

A bibliometric analysis of studies conducted globally on crude oil exploration and environmental pollution (1960-2024)

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ABSTRACT

Crude oil and its products have fueled economic and industrial revolutions around the world since the 1960s, but these benefits have come with a significant environmental pollution from exploration activities. Although several studies have addressed these impacts, little is known about global research trends. This study aims to provide a comprehensive bibliometric analysis (1960–2024) of crude oil exploration and environmental pollution studies, focusing on research patterns, leading journals, evolution of keywords, and top authors and affiliations. Data retrieved from PubMed® were analysed using Microsoft Excel 2013 and VOSviewer (v1.65), with records systematically screened for relevance and categorised by study type. Research output rose from one publication in 1970–1979 to 641 between 2020–2025. Most outputs were original articles (921; 81.9%), followed by reviews (171; 15.2%), with smaller counts for reports and perspectives. The most active journals were *Marine Pollution Bulletin* (88 papers), *Huan Jing Ke Xue* (81), and *Science of the Total Environment* (68). Across 5,703 contributing authors, Kenneth Lee (12 papers) and Baiyu Zhang (10) were the most prolific authors. We identified 4,417 keywords, from which 318 occurred at least five times, with petroleum, hydrocarbons, and environmental monitoring being among the top three. Evaluations of affiliations showed the dominance of China. These findings highlight the under-representation of systematic reviews and limited institutional contributions from major oil-producing nations, including Nigeria, Venezuela, and Saudi Arabia.

Keywords: Gas flaring; Environment; Pollution; Crude oil; Public health; Bibliometric analysis.

INTRODUCTION

The discovery of crude oil and its subsequent exploration have been described as the driving force behind the economies of nations in Africa [1], the Asia-Pacific Economic Cooperation (APEC) countries [2], Russia [3], America, and the global economy at large [4]. Since the 1960s, crude oil exploration has fueled global economies, serving as a source of income, energy, and raw materials for industries [4]. The top crude oil-producing nations of the world includes Saudi Arabia, the United States of America, Russia, Canada, Iran, Iraq, Venezuela, Nigeria, Angola, Kuwait, the United Arab Emirates, Brazil, and Norway [5]. The majority of these countries, including Nigeria, Angola, and Kuwait, have economies that are heavily reliant on revenues derived from the sales of crude oil and refined petroleum products [5][6]. From the foregoing, it is clear that crude oil has been instrumental to the developmental strides, particularly infrastructural, attained by the majority of these countries and their overall industrialisation. However, this has been at the expense of the diverse environments where crude oil exploration activities, both upstream and downstream, occur, as these environments have suffered degradation and pollution with little or no hope of restoration.

Crude oil exploration produces several by-products, chief among them being associated gases, popularly known as flared gases, which are usually burnt off, vertically or horizontally.

Despite numerous commitments to end gas flaring, it is still ongoing across the world [7][8]. The components of flared gases, including soot particles, other particulate matter, oxides of sulphur, carbon, and nitrogen, as well as aromatic hydrocarbons, collectively cause air pollution [7][8]. These components continue to adversely affect indoor and outdoor air and water qualities, contribute to acid rain, and exacerbate greenhouse gas emissions and climate change [7][8]. In addition to the ongoing gas flaring in all regions of the world where crude oil is explored, major oil and crude oil spillages have been recorded globally. These include the Exxon Valdez spill (1989), the Deepwater Horizon explosion (2010), and repeated spills in Nigeria's Niger Delta, such as the Ogoniland spills [1][9][10][11]. These events have been shown to adversely affect diverse environments, including air, soil, and water. Several studies have elaborated on the environmental impacts of crude oil exploration in the regions where it occurs [1][9][10][11]. Crude oil exploration has been reported to impact aquatic ecosystems, plants, animals, and humans in regions where it is carried out [1][9][10][11]. Specifically, oil pollution has been shown to reduce the diversity of plants, animals, and microorganisms, adversely affect soil fertility and agricultural production, and disrupt livelihoods [10][11][12]. Given the economic fortunes and the resultant environmental degradation crude oil exploration has caused in host regions,

research efforts have intensified with the aim of understanding, mitigating, and managing the environmental and social costs associated with crude oil exploration. Researchers have focused on diverse thematic areas, including crude oil and refined oil spillages [13], spill detection [14], modelling of oil spills [14], gas flaring [7][8], bioremediation technologies such as nanotechnology and phytoremediation [15], biodegradation [17], environmental impact assessments [1][18], regulatory frameworks [20][21], the socioeconomic and mental health dimensions of oil pollution [21], and oil conflicts [19]. These research efforts span a global landscape, with significant contributions not only from oil-producing countries but also from international collaborations involving universities, research centres, industry stakeholders, and non-governmental organisations. As seen from the various thematic areas of research, there has been a growing emphasis on the use of technology and artificial intelligence to model and detect oil spills in diverse ecosystems.

Despite the substantial volume of research, a comprehensive assessment of research trends related to crude oil exploration and the various aspects of environmental pollution remains lacking. Against this backdrop, we conducted a bibliometric analysis of the research trajectory from the 1960s to 2024. Bibliometric analysis is a form of study carried out in an area or field of study, aimed at identifying patterns, trends, authors, institutional affiliations, and their impacts within a particular field of study over time [23][24]. It has been utilised by various authors to examine patterns and trends over time in the oil and gas sector [24][25], and also in the health sector [27][28]. However, as far as crude oil exploration and environmental pollution is concerned, no bibliometric report exist. Conducting a bibliometric study will reveal pattern, thematic clusters and evolution of keywords, leading authors and research affiliations and also reveal gaps. Thus, our study aims to fill these gaps by conducting a global bibliometric analysis of studies on crude oil exploration and environmental pollution from 1960 to 2024.

METHODS

Data source and retrieval of literature

For this study, we utilised the PubMed® database to collect relevant literature. Our choice of database was based on several reasons. First, the database is easy to use and freely accessible to researchers worldwide. Secondly, it holds well over 37 million biomedical and life sciences records, including those related to pollution. Using the advanced search option, the keywords “crude oil exploration” and “environmental pollution” were applied, with the time span set from inception to date to cover all available studies. The search was conducted as previously reported [26][27], and relevant files (CSV and PubMed® formats) were downloaded, saved, and used for all analyses.

Screening of retrieved studies

From the CSV file, the articles were screened to ensure their relevance for inclusion in the study and to classify them into types. The titles of the studies were first sorted alphabetically to remove duplicates; care was taken to ensure that errata were not mistakenly removed as duplicates. Next, screening was systematically carried out by first reviewing the titles, and where the study types could not be inferred from the titles, the abstracts were consulted [28]. All the articles were categorised into different types, including original articles, reviews, interviews, news, and editorials. Areas of discrepancies were resolved by all authors reaching a consensus, as previously reported [28].

The step-by-step process used in screening the study types was done as described for systematic reviews [29].

Bibliometric and statistical analysis

We utilised Microsoft Excel 2013 and VOSviewer Windows version 1.65 tool to analyse the data obtained in this study. From the CSV file, descriptive statistics (percentages) were applied to the categorised article types. The years of publication of the articles were grouped into decades and then transformed into a bar chart to illustrate the decadal trend in the volume of studies. Similarly, the top journal destinations with at least 10 publications were sorted and transformed into a bar chart. Using VOSviewer Windows version 1.65, the PubMed® file was analysed to reveal old and emerging keywords, authors' networks and collaborations, and institutional networks over time.

RESULTS

The decade-by-decade trajectory of the studies retrieved on crude oil exploration and environmental pollution indicates a progressive increase in volume of studies from 1970 to 2025. The decade 1960-1969 had no study using the keywords indexed in the databases used in this study. The preceding decades, that is, 1970-1979, 1980-1989, 1990-1999, 2000-2009, 2010-2019 and 2020-2025 had 1, 1, 14, 67, 400 and 641 studies, respectively. The decade, 2020-2025, despite just being half through had the highest number of studies than the previous decades put together.

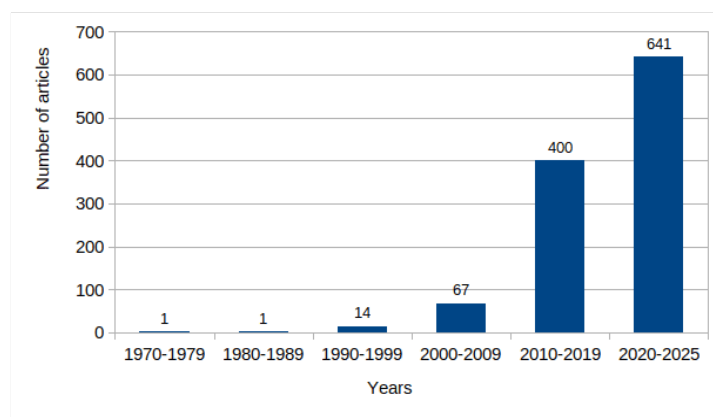


Figure1: Research trajectory of studies exploring diverse aspect of crude oil exploration and environmental pollution from 1970-2024

Table 1: Types of articles exploring diverse aspect of crude oil exploration and environmental pollution from 1970-2024

Article types	Number	Percentage (%)
Book chapter	1	0.09
Book review/film	1	0.09
Case study/case reports	17	1.51
Concept paper	1	0.09
Conference paper	1	0.09
Editorial	1	0.09
Interview	1	0.09
News	1	0.09
Original research articles	921	81.93
Perspective	2	0.18
Reviews	171	15.21
RCT	1	0.09
Reports	2	0.18
Systematic review	1	0.09
Systematic overview	1	0.09
Technical note	1	0.09

Key: RCT = Randomised control trial

Our articles analysis revealed diverse article types that included book chapter, book review/film, concept paper, conference paper, editorial, interviews, RCT, systematic review, systematic overviews, and technical with 1 article each, representing 0.09%. Other study types were perspectives, reports, reviews, and original research articles with 2, 2, 171 and 921 studies representing 0.18%, 0.18%, 15.21% and 81.93%, respectively.

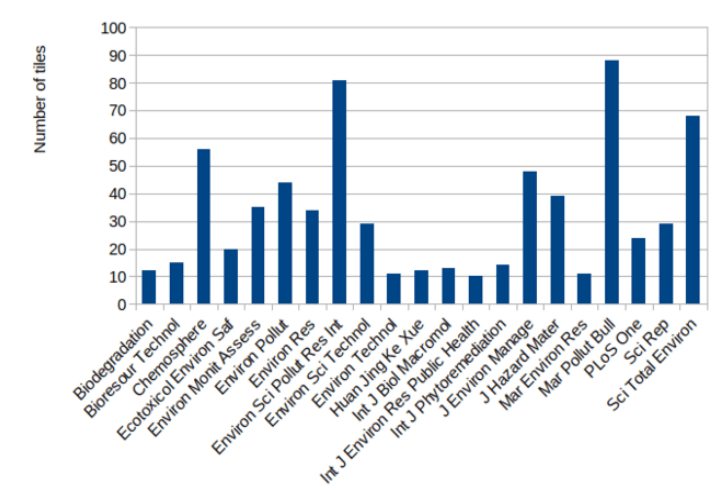


Figure 2: A barchart representation of the top journal destinations with at least 10 articles publishing studies on crude oil exploration and environmental pollution

The topmost journal destinations with at least 10 documents are presented in Figure 2. These were *Ecotoxicology and Environmental Safety* (12), *Environmental Monitoring and Assessment* (15), *Environmental Pollution* (56), *Environmental Research* (20), *Environmental Science and Pollution Research International* (35), *Environmental Science & Technology* (44), *Environmental Technology* (34), *Huan Jing Ke Xue* (81), *International Journal of Biological Macromolecules* (29), *International Journal of Environmental Research and Public Health* (11), *International Journal of Phytoremediation* (12), *Journal of Environmental Management* (13), *Journal of Hazardous Materials* (10), *Marine Environmental Research* (14), *Marine Pollution Bulletin* (88), *PLoS One* (24), *Scientific Reports* (29), and *Science of the Total Environment* (68). This indicates that *Marine Pollution Bulletin* had the highest number of documents, while the *International Journal of Environmental Research and Public Health* had the least of number of publications.

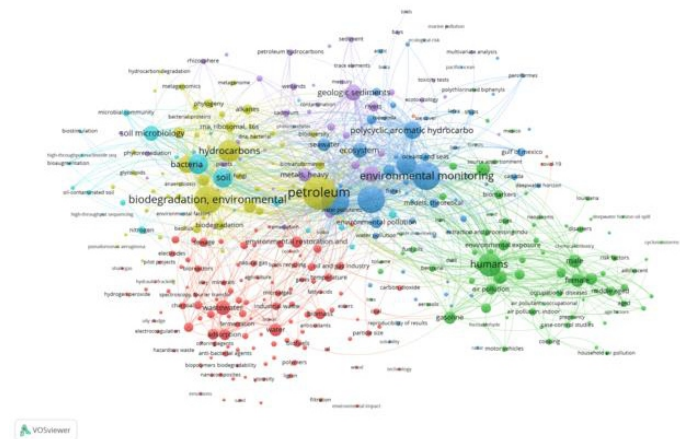


Figure 3: Network visualisation and cluster analysis of the keywords utilised in the various studies

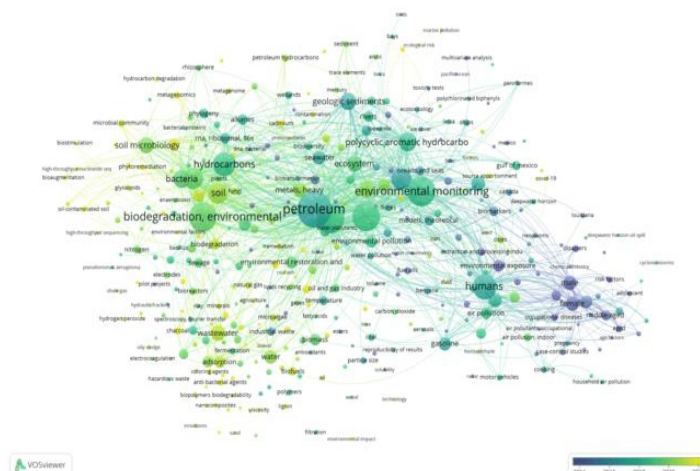


Figure 4: Network overlay analysis showing utilisation of keywords utilised in the various studies over time

The keyword analysis revealed a total of 4,417 keywords, of which 318 occurred a minimum of 5 times. Figures 3, 4 and 5 describe various aspects of the analysis of the diverse keywords used in the various studies. Specifically, Figure 3 shows the network visualisation of the diverse keywords used in all the research in terms of their sizes and clusters. The bubble sizes of the various keywords indicate the occurrence of these keywords and, as can be seen, terms such as petroleum, environmental monitoring, hydrocarbons, bacteria, humans, and polyaromatic hydrocarbon had larger bubble sizes, indicating higher frequency of occurrences compared to words such as shale gas, toluene, pilot projects, biostimulation and household air pollution, which had smaller bubble sizes, indicating fewer occurrences in the studies. These were further captured in Figure 5. The results further revealed a total of 7 clusters, which were coloured red, yellow, blue (light and dark), purple, green, and orange. On the other hand, Figure 4 shows the same diverse keywords and their clusters and how they have evolved over time. Keywords in yellow indicate those that have been in use from 2020 onwards. Charcoal, nanocomposite, viscosity, lignin, ecological risk, COVID-19, source apportionment, high-throughput sequencing, and metagenomics are a few examples.

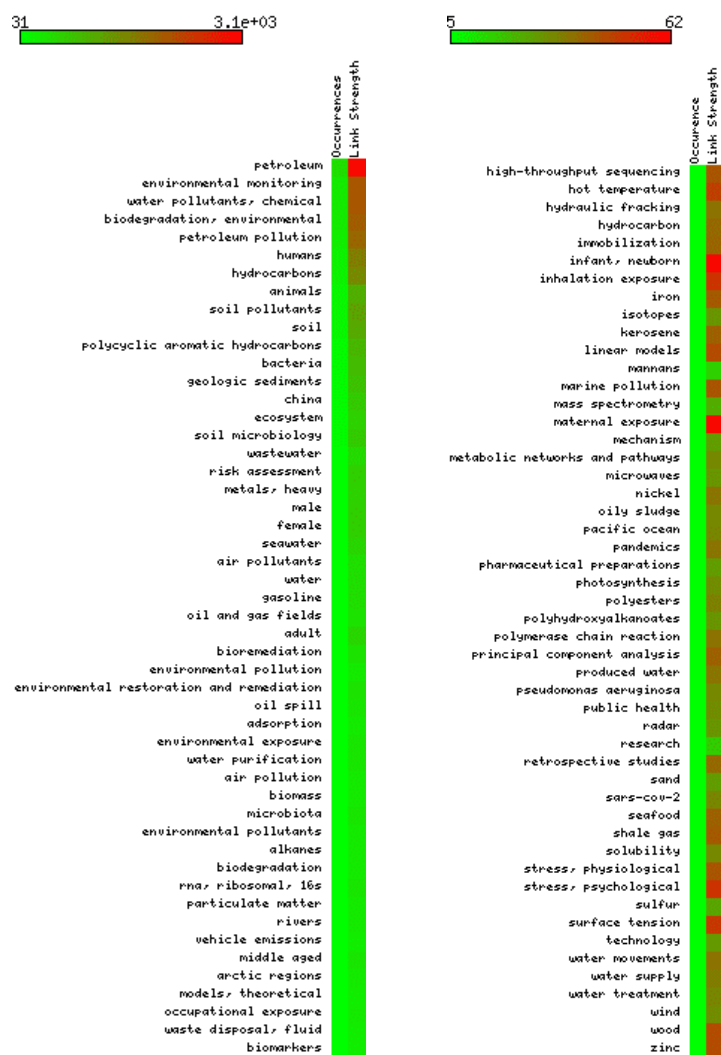


Figure 5: Heatmap visualisation of the top (a-left) and bottom (b-right) utilised in the various research

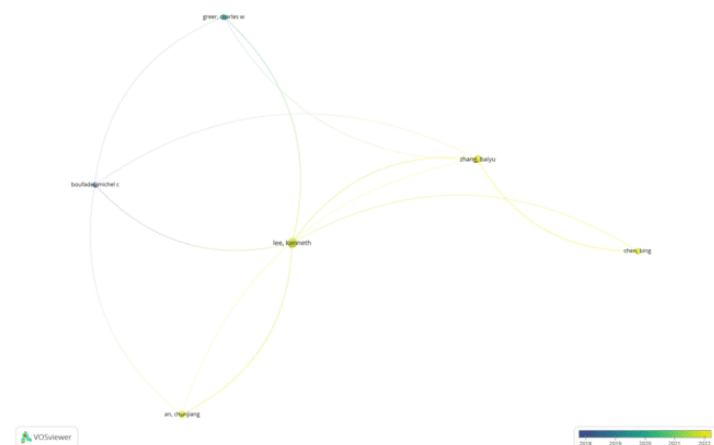


Figure 6: Network overlay analysis showing the various authors having a minimum of 5 document over time

Our analysis of the authors involved in the various studies revealed a total of 5,703 authors. Of these, only 12 authors had a minimum of six documents each (Table 2). The temporal overlay of the authors' research output over time is presented in Figure 6. The most prolific author was Kenneth Lee, affiliated with Fisheries and Oceans, Canada, with 12 documents, and this followed by Baiyu Zhang, affiliated with the Northern Region Persistent Organic Pollutants Control (NRPOP) Laboratory, Memorial University, Canada, with 10 documents. The third, fourth, fifth, and sixth most prolific authors were Andrew J. Esbaugh, Chunjiang An, Jinlan Xu, and Bing Chen, with 9, 8, 7 and 7 documents respectively. Their affiliations were the University of Texas at Austin, USA; Department of Fisheries and Oceans, Dartmouth, Canada; School of Environmental and Municipal Engineering, Xi'an University of Architecture and Technology, China; and the NRPOP Laboratory in the Faculty of Engineering and Applied Science at Memorial University, Canada. The remaining authors, each with six documents, were Zaher Mundher Yaseen, Dale P. Sandler, Charles W. Greer, Chunmao Chen, Rivelino M. Cavalcante, and Mutai Bao. Their respective affiliations were: Civil and Environmental Engineering Department, King Fahd University of Petroleum & Minerals, Saudi Arabia; Epidemiology Branch, National Institute of Environmental Health Sciences, USA; Energy, Mining and Environment Research Centre, National Research Council Canada, Montreal, Quebec, Canada; Ocean College, Zhejiang University, Zhoushan 316021, Zhejiang, China; Institute of Marine Sciences (LABOMAR), Federal University of Cear  (UFC), Fortaleza 60165-181, Cear , Brazil; and the Key Laboratory of Marine Chemistry Theory and Technology, Ministry of Education, Ocean University of China, Qingdao, Shandong Province, China. Furthermore, authors An, Chunjiang, Zhang, Baiyu and Chen Bing are authors active in research from 2022 till date, while Greer, Charles W was active earlier (from 2021).



Figure 7: Network overlay analysis showing the various institutions involved in various aspect of crude oil exploration and environmental pollution

Table 2: The most prolific authors with at least 6 documents each

ID	Author	Documents	Total Link Strength	Affiliations
381	Bao, Mutai	6	0	Key Laboratory of Marine Chemistry Theory and Technology, Ministry of Education, Ocean University of China, Qingdao, Shandong Province, China
641	Cavalcante, Rivelino M	6	10	Institute of Marine Sciences (LABOMAR), Federal University of Ceará (UFC), Fortaleza 60165-181, Ceará, Brazil.
698	Chen, Chunmao	6	0	Ocean College, Zhejiang University, Zhoushan 316021, Zhejiang, China
1542	Greer, Charles W	6	6	Energy, Mining and Environment Research Centre, National Research Council Canada, Montreal, Quebec, Canada; Department of Natural Resource Sciences, McGill University, Montreal, Quebec, Canada.
4007	Sandler, Dale P	6	5	Epidemiology Branch, National Institute of Environmental Health Sciences, USA.
5240	Yaseen, Zaher Mundher	6	10	Civil and Environmental Engineering Department, King Fahd University of Petroleum & Minerals, Dhahran, 31261, Saudi Arabia
690	Chen, Bing	7	10	Northern Region Persistent Organic Pollutant Control (NRPOP) Laboratory, Faculty of Engineering and Applied Science, Memorial University, St. John's, NL A1B 3X5, Canada.
5107	Xu, Jinlan	7	0	School of Environmental and Municipal Engineering, Xi'an University of Architecture and Technology, 710055, Shaanxi, Xi'an, China
246	An, Chunjiang	8	8	Department of Fisheries and Oceans, Dartmouth, Nova Scotia B2Y 4A2, Canada.
1222	Esbaugh, Andrew J	9	5	University of Texas at Austin, Marine Science Institute, Port Aransas, Texas, 78373, USA.
5386	Zhang, Baiyu	10	15	Northern Region Persistent Organic Pollution Control (NRPOP) Laboratory, Faculty of Engineering and Applied Science, Memorial University, St. John's, NL A1B 3X5, Canada
2427	Lee, Kenneth	16	21	Fisheries and Oceans Canada, Ecosystem Science, Ottawa, Ontario K1A 0E6, Canada

Table 3: Most prolific institutes and universities involved crude oil exploration and environmental pollution research

ID	Organisation	Documents
409	College Of Chemistry And Chemical Engineering, Southwest Petroleum University, Chengdu, 610500, China	5
3161	University Of Chinese Academy Of Sciences, Beijing 100049, China	7
3163	University Of Chinese Academy Of Sciences, Beijing, 100049, China	7

Analysis of the institutions involved in the research revealed a total of 853 organisations, with 6 having a minimum of 3 documents per organisation, as captured in Figure 7. Figure 8 also reveals the temporal involvement of the institutions and universities over time. The College of Chemistry and Chemical Engineering, Southwest Petroleum University, Chengdu, China, is still actively involved in crude oil exploration research as it relates to environmental pollution from 2020 onwards, and had a total of 5 documents (Table 3). Although the University of Chinese Academy of Sciences was involved in research around 2020 and earlier, it had the highest number of documents (n = 14).

Discussion

The aim of our study was to infer the global landscape of studies on environmental pollution as it relates to crude oil exploration with the specific objective of revealing trajectory of the studies, keywords (old and emerging), leading authors and affiliation, and their clusters and also reveals gaps. Our analysis of the research trajectory indicates a decade-by-decade increase in research outputs on crude oil exploration and environmental pollution. The total volume of studies stood at 1,124. This low volume of studies could be explained by our utilisation of only PubMed as the sole database. However, an earlier bibliometric study on sustainable oil and gas production research that utilised the Scopus databases also recorded limited volume of research in their study [24]. This is a sharp contrast to volumes of studies in health-related topics previously reported and utilising only PubMed as their sole database that reported much higher volumes [26][27]. Our findings further revealed the absence of indexed studies between 1960-1969 aligning with the early days of crude exploration, where there was little or no awareness on the impact of crude oil exploration on

environmental pollution. The subsequent decades, 1970–1979 and 1980–1989, each recorded only a single study, underscoring the nascent stage of environmental research linked to crude oil activities during those years. However, the Exxon Valdez oil spill of 1989 created adequate awareness on the environmental impacts of crude oil or oil in general [30] as the number of studies increased in the decades following it. The observed increase in the volume of studies between 2010 and 2019 coincide with major environmental catastrophes such as the Deepwater Horizon spill as well as the UNEP environmental forensic audit that revealed the dept of the environmental pollution attributed to crude exploration and oil spillages in the Niger Delta region of Nigeria [30][31]. The current decade has already witnessed a tremendous increase in the volume of studies that has surpassed other decades put together. This increase may be attributed to growing global concerns about pollution from crude oil exploration, climate change from flaring of gases, stronger regulatory requirements, advancements in environmental assessment technologies, and the broadening scope of multidisciplinary research that integrates environmental science, policy, and sustainability, as indicated by the diversity of the study types and themes.

Our analysis of the study types revealed diverse types which underscores the multidisciplinary nature of research on crude oil exploration and environmental pollution [1][9]. The low number of book chapters, book reviews/films, concept papers, conference papers, editorials, interviews, randomised controlled trials (RCTs), systematic reviews, systematic overviews, and technical reports signifies the minimal representation of such studies in the disseminating research in this field. The low number of these categories of types aligns with a previous report that utilised bibliometric analysis to evaluate the trajectory of research on avian influenza [27]. Reviews was the second most abundant study articles indicating sustained interest in synthesising existing knowledge (primary studies), to evaluate progress, and identify research gaps. The dominance of original research articles demonstrates a strong emphasis on the generation new empirical data and advancing the scientific understanding of oil-related environmental challenges [13][16]. This dominance of original research reflects the continuous need for field-specific data, novel methodologies, and case-specific evidence,

especially given the complex and evolving nature of environmental pollution associated with crude oil exploration and the need to really understand the complex nature of crude oil exploration-associated environmental pollution. These findings aligns with studies that also reported the dominance of original research articles in the health sector [26][27]. The gross absence of systematic reviews ($n = 1$) noted in our study implies an absence of evidence linking crude oil exploration to environmental pollution. This could be as result of the presence of heterogeneous studies that can impair systematic reviews and meta analysis or disinterest from the authors. Systematic reviews when well-written provides the highest level of evidence and that can informed decision-making [32]. Thus, the absence of systematic reviews indicates an absence of high level of evidence that can inform policy and decisions that can positively impacts and safe-guard diverse environments where crude oil exploration is on-going.

The analysis of top journal destinations revealed a strong preference by the authors for journals with a speciality in environmental sciences, ecotoxicology, marine pollution, and pollution control technologies such as biodegradation. Furthermore, the presence of journals such as *Chemosphere*, *Scientific Reports*, and *PLOS One* reflects the multidisciplinary nature of crude oil environmental pollution research. This aligns with the positions of some authors who have advocated for the use of multidisciplinary or multi-faceted approaches in addressing the environmental pollution associated with crude oil exploration [33][34]. The dominance of *Marine Pollution Bulletin* as the topmost destination for the various articles suggests that marine ecosystems are the most vulnerable to oil pollution and associated environmental hazards, and this aligns with available empirical evidence [33][34][35][36][37]. The presence of *Huan Jing Ke Xue*, a leading Chinese environmental science journal, among the top destinations highlights China's growing research contributions, consistent with reports of increased global environmental research outputs from Asia. Over half of the top journal destinations had the keyword "environment" as part of their titles, indicating the specialised nature of the journals to which authors submitted their studies. Prominent among the top journal destinations was the *International Journal of Environmental Research and Public Health*, indicating the crucial intersection between environmental degradation and human health outcomes, and also aligning with the One Health approach [38]. Overall, these journal destinations indicate a robust and growing body of literature addressing environmental pollution, public health, bioremediation approaches, emerging technologies, and other aspects of crude oil exploration and environmental pollution.

Our analysis of the keywords revealed diversity in their utilisations the various studies. Keywords are a set of specific terms or phrases that captures the central themes of a study and at the same time, serves as an indexing tool to improve discoverability and categorisation the study within databases [39][40]. The analysis of the keywords provides valuable insight into the thematic direction and evolving research landscape of crude oil exploration and environmental pollution studies. The large bubble sizes observed for keywords such as *petroleum*, *environmental monitoring*, *hydrocarbons*, *bacteria*, *humans*, and *polyaromatic hydrocarbons* indicates their dominance and repeated emphasis in the various studies. Their dominance further indicates the emphasis placed on pollutant tracking, biological interactions, and human health impacts in oil-related environmental research [41][42].

In contrast, keywords with smaller bubble sizes such as *shale gas*, *toluene*, *pilot projects*, *biostimulation*, and *household air pollution*, indicate emerging research niches or interest. The identification of seven distinct clusters further highlights the multidisciplinary nature of the field as they clusters, included themes such as bioremediation, chemical analysis, impact on humans and animals, environmental health, and policy and these align with multi-faceted approaches advocated by some authors [33][34][37]. Furthermore, the temporal analysis of the keywords revealed the evolution of keywords such as *charcoal*, *nanocomposite*, *viscosity*, *lignin*, *ecological risk*, *COVID-19*, *source apportionment*, *high throughput sequencing*, and *metagenomics* from 2020 onwards, indicating a shift towards advanced materials, molecular techniques, and a broader focus on ecological and health risk assessments [41][34].

The authorship analysis revealed a significant span of participation, with 5,703 authors contributing to research output on crude oil exploration and environmental pollution. Interestingly, only 12 authors published six or more documents, underscoring that while many researchers contribute occasionally, sustained productivity in this field was dominated by a few authors. In particular, Kenneth Lee of Fisheries and Oceans Canada was the most prolific author with 12 documents, highlighting the author's long-standing involvement in marine oil pollution research [43][44]. The author Baiyu Zhang from Memorial University followed closely, reflecting strong Canadian research engagement. The presence of authors from both North America and Asia, such as Jinlan Xu and Chunmao Chen, indicates a growing global collaboration in tackling oil-related environmental challenges. Notably, newer contributors like Chunjiang An and Baiyu Zhang have maintained active research output from 2022 onward, suggesting sustained interest and evolving research directions. The dominance of Canadian institutions reaffirms Canada's strategic focus on environmental protection, particularly in sensitive marine ecosystems [45]. It is also important to stress that we utilised only PubMed as a database and may have left out some studies indexed in other databases. Overall, these findings highlight both the global spread and institutional clustering of expertise, essential for developing robust, interdisciplinary approaches to oil pollution management. The findings further highlight the fact that authors from developed and developing, including Nigeria, Kuwait and Saudi Arabia were notably missing among the top authors. Their absence can be explained from the fact that authors from under presented nations may be publishing in journal indexed outside PubMed or publishing studies outside the impact of pollution on crude oil exploration.

The analysis of institutional contributions revealed that 853 organisations participated in research on crude oil exploration and environmental pollution, but only 6 institutions had at least 3 documents each. Notably, the College of Chemistry and Chemical Engineering at Southwest Petroleum University, Chengdu, China, remains actively engaged in this research area, contributing 5 publications from 2020 onwards. Interestingly, the University of Chinese Academy of Sciences had the highest output ($n = 14$), though its active contribution was more prominent before 2020. This dominance of Chinese institutions underscores China's rising research capacity and strategic focus on petroleum-related environmental issues, likely driven by its extensive oil industry and environmental challenges [45]. However, it is worrisome to note that research institutes and universities from other major oil-producing countries, such as Nigeria, Venezuela, and Saudi Arabia, are not prominently

represented among the top institutions. This could be as a result of limited research funding, a culture of publishing in journals that are not indexed in prominent databases, infrastructural challenges, and, in some cases, political or economic instability as it is the case in Nigeria [47][48]. Additionally, language barriers and a lack of international collaboration may reduce the visibility of research outputs from these countries [49]. The findings highlight the need for enhanced capacity-building and international partnerships to better document and address oil-related environmental issues globally.

Conclusion

Our bibliometric analysis offers valuable insights into the evolving landscape of research on crude oil exploration and environmental pollution. Our findings highlight a progressive increase in research outputs, particularly following major oil spill events and reports such as the UNEP of 2011 report on Ogoni land. The dominance of original research articles underscores a sustained focus on generating empirical data, while the scarcity of systematic reviews indicates a gap in high-level evidence synthesis critical for informed policymaking. Our study also reveals a strong multidisciplinary approach, with keywords and journal destinations reflecting diverse thematic areas spanning environmental monitoring, human health impacts, and bioremediation. The clustering of keywords into distinct thematic areas indicates the complexity of oil pollution and the need for integrated research approaches. Authorship and institutional analyses point to a lack of international collaboration and a conspicuous under-representation from key oil-producing nations like Nigeria and Saudi Arabia persists. This gap underscores the urgent need for enhanced research capacity and international partnerships in these regions. Overall, our findings emphasize the importance of continued investment in multidisciplinary research, greater inclusion of systematic reviews, and stronger global collaboration to effectively address the environmental and public health challenges associated with crude oil exploration.

Limitations of the study

The main limitation of our study was the utilisation of the PubMed® database alone for the retrieval of the dataset used in the study. Our choice of database was based on the fact that it is free, unlike other databases such as Scopus. By not utilising these other databases, we acknowledge that we may have missed some studies indexed there but not in the PubMed® database.

Declarations

Data availability

Data is provided within the manuscript or supplementary information files.

Funding

No funding was obtained for this study.

Ethical approval

Not applicable in this case.

Consent for publication

All consented to the publication of the study.

Competing interests

There is none to declare.

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