied environmental governance drivers with elements such as market, value, fisherman, and community. Topic 7 discusses studies that have evaluated drivers of change and their impact on climate, fisheries, and communities. Topic 8 highlights environmental drivers of change concerning climate and its impact on marine ecosystems. Topic 9 deals with studies exploring ecological and economic drivers of change in resource management and marine policy. Topic 10 highlights studies with drivers of social and ecological systems relating to conservation, stocking and marine fishery management.

In order to support these interpretations, the current study also used systematic content screening to identify the core theme of the studies selected for this paper. The findings of this approach highlighted several sub-themes falling under the scope of drivers in fisheries, which researchers have explored over the years. These have been presented in Fig. 18. All the sub-themes of drivers in fisheries identified from the literature have been further sub-categorised into four parts. Part 1, highlighted in orange, consists of themes around understanding aspects concerning the fishers. Part 2, highlighted in blue, comprises sub-themes related to fishing activities and the fisheries ecosystem. The third part, shaded in green, highlights sub-themes that involve exploring drivers of change in a particular context. Lastly, part four, highlighted in red, has been attributed to studies exploring drivers from fish consumers' perspectives.

5. Limitations of this study

This study focuses on identifying the underlying themes and exploring the research trends in the domain of fisheries drivers by restricting itself to research articles published in Scopus and Web of Science databases. Moreover, this study is limited to documents published in the form of research articles and leaves out any other research published in other forms such as books, conference proceedings, and so on.

6. Scope for future work

This study is based upon studies published in journals listed on 2 databases. Further research can focus on including research studies published in other databases. Researchers can also focus on identifying and examining the drivers which have been identified by the studies selected for this paper.

7. Conclusion

The current state of research in the fisheries domain has seen exponential growth recently. The same stands true when we focus mainly on studies which have explored the drivers in the context of fisheries. However, several themes in this domain still require

Table 6

Topic modelling output using Orange Software.

I. fishery, driver, study, fishing, activity, social, economic, fish, marine, use
II. fishery, driver, change, fisher, management, catch, lake, factor
III. fishery, driver, marine, economic, fisher, sector, community
IV. fishery, driver, change, stock, management, ecological, resource, based, marine
V. fishery, driver, change, climate, resource, management, livelihood, ecosystem
VI. fishery, driver, market, fishing, governance, environmental, fisher, community, value
VII. fishing, driver, change, climate, fisher, community, impact, trap, management,
VIII. fishery, driver, change, marine, impact, climate, fishing, ecosystem, environmental
IX. fishery, driver, change, resource, management, marine, policy, ecological, economic
X. fishery, driver, management, social, ecological, system, marine, common, stocking, conservation

Source: Authors' work using Orange Software

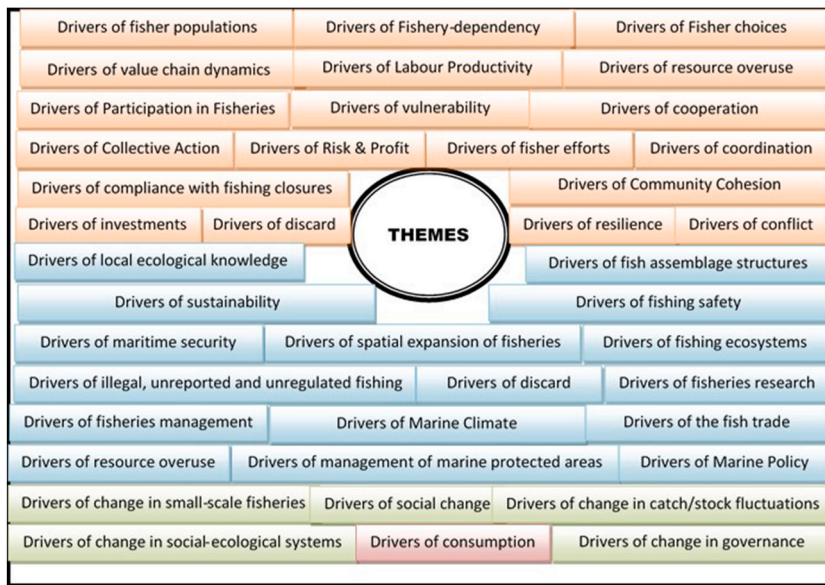


Fig. 18. Themes on drivers in the fisheries domain identified from the research studies.
Source: Authors' compilation

attention from researchers. Fisheries research has gained immense attention from the scientific communities but the managerial aspects in this study still remain underexplored. A glimpse through the studies conducted in the last 5 decades in this domain tried to reveal the need for delving deeper into certain aspects and the current state of research is pivoting into such directions. Though the volume of research on the subject of this study is growing at slower rates, the themes being focused upon highlight the crucial contributions they make. As such this opens the doors for further exploration of this area from different dimensions.

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Ethical approvals

Review and/or approval by an ethics committee was not needed for this study and informed consent was not required for this study because this study does not involve experiments on animals or human subjects.

Data availability statement

The datasets used and analysed during this study are available and included in this article in the form of supplementary materials.

CRedit authorship contribution statement

Relita Fernandes: Writing – original draft, Visualization, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Sitaram V. Sukthankar:** Writing – review & editing, Supervision, Resources, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e33335>.

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