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**THE NORTHERN SEA ROUTE:
A SCIENTOMETRIC ANALYSIS OF INFORMATION
ARRAYS IN WEB OF SCIENCE AND SCOPUS DATABASES**

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The article traces main trends of the scientific research development on the Northern Sea Route using the international database Web of Science by Clarivate Analytics and Scopus by Elsevier. Using a scientometric analysis and analytical tools of DBs, the author shows countries, institutions and organizations that study this problem, as well as funds financing them; names productive periodicals and authors with high publication activity. In conclusion, the author notes that the study of the Northern sea Route development is an urgent problem for the entire world society, not only for the northern countries.

Objective – *to carry on a scientometric analysis of information arrays (IA) in the international scientific citation indices devoted to studying the Northern Sea Route development.*

Methods: *scientometric analysis.*

Results: *countries, institutions and organizations that study this problem are represented, as well as funds financing them; productive periodicals and authors with high publication activity are designated; the main research fields are revealed.*

Practical implications: *the study should be used as an information base for further research of scientists and specialists on various aspects of the Northern Sea Route development.*

Keywords: *Northern Sea Route; research information support; Web of Sciences; Scopus; scientometric analysis*

**СЕВЕРНЫЙ МОРСКОЙ ПУТЬ: НАУКОМЕТРИЧЕСКИЙ
АНАЛИЗ ИНФОРМАЦИОННЫХ МАССИВОВ БАЗ
ДАННЫХ WEB OF SCIENCE И SCOPUS**

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В статье прослежены тренды развития научных исследований по теме «Северный морской путь» с использованием баз данных

Web of Science (компания Clarivate Analytics) и Scopus (Elsevier). В базах данных с использованием булевых операторов и ключевых слов выявлены документальные массивы по теме, проведен их сравнительный наукометрический анализ. Аналитические сервисы баз данных позволили назвать страны, учреждения и организации, занимающиеся изучением данной проблемы, а также финансирующие их фонды. Определены наиболее продуктивные периодические издания и авторы с высокой публикационной активностью. Представлены научные мероприятия, проводимые по теме. Показана тематическая структура информационных массивов. Отмечено, что развитие Северного морского пути является актуальной проблемой всего мирового сообщества, а не только северных стран. Вышеназванные базы данных могут служить информационной основой дальнейших исследований различных аспектов развития Северного морского пути.

Цель: проведение наукометрического анализа информационных массивов из международных индексов научного цитирования, посвященных изучению Северного морского пути.

Методы: наукометрический анализ.

Результаты: представлены страны, учреждения и организации, которые изучают эту проблему, а также фонды, финансирующие их; обозначены продуктивные периодические издания и авторы с высокой публикационной активностью; выявлены основные направления исследований.

Область применения результатов: исследование могут служить информационной основой дальнейших исследований ученых и специалистов по различным аспектам развития Северного морского пути.

Ключевые слова: Северный морской путь; Web of Sciences; Scopus; наукометрический анализ

Introduction

The Russian Federation Presidential Decree dated 05.03.2020 No. 164 “On the State Policy Bases of the Russian Federation in the Arctic for the Period until 2035” defines foundations of the state policy concerning

the Russian Federation Arctic regions [2]. The document emphasizes the significant role of the Northern Sea Route as a necessary tool for socio-economic development of the Arctic zone. The incident with the Ever Given container ship, which ran aground and blocked the Suez Canal, has confirmed the need to develop logistic routes in the Arctic not only for the Nordic countries, but also for the entire world community.

The article objective is to carry on a scientometric analysis of the information arrays (IA) devoted to studying the Northern Sea Route.

Materials and methods

To analyze researches on the Northern Sea Route, two databases (DBs) have been applied as the most famous and authoritative systems: Web of Science (WoS) by Clarivate Analytics Co, and Scopus by Elsevier Co, which are commercial products [1].

Information arrays (IAs) have been selected of the above-mentioned DBs using keywords and Boolean operators. The volume of IAs for the period 1960-2019 compiled over 2,800 documents in WoS (about 1,000 is Open Access), and nearly 3,000 documents (500 ones in Open Access) in Scopus on March, 2021.

A scientometric analysis of IAs of the international DBs by includes:

- 1) revealing trends of scientific research development on the topic,
- 2) representing the countries and institutions involved in the problem study, as well as organizations funding the researches,
- 3) nominating the productive periodicals on the issue,
- 4) identifying authors with high publication activity,
- 5) designating research topics.

Study results

The dynamics of IAs over a 60-year period is shown in the diagram (Fig. 1), where the growth in the publications amount can be clearly seen, growing of the number of publications is especially noticeable the last decade. The following trends are traced in the IAs dynamics: 1960-70s – publications on the topic are rare; 1980-2000s – insufficient increase of the information amount; 2000-10s – significant growth of the document corpus.

The interest of scientists and specialists to this problem is explained by the geopolitical and economic competition of the polar states and the interests of non-Arctic states to include the Northern Sea Route in their logistic schemes.

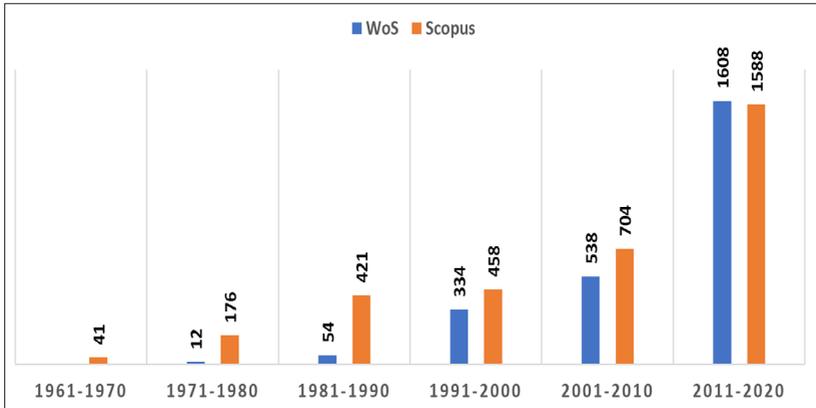


Fig. 1. Publication dynamics in DBs Web of Science and Scopus

The analytical tools of DB WoS allow users to identify the participation of the scientific community representatives from different states, affiliations of scientists and specialists, funds financing research on a particular problem.

As seen from the Table 1, the research activity on the Northern Sea Route is active in the northern states (USA, Russia, Canada, Norway), which have to develop the northern navigation due to long Arctic sea coasts and wide aquatoria. Economically developed counties (China, UK, Germany, Japan) are interested in studying the Northern Sea Route as an alternative transportation path.

Many organizations that take part in studies are presented in Table 2, among them the leaders in the publication amount are the research institutions of the Russian Academy of Sciences, National Centre for Scientific Research of France, Chinese Academy of Sciences, as well as higher schools of Norway, Finland, Canada, Germany, USA.

Table 1.

Countries with high publication activity on the topic

Rating	Scopus		WoS	
	Country	Publication number	Country	Publication number
1	USA	565	USA	529
2	Russia	446	Russia	319
3	Canada	310	China	269
4	UK	296	Norway	241
5	China	263	UK	240
6	Norway	261	Germany	236
7	Germany	230	Canada	223
8	Finland	177	Japan	144
9	South Korea	160	Sweden	133
10	Japan	157	Finland	113

Table 2.

Top 10 organizations which authors of articles in Scopus and WoS databases are affiliated with

Rating	Scopus	Number of works	WoS	Number of works
1	Norwegian University of Science and Technology	97	Russian Academy of Sciences	123
2	Russian Academy of Sciences	81	Helmholtz Accosiation	74
3	Aalto University	48	Norwegian University of Science and Technology	71
4	Memorial University of Newfoundland (Canada)	46	University of California System (USA)	60
5	Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (Germany)	44	Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (Germany)	54
6	National Research Council of Canada	43	Stokholm University	54
7	University of Cambridge	42	Centre National de la Recherche Scientifique (CNRS, France)	48
8	Chinese Academy of Sciences	41	Chinese Academy of Sciences	46
9	Korean Maritime and Ocean University	40	National Oceanic and Atmospheric Administration (USA)	43
10	Stokholm University	37	Memorial University of Newfoundland (Canada)	37

The main share of publications in the DBS is represented by English-language works (from 91% in Scopus to 94% in WoS), but 11 more languages are in the linguistic structure of the studied IAs, among them Russian, German, Japan, Chinese, Korean, etc.

Table 3 represents the organizations funding scientific research, in their midst the most active ones are the National Natural Science Foundation and National Science Foundation of China, European Commission and others.

Table 3.

Top 5 financing organizations in Scopus and WoS databases

Rating	Scopus	Number of works	WoS	Number of works
1	National Natural Science Foundation of China	86	National Natural Science Foundation of China	99
2	European Commission	58	European Commission	90
3	National Science Foundation	55	National Science Foundation	81
4	UK Research and Innovation	45	Ministry of Education, Culture, Sports, Science and Technology of Japan	44
5	Government of Canada	36	UK Research and Innovation	40

The IA type-specific structure of DBs WoS and Scopus is similar, Table 4 demonstrates the ratio of different types of documents in DBs.

Table 4.

Typical composition of the DCs in Scopus and WoS

DB	Scopus		WoS	
	Documents	%	Documents	%
Articles in periodicals	2267	60.0	1982	74.0
Conference proceedings	1373	35.5	552	20.6
Reviews	75	1.7	73	2.7
Book chapters	102	2.4	69	2.6
Books	25	0.4	2	0.1

Articles in periodicals and conference proceedings dominate in the typical structure of documents (74% and 20% in WoS, 60% and 35% in Scopus). Journals are the most efficient sources of information. Table 5 shows the Top 5 of periodical titles on the number of articles devoted to studying the Northern Sea Route.

Table 5.

**Ranking journals with the highest publication activity on the topic
in DBs WoS and Scopus**

Rating	Scopus		WoS	
	Source	Number of documents	Source	Number of documents
1	Polar Record (UK)	90	Journal of Geophysical Research. Ocean (USA)	73
2	Naval Architect (UK)	46	Cold Regions Science and Technology (the Netherlands)	41
3	Cold Regions Science and Technology (the Netherlands)	44	Deep-Sea Research. Pt. 2 (the Netherlands)	37
4	Deep-Sea Research. Pt. 2 (the Netherlands)	33	Marine Intellectual Technology (Russia)	37
5	Atmospheric Chemistry and Physics (Germany)	30	Geophysical Research Letters (USA)	35

Conference proceedings are no less important for the scholar community than periodicals, because there is an active exchange of information, discussion of topical issues, discussions on pressing issues during scientific meetings of various ranks. Most forums are held on an ongoing basis, the following of them should be noted: *International Offshore and Polar Engineering Conference; International Conference on Port and Ocean Engineering under Arctic Conditions; International Conference on Collision and Grounding of Ships and Offshore Structures; International Conference on Ecological Vehicles and Renewable Energies; Conference on Offshore Mechanics and Arctic Engineering; Ocean IEEE conference*, and others.

A small group of monographic publications is the most important component of IAs as they summarize the results of multi-year research by teams of scientists. There are books published recently: the one by T. Pastusiak devoted the history of navigation on the Northern Sea Route and vessels ability to overcome ice on the Northern Sea Route, and the criteria of safe speed and maneuvering vessels on ice [5, 6], as well as a work edited by F. Lasserre and O. Faury considering the present state of the Arctic shipping, future trends of maritime transportation [4]. But

the most cited monograph covering studies of sea ice along the Northern Sea Route is written by O. Johannessen and co-authors [3].

Table 6 represents the authors with high publication activity, among them the most productive authors are K. Choi (Korean Maritime and Ocean University), S. Ehlers (Hamburg University of Technology), P. Kujala (Aalto University), K. Riska (Delft University of Technology) studying ice/structure interactions, maritime structures, icebreaker design and dealing with ship operations and transportation risks, S. Sandven (Nansen Environmental and Remote Sensing Center) and O. Johannessen (Nansen Scientific Society), whose research activities are in the areas of sea ice, oceanographic processes, climate monitoring.

Table 6.

Top 5 authors with high publication activity on the topic in DBs WoS and Scopus

DB	Scopus		WoS	
Rating	Authors' name	Record number	Author	Record number
1	Choi K.	31	Sandven S.	24
2	Ehlers S.	27	Ehlers S.	23
3	Kujala P.	26	Riska K.	21
4	Riska K.	26	Kujala P.	19
5	Sandven S.	24	Johannessen O.M.	18

Thematically, IAs of databases are structured identically, which indicates the general research trends aimed to solve the following problems:

- engineering issues (ship building, icebreakers, vessels),
- safe navigation and transportation along the Northern Sea Route,
- sea ice cover and ice forecasts,
- Arctic meteorology.

DB Scopus represents keywords most frequently used in articles (meeting 200 times and more): ice or sea ice – 1015; icebreaker – 573; ships – 494; Arctic Ocean – 432, Northern Sea Route – 202, transportation routes – 200.

Conclusion

To summarize the results, it should be noted that studying the Northern Sea Route is an urgent problem for both the northern countries and world

community. The amount of information on the topic is steadily growing. While using a scientometric analysis and analytical tools of DBs, the author shows countries, institutions and organizations that study this problem, as well as funds financing them; names productive periodicals and authors with high publication activity; reveals the main research areas.

Searching filters in both DBs make it easy to find relevant documents on the topic that can form the basis for further research. Both DBs includes free access papers, while the others can be read by license agreement.

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