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RESEARCH ARTICLE

Analysis of the world scientific production on public's opinion on environmental issues

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ABSTRACT

The aim of this study is to investigate the scientific production related to public attitude, behavior and acceptance of environmental issues through a bibliometric analysis. The databases Scopus was used to analyze the papers published in the subject area of environmental science. Bibliometric analysis was performed for authors, institutions, source type, document type, number of citations and countries in relation to publication year. An analysis of keywords of publications was also performed. The number of publications shows an overall exponential trend after 1965 until 2017. The most productive institution is the Wageningen University and Research Centre, followed by the Chinese Academy of Sciences Beijing Normal University. The keywords of the categories associated with "Ecology", "Sustainability," and "Environmental Policy-Management" are the most commonly used in most studies. It seems that there is room for more intensive research on fields related to public's opinion on specific environmental issues. The findings of the research will contribute to a better understanding of the current state of the art, identifying key research areas in the field of public opinion on environmental issues and identifying future research trends and directions.

Keywords: Public opinion, environmental issues, bibliometric analysis, research trends, Scopus, social acceptance

1. INTRODUCTION

The global community is experiencing several environmental threats such as climate change, biodiversity loss [1], pollution and the overexploitation of natural resources. To address the world's environmental problems, it is essential that engineers and social scientists work together [2]. Engineers can provide the best, safest and most efficient solutions, whereas social scientists can facilitate better understanding of the reasons for public acceptance or resistance to a proposed environmental policy. Social scientists can also suggest ways in which public policy makers may be able to increase citizens' acceptance and find solutions which are more acceptable for the community.

The implementation of effective environmental policies depends on the broad public support [3]. So, the results of surveys exploring social acceptance on environmental issues are very important as they can help policy makers better understand and design policies to minimize resistance of the citizens. The findings are also key information for public policy makers as they convey the nature of the communication message that is likely to be effective and they provide guidance to public policy makers about interventions that are likely to increase public acceptance.

One of the most widely used and accepted tools to measure the scientific research productivity in any particular field of research is bibliometric analysis. Bibliometrics, firstly introduced by Pritchard [4], is considered as a well-established research method for conducting systematic analyses [5]. Bibliometrics uses quantitative analysis and statistics to analyze the bibliometric characteristics of a given field, evaluate the performance of authors, academic institutions or countries, discover the hot topics, reveal the research tendency in future and help researchers to recognize novel schemes within research [6]-[8].

The field of environmental science shows a remarkable growing volume of scientific production. Bibliometric analysis has been used to study particular environmental fields, such as: water conservation and consumption [8]-[11], waste management and

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recycling [12]-[16], energy consumption and solar energy [17]-[20], air pollution [21]-[24] or soil degradation [25]-[29]. Other studies treat more general environmental problems, but rather focus on certain geographic areas or countries [30], [31].

Bibliometric analysis was applied in the aforementioned studies to investigate the tendency of the literature in specific environmental issues. The use of bibliometric analysis on the investigation of public opinion and acceptance on environmental issues is limited. Literature review reveals limited studies investigating the research trend on the public's views on the environment. Indicatively, reference [32], by using content analysis and studying three specific energy journals, attempted the assessment of the journals production, aiming at pointing out the key trends in these journals. Reference [33], by selecting several studies related to social and public acceptance of energy systems, highlighted the emerging trends and identified the main research areas. Reference 34, using content and bibliometric analysis, investigated the literature trend related to social acceptance of energy technology and fuels.

Therefore, this study aims to investigate and analyze the scientific production related to public attitude, behavior, perception and acceptance of environmental issues through a bibliometric analysis. To accomplish this, we perform an analysis of publications, journals, institutions, source type, and document type, number of citations and countries in relation to publication year. An analysis of keywords of publications was also performed. The scientific research productivity in this particular field of research is of great importance. The research will contribute to a deeper understanding of the importance of public opinion on several environmental issues, as public participation is considered one of the key factors in the effective implementation of environmental policies. In addition, research findings will highlight the fields that gain the interest of scientists and will indicate future directions of research.

2. METHODS

Elsevier's Scopus database covers a significant part of the world scientific production and was selected for its vast abstract and citation collection of over 22,000 journals from 5,000 international publishers. We conducted a search using Scopus for topics containing three combinations of keywords. The first one comprises the "public": ("public" OR "social"), the second one denotes "acceptance": (opinion OR perception OR acceptance OR attitude OR knowledge OR behavior OR behaviour) and the last is the component: "environment*" (referring to the keywords produced by the combination of the root "environment" and any suffix). The option of having these words in the title, abstract and keywords is selected.

We restricted this search to material published until 2017, as 2018 is ongoing and the number of works changes every day. Also, only the works published in English are selected (more than 93% of the total documents). Moreover, "trade publications" and "undefined" of the "source type" are excluded (about 660 documents). The research is performed from 12 to 16 of March 2018.

This initial search returned 145,277 documents. The number of documents per subject area is: Medicine: 51,602, Social Sciences: 36,691, Psychology: 22,075, Environmental Science: 20,398, Agricultural and Biological Science: 13,805, Computer Science: 13,196, Engineering: 11,877, Business, Management and Accounting: 9,112, Biochemistry, Genetics and Molecular Biology: 9,015, Arts and Humanities: 8,985, etc. These results show that the component "environment" is related to different fields (such as social, work, health) and does not have the narrow sense of environmental science. Since the research focuses on the public's opinion on environmental issues we choose to limit our research on the 20,398 documents related only to environmental science.

We extracted and analyzed the following data: year of publication, document type, country, institution, authors, and number of citations in Scopus. In order to enhance the analysis of the main issues, we also surveyed the keywords given by authors and by Scopus. The impact factors (IFs) were obtained from the Journal Citation Reports (JCR) Science Edition 2016. The total publications and citations per country were obtained by SCImago Journal & Country Rank. SCImago Journal & Country Rank is a portal that includes the journals and country scientific indicators developed from the information contained in the Scopus database.

3. RESULTS AND DISCUSSION

3.1. Analysis of publications and citations per year

In order to have a comprehensive overview of the research production on public opinion on environmental issues, the publication and citation number of each year is analyzed (Fig 1). According to the current Scopus documents coverage, the first publication on the topic was published in 1951 and until 1964 only 5 documents were published. The number of publications shows an overall exponential trend after 1965 until 2017. This trend can be divided into three periods: 1965–1989, 1990-2007 and 2008-2017 and the growth rate of each period can be described using a best-fit line. The display of these best-fit lines in the figure makes it difficult in reading, so the equation of each one is simply recorded to the text of the article. During the first period ($y=3.5246x-6,933.2$, $r^2=0.9282$), the number of publications appeared is quite low: 1 in 1965 and 92 in 1989, total 873 publications in 25 years. It is obvious that the research on the topic was just at the beginning. At the second period ($y=34.347x-68,320$, $r^2=0.936$) an increase of the number of publications begins: 108 in 1990 to 692 in 2007, total 5,788 publications in 18 years. During the third period ($y=163.4x-327,481$, $r^2=0.976$), the number of publications is growing even more: from 734 in 2008 to 2,223 in 2017, total 13,732 publications in 10 years. The results show that the research has rapidly developed and attracted widespread attention increasingly. The exponential growth in the production of scientific articles of the last

decade in environmental science has been also reported by previous studies [34], [35].

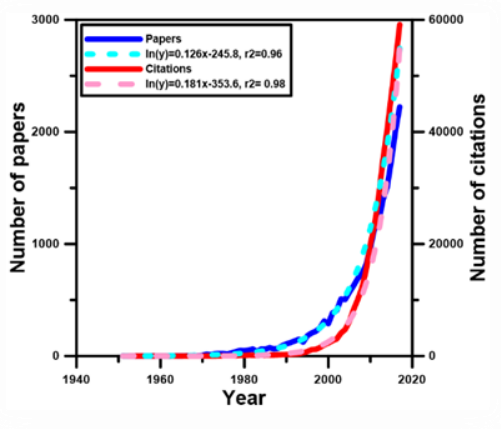

Fig 1. Number of documents and citations per year

Looking at the amount of citations in these 20,398 articles, there are 384,927 citations distributed along the study period, with an average of 18,89 citations per published article. The number of citations increases gradually every year with the amount of publications per year (Fig 1). Fig 2 shows the distribution of publications and their citation grouped into 10-year periods and confirms the increase in the amount of publications and citations. Moreover, the average number of citations per article has increased in each period. The increasing trend in the number of publications and citations in the field of environmental sciences is also highlighted in previous studies [34], [35].

3.2. Document and source type

Of the 20,398 publications recorded to Scopus from 1951 to 2017 in our search, twelve document types are identified: The peer-reviewed journal articles is the most common type (16,103 papers or 78.9% of all 20,398 publications), followed by reviews (1,769 papers, 8.7%), conference papers (1,321 papers, 6.5%), book chapters (508 chapters; 2.5%), books (166, 0.8%) and article in press (156, 0.8%). The predominance of articles as the most widespread way of disseminating and communicating scientific knowledge has been also highlighted by previous studies in the field of environmental research [36]. Other document types includes editorials (125, 0.6%), notes (109, 0.5%), short surveys (70, 0.3%), letters (42, 0.2%), conference reviews (28, 0.1%) and report (1). As a consequence of the previous results, the majority of documents are published in journals (18,534, 90.86%), following by books (848, 4.16%), conference proceedings (660, 3.24%) and book series (355, 1.74%).

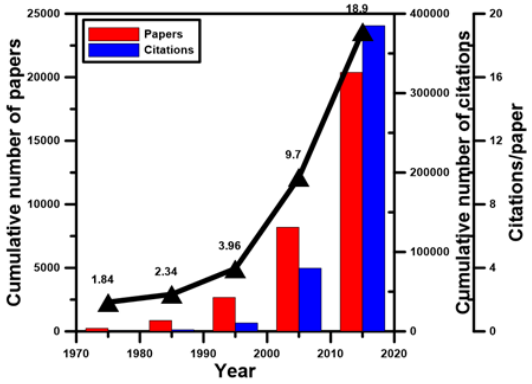

Fig 2. Cumulative publications and citations per period of 10 years

We extracted from Scopus the total citations for the most common document types (articles, reviews and conference paper) and it has been calculated the ratio Total number of each document type/Total citations of each document type, as shown in Table 1. The comparison of the aforementioned ratios reveals that reviews are the most cited document type (with almost 40 citations/document) although it counts significant less total number of publications. Articles received almost 19 citations/document and conference papers quite less, 12 citations/document.

3.3. Analysis of the major sources of publication and citation

There is an export limit of 160 terms when searching to Scopus; consecutively, all journals which published the articles of our research cannot be extracted. Thus, we analyze only the first 160 journals based on the number of publications. Almost 66% (13,353 papers) of the total number of papers have been published in the first 160 journals. Fig 3 shows the cumulative percentage of articles covered by these journals as a function of the number of journals that publish them, in decreasing order of journals, according to the number of articles they have published. It can be seen that, even if the journals with the highest number of publications occupy a significant part of the total articles published, a high predominance of a few journals is not observed (for example, about 70 journals have published only the 50% of the articles).

Table 1. Total citations of the most common document types

Document type	Total number of document type (1951-2017)	Total citations of document type (1951-2017)	Total number of document type/Total citations
Article	16,103	302,796	18,80
Review	1,769	69,249	39,15
Conference Paper	1,322	16,324	12,35

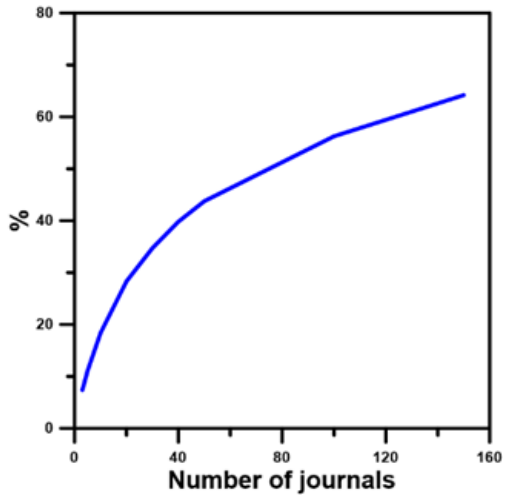

Fig 3. Cumulative percentage of papers published as a function of the number of journals have published them

The 20 main sources of publication and citation are grouped in decreasing order from the most productive to the least productive journal (Table 2). The 20 first sources of publication account for 28% of the total number of publications. Environmental Management, have published 563 publications, is the first on the journal list covering the 2.8% of the total documents; meanwhile, the second most productive journal is Journal Of Environmental Management with 480 publications (2.4%), followed by International Journal Of Environmental Research And Public Health (464 documents, 2.3%).

The columns "Rank Citations" and "Rank Publications" in Table 2 show the classification of the journals based on the amount of citations and publications. Interestingly, there is no correlation between the number of publications and the number of citations. For example, Environmental Health Perspectives has the highest number of citations (16,161), but ranks in the fourth position regarding the amount of publications (382) (Table 2).

Taking into consideration the index citations/documents, Global Environmental Change is in the first place of the ranking with 71.9 citations per document published, followed by Environment and Behavior (48.5 citations per document) and Environmental Health Perspectives (42.3 citations per document). Average citation per document is considered as a parameter that can express the influence of a journal in the research community (36 Jin et al., 2018). All the aforementioned journals have also been characterized by having high impact factor, between 3.378 and 9.776 (Table 2). As a result, we can draw a conclusion that these journals had an important influence on research related to public opinion towards environmental issues.

3.4. Analysis of countries

Table 3 shows the publication contribution of the top 10 productive countries. Undoubtedly, the most productive country is the USA in terms of the number of total publications from single-country articles and international collaborations (6,442 papers), followed by United Kingdom (2,717), Australia (1,624), Canada (1,371), Germany (976), China (946), Netherlands (867), Spain (807), Italy (743) and Sweden (718). The predominance of USA and United Kingdom to the scientific production has been also revealed by previous studies [37].

The contribution of the top ten countries in the field of environmental science as pointed out in the database of SCImago Journal and Country Rank [38], based on the total publications and the H-index, is shown also in Table 3. The H-index of each country is an index used for the evaluation of the country's scientific performance in the environmental field. This parameter integrates measures of quantity (represented by the number of publications) and measures of quality (represented by the total citation scores) [39]. The h-index of each country was obtained by SCImago Journal & Country Rank portal [38]. The position of each country in the list of the top ten productive countries for the search performed here is quite close to the position in the fields of environmental science extracted by SCImago 2017.

In addition, we calculated each country's ratio of citations per document of our search to total citations per total documents (for all subject categories and for the subject area "environmental science") (Table 4). The data of the total documents and total citations per country was extracted by SCImago Journal & Country Rank for the period 1996-2017, for all subject areas and for the subject area "environmental science". The ratio for all subject categories (Table 4) is roughly stable for the countries United Kingdom, Australia, Canada, Germany and Netherlands, close to 1.2. The low ratio of United States (1.02) and the high ratio of China and Sweden (1.78 and 1.58 respectively) reveals that these countries produce respectively much lower and higher citable works than the other countries.

The corresponding ratio for the subject category "environmental science" is also roughly stable for the countries United States, United Kingdom, Australia, Canada, Germany, China and Netherlands, close to 1.1 to 1.2. The low ratio of Spain (0.84) and the high ratio of Sweden (1.58) reveals that these countries produce in the field of environmental science respectively much lower and higher citable works than the other countries, for the specific research issue. The great production and influence of USA and the lowest production and influence among the north European countries (such as Spain and Greece) in the environmental field, has also been indicated by previous studies [40].

Table 2. Ranking of 20 journals in terms of publications and citations

Journal name	Documents	Document ranking	Citations	Citation ranking	Citations/ Documents	Impact Factor 2016*
Environmental Management	563	1	13,252	4	23.5	1.878
Journal Of Environmental Management	480	2	13,490	3	28.1	4.010
International Journal Of Environmental Research And Public Health	464	3	3,563	17	7.7	2.101
Environmental Health Perspectives	382	4	16,161	1	42.3	9.776
Science Of The Total Environment	371	5	8,086	10	21.8	4.900
Journal Of Cleaner Production	362	6	5,867	14	16.2	5.715
Sustainability Switzerland	305	7	981	20	3.2	1.789
Environment And Behavior	290	8	14,068	2	48.5	3.378
Ecological Economics	275	9	9,231	6	33.6	2.965
Ecology And Society	254	10	7,364	12	29.0	2.842
Environmental Science And Policy	243	11	5,716	16	23.5	3.751
Energy Policy	232	12	6,900	13	29.7	4.140
Proceedings Of The Royal Society B Biological Sciences	219	13	8,610	7	39.3	4.940
Landscape And Urban Planning	205	14	8,112	9	39.6	4.563
Society And Natural Resources	197	15	5,818	15	29.5	1.534
Environmental Science And Technology	196	16	8,204	8	41.9	6.198
Water Science And Technology	195	17	2,450	19	12.6	1.197
Conservation Biology	192	18	7,999	11	41.7	4.842
Ocean And Coastal Management	182	19	2,587	18	14.2	1.861
Global Environmental Change	170	20	12,231	5	71.9	6.327

* The impact factors of the journals were obtained from the Journal Citation Reports (JCR) Science Edition 2016

Table 3. Contribution of the top 10 productive countries

Country	Documents	Document ranking	Total Documents (SCImago 2017, Environmental Science)	Document Ranking (SCImago 2017, Environmental Science)	H-Index
United States	6442	1	470,621	1	545
United Kingdom	2717	2	134,007	3	262
Australia	1624	3	73,849	7	281
Canada	1371	4	90,369	5	303
Germany	976	5	106,899	4	320
China	946	6	219,409	2	262
Netherlands	867	7	43,460	12	287
Spain	807	8	63,273	10	245
Italy	743	9	59,101	11	226
Sweden	718	10	33,675	14	254

Fig 4 shows the comparison of the growth trends of the top seven most productive countries for the period 1990-2017, where all countries have started their publication activity. USA has a predominant role in publications, while China's history in the field of publications starts only in 1990, very recently in

relation to the rest of the top seven countries. From 1990 to 2008, the increase in speed of annual publication is slower for China. Beginning in 2009, the annual number of publications from China increases rapidly. By 2015, the annual number of publications from China is in upward trend. This reflects the fact that China has made considerable progress and has made great contributions to the research fields around the world, which is mainly a result of the rapid economic and industrial development. However, the annual number of publications from other countries (such as Australia Canada, Germany, and Netherlands) shows a tiny increase from 2001 to 2015 and from 2015 to 2017 a tiny decrease.

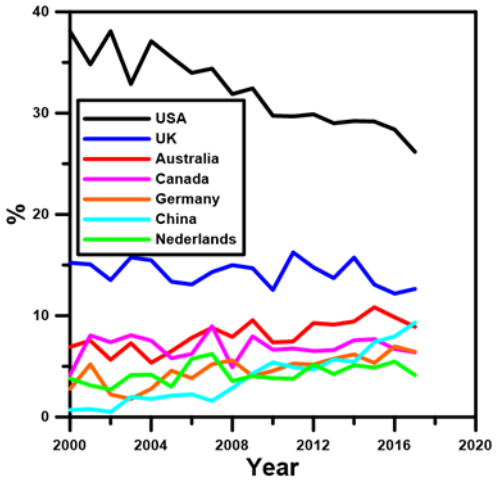

Fig 4. Comparison of the growth trends of the top seven most productive countries (1990-2017)

3.5. Analysis of institutions

Among the first 160 most productive institutions extracted by Scopus, the Wageningen University and Research Centre is the most productive institution with 213 papers, followed by the Chinese Academy of Sciences with 190, the United States Environmental Protection Agency with 160, the University of East Anglia with 154, the University of Queensland with 153, the USDA Forest Service with 50, the Australian National University with 141, the University of Oxford with 140, the University of British Columbia with 138 and the University of Washington, Seattle with 138.

The columns “Rank Citations” and “Rank Publications” in Table 6 show the classification of the institutions based on the amount of citations and publications. The institution with the highest number of publications is not necessarily the most widely cited. For example, Wageningen University and Research Centre is the institute with the largest number of publications, totalling 213, but it ranks in the second position in terms of citations, with 8.580 citations, while University of East Anglia has the largest number of cited articles (10,764 citations), being in the fourth position regarding the amount of publications (154). It is worthy of notice that the Chinese Academy of Sciences occupies the second place in the ranking of documents but is found only in the 10th place of citation ranking. This is a consequence of the fact that China started publishing articles much recently in relation to other countries and, thus, the time period to accumulate citations is much shorter.

3.6. Analysis of the keywords

Keyword investigation helps researchers choose appropriate keywords and contributes to access to research theme from scientific database with the correct term [41]. Identifying publication themes from keywords is an important means of enhancing visibility and scientific communication, thereby promoting higher quality research and discussion.

When searching to Scopus for a specific topic the extracted keywords are a combination of author keywords (assigned to the documents by the authors) and indexed keywords (controlled vocabulary terms and indexing vocabulary terms from subject-specific databases assigned to the documents by Scopus). To our research a total of approximately 4,000 keywords (109,480 total frequencies) were given by authors and by Scopus. In the top five terms (based on frequency of use) across both author-supplied and Scopus keywords, only one specific keyword (environmental protection, frequency 2,286) concerning the environment is found. The rest of the top five keywords were general and obviously given by Scopus (article, human, humans, United States).

For further analysis, the first 160 keywords (extracted by Scopus with the highest frequency) are categorized according to their content. There are created nine broad categories of these 160 keywords, shown in Table 6.

The terms of the categories "Environment" and "Social" are the most related terms to the research issue and to the keywords used in the search of articles. 60 keywords of total frequency 38,883 are included in the category "Environment" and 23 keywords of total frequency 13,299 are included in the category "Social". These two main categories cover the 52% of the amount of the 160 keywords and the 48% of total frequency obtained. The number of articles corresponding to the category "Environment" and "Social" is 14,165 documents and 8,403 documents respectively. The rest of the categories ("Human", "Methodology", "Policy-Management", "Geography", "Paper", "Health", "Psychology", "Animals") includes 77 keywords of total frequency 57,298; 52% of total frequency obtained. A further elaboration of the category "Environment" is performed, according to the context of each keyword, and 7 subcategories has been created (Table 7).

Table 4. Comparison of research documents and citations with corresponding data of Scimago Journal (all subject categories and subject category "environmental science")

	Research			Scimago Journal & Country Rank (all subject categories)				Scimago Journal & Country Rank (Environmental Science)			
Country	Documents	Citations	Citations per Document	Total Documents	Total citations	Total Citations/Total Document	(Citations/Documents)/(Total Citations/Total Documents)	Documents	Citations	Citations per Document	(Citations/Documents)/(Total Citations/Total Documents) (Environmental Science)
United States	6,442	155,489	24.14	10,193,964	240,363,880	23.58	1.02	470,621	9,962,559	21.17	1.14
United Kingdom	2,717	71,073	26.16	2,898,927	60,988,844	21.04	1.24	134,007	3,132,493	23.38	1.12
Australia	1,624	33,816	20.82	1,111,010	20,363,776	18.33	1.14	73,849	1,496,355	20.26	1.03
Canada	1,371	34,950	25.49	1,468,796	31,052,115	21.14	1.21	90,369	1,904,667	21.08	1.21
Germany	976	21,796	22.33	2,570,206	49,023,207	19.07	1.17	106,899	1,995,033	18.66	1.20
China	947	12,060	12.73	4,595,249	32,913,858	7.16	1.78	219,409	2,327,649	10.61	1.20
Netherlands	867	25,451	29.36	816,316	20,136,037	24.67	1.19	43,460	1,135,221	26.12	1.12
Spain	807	13,986	17.33	1,148,258	18,244,660	15.89	1.09	63,273	1,301,472	20.57	0.84
Italy	743	13,868	18.66	1,449,301	25,366,435	17.50	1.07	59,101	1,047,193	17.72	1.05
Sweden	719	26,748	37.20	552,343	13,028,361	23.59	1.58	33,675	854,016	25.36	1.47

As shown in Table 7, there are seven thematic subcategories of the category "Environment". In the subcategory "Ecology-Environment" is included 20 of the total 60 terms related to wider environmental concepts. The total frequency of these keywords is 12,703, 33% of the total frequency of the category "Environment". The next category "Environmental policy-management" includes 13 terms of total frequency 9,164; 23% of the total frequency of the category "Environment". The subcategory "Sustainability" includes the less number of keywords, only five, of total frequency 6,518 but cover the 17% of the total frequency of the category "Environment". Researchers' interest in the concept of sustainability has been highlighted by previous studies [35], [42] and reinforced by the fact that sustainability is a rather new concept that has emerged in recent years; its definition took place in the Brutland report in 1987 [43].

Table 5. Contribution of the top 10 productive institutions

Institution	Documents	Document ranking	Citations	Citation ranking	Citations/Documents
Wageningen University and Research Centre	213	1	8,580	2	40.3
Chinese Academy of Sciences	190	2	3,348	9	17.6
United States Environmental Protection Agency	160	3	5,382	5	33.6
University of East Anglia	154	4	10,764	1	69.9
University of Queensland	153	5	3,195	10	20.9
USDA Forest Service	150	6	5,768	3	38.5
Australian National University	141	7	5,426	4	38.5
University of Oxford	140	8	4,217	6	30.1
The University of British Columbia	139	9	4,123	8	29.7
University of Washington, Seattle	138	10	4,171	7	30.2

Table 6. Keywords categories

Keywords categories	Total frequency	Keywords categories	Total frequency	Keywords categories	Total frequency
Environment	33,833	Human	13,345	Policy-Management	9,216
Environmental Protection	2,286	Human	3,500	Decision Making	1,913
Sustainable Development	1,798	Humans	2,935	Public Policy	947
Environmental Management	1,610	Female	1,544	Stakeholder	939
Environmental Impact	1,559	Male	1,449	Economics	734
Climate Change	1,481	Adult	1,178	Policy Making	678
Sustainability	1,452	Nonhumam	851	Local Participation	667
Environmental Policy	1,207	Middle Aged	594	Policy	641
Conservation Of Natural Resources	1,198	Child	481	Governance Approach	503
Environmental Monitoring	1,141	Aged	464	Government	455
Environmental Exposure	1,061	Young Adult	349	Adaptive Management	419
Environment	988	Social	13,299	Management	398
Biodiversity	855	Perception	2,092	Risk Management	343
Ecology	833	Public Attitude	1,352	Planning	299
Environmental Planning	831	Public Opinion	866	Economic Aspect	280
Water Management	788	Social Behavior	805	Geography	8,083
Water Supply	768	Risk Perception	792	United States	2,099
Waste Management	751	Economic And Social Effects	775	Europe	891
Urban Area	691	Knowledge	703	Eurasia	832
Water Quality	675	Education	529	United Kingdom	699
Agriculture	638	Attitude	504	China	680
Environmental Economics	634	Socioeconomics	425	Australia	659
Ecosystem	608	Environmental Education	424	North America	547
Land Use	591	Social Aspect	418	Canada	430
Environmental Impact Assessment	590	Demography	402	Asia	358
Conservation	589	Consumption Behavior	382	Spain	316
Environmental Health	580	Behavior	373	European Union	287
Pollution	549	Social Aspect	368	Developing Countries	285
Environmental Factor	540	Willingness To Pay	352	Paper	7,413
Ecosystems	540	Social Environment	324	Article	4,224
Recycling	520	Public Participation	298	Priority Journal	1,901
Water Pollution	489	Socioeconomic Factors	296	Review	917
Air Pollution	486	Communication	283	Conference Paper	371
Resource Management	474	Behavioral Research	268	Health	5,142
Forestry	458	Concentration (composition)	268	Public Health	1,680
Conservation Management	431	Methodology	9,552	Health Risk	681
Waste Disposal	423	Risk Assessment	1,636	Health Hazard	576
Ecosystem Service	418	Questionnaire	616	Health Risks	512
Urban Planning	401	Questionnaire Survey	544	Health	474
Pollution Exposure	391	Surveys	539	Physiology	313
Environmental Issue	390	Participatory Approach	527	Health Impact	312
Forest Management	356	Methodology	513	Major Clinical Study	308
Environmental Engineering	333	Procedures	464	Toxicity	286
Air Quality	330	Research	397	Psychology	2,246
Water Resources	330	Attitudinal Survey	397	Controlled Study	1,109
Drinking Water	321	Risk Factor	388	Adolescent	477
Nature-society Relations	320	Regression Analysis	356	Psychology	358
Pollution Control	320	Conceptual Framework	354	Adaptation	302
Water	320	Learning	341	Animals	2,301
Environmental Pollutants	318	Models, Theoretical	339	Animals	995
Environmental Change	316	Comparative Study	337	Animalia	660
Rural Area	313	Analysis	330	Animal	646
Nature Conservation	305	Numerical Model	322		
Environmental Assessment	297	Questionnaires	319		
Environmental Values	296	Integrated Approach	287		
Natural Resource	294	GIS	277		
Water Pollutants, Chemical	293	Statistics And Numerical Data	269		

Table 7. Further elaboration of keywords related to environment

Keywords subcategory	Total frequency	Keywords subcategory	Total frequency
ECOLOGY-ENVIRONMENT	13,023	SUSTAINABILITY	6,518
Environmental Protection	2,286	Sustainable Development	1,798
Environmental Impact	1,559	Climate Change	1,481
Environment	988	Sustainability	1,452
Biodiversity	855	Conservation Of Natural Resources	1,198
Ecology	833	Conservation	589
Ecosystem	608	WATER	4,407
Environmental Health	580	Water Management	788
Pollution	549	Water Supply	768
Ecosystems	540	Water Quality	675
Environmental Factor	540	Water Pollution	489
Ecosystem Service	418	Waste Disposal	423
Pollution Exposure	391	Water Resources	330
Environmental Issue	390	Drinking Water	321
Environmental Engineering	333	Water	320
Nature-society Relations	320	Water Pollutants, Chemical	293
Pollution Control	320	LAND USE	3733
Environmental Pollutants	318	Urban Area	691
Environmental Change	316	Agriculture	638
Nature Conservation	305	Land Use	591
Natural Resource	294	Forestry	458
Fish	280	Urban Planning	401
ENVIRONMENTAL POLICY-MANAGEMENT	9,164	Forest Management	356
Environmental Management	1,610	Rural Area	313
Environmental Policy	1,207	Protected Area	285
Environmental Monitoring	1,141	WASTE	1271
Environmental Exposure	1,061	Waste Management	751
Environmental Planning	831	Recycling	520
Environmental Economics	634	AIR	1087
Environmental Impact Assessment	590	Air Pollution	486
Resource Management	474	Air Quality	330
Conservation Management	431	Atmospheric Pollution	271
Pollution Control	320		
Environmental Assessment	297		
Environmental Values	296		
Environmental Risk	272		

The rest four subcategories are exclusively thematic and are determined by the key components of the concept of the environment which are water, land use, waste and air. The total frequency of the terms of these four categories is 10,498, 27% of the total frequency of the category "Environment". The total number of articles corresponding to these four subcategories is 7,251 documents. Among these four subcategories, it seems that the most frequent subject of research is water, followed by land use, waste and air. In the subcategory "Water" is included nine keywords of total frequency 4,407, 11.33% of the total frequency of the category "Environment". The subcategory "Land use" includes 8 terms of total frequency 3,733; 9.6% of the total frequency of the category "Environment". The subcategory "Waste" includes only two terms of total frequency 1,271; 3.27% of the total frequency of the category "Environment". At last, in the subcategory "Air" is included three keywords of total frequency 1,087, 2.80% of the total frequency of the category "Environment". The number of articles corresponding to each subcategory is 2,500 documents for "Water", 2,954 documents for "Land use", 1,038 documents for "Waste" and 759 documents for "Air".

From the categories of the keywords and the related frequencies it seems that most articles in the research field, concern public opinion on more general environmental issues that are primarily related to ecology, sustainability and environmental policy and management. Publication themes concerning public opinion on specific environmental issues related to water, waste, air, land use appear to be much less.

4. CONCLUSIONS

Based on the 20,398 publications obtained from Scopus (for the time period 1951 to 2017), restricted to subject category of environmental science, we conducted a scientific research on public attitude, behavior, perception and acceptance of environmental issues by using bibliometric analysis. Article is the most commonly used document type but reviews are the most cited document type. The notable increase of annual number of publications after 1965 suggests that the research on the specific field developed rapidly and has increasingly attracted researcher's attention. 62% of the total documents were distributed into 160 different journals during the years 1951–2017. Environmental Management, Journal of Environmental

Management and International Journal of Environmental Research and Public Health ranked the top three on the journal list. In this study, we also found that the 20,398 publications with author's address information represented 160 countries and more than 160 institutions. Among the 160 countries, the USA, the UK, and Australia were the top three productive countries, followed by Canada, Germany and China. Among the first 160 most productive institutions extracted by Scopus, the Wageningen University and Research Centre took the leading position, followed by the Chinese Academy of Sciences and the United States Environmental Protection Agency. It is worthy of notice that the Chinese Academy of Sciences occupies the second place in the ranking of documents, but in the 10th place of citation ranking. This is a consequence of the fact that China has started publishing articles much recently than other countries and thus the time period to accumulate citations is much shorter. In addition, the keywords are categorized according to their content. The main research fields on public's opinion on environmental issues were related to ecology, sustainability and environmental policy and management, and less to specific environmental issues, such as water, waste, air, land use. These topics may become new research fields in the future.

The findings of the research activity related to public opinion on environmental issues contribute to a better understanding of the current state, identifying key research areas in this field and identifying future research trends and directions. Results can also be a useful tool for policy makers to establish future research priorities.

Main limitation of the research is that it was restricted to data obtained only from database Scopus. Future research should seek to include a larger database or to extract data from different databases enabling the comparison between the different sources and identifying general trends.

REFERENCES

[1]. J. Rockstrom, W. Steffen, K. Noone, A. Persson, F.S. Chapin and E.F. Lambin, "A safe operating space for humanity," *Nature*, Vol. 461 (7263), pp. 472-475, 2009.

[2]. S. Dolnicar, A. Hurlimann and B. Grun B, "What affects public acceptance of recycled and desalinated water?" *Water Research*, Vol. 45, pp. 933-943, 2011.

[3]. J.C.J.M. Drews and van den Bergh, "What explains public support for climate policies? A review of empirical and experimental studies", *Climate Policy*, Vol. 16 (7), pp. 855-876, 2016.

[4]. A. Pritchard, "Statistical Bibliography or Bibliometrics", *Journal of Documentation*, Vol. 25, pp. 348-349, 1969.

[5]. A.F. Van Raan, "For your citations only? Hot topics in bibliometric analysis", *Measurement,* Vol. 3, pp. 50–62, 2005.

[6]. J.A. Wallin, "Bibliometric methods: pitfalls and possibilities", *Basic & Clinical Pharmacology & Toxicology*, Vol. 97, pp. 261-275, 2005.

[7]. F. De Battisti and S. Salini, "Robust analysis of bibliometric data", *Statistical Methods & Applications*, Vol. 22 (2), pp. 269–283, 2013.

[8]. H.Z. Fu, M.H. Wang and Y.S. Ho, "Mapping of drinking water research: A bibliometric analysis of research output during 1992-2011", *Science of the Total Environment*, Vol. 443, pp. 757-765, 2013.

[9]. S.H. Zyoud, A.E. Al-Rawajfeh, H.Q. Shaheen and D. Fuchs-Hanusch, "Benchmarking the scientific output of industrial wastewater research in Arab world by utilizing bibliometric techniques", *Environmental Science and Pollution Research*, Vol. 23(10), pp. 10288-10300, 2016.

[10]. J. Hu, Y. Ma, L. Zhang, F. Gan and Y.S. Ho, "A historical review and bibliometric analysis of research on lead in drinking water field from 1991 to 2007", *Science of the Total Environment*, Vol. 408 (7), pp. 1738-1744, 2010.

[11]. M. Wang, T.C. Yu and Y.S. Ho, "A bibliometric analysis of the performance of water research", *Scientometrics*, Vol. 84 (3), pp. 813–820, 2010.

[12]. H. Chen, W. Jiang, Y. Yang and X. Man, "State of the art on food waste research: a bibliometrics study from 1997 to 2014", *Journal of Cleaner Production*, Vol. 140, pp. 840-846, 2017.

[13]. H. Chen, W. Jiang, Y. Yang, X. Man, M.A. Tang, "A bibliometric analysis of waste management research during the period 1997–2014", *Scientometrics*, Vol. 105 (2), pp. 1005-1018, 2015.

[14]. S.H. Zyoud, S.W. Al-Jabi, W.M. Sweileh, A.F. Sawalha, R. Awang, "The Arab world's contribution to solid waste literature: A bibliometric analysis", *Journal of Occupational Medicine and Toxicology*, Vol. 10 (1),35, 2015.

[15]. L. Yang, Z. Chen, T. Liu, Z. Gong, Y. Yu, J. Wang "Global trends of solid waste research from 1997 to 2011 by using bibliometric analysis", *Scientometrics*, Vol. 96 (1), pp. 133–146, 2013.

[16]. H.Z. Fu, Y.S. Ho, Y.M. Sui and Z. Li, "A bibliometric analysis of solid waste research during the period 1993–2008", *Waste Management*, Vol. 30 (12), 2410-2417, 2010.

[17]. T.M. Cristino, A. Faria Neto and A.F.B. Costa, "Energy efficiency in buildings: analysis of scientific literature and identification of data analysis techniques from a bibliometric study", *Scientometrics*, Vol. 114 (3), pp. 1275-1326, 2018.

[18]. H. Du, N. Li, M.A. Brown, Y. Peng and Y. Shuai, "A bibliographic analysis of recent solar energy literatures: The expansion and evolution of a research field", *Renewable Energy*, Vol. 66, pp. 696-706, 2014.

[19]. H. Du, L. Wei, M.A. Brown, Y. Wang and Z. Shi, "A bibliometric analysis of recent energy efficiency literatures: An expanding and shifting focus", *Energy Efficiency*, Vol. 6 (1), pp. 177-190, 2013.

[20]. I. Sakata and H. Sasaki, "Bibliometric analysis of international collaboration in wind and solar energy. Journal of Sustainable Development of Energy", *Water and Environment Systems*, Vol. 1 (3), pp. 187-198, 2013.

[21]. A. Andrade, F.H. Dominski and D.R. Coimbra, "Scientific production on indoor air quality of

environments used for physical exercise and sports practice: Bibliometric analysis", *Journal of Environmental Management*, Vol. 196, pp. 188-200, 2017.

[22]. A.F. De Paulo and G.S. Porto, "Solar energy technologies and open innovation: A study based on bibliometric and social network analysis", *Energy Policy*, Vol. 108, pp. 228-238, 2017.

[23]. X. Jia, and X. Guo, "Bibliometric analysis of associations between ambient pollution and reproductive and developmental health", *Chinese journal of preventive medicine*, Vol. 48 (6), pp. 521-526, 2014.

[24]. P. Brimblecombe and C.M. Grossi, "The bibliometrics of atmospheric environment", *Atmospheric Environment*, Vol. 43 (1), pp. 9-12, 2009.

[25]. X. Wu, X. Chen, F.B. Zhan and S. Hong, "Global research trends in landslides during 1991–2014: a bibliometric analysis", *Landslides*, Vol. 12 (6), pp. 1215-1226, 2015.

[26]. Y. Zhuang, C. Du, L. Zhang, Y. Du and S. Li, "Research trends and hotspots in soil erosion from 1932 to 2013: a literature review", *Scientometrics*, Vol. 105 (2), pp. 743-758, 2015.

[27]. M. Wang, D. Liu, J. Jia, and X. Zhang, "Global trends in soil monitoring research from 1999–2013: a bibliometric analysis", *Acta Agriculturae Scandinavica Section B: Soil and Plant Science*, Vol. 65 (6), pp. 483-495, 2010.

[28]. B. Niu, S. Hong, J. Yuan, Z. Wang and X. Zhang, "Global trends in sediment-related research in earth science during 1992-2011: A bibliometric analysis", *Scientometrics*, Vol. 98 (1), pp. 511-529, 2014.

[29]. A.G.O.P. Barretto, J.S. Lino and G. Sparovek, "Bibliometrics in Brazilian research on accelerated soil erosion: Institutions, topics, space and chronology", *Revista Brasileira de Ciencia do Solo*, Vol. 33 (6), pp. 1845-1854, 2009.

[30]. M. Acosta, D. Coronado and A. Fernandez, "Exploring the quality of environmental technology in Europe: evidence from patent citations", *Scientometrics*, Vol. 80 (1), pp.133–54, 2009.

[31]. M.M.S. Karki, "Environmental science research in India: An analysis of publications", *Scientometrics*, Vol.18 (5-6), pp. 363-373, 1990.

[32]. K.B. Sovacool, "What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda", *Energy Research & Social Science*, Vol.1, pp. 1–29, 2014.

[33]. P. Upham, C. Oltra and À. Boso, "Towards a cross-paradigmatic framework of the social acceptance of energy systems", *Energy Research & Social Science*, Vol. 8, pp. 100–112, 2015.

[34]. J. Gaede and H.J. Rowlands, "Visualizing social acceptance research: A bibliometric review of the social acceptance literature for energy technology and fuels", *Energy Research & Social Science*, Vol. 40, pp. 142–158, 2018.

[35]. S. Martinez, D.M.M. Delgado, M.R Marin and S. Alvarez, "Science mapping on the Environmental Footprint: A scientometric analysis based review", *Ecological Indicators*, Vol. 106 (105543), pp. 1-11, 2019.

[36]. R. Jin, S. Gao, A. Cheshmehzangi and E Aboagye-Nimo, "A holistic review of off-site construction literature published between 2008 and 2018", *Journal of Cleaner Production*, Vol. 202, 1202–1219, 2018.

[37]. H.SH. Zyoud, D. Fuchs-Hanusch, H.S. Zyoud, A.E. Al-Rawajfeh and H.Q. Shaheen, "A bibliometric-based evaluation on environmental research in the Arab world", *International Journal of Environmental Science and Technology*, Vol. 14 (4), pp. 689–706, 2017.

[38]. SCImago Journal and Country Rank. "SCImago Research Group 2017. Available at: http://www.scimagojr.com [Accessed: 12 March 2018].

[39]. L. Egghe and R. Rousseau, "An informetric model for the Hirsch-index", *Scientometrics*, Vol. 69 (1), pp. 121-129, 2006.

[40]. Y. Zhang, K. Shi and X. Yao, "Research development, current hotspots, and future directions of water research based on MODIS images: a critical review with a bibliometric analysis", *Environmental Science and Pollution Research*, Vol. 24, pp. 15226–15239, 2017.

[41]. I. Blank, L. Rokach and S. Guy, "Leveraging metadata to recommend keywords for academic papers", *Journal of the Association for Information Science and Technology*, Vol. 67 (12), pp. 3073-3091, 2016.

[42]. J. Zhu and W. Hua, "Visualizing the knowledge domain of sustainable development research between 1987 and 2015: a bibliometric analysis", *Scientometrics*, Vol. 110, pp. 893–914, 2017.

[43]. G. Brundtland, "Report of the World Commission on Environment and Development: Our Common Future", Oxford Paper Report, 1987.