

Bibliometric Methods to Support Strategic Analysis of the Security Environment: Mapping and Profiling the Urbanization Research Field

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ABSTRACT

The aim of the paper is to explore the potential of bibliometric methods to support strategic analysis of the security environment. The case of urbanization trends will be used to study the usefulness of employing bibliometric methods for military analysis. The research questions are: (1) Who are the main contributors (countries, research institutions, journals, authors) to the research field? (2) What are the leading and emerging themes within the research field? (3) What aspects of urbanization are studied in regard to the military context? The study is embedded in the context of the strategic foresight analysis project nicknamed NUP 2X35, conducted by the Polish Armed Forces Doctrine and Training Centre. The applied methodology includes research profiling, keywords co-occurrence analysis, and systematic literature review. Scopus database is used as the source of data for bibliometric analysis. The VOSviewer software is applied to support co-citation analysis.

1.0 INTRODUCTION

As contemporary armed forces operate in a multidimensional security environment driven by political, legal, economic, socio-cultural, demographic and technological forces, military analysts are often required to expand the scope of their studies beyond the research fields traditionally associated with military strategy, operational art or tactics. To conduct studies in new, unexplored research fields in an efficient and effective way, they need to apply relevant research methods supporting them in recognizing valuable external data, information and knowledge, amassed by civilian scholars cultivating these fields, and identifying relevant contributors to the field in order to develop collaborative networks.

Such a challenge has been faced by the analysts of the Polish Armed Forces Doctrine and Training Centre (PAF DTC), appointed by the chief of the General Staff of the Polish Armed Forces to conduct the research project nicknamed NUP 2X35. The name of the project (in translation the New Polish Battle Order) refers to the Old Polish Battle Order, which was typical of the Polish art of war between the 15th and 17th centuries and contributed to numerous victories of the Polish military. The aim of the NUP 2X35 project is to conduct a strategic analysis of the security environment by 2035 and identify its implications for the development of the Polish Armed Forces (“Nowe Urządzenie Polskie: O co nam chodzi...,” n.d.). The project assumptions are similar to the NATO’s Strategic Foresight Analysis (SFA) accomplished under the umbrella of the Long Term Military Transformation project (“Futures Work: NATO’s ACT,” n.d.; Kubisiak, 2019). The idea of the first cycle of NUP 2X35 is to validate how trends and implications identified within the NATO SFA may shape

the security environment in the particular context of Poland and Central and Eastern Europe. What makes the difference is the inclusive approach which includes building networks consisting of cohorts of co-operating civilian scholars and experts. Therefore, good understanding of relevant research fields is an issue of paramount importance. In its first cycle, the NUP 2X35 project follows the structure of the security environment categorized in the NATO SFA report (*Strategic Foresight Analysis*, 2017) including political, human, technology, economics and environment themes. In regard to the structure of this analysis, the only alteration is that in the NATO SFA urbanization processes are studied as one of the trends under the umbrella of the human dimension of the security environment, while in the Polish NUP 2X35 project urbanization is considered as a separate theme/dimension of the security environment. Nowadays, 55% of the world's population lives in urban areas, and this number is forecasted to increase up to 68% in 2050 (*World Urbanization Prospects 2018*, 2019). From the military perspective, it is predicted that urban areas will more and more likely be the field of military operations (*Framework for Future Alliance Operations*, 2018; cf. Mokrzycki, Lis, & Szymańska, 2019). In consequence, there is a growing need to thoroughly understand the fundamentals of urbanization processes and their relationships with security, defense and military issues.

The aim of the paper is to explore the potential of bibliometric methods to support strategic analysis of the security environment in the military context. The case of urbanization trends will be used to study the usefulness of employing bibliometric methods for military analysis. The research questions are: (1) who are the main contributors (countries, research institutions, journals, authors) to the research field? (2) what are the leading and emerging themes within the research field? (3) what aspects of urbanization are studied in regard to the security and military context?

The main body of this study consists of three sections. Firstly, the method of study is presented and the research sampling process is explained. Secondly, the research productivity in the field is analyzed and dynamics of its growth is compared and contrasted against the increase in the number of publications indexed in the Scopus database. Thirdly, the findings from general publication profiling, which is a component of the research profiling methodology (cf. Martinez, Jaime, & Camacho, 2012; Sudolska, Lis, & Błaś, 2019), of research on urbanization are discussed. Fourthly, thematic areas (clusters) and emerging topics within the urbanization research field are identified and analyzed. Finally, aspects of urbanization studied from the perspective of security and the military are explored.

2.0 METHOD OF STUDY

This section presents the employed methods, techniques and instruments, and explains the research sampling procedure. Bibliometrics and scientometrics are listed among the methods used to support foresight programs and they are categorized as extrapolatory, analytical, and evidence-based methods (Kononiuk & Magruk, 2008). The methodology applied in this study includes: research profiling, keywords co-occurrence analysis, and systematic literature review. The VOSviewer software (van Eck & Waltman, 2010, 2014, 2018) is applied to support keywords co-occurrence analysis.

2.1 Research methods, techniques and instruments

The research methodology applied to achieve the aim of the study combines the methods of research profiling, keywords co-occurrence analysis and qualitative systematic literature review. Research profiling is a bibliometric descriptive study aimed at scanning a wide range of subject literature in order to support traditional literature surveys. In comparison with traditional literature reviews, research profiling is focused on a macro perspective: i.e., patterns and trends within the body of literature, encompassing the topics of inquiry and related areas, and combining textual, numerical and graphical presentation of the results of analysis (Porter, Kongthon, & Lu, 2002). The aforementioned macro perspective is achieved through incorporating a large number of publications (even dozens of thousands of bibliometric records) into quantitative analysis, which makes it different from traditional, qualitative systematic literature reviews. Referring to Paisley (1990), Porter and associates (2002, p. 354) emphasize the following research questions as part of the research profiling

method: “What issues are central [in the research field]? What techniques are emphasized? Who constitutes the scholarly community engaged in this particular research domain? When – how is the research domain evolving over the time?” In consequence, research profiling can be used in order to (Porter et al., 2002, p. 364):

- (1) “[d]epict the research context to target [...] research efforts wisely”,
- (2) “[u]nderstand the research community”; and,
- (3) “[e]xplore topics (techniques)”.

The standard procedure of research profiling consists of three components, i.e. (cf. Choi, Lee, & Sung, 2011; Martinez et al., 2012; Sudolska & Lis, 2018; Sudolska, Lis, & Błaś, 2019; Sudolska, Lis, & Chodorek, 2019):

- (1) general publication profiling aimed at mapping the research community;
- (2) subject area profiling used to explore multidimensionality of the studied research field; and,
- (3) topic profiling focused on identifying thematic boundaries of the field and leading topics.

For the purpose of this paper, only the first component of the procedure i.e. general publication profiling is employed. The method of research profiling is applied to conduct the part of the study focused on the first research question: who are the main contributors (countries, research institutions, journals, authors) to the research field?

The method of keywords co-occurrence analysis is applied instead of traditional topic profiling (cf. Martinez et al., 2012; Sudolska, Lis, & Błaś, 2019; Sudolska, Lis, & Chodorek, 2019) in order to explore leading and emerging topic areas within the research field. Recently, such a solution is often observed in studies employing bibliometric methods to map relevant research fields (Guo, Chen, Long, Lu, & Long, 2017; Lis, 2018, 2020; Marín-Marín, López-Belmonte, Fernández-Campoy, & Romero-Rodríguez, 2019). As defined by He (1999, p. 134) “[c]o-word analysis is a content analysis technique that uses patterns of co-occurrence of pairs of items (i.e., words or noun phrases) in a corpus of texts to identify the relationships between ideas within the subject areas presented in these texts. Indexes based on the co-occurrence frequency of items, such as an inclusion index and a proximity index, are used to measure the strength of relationships between items. Based on these indexes, items are clustered into groups and displayed in network maps.” Keywords co-occurrence is one of the types of relations within bibliometric networks used to visualize them (‘science mapping’) (van Eck & Waltman, 2014). The method of keywords co-citation analysis is applied to conduct the part of the study focused on the second research question: What are the leading and emerging themes within the research field?

In order to triangulate employed research methods and focus the attention on the scientific output dealing with urbanization issues in the security and military context, the method of qualitative literature survey is added to the study toolbox. “Systematic reviews are scientific investigations in themselves, with pre-planned methods and an assembly of original studies as their ‘subjects’. They synthesize the results of multiple primary investigations by using strategies that limit bias and random error. These strategies include a comprehensive search of all potentially relevant articles and use of explicit, reproducible criteria in the selection of articles for review” (Cook, Mulrow, & Haynes, 1997, p. 377). This rigorous research procedure is the key feature distinguishing systematic reviews from narrative literature reviews. As observed by Tranfield and his associates, “systematic literature reviews differ from traditional narrative reviews by adopting a replicable, scientific and transparent process, in other words a detailed technology, that aims to minimize bias through exhaustive literature searches of published and unpublished studies and by providing an audit trail of the reviewers decisions, procedures and conclusions” (Tranfield, Denyer, & Smart, 2003, p. 209). Qualitative systematic review is the technique which summarizes the contents of the publications selected for the sample but does not employ any statistical methods to analyze data (Cook et al., 1997). The method of qualitative systematic literature survey is applied to conduct the part of the study focused on the third research question: What aspects of urbanization are studied in regard to the military context?

2.2 Research sample

The Scopus database is used as the main source of data for bibliometric analysis. Together with the Web of Science, Scopus is considered among the most widely recognized and prestigious bibliometric databases. Scopus indexes publications from high quality source titles, and ranks them according to the number of received citations manifesting the interest of the academia. Compared and contrasted with the Web of Science, the coverage of the publications indexed in Scopus was initially limited to publications issued from the mid-1990s (Falagas, Pitsouni, Malietzis, & Pappas, 2008). Since those days Scopus has made significant efforts to expand its coverage adding numerous pre-1996 data (11.5 million records). In 2017, there were 69 million of bibliometric records indexed in the database (62.4 million of them are post 1969 publications with references) and 1.4 billion cited references. 3 million new records are added every year. Scopus-indexed publications come from nearly 23 thousand of source titles, including almost 22 thousand peer-reviewed journals (*Scopus Content Coverage Guide*, 2017). Nevertheless, limited coverage of political and military studies in Scopus is a limitation worth mentioning.¹

2.2.1. Research profiling and keywords co-occurrence analysis

For the purpose of the research sampling process the following query was conducted in the Scopus database as of 15 July 2019:

Searched for Title: ('urbani?ation'). Subject area: unlimited. Time span: unlimited.

In result, 9,675 publication records were retrieved, which received in total 137,986 citations. The search was intentionally narrowed to searching for the expression 'urbanization' within the titles of publications only (Title Search) in order to focus the attention on those publications which directly refer to the issue under the study. Neither subject area, nor time span were limited in order to include all relevant items and ensure the multidimensionality of the research sample i.e. include the publications indexed in numerous subject areas, as detailed in the next paragraph, representing the variety of research disciplines, and ranging from humanities through social sciences to natural sciences. A wildcard technique (i.e. searching for the phrase 'urbani?ation') (cf. Mishra, Satapathy, & Mishra, 2009; Satapathy, Mishra, & Mishra, 2010) was employed in order to include both spelling versions of the searched expressions in British English ('urbanisation') and American English ('urbanization').

The publications within the research sample are distributed among 27 subject areas defined by the Scopus database. The top 10 most populated among them are: Social Sciences (3,853 items), Environmental Science (3,380), Earth and Planetary Sciences (1,964), Agricultural and Biological Sciences (1,290), Engineering (1,188), Medicine (1,032), Arts and Humanities (724), Economics, Econometrics and Finance (554), Business, Management and Accounting (451) and Energy (410). Journal articles are the most numerous type of documents in the sample (7,417 items). Other highly represented categories are: conference papers (890), book chapters (645) and reviews (353).

2.2.2. Systematic literature review

Czakon (2011) highlights the role of research sampling in the methodology of systematic literature review. The sampling process consists of three steps. Firstly, the source of data is selected. Secondly, bibliometric records are identified through searching for keywords. Thirdly, abstracts of bibliometric records are studied in order to select publications subject to full-text analysis.

¹ The Authors are grateful to Matthew MacLeod from Defence Research and Development Canada for pointing out this limitation of the study.

The Scopus database was selected as the source of data for systematic literature reviews. In order to identify publications dealing with urbanization processes, relevant from the perspective of military analysis the following query was conducted in the Scopus database as of 18 August 2019:

Searched for: Title: ('urbani?ation) AND Topic (Title, Keywords, Abstracts): ('military' OR 'army' OR 'armed' OR 'defen?e' OR 'security'). Subject area: unlimited. Time span: unlimited.

Similarly to the sampling process for research profiling and keywords co-occurrence analysis, a wildcard technique was employed in order to include in the searched phrases all spelling alterations of the phrases 'urbanization' and 'defense'. As a result of the search 301 records were identified dealing with the issues of urbanization and security, which were subject to the abstract analysis aimed at selecting publications relevant for the qualitative literature review. The update of the search for the purposes of the research field productivity analysis, conducted as of 26 November 2019, revealed 309 publications.

The publications in the sample are distributed over 21 subject areas defined by the Scopus database. Among them those with the highest number of publications indexed within are: Environmental Science (106 publications), Earth and Planetary Sciences (60), Engineering (48), Agricultural and Biological Sciences (43). In regard to document types, those mostly represented in the sample are articles (216), followed by: conference papers (44) and book chapters (24).

3.0 RESEARCH FIELD PRODUCTIVITY

The analysis of the number of publications amassed in the research field over the period of time may provide evidence for assessing the field development stage in the life-cycle model (Czakov, 2011, p. 59). In regard to the urbanization research field, the earliest publication dates back to 1919. However, very few items issued prior to 1960 are represented in the sample. In the following decades the increasing trend was observed. In the 2010s this growth skyrocketed (cf. Figure 1-1).

The growth dynamics in the urbanization scientific output is even more visible when compared and contrasted with the increasing number of all bibliometric records indexed in the Scopus database (cf. Figure 1-2). The gap between the two trend lines widened dramatically in the 2000s and the 2010s. Urbanization studies related to security issues are not included in this analysis presented in Figure 1-2, as the 'urbanization & security' sample does not include a single record in the 1960s, which is the reference point for assessment of the increase in scientific productivity in the following decades. The number of publications combining urbanization and security aspects in relevant periods covered by the analysis is as follows: 1971-1980 – 2, 1981-1990 – 9, 1991-2000 – 9, 2001-2010 – 58, 2011-2019 – 231. These numbers confirm the growing interest of the researchers in this area observed in last two decades.

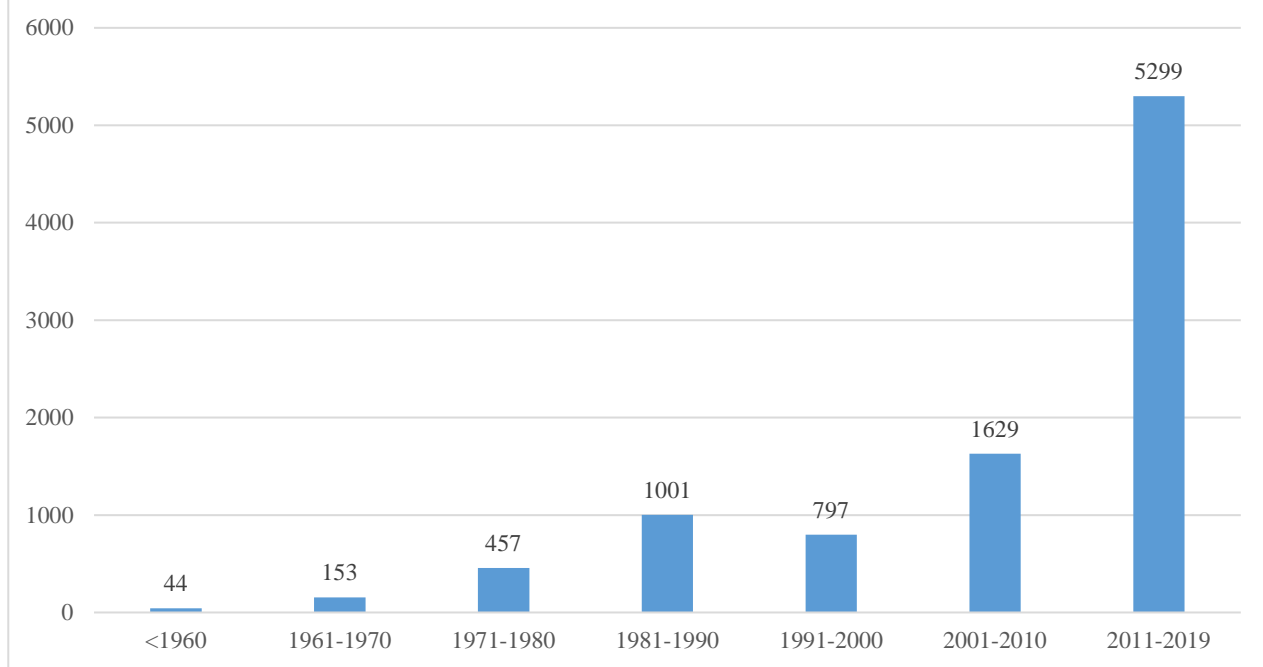


Figure 1-1: Scientific productivity of research on urbanization [number of publications]
Source: Own study based on data retrieved from Scopus database (15 July 2019).

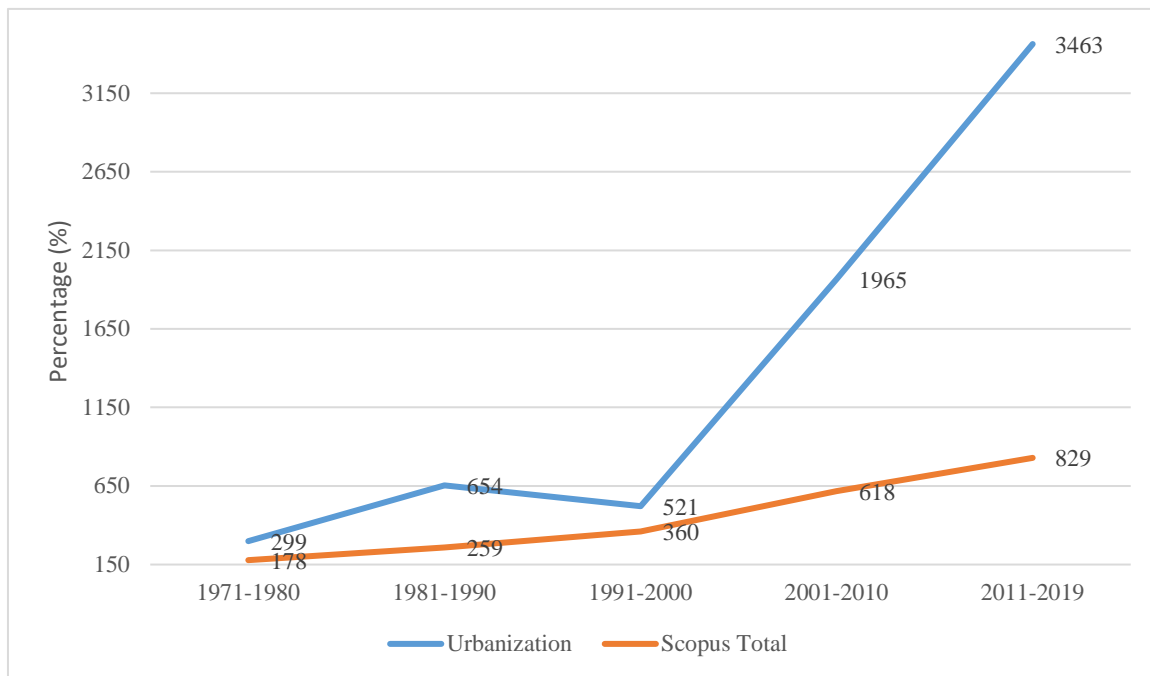


Figure 1-2: Relative increase in scientific productivity of research on urbanization and all publications indexed in Scopus [percentage; 1961-1970=100%]
Source: Own study based on data retrieved from Scopus database (Urbanization as of 15 July 2019; Scopus Total as of 24 November 2019).

The magnitude of the growing trend is evident while analyzing the yearly distribution of research output within the last decade (cf. Figure 1-3). Between 2011 and 2018, the number of publications on urbanization issues increased from 387 up to 849, translation to a rise of 219%. As of 24 November 2019, the level of research productivity in 2019 is 815 publications. Extrapolating data based on the number of items per month, it is assumed that in 2019 around 900 new publications would be indexed.

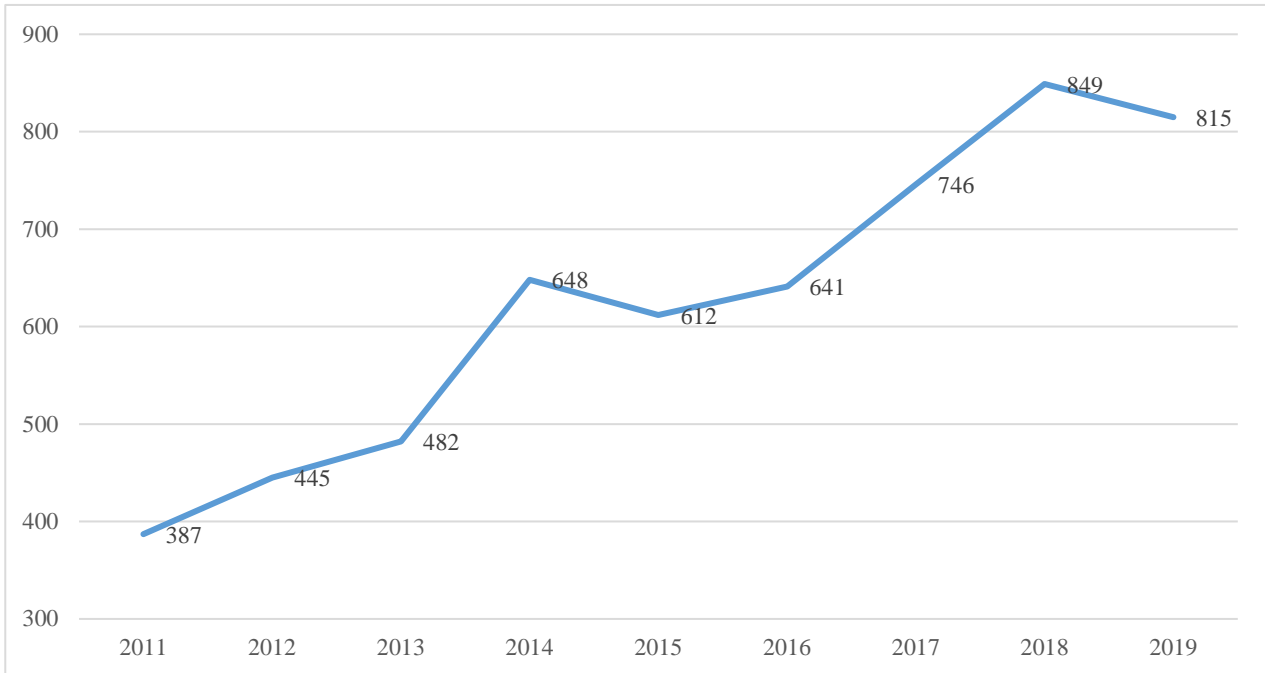


Figure 1-3: Scientific productivity of research on urbanization in the 2010s [number of publications]
Source: Own study based on data retrieved from Scopus database (15 July 2019, updated 24 November 2019).

While compared against the increase in the number of all the publication records indexed in the Scopus database in the 2010s (cf. Figure 1-4), the growth trend for the studies focused on urbanization processes shows much greater growth. The amplitude of changes was particularly visible in 2014, and 2017-2018. In regard to urbanization studies related to security issues, a similarly increasing trend line was observed between 2011 and 2016. In 2017, a decrease can be noted, and then in 2018 – an increase once again. Nevertheless, it should be highlighted that due a relatively small number of records included in the ‘urbanization & security’ sample (N=309, as of 26 November 2019), these data may show some volatility and should be treated with caution.

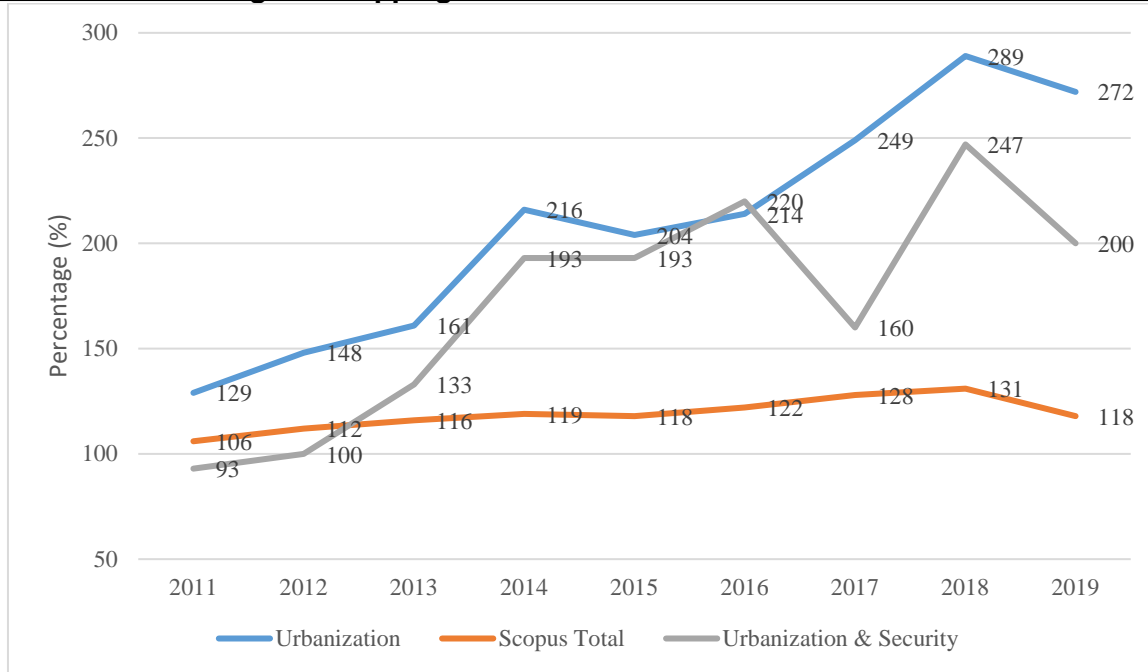


Figure 1-4: Relative increase in scientific productivity of research on urbanization and all publications indexed in Scopus in the 2010s [percentage; 2010=100%]
Source: Own study based on data retrieved from Scopus database (Urbanization 2010-2018 as of 15 July 2019; Urbanization 2019 and Scopus Total as of 24 November 2019).

The comparative analysis of research productivity in the urbanization field against the total scientific output indexed in the Scopus database shows much higher growth dynamics of the former, which has been particularly noticed in last two decades. Such an observation may be considered as an evidence supporting the statement that the urbanization research field is within the growth stage of its lifecycle.

4.0 GENERAL RESEARCH PROFILING

This section provides the findings from the general research profiling procedure employed to explore the scientific output on urbanization processes and to find out the main contributors to the field. Firstly, the most productive countries in the research field are identified. Secondly, leading research institutions are discovered. Thirdly, the source titles with the highest number of relevant publications are ranked. Finally, the most prolific authors are recognized.

4.1 Country profiling

The productivity of research on urbanization indexed in the Scopus database is distributed over 140 countries/territories. Among the leading contributors are the nations representing Asia, North America, Europe, Australia and Africa (cf. Table 1-1). China and the United States are the unquestionable leaders of the ranking. When adjusted for the country population i.e.. counting the number of publications per million of inhabitants, the contribution made by Anglo-Saxon countries should be highlighted (in particular Australia, followed by the United Kingdom, Canada and the United States). Moreover, what is interesting, China is the most productive country in regard to the number of publications, but the scientific output affiliated at the U.S. research institutions received twice as many citations as the Chinese contributions to the research field, which may be considered as the manifestation of significant influence of U.S. affiliated papers on the research field. Nevertheless, the bias of the Scopus database towards English language publications, which favors English native speaking countries, should be mentioned among possible explanations of such a situation. For instance, publications written in English make up about 87.5% of the sample, while those in Chinese, which is the

second most often represented language – only 3.6%. Among top most productive countries, the third position, both in regard to the number of publications and received citations, is occupied by the United Kingdom. Similarly to the United States and the United Kingdom, other English speaking countries (i.e. Australia and Canada) boast a higher percentage of received citations in relations to the number of works they contributed with. A similar situation may be observed in regard to the h-index. Both these observations may be considered as confirmation of influence these countries have on the development of research within the field.

Table 1-1: Top most prolific countries in research on urbanization

No.	Country	Publications			Citations			
		N	%	N per million inhabitants	N	%	N per publication	h
1.	China	2,395	24.75	1.72	26,562	19.25	11.09	nd
2.	United States	2,042	21.11	6.24	52,046	37.72	25.49	nd
3.	United Kingdom	641	6.63	9.64	13,565	9.83	21.16	60
4.	Australia	365	3.77	14.60	6,913	5.01	18.94	43
5.	India	326	3.37	0.24	4,818	3.49	14.78	30
6.	Canada	304	3.14	8.20	7,152	5.18	23.53	37
7.	France	295	3.05	4.40	3,353	2.43	11.37	28
8.	Germany	246	2.54	2.97	5,133	3.72	20.87	36
9.	Japan	232	2.40	1.83	3,814	2.76	16.44	31
10.	South Africa	199	2.06	3.44	3,407	2.47	17.12	29

Source: Own study based on data retrieved from Scopus database (15 July 2019) and World Bank website (05 December 2019)

The output of research on urbanization is very concentrated. The leaders – i.e., China and the United States together contribute to nearly half of all publications indexed in the sample. The same concentration ratio for the top 10 most productive countries within the research field is over 70%.

Poland with an output of 89 publications is ranked 18th. It is interesting to note that Polish researchers appear quite eager to cooperate with their colleagues from other countries, as their works are co-authored by 50 scholars affiliated abroad, representing 22 nations. The most intensive cooperation observed between Polish researchers and their colleagues in other nations is from France (6 publications), Spain (5), Czech Republic (5), Finland (4), the United Kingdom (4), Estonia (3), Germany (3), Hungary (3), Norway (3) and Sweden (3). Among those leading nations co-operating with Poland, there are both the representatives of the most productive countries and the partners from Central and Eastern Europe.

4.2 Research institution profiling

The top most prolific institutions in the research field contributed with 17.25% of the scientific output (publications), which received 20.99% of all citations. The leading contributors are listed in Table 1-2. As the

top 10 is dominated by Chinese organizations, we supplemented the table with the highest ranked research institution from the countries identified among the most prolific contributors in Table 1-1, regardless of the position those institutions occupy in the ranking list.

Table 1-2: Top most prolific research institutions in research on urbanization

No.	Institution	Country	Publications		Citations		N per publication	h
			N	%	N	%		
1.	Chinese Academy of Sciences	China	534	5.52	8,587	6.22	16.08	45
2.	University of Chinese Academy of Sciences	China	201	2.08	3,077	2.23	15.31	28
3.	Institute of Geographical and Natural Resources Research, Chinese Academy of Sciences	China	169	1.75	2,938	2.13	17.38	29
4.	Nanjing University	China	135	1.40	1,825	1.32	13.52	23
5.	Beijing Normal University	China	125	1.29	2,325	1.68	18.60	27
6.	Ministry of Education China	China	124	1.28	2,047	1.48	16.51	20
7.	Peking University	China	118	1.22	2,210	1.60	18.73	23
8.	Sun Yat-Sen University	China	101	1.04	1,560	1.13	15.45	22
9.	Arizona State University	US	84	0.87	2,752	1.99	32.76	27
10.	Zhejiang University	China	77	0.80	1,672	1.21	21.71	20
11.	Centre National de la Recherche Scientifique	France	71	0.73	1,115	0.81	15.70	18
19.	University of Toronto	Canada	50	0.52	542	0.39	10.84	13
23.	Australian National University	Australia	46	0.48	616	0.45	13.39	15
28.	University of Cape Town	South Africa	44	0.45	860	0.62	19.55	11
30.	University of Oxford	UK	41	0.42	1,684	1.22	41.07	18
42.	University of Tokyo	Japan	35	0.36	555	0.40	15.86	12
	Deutsches Zentrum für Luft- und Raumfahrt	Germany	16	0.17	417	0.30	26.06	6
	Jawaharlal Nehru University	India	12	0.12	104	0.08	8.67	6

Source: Own study based on data retrieved from Scopus database (15 July 2019).

The Chinese Academy of Sciences, contributing with 534 publications (5.52% of the total research output) receiving 8,587 citations (6.22%) is the unflagging leader of the ranking of the most prolific institutions within the research field. While combined with other institutions associated with the Chinese Academy of Sciences – i.e. The University of the Chinese Academy of Sciences and The Institute of Geographical and Natural Resources Research – these contributions increase respectively to the level of 9.35% of all the scientific productivity in the research field measured by the number of publication, and 10.58% of all received citations. These aforementioned Chinese research institutions make up the top 3 of the ranking. They are leaders both in regard to the number publication and received citations, as well as the h-index. This observation confirms the leading position of China in conducting research on urbanization processes. While compared and contrasted with the United States, it is interesting that having very similar contribution of the number of publications at the national level, the research productivity in China is much more concentrated within leading institutions, which results in dominance of Chinese institutions among top 10 contributors.

Within the top 10 list, there is only one non-Chinese institution – i.e., Arizona State University from the United States. Ranked at the 9th position in the number of produced publications, Arizona State University should be considered as a much more important player (2nd ranked) in regard to the number of received citations per publication. In this category, the University of Oxford is the leader. This may be considered as the manifestation of quality of publications and attention they received within the community. Research institutions representing other main contributing nations are ranked in the top 20 (French Centre National de la Recherche Scientifique and Canadian University of Toronto), or the top 30 (Australian Nation University,

the University of Cape Town from South Africa, and the University of Oxford from the United Kingdom). They are followed by lower-ranked the University of Tokyo (Japan), Deutsches Zentrum für Luft- und Raumfahrt (Germany) and Jawaharlal Nehru University (India). Among Polish research institutions, the leading contributors are: Warsaw University (11 publications), Adam Mickiewicz University (11), Polish Academy of Sciences (10), Warsaw University of Life Sciences (10) and Poznań University of Life Sciences (8).

4.3 Source title profiling

The 10 most prolific source titles contributed to the research field with 738 publications (7.64%), receiving 13,878 citations (10.06%). Table 1-3 presents top 10 most productive source titles in research on urbanization.

Table 1-3: Top most prolific source titles in research on urbanization

No.	Source title	Publications		Citations		N per publication	h
		N	%	N	%		
1.	Sustainability Switzerland	101	1.04	630	0.46	6.24	14
2.	Science of the Total Environment	83	0.86	1,369	0.99	16.49	20
3.	Landscape and Urban Planning	79	0.82	3,729	2.70	47.20	29
4.	Journal of Cleaner Production	76	0.79	1,407	1.02	18.51	21
5.	Urban Ecosystems	76	0.79	1,868	1.35	24.58	18
6.	Habitat International	75	0.78	2,055	1.49	27.40	25
7.	Advanced Materials Research	67	0.69	25	0.02	0.37	2
8-9.	Dili Xuebao Acta Geographica Sinica	61	0.63	765	0.55	12.54	16
8-9	Urban Studies	61	0.63	2,009	1.46	32.93	24
10.	Applied Mechanics and Materials	59	0.61	21	0.02	0.36	2

Source: Own study based on data retrieved from Scopus database (15 July 2019).

In regard to the number of published papers, the ranking is opened by *Sustainability Switzerland* (101). The followers are: *Science of the Total Environment* (83), *Landscape and Urban Planning* (79), *Journal of Cleaner Production* (76), *Urban Ecosystems* (76) and *Habitat International* (75). In regard to the number of received citation and the h-index, which may be considered as an indicator of research quality, *Landscape and Urban Planning* (3,729; 29) is the leader. The runner-up source titles are: *Habitat International* (2,055; 25), *Urban Studies* (2,009; 24), *Urban Ecosystems* (1,868; 18), *Journal of Cleaner Production* (1,407; 21), and *Science of the Total Environment* (1,369; 20).

4.4 Author profiling

Due to the fact that Chinese research institutions are found to be the leading contributors to the research output in the field, it is not surprising that the ranking of the most prolific authors is mainly populated by researchers affiliated in China. Among the top ten most prolific authors, six represent Chinese institutions. There are two researchers from Hungary, one representing the United States, and the other one from Denmark. Details are provided in Table 1-4.

Table 1-4: Top most prolific authors in research on urbanization

No.	Author	Institution	Country	Publications		Citations		N per publication	h
				N	%	N	%		
1.	Xu, Y.	Nanjing University	China	28	0.29	366	0.27	13.07	7
2.	Fang, C.	Institute of Geographical and Natural Resources Research, Chinese Academy of Sciences	China	26	0.27	478	0.35	18.38	12
3.	Tóthmérész, B.	MTA-DE Biodiversity and Ecosystem Services Research Group, Debrecen	Hungary	20	0.21	643	0.47	32.15	14
4.	Seto, K.C.	Yale University	US	19	0.20	1,336	0.97	70.32	14
5.	Shen, L.	Chongqing University	China	19	0.20	397	0.29	20.89	11
6.	Chen, M.	University of Chinese Academy of Sciences	China	17	0.18	292	0.21	17.18	9
7.	Wu, J.	Beijing Normal University	China	17	0.18	919	0.67	54.06	14
8.	Lövei, G.L.	Aarhus University	Denmark	16	0.17	306	0.22	19.13	7
9.	Magura, T.	Debreceni Egyetem	Hungary	15	0.16	470	0.34	31.33	11
10.	Zhang, X.	City University of Hong Kong	China	15	0.16	333	0.24	22.20	9

Source: Own study based on data retrieved from Scopus database (15 July 2019).

In regard to the number of authored publications, the leaders are: Y. Xu (28 publications) representing Nanjing University and C. Fang (26) from the Institute of Geographical and Natural Resources Research of the Chinese Academy of Sciences. When the number of received citations (in total and per publication) is counted, the contribution made by K.C. Seto from Yale University in the United States should be highlighted as the highest total (1,336; 70.32). The other authors worth mentioning are: J. Wu from Beijing Normal University in China (919 citations; 54.06 citations per publication) and B. Tóthmérész affiliated at MTA-DE Biodiversity and Ecosystem Services Research Group, Debrecen, Hungary (643 citations; 70.32 citations per publication). The research output of all these three researchers is also characterized by the highest value of h-index (14) among the most prolific authors in the research field.

5.0 MAPPING THE RESEARCH FIELD

This section aims at mapping the research field in order to explore the leading and emerging topics in urbanization studies. Firstly, high-frequency keywords in research on urbanization are studied. Secondly, keywords network analysis is conducted, which leads to identifying keywords clusters. Thirdly, these clusters are analyzed. Fourthly, emerging topics in the field are discovered. Finally, urbanization and the security and military issues discussed.

5.1 High-frequency keywords

Keywords provided by authors manifest authors' (and potentially editors') understanding of contribution made by their publications to the given research field (Uddin & Khan, 2016). Nowadays, in the process of indexation in bibliometric databases, author keywords are often supplemented with additional sets of machine-generated keywords (e.g. Indexed Keywords in Scopus or Keywords Plus in Web of Science Core Collection). Certainly, keywords added in the process of indexation are not so accurate and meaningful in describing paper content as author keywords. Nevertheless, as proved by Zhang et al. (2016), both categories of keywords are equally effective in bibliometric analysis.

The publications in the research sample include in total 28,291 unique keywords. Among them, 18,972 expressions occur only once. Certainly, ‘urbanization’ is the most often cited keyword within the research sample (N=5,309). If the British English spelling version is added (‘urbanisation’, N=611), in total 5,920 occurrences are reported. The leading keywords identified within the research output focused on urbanization are presented in Table 1-5.

Table 1-5: Top 30 high-frequency keywords in research on urbanization

No.	Keyword	N	No.	Keyword	N
1.	Urbanization	5,309	16.	Spatial distribution	432
2-3.	Article	1,301	17.	Developing country	424
2-3.	China	1,301	18.	Population	416
4.	Human	787	19.	Female	415
5.	Urban population	750	20.	Land use change	398
6.	Land use	650	21.	Economic development	387
7.	Urban growth	640	22.	Sustainable development	386
8.	Urbanisation	611	23.	Geography	385
9.	Urban area	606	24.	Developing countries	384
10.	Urban planning	552	25.	Male	381
11.	Economics	509	26.	Asia	362
12.	Humans	505	27.	Climate change	359
13.	Urban development	497	28.	Geographic factors	350
14.	Demography	489	29.	Remote sensing	345
15.	United States	447	30.	Population dynamics	320

Source: Own study based on data retrieved from Scopus database (15 July 2019).

Analyzing the top 30 high-frequency keywords within the sample, some trends may be observed. The focus seems to be given to geographical and economic perspectives. In regard to the geographical locations, China and the United States are the highest ranked nations, which correlates with contribution of these countries to the research field (cf. Table 1-1). This may be also associated with a very rapid urban ascent in China (Farrell & Westlund, 2018) and the fact that Northern America is the most urbanized geographic region in the world (*World Urbanization Prospects 2018, 2019*), while the United States contributing most to such a situation. However, Asia in general and developing countries are two other locations worth mentioning. As noticed in the United Nations report (*World Urbanization Prospects 2018, 2019*, p. 23) “[d]espite its relatively low level of urbanization, Asia, because of its large population, has the largest number of persons living in urban areas (2.3 billion in 2018)”. The Asia region is also expected to reach the level of 3.5 billion urban dwellers by 2050 due to a very high growth rate of urban population. In regard to developing nations it should be noticed that “[w]hile just under half of the population of the less developed regions currently lives in rural areas, (...) [h]owever, the urban population of the less developed regions has been growing considerably faster than that of the more developed regions (...), and as a result, its share of the world’s urban population has been rising” (*World Urbanization Prospects 2018, 2019*, p. 12). The growth and development of urban areas are found to be important themes, which is illustrated with such keywords as: ‘urban growth’, ‘urban development’, ‘economic development’, or ‘sustainable development’. Certainly, this growth and development is determined by the issues related with the land, where cities are located, which corresponds to such expressions as: ‘land use’, ‘urban area’, ‘urban planning’, ‘spatial distribution’, ‘land use change’. The aspects related to humans and population seem to be another area of interest of research in the field. This interest is manifested through the presence among top high-frequency keywords of such expressions as: ‘human’, ‘urban population’, ‘humans’, ‘demography’, ‘population’, ‘female’, ‘male’, ‘population dynamics’.

5.2 Keyword network mapping

As the aforementioned identification of leading themes with a simple analysis of top high-frequency keywords may be considered as superficial and subjective, in order to map the research field thoroughly, a keywords co-occurrence analysis was conducted. VOSviewer software, developed by the researchers from the University of Leiden, Netherlands (van Eck & Waltman, 2010, 2014), was employed to support the analysis. Taking into account the number of keywords in the sample, and following the formula

$$N = \frac{1}{2}(-1 \mp \sqrt{1 + 8I_1});$$

N – the number of high-frequency keywords; I_1 – number of keywords with only one occurrence

provided by Donohue (1974; as cited in: Guo et al., 2017, p. 7), the threshold of the minimum number of occurrences (75) and the number of high-frequency keywords subject to further analysis (195) were calculated. The parameters used to analyze bibliometric data with VOSviewer software are presented in Table 1-6. The maps of keywords co-occurrences including network visualization (Figure 1-4) and density visualization (Figure 1-3 and Figure 1-5) are the products of this analysis.

Table 1-6: VOSviewer parameters used for analysis

Item	Characteristic/ value
Type of analysis	Co-occurrence analysis
Unit of analysis	All keywords
Counting method	Full counting
Method of normalization of strength of the links between items	Association strength method
Layout	
Attraction	2
Repulsion	0
Clustering	
Resolution parameter (detail of clustering)	2
Minimum cluster size [N]	10
Merging small clusters	Switched on
High frequency keywords used for analysis [N]	Main research sample – 195
Minimum occurrences of a keyword used for analysis [N]	Main research sample – 75

Item density visualization indicates the most prominent keywords within the research field taking into account their relationship with other expressions. As explained by the authors of the VOSviewer software (van Eck & Waltman, 2018, p. 10) “[e]ach point in the item density visualization has a color that indicates the density of items at that point. By default, colors range from blue to green to yellow. The larger the number of items in the neighborhood of a point and the higher the weights of the neighboring items, the closer the color of the point is to yellow. The other way around, the smaller the number of items in the neighborhood of a point and the lower the weights of the neighboring items the closer the color of the point is to blue”. In the present versions of VOSviewer (version 1.6.7 and newer) a viridis color scheme is used as default for density (cf. Fig. 1-5, and 1-7) and overlay (cf. Fig. 1-8) visualizations. Van Eck and Waltman (2018) state that “[v]iridis and the other new color schemes for the overlay and density visualization and perceptually uniform. As explained in the Matplotlib user guide, the idea of perceptually uniform color scheme is that ‘equal steps in data are perceived as equal steps in the color space’”. The visualization of item density for high-frequency keywords representing the research field focused on urbanization is presented in Figure 1-5.

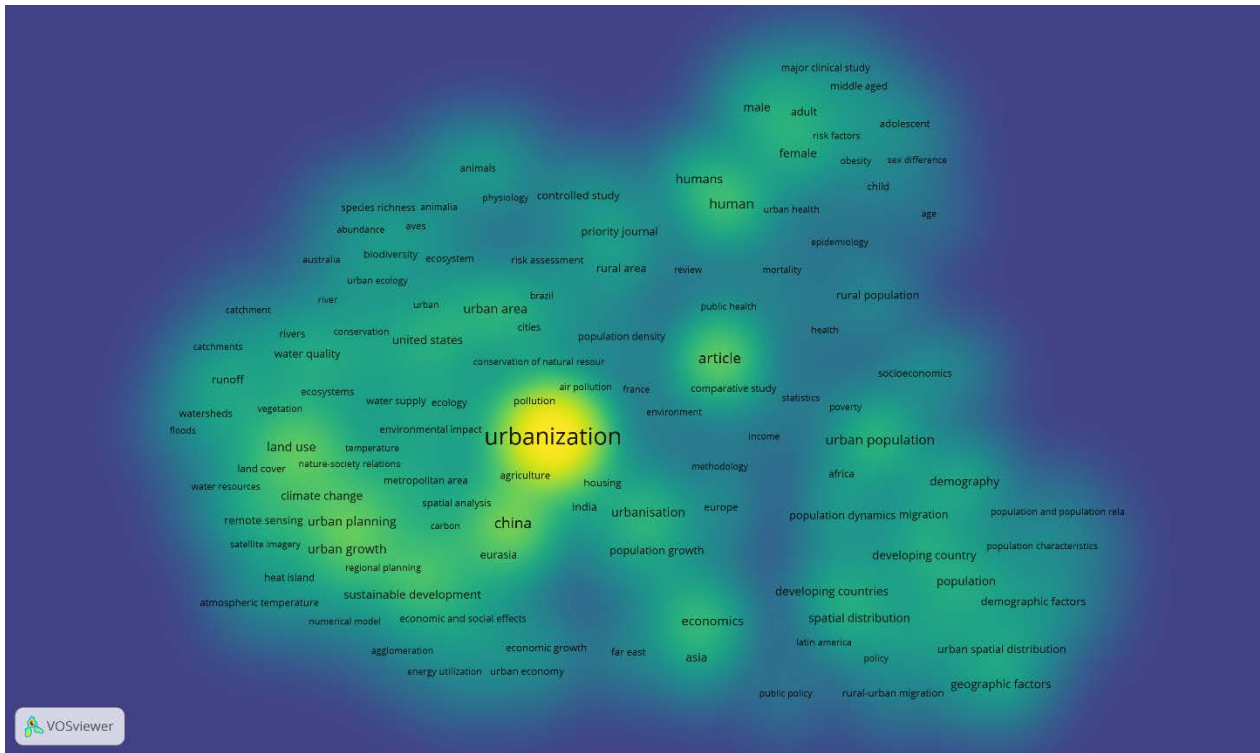


Figure 1-5: Item density visualization of keywords co-occurrence analysis of research on urbanization
Source: Own study based on data retrieved from Scopus database (15 July 2019).

The analysis of item density visualized in Figure 1-3 indicates that ‘urbanization’ is the central point in the research field. Other high-frequency expressions, which can be considered as focal points, are: ‘land use’, ‘climate change’, ‘urban planning’, ‘urban growth’, ‘China’, ‘article’, ‘human’, and ‘economics’. In regard to ‘article’, it seems that this expression has no meaning as a topic but it is simply that a lot of papers used this word when referring to themselves (e.g., defining document type) or to other articles.²

Network visualization is the next step of the research procedure. Network analysis results in categorizing the items into the clusters consisting of high-frequency keywords showing similarity and relatedness, which enables researchers to identify leading research topic areas or themes within the research field. Clusters, which make up a network, are the groups of interrelated keywords and links among them. In the network visualization, the distance between the two keywords represents the relatedness between them – i.e., the closer they are to each other, the stronger the relationship between them was in the data. Additionally, the strongest co-occurrences are visualized with lines. By default, the VOSviewer displays 500 lines representing relationships between the items of analysis. The size of the label and the circle around it indicates the importance of the item within the cluster i.e. those keywords with the highest number of occurrence are represented with the largest labels and circles (van Eck & Waltman, 2018, p. 8). Network visualization of high-frequency keywords representing the research field focused on urbanization is presented in Figure 1-6.

² The Authors are grateful to Matthew MacLeod from Defence Research and Development Canada for pointing out this comment.

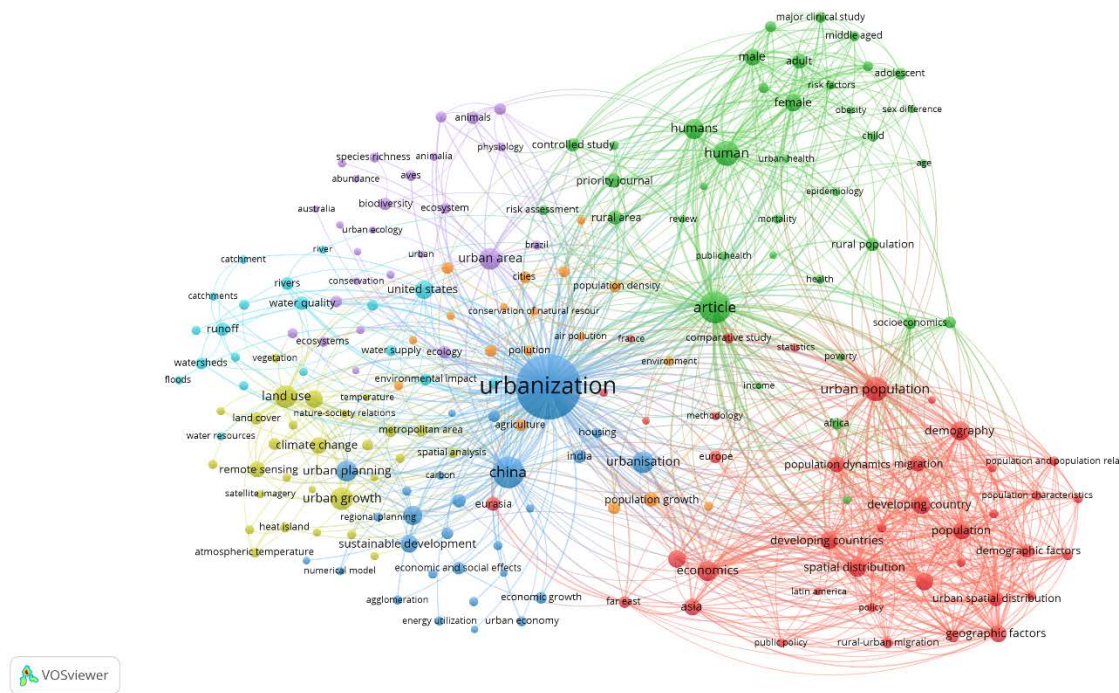


Figure 1-6: Network visualization of keywords co-occurrence analysis of research on urbanization
Source: Own study based on data retrieved from Scopus database (15 July 2019).

The network visualization of keywords co-occurrence analysis of research on urbanization indicates seven thematic areas or clusters within the research field. Taking into account their composition, the clusters are labelled as:

- (1) urbanization and urban development;
- (2) population, demographics and migrations;
- (3) human aspects of urbanization;
- (4) urban growth, land use and climate changes;
- (5) biology and ecology in the urban context;
- (6) water and hydrology; and
- (7) environmental impact of urbanization.

5.3 Keyword clusters' structure

With reference to the map presenting network visualization, cluster analysis of research on urbanization was conducted. Network visualization is supported with cluster density visualization. In this case, “the color of a point in the visualization is obtained by mixing colors of different clusters. The weight given to the color of a certain cluster is determined by the number of items belonging to that cluster in the neighborhood of the point. Like in the item density visualization, the weight of an item is taken into account as well” (van Eck & Waltman, 2018, pp. 10–11). It is worth noting that “the complex nature of colour perception means that it is impossible to predict even the appropriate colour appearance of a patch in a scene without specifying the surrounding colours” (Westland & Cheung, 2006, p. 17). Therefore, the perception of colors assigned to the clusters may be influenced by color contrast, constancy and appearance (cf. Westland & Cheung, 2006). The cluster density visualization of keywords co-occurrence analysis of research on urbanization is displayed in Figure 1-7.

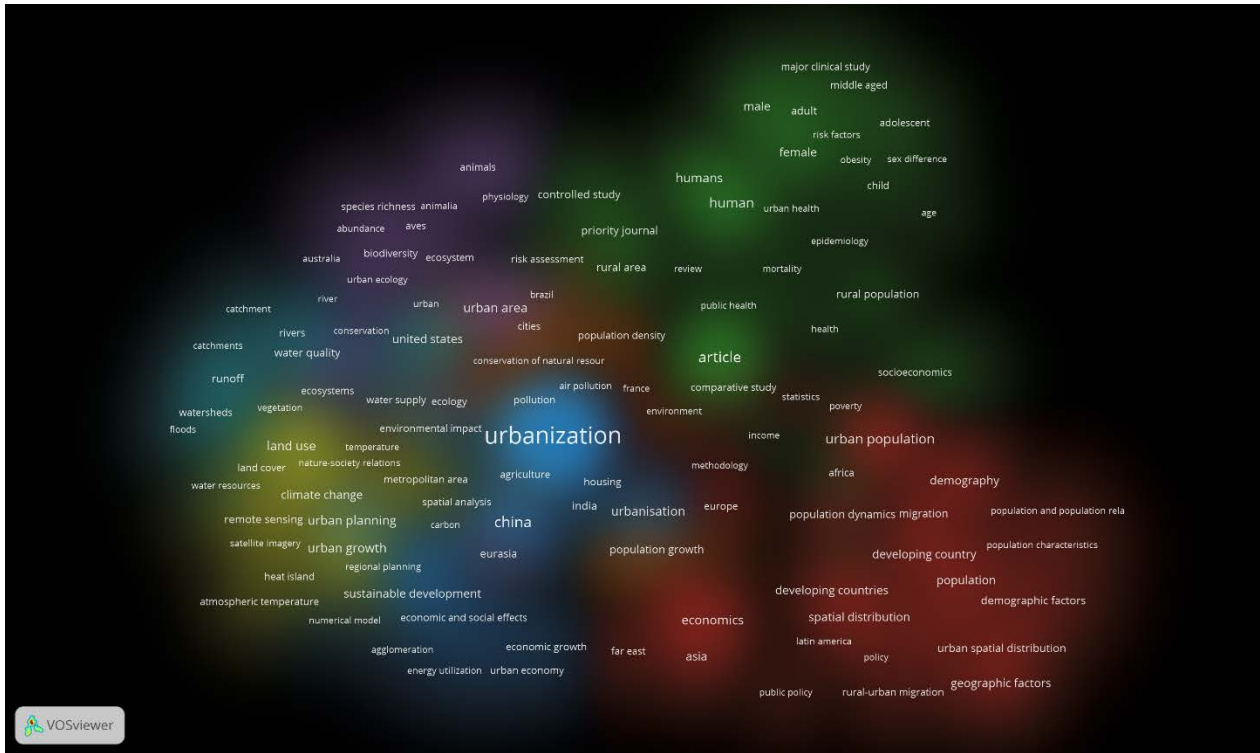


Figure 1-7: Cluster density visualization of keywords co-occurrence analysis of research on urbanization
Source: Own study based on data retrieved from Scopus database (15 July 2019).

In Section 5.2, seven clusters have been identified within the research output on urbanization. 195 items included in the clusters create 14,104 links with total link strength equal to 215,728. The data (high-frequency keywords) used for the analysis of the research output in the field are presented in Table 1-7. The most prominent keywords (i.e. those with the highest numbers of occurrences, links, and total strength links) in the research field are bolded. The relevant values of the above-said indicators are provided within the brackets.

Table 1-7: Clusters of high-frequency keywords related to research on urbanization

Cluster label / color	Item [N]	Keywords (numbers in brackets provide the numbers of occurrences, links, and total strength links for the most prominent keywords)
Urbanization and urban development / dark blue	28	agglomeration, carbon, carbon dioxide, carbon emission, China (1,301; 194; 9,324) , decision making, developing world, economic and social effects, economic growth, empirical analysis, energy utilization, environmental management, housing, India, land use planning, numerical models, planning, population statistics, regional planning, regression analysis, sustainability, sustainable development (386; 166; 2,415) , urban development (498; 179; 3,016) , urban economy, urban planning (575; 178; 3,310) , urban policy, urbanisation (611; 193; 2,613) , urbanization (5,346; 194; 32,608)

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Population, demographics and migrations / red	39	Asia, comparative study, demographic factors, demography (489; 165; 7,944) , developed countries, developed country, developing countries (384; 179; 6,098) , developing country (424; 151; 5,954) , economic development (387; 187; 4,083) , economic factors, economics (509; 184; 6,117) , emigration and immigration, English abstract, Eurasia, Europe, Far East, France, geographic factors, geography, Japan, Latin America, methodology, migration, policy, population (416; 157; 7,102) , population and population relations, population characteristics, population dynamics, public policy, research, research methodology, residential mobility, rural-urban migration, social change, spatial distribution (432; 182; 6,980) , statistics, urban population (750; 183; 10,383) , urban spatial distribution, theoretical models
Human aspects of urbanization / green	37	adolescent, adult, Africa, age, aged, article (1,301; 194; 16,748) , child, controlled study, employment, epidemiology, female, geographic distribution, health, human (787; 187; 8,396) , humans (505; 185; 6,200) , income, major clinical study, male, middle aged, mortality, obesity, poverty, prevalence, priority journal, public health, review, risk assessment, risk factor, risk factors, rural area, rural population, sex difference, socioeconomic factors, socioeconomics, South Africa, statistics and numerical data, urban health
Urban growth, land use and climate changes / yellow	28	air temperature, atmospheric temperature, Beijing, climate change (359; 171; 2,426), geographic information, GIS, global warming, Guangdong, heat island, land cover, land use (651; 178; 5,116) , land use change (398; 177; 3,410) , land-use change, landforms, metropolitan area, nature-society relations, rapid urbanizations, remote sensing (345; 155; 2,295) , rural areas, satellite imagery, spatial analysis, spatiotemporal analysis, temperature, urban areas, urban growth (641; 182; 4,188) , urban heat island, urban sprawl, vegetation
Biology and ecology in the urban context / violet	26	abundance, animal, animalia, animals, anthropogenic effect, Australia, Aves, biodiversity, Brazil, conservation, ecology, ecosystem, ecosystem service, ecosystems, forestry, habitat fragmentation, human activity, landscape, nonhuman, physiology, species diversity, species richness, urban, urban area (606; 186; 5,456) , urban ecology, urban ecosystem
Water and hydrology / light blue	19	catchment, catchments, environmental impact, floods, ground water, hydrology, North America, rain, river, rivers, runoff, United States (447; 189; 3,375) , water management, water pollution, water quality, water resources, water supply, watershed, watersheds
Environmental impact of urbanization / orange	18	agricultural land, agriculture, air pollution, analysis, cities, city, concentration (composition), conservation of natural resources, environment, environment impact assessment, environmental monitoring, environmental protection, industrialization, industry, pollution, population density, population growth, trends

Urbanization is considered to be closely related to sustainable development, including economic, societal and environmental aspects. The United Nations report on urbanization processes point out that “[w]ell-managed urbanization (...), can help to maximize the benefits of agglomeration while minimizing environmental degradation and other potential adverse impacts of a growing number of city dwellers (...). Unplanned or inadequately managed urban expansion, in combination with unsustainable production and consumption patterns and a lack of capacity of public institutions to manage urbanization, can impair sustainability due to urban sprawl, pollution and environmental degradation” (*World Urbanization Prospects 2018*, 2019, p. 1). The analysis of the structure of thematic clusters identified within the research field seems to confirm the interest of the academia in trends related to urbanization processes observed in the aforementioned report from the economic, societal and environmental perspectives.

Cluster 1 (marked in dark blue in Figure 1-6) is focused on the issues of ‘urbanization and urban development’. As noticed by the United Nations “[u]rbanization is shaped by spatial and urban planning as well as by public and private investments in buildings and infrastructure. An increasing share of economic activity and

innovation becomes concentrated in cities, and cities develop as hubs for the flow of transport, trade and information. Cities also become places where public and private services of the highest quality are available and where basic services are often more accessible than in rural areas” (*World Urbanization Prospects 2018*, 2019, p. 3). In regard to the ‘urbanization and urban development’ cluster, the keyword ‘urbanization’ occupies the central position both within the cluster and the whole research field. This expression shows numerous relationships with the items representing all the clusters. Other prominent nodes within the cluster are such expressions as: ‘China’, ‘urbanisation’, ‘urban development’, ‘sustainable development’ and ‘urban planning’. Similarly to ‘urbanization’, ‘China’ shows numerous relationships with all the clusters in the research field. ‘Urbanisation’ is linked with the items in ‘Population, demographics and migrations’ cluster, while the other aforementioned expressions are mainly connected with the keywords categorized within the ‘urban growth, land use and climate changes’ cluster.

Cluster 2 (marked in red in Figure 1-6) is focused around the issues of population, demographics and migrations, both in the context of developing countries and developed countries. What is interesting in regard to the structure of the cluster, is that there is a lack of a dominant central node. Instead, there are several keywords of a relatively similar prominence. Such a structure can be labelled as multi-nodal (with the most prominent keyword in each cluster forming a node). In general, the items within the cluster are very regularly distributed. There is only one branch on its left flank, which is characterized by weaker relationships with other items in the cluster, displayed in Figure 1-6 by a longer distance between them. This branch concentrates around the issues of ‘economics’ and economic development. In regard to the economic aspect, it should be highlighted that historically (i.e. in the 19th and 20th centuries) urbanization was strongly linked with industrialization processes and economic development, and these relationships are found to be reciprocal. Nevertheless, it is worth noting that recently observed urbanization processes in developing countries, e.g. in Sub-Saharan Africa show much lower consistency with economic theories of urbanization and are rather explained with demographic theories of urban transition (*World Urbanization Prospects 2018*, 2019, p. 3).

Cluster 3 (marked in green in Figure 1-6) concentrates on human aspects of urbanization, including the consequences of urbanization processes experienced by people. The expression ‘article’ is the most prominent keyword categorized within the cluster. Nevertheless, as already mentioned, this keyword has no meaning as a topic but it is simply that a lot of papers used this word when referring to themselves (e.g., defining document type) or to other articles. In regard to the expressions directly related to the leading themes of research in the cluster, ‘human’ and ‘humans’ are found to be the most important, as they show the highest prominence. Such expressions as ‘female’, ‘male’, ‘adult’, ‘aged’, ‘middle-aged’, ‘adolescent’ may suggest that the studies discriminate among different groups of population. Examples of other issues attracting the attention of researchers are: ‘risk factors’, ‘obesity’, ‘health’, ‘epidemiology’, ‘mortality’.

All the remaining clusters are mostly related to environmental issues, which are of high importance for urbanization processes and well-being of urban dwellers. As noticed in the United Nations report “[t]he future growth of cities and concomitant appropriation of land and natural resources will determine success towards an environmentally sustainable future. [However, i]n some cities, unplanned or inadequately managed urban expansion leads to rapid sprawl, pollution, and environmental degradation, together with unsustainable production and consumption patterns” (*World Urbanization Prospects 2018*, 2019, p. 4). Cluster 4 (marked in yellow in Figure 1-6) is focused on the issues related to urban growth, land use and climate changes. The main nodes within the cluster are such expressions as: ‘urban growth’, ‘land use’, ‘land use change’, ‘climate change’ and ‘remote sensing’. Cluster 5 (marked in violet in Figure 1-6) deals with the issues of biology and ecology in the urban context. ‘Urban area’ is the most prominent keyword within the cluster. The leading research topics include: ‘ecosystem(s)’, ‘ecology’, ‘anthropogenic effect’, or ‘biodiversity’. Cluster 6 (marked in light blue in Figure 1-6) is focused on the issues of water and hydrology. This aspect is found to be very important in the context of the ‘United States’. Research deals with such topics as among others: ‘water quality’, ‘runoffs’, ‘watershed(s)’, ‘water supply’. Cluster 7 (marked in orange in Figure 1-6) seems to be related to various aspects of the environmental impact of urbanization, including: ‘environmental impact monitoring’, ‘environmental impact assessment’, and ‘environmental protection’ as well as ‘air pollution’.

‘Industrialization’, ‘population growth’ and ‘population density’ are other issues under investigation of publications categorized within Cluster 7.

5.4 Emerging research topics

Identification of emerging topics within a research field may be supported with the function of the overlay visualization of VOSviewer software. The overlay visualization presents the items categorized as in the case of the network visualization, but colored in a different way. While the scores (here the year of publication) are assigned to the items used for analysis, the color of items ranges from blue (lowest score) to green (middle score) and yellow (the highest score) (van Eck & Waltman, 2018, p. 9). In order to discover the most up-to-date topics dealing with urbanization, the year of publication was assigned as a score to each item. The overlay visualization of research on urbanization displaying the average year of publication for the keywords within the identified thematic clusters, which *de facto* makes up the map of emerging topics, is presented in Figure 1-8.

The findings show that items categorized within Cluster 2 (population, demographics and migrations) and Cluster 3 (human aspects of urbanization) were the earliest issues of interest in the field. They are mainly assigned to the 1990s (Cluster 2) and the 2000s (Cluster 3). In general, the more the items are located to the left flank of the map, the more research interest they have been receiving in recent years. The overlay visualization in Figure 1-8 indicates the following keywords attracting increasing attention in academia (the dominant majority among affiliated institutions) and governmental research centers in recent years, which can be considered as emerging topics in the research field: ‘rapid urbanization’ (average publication year: 2015.65), ‘energy utilization’ (2015.57), ‘ecosystem service’ (2015.38), or ‘Beijing’ (2015.18), ‘carbon dioxide’ (2014.93), ‘economic and social effects’ (2014.28). The presence of the expressions related to research processes among the keywords with the highest score of the average publication year may be a confirmation of a growing trend of using numerical analysis. These expressions include such high-frequency keywords as: ‘statistics and numerical data’ (2016.51), ‘analysis’ (2016.12), ‘trends’ (2015.55), or ‘spatiotemporal analysis’ (2014.28). Although of a high score of the average publication year, all the aforementioned items are characterized by rather low prominence, measured by the number of occurrences, the number of links and the total link strength. Among the items of high prominence (in terms of the number of occurrences), the following ones are found as receiving significant attention in recent years: ‘land use change’ (average publication year: 2013.46), ‘urban growth’ (2013.39), ‘climate change’ (2013.29), ‘land cover’ (2013.27), and ‘sustainable development’ (2013.23).

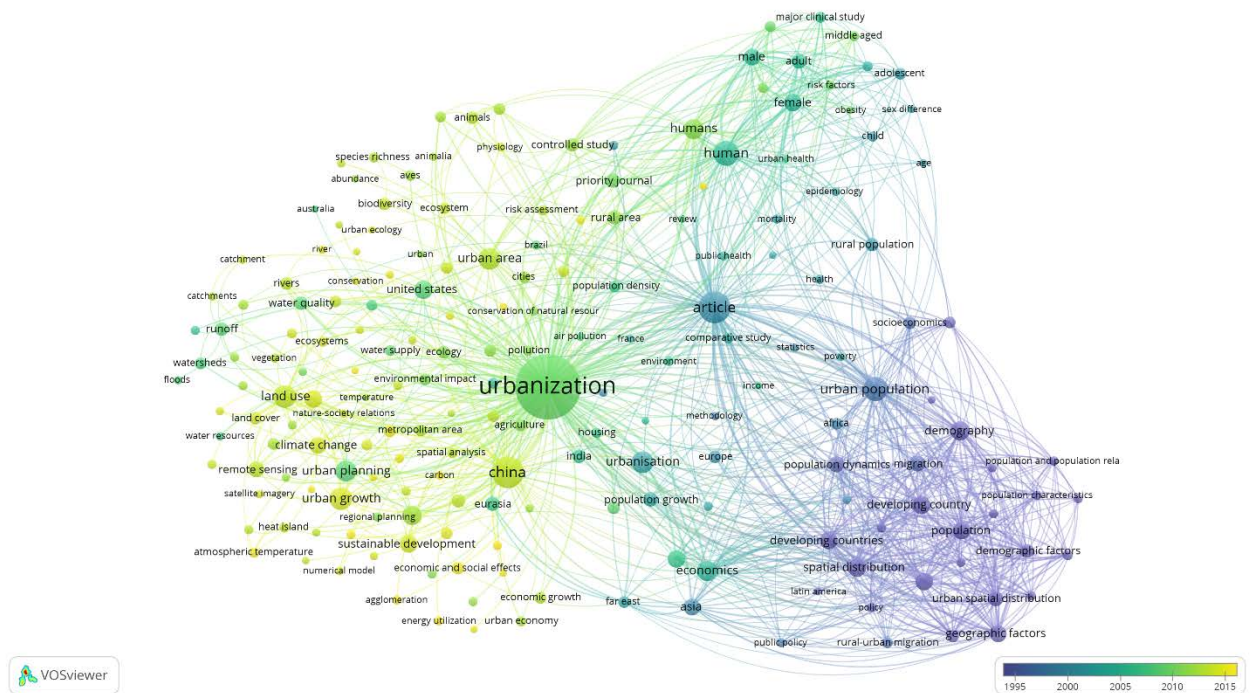


Figure 1-8: Overlay visualization of keywords co-occurrence analysis of research on urbanization

Source: Own study based on data retrieved from Scopus database (15 July 2019).

5.5 Urbanization and the security and military issues – systematic literature review

Our exploration of the research output on urbanization in regard to the security and military context ('urbanization and security sample', cf. Section 2.2.2) has provided limited but inspiring results. Firstly, attention is given to the problem of the security of populations living in urban areas from various perspectives, going far beyond the 'military bubble'. Secondly, we have found very few but interesting works dealing with the more 'military' aspects of urbanization.

Through systematic literature review, we discovered the following topics important for the security environment, highlighted within publications comprising the sample:

- (1) food security (e.g. Chen, 2007; Christiansen, 2009; Crush & Battersby, 2016; Wang, 2019; Wenban-Smith, Faße, & Grote, 2016; Zhu, 2011);
- (2) water security (e.g. Narain, Khan, Sada, Singh, & Prakash, 2013);
- (3) ecological security (e.g. Capps, Bentsen, & Ramírez, 2016; Han et al., 2009);
- (4) human security issues associated with climate changes and natural disasters (e.g. Pelling & Wisner, 2009; Redclift, Manuel-Navarrete, & Pelling, 2011);
- (5) energy use and security (e.g. Li, Li, & Strielkowski, 2019; Sadorsky, 2013); and
- (6) security of urban critical infrastructure (e.g. water and sewage, transportation, food storage, health service etc.) (e.g. Coward, 2009).

The scope of identified topics of research interest indicates the need of the multidimensional understanding of security issues in the urban areas, going far beyond the traditional military approach. This results in challenges for military commanders and planners who need to take into account expertise from various subject areas while making their analyses of the future security environment and their possible implications for military operations.

That said, urban areas can be considered as a field of future military operations. For instance, among the publications reviewed by the authors, Taw and Hoffman (1995) analyze the process of insurgency urbanization and the consequences of it to U.S. military operations. Coward (2009) studies how contemporary warfare of both insurgent groups and regular forces impact the infrastructure within the urban areas. In other publications, consideration has been given to the military importance of cities (Fort, 2015), and political and sociological issues of military operations in the cities (Karakatsanis & Swarts, 2013). In regard to the studies of military issues in the urbanization context, the contribution by S. Graham from the Newcastle University (the United Kingdom) is worth mentioning. In his most recent work he discusses militarization of urban areas and its consequences, exploring such aspects as: “the urbanization of military and security doctrines; the links between militarized control technologies and digitized urban life; the cultural performances of militarized media consumption; the emerging urban political economies of the ‘security’ industries, and the new state spaces of violence” (Graham, 2012, p. 136). In an older work, Graham (2008) analyzes the use of robots and automated systems by the U.S. military to counteract insurgents in urban areas. The issues of technology and the Revolution in Military Affairs in the context of urban areas are the themes of his earlier studies (Graham, 2006, 2007).

6.0 CONCLUSIONS

The output of research on urbanization is characterized by its multidimensionality, including studies from various research areas and scientific disciplines, ranging from humanities through social sciences to natural sciences. The publications included within the research sample considered in this report are distributed among 27 subject areas. The most populated among them are: Social Sciences (3,853 items), Environmental Science (3,380), Earth and Planetary Sciences (1,964), Agricultural and Biological Sciences (1,290), Engineering (1,188), and Medicine (1,032). Analyzing the yearly distribution of the number of publications, a significant increase in the interest of the academia in researching urbanization issues is observed. This trend is particularly visible in the 2010s decade, when the research output skyrocketed, comparing and contrasting with the yearly distribution of all bibliometric data indexed in Scopus database (cf. Section 3).

This study has: (1) identified the main contributors (countries, research institutions, journals, authors) to the research field, (2) identified the leading and emerging themes within the research field, (3) discussed the aspects of urbanization studied in regard to the military context. China and the United States are found to be the most productive countries in raw totals in research on urbanization. When adjusting for the country population i.e., counting the number of publications per million of inhabitants, the contribution made by Anglo-Saxon countries becomes prominent (in particular Australia, followed by the United Kingdom, Canada and the United States). The Chinese domination in the number of published papers is particularly visible while the contributions made by research institutions are taken into account: nine among top ten most productive institutions in the research field are located in China. The same applies to author profiling. Among the top ten most prolific authors, six are affiliated at Chinese research institutions. In the category of the most productive source title, in regard to the number of published papers, the ranking is led by *Sustainability Switzerland*. In regard to the number of received citation and the h-index, which may be considered as an indicator of research quality, *Landscape and Urban Planning* is the leader. The structure of the research field includes the following thematic areas/ clusters: (1) urbanization and urban development, (2) population, demographics and migrations, (3) human aspects of urbanization, (4) urban growth, land use and climate changes, (5) biology and ecology in the urban context, (6) water and hydrology, and (7) environmental impact of urbanization. The analysis of publications related to security and military issues indicates two streams of research. First of all, the authors consider security of urban areas and their inhabitants through the prism of such aspects as: (1) food security, (2) water security, (3) ecological security, (4) human security in the context of climate changes and natural disasters, (5) energy security, (6) security of critical infrastructure. Secondly, a very limited number (only eight) of interesting publications were found discussing urban areas of potential battle fields and the consequences of it for military doctrine and operations.

The added value of the study can be considered from three perspectives i.e. theoretical, practical and methodological. Firstly, mapping the research field focused on urbanization and profiling the research productivity within this field is the main contribution of the study to theory development. Secondly, the practical aspect of the paper is related to discovering and discussing the key aspects of urbanization studied from the point of view of the security and the military and pointing out the topics in the field, which should be considered in the foresight analysis of the future security environment. As such the study contributes directly to the NUP 2X35 project aimed the strategic analysis of the security environment by 2035, conducted in the Polish Armed Forces. Thirdly, the study may be considered as a case study illustrating the use of bibliometric research methods to support military strategic foresight analysis.

To conclude, the limitations of the study should be made explicit and the recommendations for further research proposed. First of all, as Scopus was used as the only source of bibliometric data this should be considered as one of constraints of the study. It refers in particular to the fact that Scopus database is biased towards English-language publications, while often neglecting the works, even those important for the research field, issued in other languages. Therefore, the replication of the study with the use of other sources of bibliometric data is worth considering. Secondly, due to the interest of the paper in the connections between the military perspective and urbanization processes, only this aspect was studied with the use of qualitative methods i.e. systematic literature review. All other topics and themes, which may be of great importance for shaping the future security environment, were explored with the use of quantitative bibliometric methods only. On the one hand, these methods enable researchers to analyze great amount of data, but this analysis may seem to be a little bit superficial. Therefore, more thorough analysis ('a deep dive') of identified leading and emerging topics is recommended with the use of systematic literature review. Thirdly, due to the rapidly increasing research output within the research field, it is recommended to replicate the study in 4 or 5 years in order to discover the dynamics of changes in regards to main contributors as well as leading and emerging topics.

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