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BIBLIOMETRIC ANALYSIS OF THE DEVELOPMENT OF THE DIRECTION "DREDGING" IN WORLD PRACTICE

Objective. The study is aimed at obtaining new up-to-date knowledge and analysis of already existing one about the development of the "Dredging" direction in the world scientific space using the products and services of the Scopus scientometric database. Therefore, the chronological framework of the scientific articles under study is limited only by their availability in the Scopus database. **Methods.** In order to obtain relevant empirical data, the authors of the study reviewed the world scientific literature on the topic "Dredging" using the resources of the international reference and scientometric database of peer-reviewed literature Scopus. The algorithm of "step by step" actions in the Scopus database is considered: 1. Forming the circle of the most cited publications; 2. Defining the most relevant topics; 3. Identifying the most productive authors; 4. Determining the level of representation in the Scopus database of publications of Ukrainian scientists by the research topic. **Results.** During the study the authors have proved: 1. The main topics of the "Dredging" direction are: the impact of dredging on the ecology of the aquatic environment and marine life; models and algorithms for assessing and minimizing the risks associated with dredging; application of bottom sediments after dredging and their disposal in open waters; dredging fleet maintenance; 2. Scientists of our country are very slowly joining the world processes of exchange of scientific information in the "Dredging" direction; 3. The most intellectually productive authors of scientific articles in this field are scientists from the USA, Spain, Great Britain and Australia. **Conclusions.** For the first time in Ukraine, the authors conducted a bibliometric study in the field of water transport (subject area "Dredging") on the basis of products and services of the Scopus scientometric database. The results obtained can be used for further scientific research on this and related topics, as well as applied in the dredging discipline teaching process.

Keywords: bibliometry; scientometric analysis; scientometric database; Scopus; dredging operations

Introduction

Ukrainian ports are an essential element of the country's logistics infrastructure. In the World Economic Forum's Port Quality Rating, from 2014 to 2017, Ukraine improved its position slightly, rising from 107th to 93rd position (among 137 countries) (Hryhorenko, 2018). Dredging works are of great economic importance for increasing freight traffic and expanding ports, as the development of world trade is forcing ports to increase their capacity. This leads to the deepening of the water areas of the ports and the existing access channels, which makes it possible to accept larger merchant vessels (Dnoughlubitelnyie i morskije raboty, 2018).

In 2018 Ukraine spent more than \$ 1.5 billion on dredging in 6 of the country's 13 ports (Kyrychevskyi, 2019). In 2019 the Administration of Seaports plans to carry out operational dredging in 7 more seaports of the country: Mariupol, Berdyansk, Izmail, Chernomorsk, Mykolayiv, Odessa, Kherson and on 4 channels: Danube-Black Sea, Buh-Dnipro-Lyman, Dnistro-Lyman, Kherson marine channel (U portu Kherson zavershyly dnopohlyblennia yakirnykh stoianok ta rozpochaly roboty na pidkhidnomu kanali, 2019).

For Mykolayiv, these works are very important, because the Mykolayiv seaport will have all the conditions for servicing Panamax heavy-duty vessels, which will increase the port fees and payments to the state budget of Ukraine and will allow to develop business for Ukrainian companies operating in the water area of the port.

For a long time no one has addressed the dredging issue in Ukraine properly. There is almost no research on the dredging problems in modern Ukrainian scientific literature. International experience confirms the necessity and prospect of this direction. Numerous world studies in recent years indicate the continued interest of scientists in various aspects of the development of water transport and the provision of uninterrupted and safe navigation through the regular production of track works, one of the main types of which is dredging.

Recently, the results of scientific studies in librarianship and scientometrics in various directions are increasingly appearing in the domestic scientific literature. However, the authors conducted the bibliometric research in the field of water transport ("Dredging" subject area) on the basis of products and services of Scopus scientometric database (DB) for the first time in Ukraine.

Methods

The practical part of the study is based on the Scopus DB – a bibliographic and abstract database and a tool for tracking the citation of articles published in scientific publications. This database is the most comprehensive resource for the search of scientific literature.

Step by step search activity in Scopus DB.

1. We start working with the Scopus database from the main page at <https://www.scopus.com>. In the Advanced Search tab, we list the keywords "dredging" and "ships" and select the "AND" operator. The system search result consists of 2,593 documents.
2. Then we specify the request. In the "Knowledge area" select "Engineering". In the field "Document type" select "Article". In the "Keywords" field, we choose, among the ones provided by the system, those that are directly related to dredging and ships, ports and terminals, environmental and ecosystem protection, sediment contamination, etc. ("Dredging", "Ships", "Dredges", "Sediments", "Ports And Harbors", "Dredger", "Geologic Sediments", "Marine Environment", "Shipbuilding", "Ecosystem", "Water Pollution", "Sediment Pollution", "Waterway Transportation", "Environmental Protection", "Land Reclamation", "Climate Change", "Suction Dredger", "Coastal Engineering", "Ecosystems", "Environmental Impact Assessment", "Hydraulic Structures", "Marine Engineering", "Dredging Operations", "Port Terminals", "Cutter Suction Dredger", "Marine Sediment", "Oceans And Seas", "Coastal Zone", "Port Development", "Navigation Channels", "Conservation Of Natural Resources"). As a result, we get 1,441 documents.
3. Further work is the analysis of selected documents using the service "Analyze search results". The analysis results is the number of published documents for each year (Fig. 1): 2020 – 1, 2019 – 45, 2018 – 75, 2017 – 89, 2016 – 94, 2015 – 69. Data for other years are presented in Figure 1.
4. Analysis of documents by source. Most articles (70) were published in Marine Pollution Bulletin (Elsevier Publisher, CiteScore (2018) 4.01, SJR (2018) 1.215, SNIP (2018) 1.305); 61 articles were published in HSB International (published by Uitgeverij Radius BV, SJR (2018) 0.112); 55 articles were published in Ports and Dredging (published by I H C Holland SJR (2018) 0.101); 48 articles were published in World Dredging, Mining and Constructions (published by World Dredging Magazine, SJR (2018) 0.101); 19 articles were published in the Journal of Coastal Research (published by Coastal Education & Research Foundation, Inc. CiteScore (2018) 1.21, SJR (2018) 0.424, SNIP (2018) 0.813); 16 articles were published in Holland Shipbuilding (published by Uitgeverij Radius BV, SJR (2018) 0.108), Maritime by Holland (published by Navingo

BV, SJR (2018) 0.100) and Science of the Total Environment (publisher Elsevier, CiteScore (2018) 5.92, SJR (2018) 1.536, SNIP (2018) 1.809); 15 articles were published in Water Environment Research (published by Water Environment Federation, CiteScore (2018) 0.96, SJR (2018) 0.286, SNIP (2018) 0.382).

Unfortunately, Scopus has stopped indexing the journals Marine Pollution Bulletin, Ports and Dredging, World Dredging, Mining and Constructions, HSB International, Holland Shipbuilding.

Documents by year

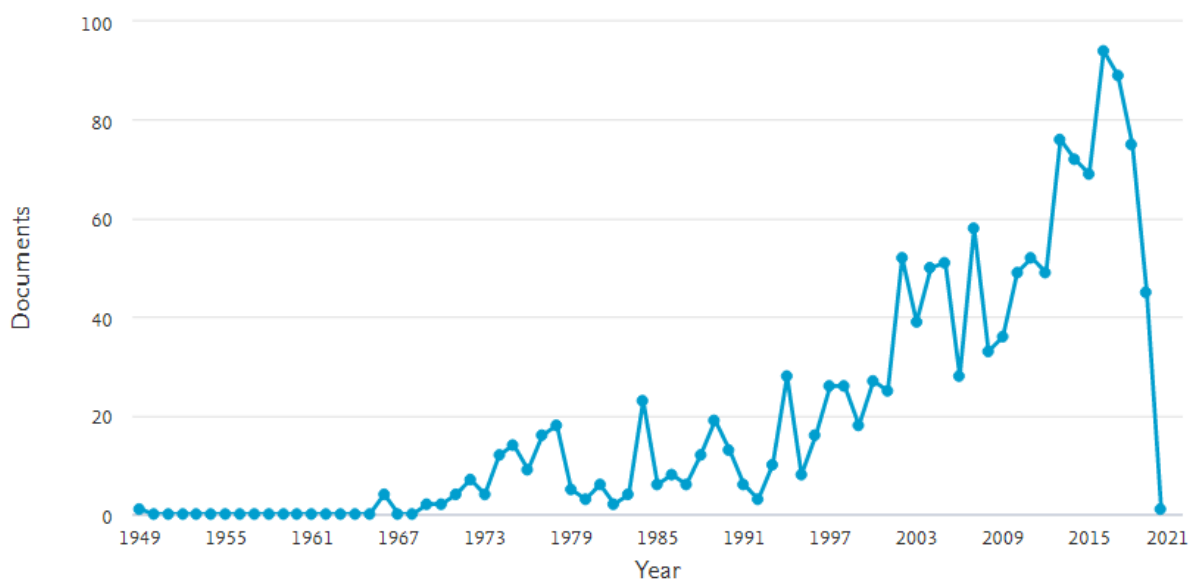


Figure 1. Number of published documents by year according to Scopus database

Analysis of documents by countries and territories. Most articles (349) belong to authors from the USA, 103 articles – to authors from the UK, 100 articles – to authors from China, 96 articles – to authors from Australia, 70 articles – to authors from the Netherlands. The Ukrainian authors are represented by two papers published in the journal *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu* (2014) and the proceedings of the US/EU-Baltic International Symposium: Ocean Observations, Ecosystem-Based Management and Forecasting – Provisional Symposium Proceedings, *BALTIC* (2008). T. O. Kolesnykova's studies (2013 and 2016) (Kolesnykova, 2013; Kolesnykova, Pominova, & Kolesnykov, 2016) confirm the lack of integration of Ukrainian science into the world scientific information space and the existing problems of insufficient representativeness of our scientists' publications in international citation indexes.

Analysis of documents by institution. The organizations whose authors work in Dredging direction include The United States Army Corps of Engineers (24 articles), Delft University of Technology (20 articles), National Oceanic and Atmospheric Administration (16 articles), Shanghai Jiao Tong University (15 articles) Consiglio Nazionale delle Ricerche (14 articles), University of Southampton (14 articles), Curtin University (14 articles) and others.

5. The leader in international recognition of publications is determined by the citation of works. Therefore, the next step is to identify the most cited articles that will constitute the so-called "core" and to compile a citation report (Table 1). To do this, go to the tab "View Citation Overview" and sort the selected documents by the number of citations in order of reduction. The number of citations during the last 15 years is presented in Figure 2.

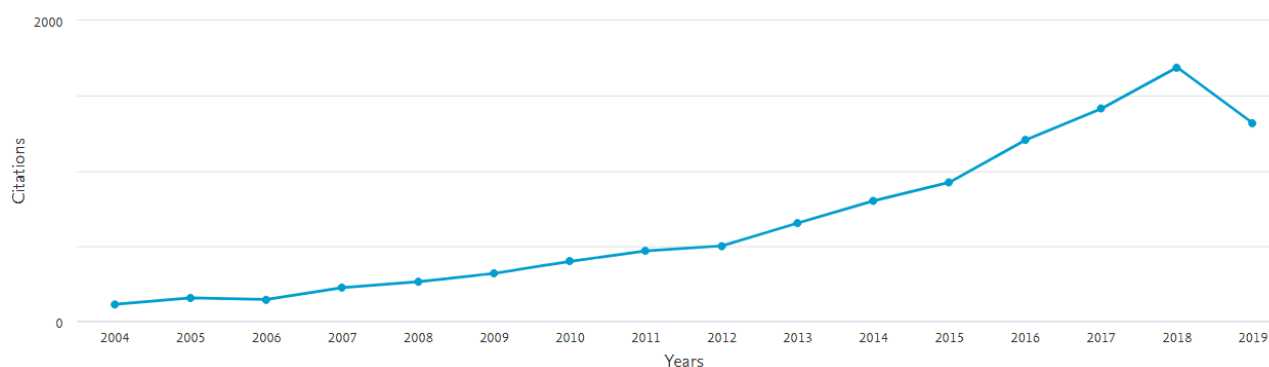


Figure 2. Number of citations during the last 15 years according to Scopus database

The total number of citations of 1 411 documents selected for analysis is 11 134.

Among the selected articles, 676 have non-zero citations. Of these, 557 articles have been cited more than 1 time and 20 cited more than 100 times. The most citations were received by articles in 2018 (1689), 2017 (1414) and 2016 (1205). In 2019, the articles received 1,316 citations.

Of the 1 411 articles, 97 are presented in Open Access, thereof 76 have more than 1 citation. 3 articles have more than 100 citations.

Table 1. Citation report of the most cited publications by keywords "dredging" and "ships" in Scopus database

| No. | Authors | Title of Article | Journal name | Year of publication | Total citations | Average number of citations per year |
|-----|--|---|-------------------------------|---|-----------------|--------------------------------------|
| 1. | Erfteemeijer, P.L.A., Riegl, B., Hoeksema, B.W., Todd, P.A. | Environmental impacts of dredging and other sediment disturbances on corals: A review | Marine Pollution Bulletin | Volume 64, Issue 9, September 2012, Pages 1737-1765 | 277 | 35 |
| 2. | Vanhellemont, Q., Ruddick, K. | Turbid wakes associated with offshore wind turbines observed with Landsat 8 | Remote Sensing of Environment | Volume 145, 5 April 2014, Pages 105-115 | 148 | 25 |
| 3. | Nogales, B., Lanfranconi, M.P., Piña-Villalonga, J.M., Bosch, R. | Anthropogenic perturbations in marine microbial communities | FEMS Microbiology Reviews | Volume 35, Issue 2, March 2011, Pages 275-298 | 134 | 15 |

Table 1. Citation report of the most cited publications by keywords "dredging" and "ships" in Scopus database (continuation)

| | | | | | | |
|----|---|---|-------------------------------|---|-----------|----------|
| 4. | Falloon, T.J., Danyushevsky, L.V., Crawford, A.J., Meffre, S., Woodhead, J.D., Bloomer, S.H. | Boninites and adakites from the northern termination of the Tonga Trench: Implications for adakite petrogenesis | Journal of Petrology | Volume 49, Issue 4, April 2008, Pages 697- 715 | 98 | 9 |
| 5. | Ormerod, S.J. | Current issues with fish and fisheries: Editor's overview and introduction | Journal of Applied Ecology | Volume 40, Issue 2, April 2003, Pages 204- 213 | 79 | 5 |

The main topics of the most cited works are, first of all, devoted to the impact of dredging on the ecology of the aquatic environment and marine life. The addressed issues also include: dredging risk assessment and minimization; environmental impact of deepening of the bottom and widening of the reservoir bed by extraction of underwater soil; application of bottom sediments after dredging and their disposal in open waters; dredging fleet maintenance.

The distribution of the most cited articles by country is as follows, %:

- United Kingdom – 20
- Australia – 40
- Belgium – 20
- Spain – 20

The distribution of the most intellectually productive authors of scientific articles by the Hirsch index is presented in Table 2.

Table 2. List of the most productive authors

| No. | Author | Institution | Country | h-index |
|-----|--------------------------|---|-------------------|---------|
| 1. | Thompson, Paul Murray | David Geffen School of Medicine at UCLA | United States | 128 |
| 2. | Duarte, Carlos M. | CSIC-UIB - Instituto Mediterraneo de Estudios Avanzados (IMEDEA) | Spain | 98 |
| 3. | Roberts, Callum | University of York | United Kingdom | 57 |
| 4. | Ormerod, Stephen J. | University of Wales | United Kingdom | 51 |
| 5. | Woodhead, Jon D. | University of Melbourne | Australia | 50 |

Results and Discussion

The content analysis of publications in the field of dredging proves that dredging problems are relevant in many countries of the world. They are considered and researched from numerous aspects. Scientists study and analyse: projects for deepening rivers, lakes and ponds; environmental issues related to the clarification of reservoirs after dredging; the impact of hydrotechnical structures on the environmental situation in water bodies and adjacent territories; problems of design and application of dredging equipment; solving port infrastructure problems. During the study the following results were obtained: in Scopus database 1 411 documents correspond to the given parameters. Most articles (70) were published in the Marine Pollution Bulletin; 61 articles were published in HSB International; 55 articles were published in Ports and Dredging. Unfortunately, Scopus stopped indexing these journals. Of the 1 411 documents the most cited are the 5 that made up the so-called "core". These articles are primarily concerned with the impact of dredging on the ecology of the aquatic environment and marine life. The highest figures for the average number of citations per year are the articles of the composite authors: Erfteimeijer, P.L.A., Riegl, B., Hoeksema, B.W., Todd, P.A. (35); Vanhellemont, Q., Ruddick, K. (25); Nogales, B., Lanfranconi, M.P., Piña-Villalonga, J.M., Bosch, R. (15); Falloon, T.J., Danyushevsky, L.V., Crawford, A.J., Meffre, S., Woodhead, J.D., Bloomer, S.H. (9); Ormerod, S.J. (5). The most intellectually productive authors of scientific articles are scientists from the USA, Spain, Great Britain and Australia. They represent such renowned institutions as: David Geffen School of Medicine at UCLA, CSIC-UIB – Instituto Mediterraneo de Estudios Avanzados (IMEDEA), University of York, University of Wales and University of Melbourne. Distribution of most cited articles by country, %: United Kingdom – 20; Australia – 40; Belgium – 20; Spain – 20.

Ukrainian scientists are represented in the Scopus database by two papers which discuss the problems of dredging. They were published in the journal *Naukovi Visnyk Natsionalnoho Hirnychoho Universytetu* (2014) and in the proceedings of the US/EU-Baltic International Symposium: Ocean Observations, Ecosystem-Based Management and Forecasting – Provisional Symposium Proceedings, BALTIC (2008). Such a number of documents confirms the fact that for a long time nobody has properly dealt with the dredging issue in Ukraine.

Conclusions

During the study the authors proved that the main topics of the “Dredging” direction are: the impact of dredging on the ecology of the aquatic environment and marine life; models and algorithms for assessing and minimizing the risks associated with dredging; application of bottom sediments after dredging and their disposal in open waters; dredging fleet maintenance; scientists of our country are very slowly joining the world processes of exchange of scientific information in the "Dredging" direction; the most intellectually productive authors of scientific articles in this field are scientists from the USA, Spain, Great Britain and Australia.

Subsequently, the study materials can be used to create an information base and to train dredging specialists.

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БІБЛІОМЕТРИЧНИЙ АНАЛІЗ РОЗВИТКУ НАПРЯМУ «ДНОПОГЛИБЛЮВАЛЬНІ РОБОТИ» У СВІТОВІЙ ПРАКТИЦІ

Мета. Дослідження спрямовано на отримання нових сучасних та аналіз вже існуючих знань про розвиток напрямку «Днопоглиблювальні роботи» у світовому науковому просторі з використанням продуктів і сервісів наукометричної бази даних Scopus. Тому, хронологічні рамки досліджуваних наукових статей обмежуються тільки їх наявністю у базі даних Scopus. **Методика.** З метою отримання релевантних емпіричних даних авторами дослідження проведений огляд світової наукової літератури за темою «Днопоглиблювальні роботи» з використанням ресурсів міжнародної реферативної та наукометричної бази рецензованої літератури Scopus. Розглянуто алгоритм «покрокових» дій у базі даних Scopus щодо: 1. Формування кола найбільш цитованих публікацій; 2. Визначення найбільш актуальних тем; 3. Виявлення найбільш продуктивних авторів; 4. Визначення рівня представництва в базі даних Scopus публікацій українських вчених за темою дослідження. **Результати.** Під час дослідження авторами доведено: 1. Основними темами напрямку «Днопоглиблювальні роботи» є: вплив днопоглиблювальних робіт на екологію водного середовища та морських мешканців; моделі і алгоритми для оцінки та мінімізації ризиків, пов'язаних з днопоглиблювальними роботами; застосування донних відкладень після проведення днопоглиблення та їх утилізації у відкритих водах; технічне обслуговування днопоглиблювального флоту; 2. Вчені нашої країни дуже повільно долучаються до світових процесів обміну науковою інформацією з напрямку «Днопоглиблювальні роботи»; 3. Найбільш інтелектуально продуктивними авторами наукових статей з цього напрямку є вчені США, Іспанії, Великобританії та Австралії. **Висновки.** Авторами вперше в Україні було проведено бібліометричне дослідження в галузі водного транспорту (предметний напрямок «Днопоглиблювальні роботи») на основі продуктів і сервісів наукометричної бази даних Scopus. Отримані результати можна використовувати для подальших наукових досліджень з даної та суміжних тем, а також застосовувати в процесі викладання дисциплін з днопоглиблювальних робіт.

Ключові слова: бібліометрія; наукометричний аналіз; наукометрична база даних; Scopus; днопоглиблювальні роботи