COMPREHENSIVE BIBLIOMETRIC STUDY OF JOURNAL OF ENVIRONMENTAL ENGINEERING AND LANDSCAPE MANAGEMENT FROM 2007 TO 2019

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Abstract. Since the world became industrialized, our environment has been changed, bringing different environmental issues. The world benefits from industrialization but suffers from diverse pollutions simultaneously. Therefore, we are motivated to investigate the environment and landscape management explorations by analyzing 403 papers published in the Journal of Environmental Engineering and Landscape Management (JEELM) from 2007 to 2019. As one of the scientific journals that investigate environment management, JEELM mainly focuses on the area of environmental changes caused by human activities. By analyzing the issues such as atmosphere, water, and soil pollution and their mitigation technologies, JEELM accepts the scientific outputs written in English. Based on the data retrieved from Web of Science, we provide an overview of the status quo and emerging trends of the researches published on JEELM. Diverse researches such as publication distribution, citation structure, co-citation analysis and key contributors on the aspects of countries, institutions, and authors are given to comprehensively analyze the current situation of JEELM's. Besides, the emerging trends and hot spots can be revealed by burst detection and timeline view. Therefore, this paper contributes to providing a general picture of the knowledge domain of JEELM' research which enables researchers, especially the beginners to learn about this journal's development.

Keywords: environmental engineering, landscape management, JEELM, bibliometrics, CiteSpace.

Introduction

Never in history was sustainability so significant for the development of the economy in different societies. With the increasing attention towards sustainability, environmental issues are gradually becoming one of the crucial elements for economic growth, leading more journals to discuss the effective methods for environmental management. Among these journals, Journal of Environmental Engineering and Landscape Management (JEELM) made some contributions to the research of environmental changes caused by human activities and the sustainability-related investigations. As a research journal, JEEML was produced by Vilnius Gediminas Technical University (VGTU). It was acknowledged by The Lithuanian Academy of Sciences and The International Academy of Ecological and Life Protection Sciences (IAELPS).

Besides, JEELM is also one of the associate members of the Public Information Department of the United Nations. Being published in 1995, Journal of Environmental Engineering was established instead of proceedings from the previous research Environmental Protection of Vilnius Technical University. Then 6 issues were published between 1995 and 1998. Since 1998, the Journal of Environment Engineering released its scientific articles in volumes. From 2003, this journal was renamed as Journal of Environmental Engineering and Landscape Management, receiving research articles in English and Lithuanian. With the aim of publishing the original investigations that focus on the environment, JEELM mainly pays attention to the changes brought by human activities and the research outputs related to sustainability. Specifically, there are many articles published by JEELM analyze the atmosphere and air pollution. Also, water and soil contaminations are in

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the scope of the journal's investigation. How to control and mitigate these pollutions by utilizing effective technologies is the main stream in JEELM as well. The articles such as short reports, observations, and reviews, reports on conferences and workshops are also in the consideration of publishing. As a result, it can be found that JEELM is an interdisciplinary and international journal, which covers diverse forms of research outputs.

In order to know the development, the current status and the emerging trends of the research articles published on JEELM, this paper provides a scientometric analysis to comprehensively investigate the knowledge domain of research published on this journal. According to Chen, Hu, Liu, and Tseng (2012), scientometrics belongs to the field of informatics which quantitatively investigates scientific articles to learn emerging trends and the knowledge structure of a certain research area. Therefore, in this paper, an effective bibliometric tool namely CiteSpace is selected as the main methods to analyze the publications of JEELM. As introduced by Chen (Chen, 2006, 2017; Chen et al., 2012), CiteSpace presents a synthesized network to demonstrate the intellectual structure of a knowledge domain on the basis of a time series of networks derived from annual publications. Different bibliometric studies are involved in CiteSpace such as co-citation analysis in terms of documents and authors, collaboration network and geospatial visualizations. Besides, there are also other bibliometric tools which are broadly utilized in various research areas such as VOSviewer (Van-Eck & Waltman, 2009; Stopar & Bartol, 2019), Bicomb (Lu, Li, & Arthur, 2014; Zhao et al., 2018; Yu, Xu, & Šaparauskas, 2019), and BibExcel (Qaiser, Ahmed, Sykora, Choudhary, & Simpson, 2017; Tian et al., 2018). The timeline and the burst detection analyses provided by CiteSpace could comprehensively illustrate the landmark articles and keywords in certain time periods. Therefore, hot spots and emerging trends of a research area can be revealed.

Since its establishment, CiteSpace has been widely applied in different fields. For instance, Morar and Agachi (2010) reviewed the development of heat integration and heat exchanger network synthesis (HENS) by utilizing CiteSpace. By investigating the relations between disciplines, authors and journals with the research area, the visualized network, and structure of HENS are presented in an easy understanding way. Niazi and Hussain (2011) focused on agent-based computing and analyzed the complex network in terms of the domain, detailed visualization-based of the bibliographic data by applying CiteSpace. In recent years, there has been an increasing number of researches using CiteSpace to comprehensively investigate diverse areas such as the computer and information ethics (Heersmink, Hoven, Eck, & Berg, 2011), the GIS research (Wei, Grubesic, & Bishop, 2015), the information literacy assessment (Pinto, 2015), and the aggregation operator research (Yu, 2015). Recently, based on the new and improved version, CiteSpace 5.0–5.4, which can be used to show the more visualizations and results, Cui and Zhang

(2018), Zhang and Li (2018), Ekanayake et al. (2019), and Zhong et al. (2019) respectively reviewed the research on circular economy, urban resilience and sustainability, value management, and the ontology research. Therefore, it can be seen that CiteSpace is an effective method to assist scholars in various field with their bibliometric studies.

Obviously, there are also some researches that analyze the bibliometric development of specific journals. Pinto, Barquin, Gonzalez, and Kauric (2009) presented an analysis of the social network by retrieving the data on the Journal of Documentation. Valenzuela, Merigo, Johnston, Nicolas, and Jaramillo (2017) revealed the contribution made by the Journal of Business & Industrial Marketing based on bibliometric methodologies. Recently, Francisco, Mercedes, and Bartolomé (2016), Yu, Xu, Pedrycz, and Wang (2017), Tang, Liao, and Su (2018), Xu, Yu, and Wang (2019), and Thijs and Glanzel (2018) overviewed the development trends of International Journal of Hospitality Management, Information Sciences, International Journal of Fuzzy Systems, International Journal of Machine Learning and Cybernetics, and Scientometrics from the perspective of bibliometrics, respectively. Besides, journals are classified based on their scope of research. The scientometric investigations about journals in certain areas are also how scholars explore the development trends in different disciplines. A ranking of 69 marketing journals based on a new Hirsch-type index was given by Touzani and Moussa (2010) to find out the relationship between the hg-ranking and rankings in previous citation-based investigations of market journals. In addition, Sebo et al. (2019) made an evaluation of the publication speed of manuscripts submitted to general medical journals. They revealed the relations between the publication speed and authors, papers and journal characteristics. These papers have received wide attention, and more comprehensive and insightful bibliometric analyses are presented to assist researchers with their investigations in diverse areas.

In order to present the comprehensive and insightful investigation about the papers published on JEELM, this paper introduces the focuses and editor list in Section 1. The publication and citation numbers and citation structure are analyzed in Section 2. The influential contributors in terms of papers, countries/regions and institutions, and the burst detections are given in Section 3 and Section 4, respectively. Section 5 focuses on the keyword network and timeline view analysis. Lastly, this paper ends up with some conclusions, which can be seen in the last section.

1. Scope and focuses of JEELM

In order to briefly learn the specific research streams of the publications in JEELM, the scope and focus of JEELM's investigation are listed in Table 1. It can be seen that the direction atmosphere and air pollution control and the pollution mitigation technologies rank at the first place, which is followed by the research of the pollution control and the pollution mitigation technologies in terms of

water and soil. It can be seen that the pollutions in terms of atmosphere, water and soil and the approaches that mitigate these contaminations are considered as the most significant. Also, nuclear hydro physics and radioactive pollution are included in the scope of JEELM's research. Specifically, water management, landscape protection, and the modeling environmental process are the methods proposed by researchers, aiming at improving the environment from different perspectives. Other considerations such as environmental ethics, law, and management are involved. Therefore, the JEELM is multidisciplinary.

Table 1. The scope of the JEELM publications

Rank	Scope
1	Atmosphere and air pollution control and pollution mitigation technologies
2	Water pollution control and pollution mitigation technologies
3	Soil pollution control and pollution mitigation technologies
4	Entrails of the earth and their protection
5	Waste management including zero-waste technologies
6	Environmental expertise
7	Control over physical and technological environmental impacts and reduction technologies
8	Nuclear hydro physics and radioactive pollution
9	Modeling environmental processes
10	Environmental monitoring
11	Landscape protection
12	Environmental ethics
13	Environmental law and management
14	Quality of indoor and outdoor environments

2. Publication and citation numbers and citation structure

2.1. Data collection and analysis

In this study, Web of Science (WOS) is chosen to be the data source as it is a platform that provides a huge number of detailed information about the articles published around the world, including the data from Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI) (Van-Leeuwen, 2006). Then, through searching the journal's name "Journal of Environmental Engineering and Landscape Management", we found 403 papers are published from 2007 to May 2019.

We select the bibliometric tool namely CiteSpace to analyze the data retrieved from WoS and present the knowledge domain of JEELM. CiteSpace is one of the most popular bibliometric methods to simplify and clarify co-citation networks of all the papers; hence they could reflect the structure and characteristics of the research field (Chen, 2006).
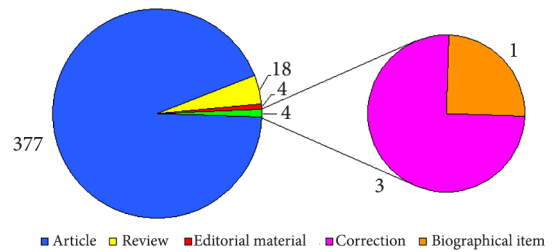

Figure 1. Types of the JEELM publications

On the basis of the analytic results given by WoS, we can get Figure 1 and find that the research outputs published on JEELM are classified into 5 types. Remarkably, the number of articles is far more than other types of publications. Specifically, 18 papers are considered as reviews, 4 papers are about editorial material, 3 papers are identified as the correction. Furthermore, there is only one biographical item. These also show that JEELM focuses on the academic article.

2.2. Annual publication distribution and citation structure of JEELM

There are 403 papers released on JEELM between 2007 and 2019 according to the searching results on WoS. Figures 2 and 3 present the information of the publication number and citation number of JEELM, respectively between 2007 and 2019. It can be seen from Figure 2 that there is a large number of papers published in 2007. However, it decreases sharply in 2008. After that, the publication amount of JEELM climbs between 2008 and 2010 year by year. Notably, it reaches a peak in 2010. Although the publication number experiences some fluctuations after 2010, it is still in a slightly declining trend. Figure 3 lists the citations received by JEELM between 2007 and 2019. It is noteworthy that the number of citations rises rapidly from 2007 to 2011. Compared with 2010, the number of citations in 2011 grows sharply. Therefore, it can be found that the papers published between 2007 and 2011 made great help to the study for the publications of JEELM in 2011. Based on Table 2, more influential papers were published between 2007 and 2011; therefore, the achievement in this period has a significant influence on the later research in the field. The number of citations falls in 2012.
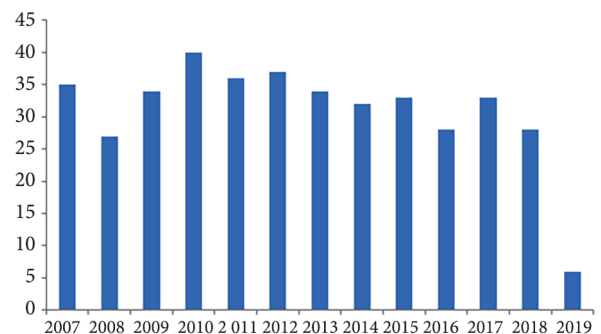

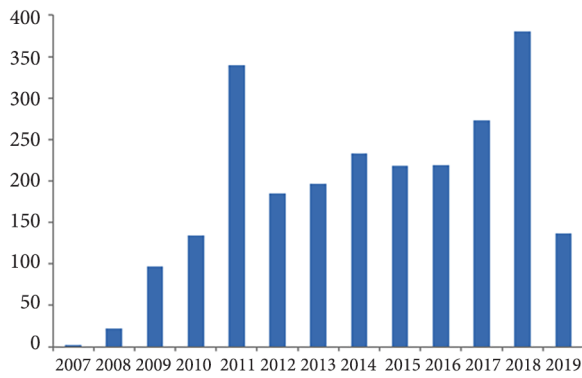Figure 2. Distributions of the JEELM publications by year (2007–2019)

Figure 3. Annual distributions JEELM´s citation number
(2007–2019)

Additionally, the number of citations rise rapidly again between 2016 and 2018, indicating that previous papers published in JEELM also impact on the development and study of the current research area. In addition, Table 2 is provided to explore more detailed information about JEELM publications. "TP" is the total publications, "TC" denotes the total citations until May of 2019 in each year, "AC" represents the average citations per paper, "≥50", "≥20", "≥10", "≥5" and "≥1" are different intervals which reflect the number of citations. As well as, H-index could accurately and successfully reflect academic achievements. Moreover, a higher H-index implies a greater achievement (Hirsch, 2005). We can see that the papers published between 2007 and 2010 have the most TC, AC, and maximum H-index. Hence, it is obvious that the JEELM publications in these years significantly impact on this journal. Based on the data collection from WoS, only two papers conform the standard of "≥50", in other words, this paper has been cited above 50 times. Moreover, these two articles are introduced and analyzed in the following section, namely the first and second papers in Table 3.

3. Influential contributors in terms of papers, countries/regions, and institutions

Table 3 lists the top 30 most cited papers in JEELM from 2007 to May 2019. Obviously, the paper "Sustainable construction taking into account the building impact on the environment" (Medineckienė, Turskis, & Zavadskas, 2010) was frequently cited 67 times. This paper depicted the impact of construction on the environment and the people's health. Based on it, the authors provide an optimal approach of building construction, which could meet the environmental control standards. The paper "Phytoremediation for heavy metal-contaminated soils combined with bioenergy production" (Ginneken et al., 2007) was cited more than 60 times. As a result, it is a vital reference to the later papers. It describes the application of phytoremediation to clean soil polluted by heavy metals. By adding biodegradable physicochemical agents to plant, more heavy metals can be cleaned.

Additionally, the authors also researched and compared different energy-recovery-techniques that could make harvested biomass crops convert into bioenergy. The third-ranked journal is "An approach to the multi-attribute assessment of indoor environment before and after the refurbishment of dwellings" (Zavadskas, Kaklauskas, Turskis, & Kalibatas, 2009). It analyzed the relationship between indoor environmental status and residents' need and the Lithuanian Hygienic Norm, the researchers offered access for multi-attribute assessment of residences before and after refurbishment and/or renovation.

In these 30 papers, we can find that there is no paper published in recent years, thus the papers published in recent years still need time to catch up. Generally, the top 30 most cited papers all promoted the development of the journal and the related fields.

Table 2. JEELM publication characteristics between 2007 and 2019

Year	TP	TC	AC	H-index	≥50	≥20	≥10	≥5	≥1
2007	35	372	10.63	11	1	5	14	22	34
2008	27	286	10.59	11	0	4	12	21	25
2009	34	356	10.47	12	0	5	17	22	33
2010	40	423	10.58	12	1	7	14	25	35
2011	36	165	4.58	7	0	1	5	16	31
2012	37	212	5.73	8	0	2	7	15	33
2013	34	140	4.12	6	0	1	4	10	31
2014	32	127	3.97	7	0	0	2	12	26
2015	33	105	3.18	6	0	0	1	8	27
2016	28	92	3.29	5	0	0	2	6	23
2017	33	155	4.70	7	0	1	6	8	26
2018	28	4	0.14	1	0	0	0	0	4
2019	6	0	0	0	0	0	0	0	0
Total	403	2437	–	–	2	26	84	165	328
Percentage	–	–	–	–	0.49%	6.45%	20.84%	40.94%	81.39%

Table 3. Top 30 most cited papers in JEELM between 2007 and 2019

| Rank	Title	Author(s)	TC	Year	AC
1	Sustainable construction taking into account the building impact on the environment	Medineckienė et al.	67	2010	6.7
2	Phytoremediation for heavy metal-contaminated soils combined with bioenergy production	Ginneken et al.	66	2007	5.08
3	An approach to multi-attribute assessment of indoor environment before and after refurbishment of dwellings	Zavadskas et al.	41	2009	3.73
4	Intuitionistic fuzzy EDAS method: An application to solid waste disposal site selection	Kahraman et al.	34	2017	11.33
5	Spatial distribution of heavy metals released from ashes after a wildfire	Pereira and Úbeda	34	2010	3.4
6	Application of numerical models to evaluate oil spills propagation in the coastal environment of the black sea	Rusu	32	2010	3.2
7	Fuzzy multiple criteria assessment of construction site alternatives for non-hazardous waste incineration plant in Vilnius city, applying ARAS-F and AHP methods	Turskis et al.	31	2012	3.88
8	Removal of nitrates and ammonium ions from water using natural sorbent zeolite (clinoptilolite)	Mažeikienė et al.	31	2008	2.58
9	Environmental evaluation of waste management scenarios-significance of the boundaries	Ghinea et al.	30	2012	3.75
10	Investigation into the air treatment efficiency of biofilters of different structures	Baltrėnas and Zagorskis	30	2010	3
11	Search for optimal solution of public building renovation in terms of life cycle	Užšilaitytė and Martinaitis	29	2010	2.9
12	Assessment of primary factors causing positive or negative local perceptions on protected areas	Alkan et al.	26	2009	2.36
13	Ultraviolet radiation albedo of natural surfaces	Chadyšiene and Girgždys	26	2008	2.17
14	Investigation into emissions of gaseous pollutants during sewage sludge composting with wood waste	Zigmontienė and Zuokaitė	25	2010	2.5
15	Comparing environmental impacts of natural inert and recycled construction and demolition waste processing using LCA	Simion et al.	23	2013	3.29
16	Modelling of motor transport exhaust gas influence on the atmosphere	Baltrėnas et al.	23	2008	1.92
17	Mathematical simulation of solid particle dispersion in the air of Vilnius city	Baltrėnas et al.	23	2008	1.92
18	Anthropogenic effects on heavy metals and macronutrients accumulation in soil and wood of Pinus sylvestris L	Pundytė et al.	22	2011	2.44
19	Investigation of volatile organic compound (VOC) emission in oil terminal storage tank parks	Paulauskienė et al.	22	2009	2
20	Investigation of cleaning efficiency of a biofilter with an aeration chamber	Baltrėnas and Zagorskis	22	2009	2
21	Analysis of numerical modelling of turbulence in a conical reverse-flow cyclone	Vaitiekūnas and Jakštonienė	21	2010	2.1
22	Investigation of seaport air dustiness and dust spread	Baltrėnas et al.	21	2007	1.62
23	Effect of sewage sludge fertilization in short-rotation willow plantations	Lazdiņa et al.	21	2007	1.62
24	Hazard profile in manufacturing: determination of risk levels towards enhancing the workplace safety	Reinhold and Tint	20	2009	1.82
25	Modelling of Cu, Ni, Zn, Mn and Pb transport from soil to seedlings of coniferous and leafy trees	Baltrėnaitė and Butkus	20	2007	1.54
26	Application of agronomic practice improves phytoextraction on a multipolluted site	Claus et al.	20	2007	1.54
27	Lignin from steam-exploded wood as binder in wood composites	Grāvītis et al.	19	2010	1.9
28	Research on anaerobically treated organic waste suitability for soil fertilisation	Kvasauskas and Baltrėnas	19	2009	1.73
29	Modeling of motor transport exhaust pollutant dispersion	Vaitiekūnas and Banaitytė	19	2007	1.46
30	Efficiency evaluation of a noise barrier	Baltrėnas et al.	19	2007	1.46
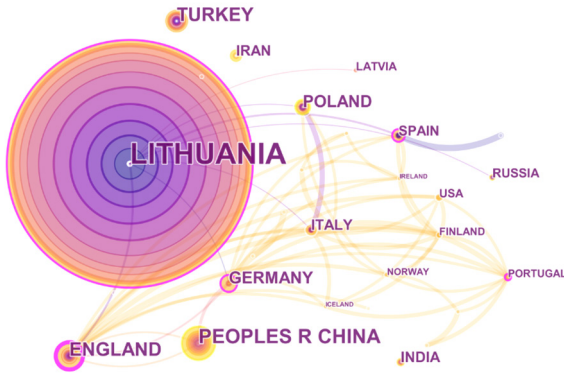
Figure 4. A visualization of the country collaboration network

Figure 4 illustrates the country collaboration network JEELM's publications. Combining with the analytic results in Table 4, the node size in Figure 4 represents the number of publications in each country. If the node size is bigger, the corresponding country has more publications. Furthermore, the density of the links of a country indicates the degree of geographic collaboration. If the lines connecting the corresponding node are denser, it means that the country has more collaboration with other countries. Similarly, the thinness of the links connecting the corresponding node implies a low level of international cooperation. From Figure 4, we can find that England,

Germany, Italy, and Portugal have more lines. Therefore, they have more collaboration with other countries. The top 10 most influential countries of the JEELM publications are listed in Table 4. Lithuania has the most TP, TC and highest H-index.

In addition, it can be clearly seen that 10 papers of JEELM from Lithuania have more than 25 citations, 18 papers have more than 20 citations, and 26 papers have more than 15 citations, which are far more than other countries. Therefore, Lithuania is a big contributor to this journal. It should be noted that although Italy has only 12 publications on JEELM, it has the highest AC with 7.38 which means these papers significantly impact JEELM and the related research field. Among the above articles, we can find that the most cited paper entitled "Comparing environmental impacts of natural inert and recycled construction and demolition waste processing using LCA" (Simion, Fortuna, Bonoli, & Gavrilescu, 2013) is aiming to quantify the environmental impacts of construction and demolition wastes recycling or reuse, and the authors concluded that the environmental impacts of construction and demolition wastes recycling or reuse account for about 40% of the impacts of natural inert processing. Notably, we find that all the 10 countries are from Europe or Asia.

Figure 5 shows a visualized collaboration network in terms of institutions. Similarly, we can see that Vilnius Gediminas Technical University, Martin Luther University, California State University-Stanislaus, Cranfield

Table 4. The top 10 most influential countries of the JEELM publications

| Rank	Country	Continent	TP	TC	AC	H-index	≥25	≥20	≥15	≥10	≥5	≥1
1	Lithuania	Europe	201	1468	7.3	19	10	18	26	53	98	183
2	China	Asia	33	74	2.24	5	0	0	0	1	5	23
3	England	Europe	25	149	5.96	8	0	0	1	6	12	23
4	Turkey	Asia	25	160	6.4	7	2	2	2	4	13	23
5	Poland	Europe	22	89	4.05	6	0	0	0	4	7	15
6	Germany	Europe	18	141	7.83	8	0	1	3	7	10	16
7	Iran	Asia	18	63	3.5	3	1	1	1	3	3	10
8	India	Asia	14	79	5.64	5	0	0	2	3	6	11
9	Italy	Europe	13	96	7.38	7	0	1	2	3	7	12
10	Latvia	Europe	12	66	5.5	4	0	1	2	2	3	8
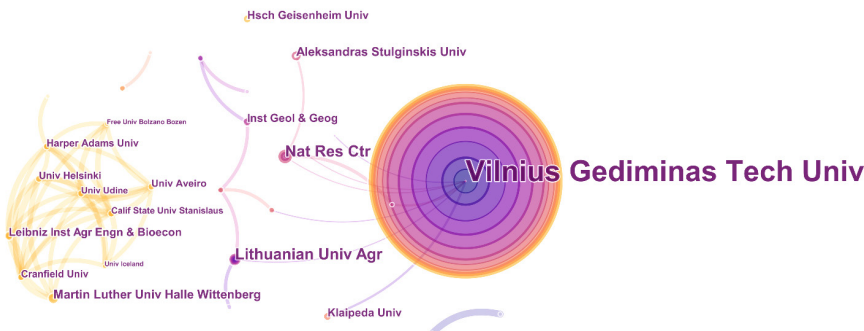
Figure 5. A visualization of the institution collaboration network

University, University of Udine, University of Helsinki and Harper Adams University have more relations and collaboration with other institutions.

Furthermore, Table 5 is presented to demonstrate more details of the institutions that significantly impact JEELM. As the most prolific institutions, Vilnius Gediminas Technical University has the highest TP, TC and the highest H-index which are obviously more than the second-ranked institution, Aleksandras Stulginskis University. Although TP of Nature Research Centre Lithuania is ranked in the third place, its AC is relatively less than others. Besides, Gheorghe Asachi Technical University of Iasi has higher AC than which of Aleksandras Stulginskis University. Therefore, the publications of the Gheorghe Asachi Technical University of Iasi have an important effect on the later research. Its most cited paper "Environmental evaluation of waste management scenarios – significance of
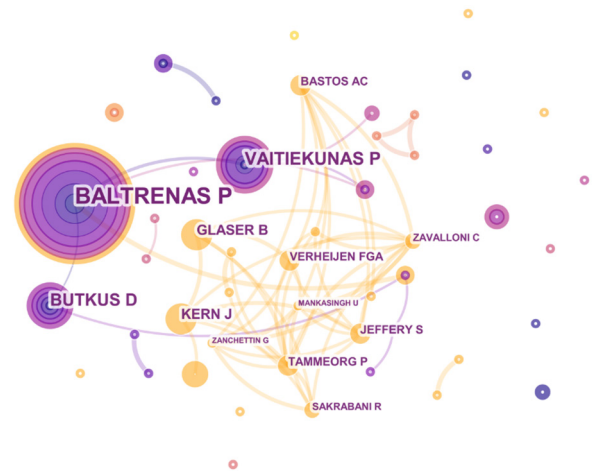

Figure 6. A visualization of the author collaboration network

Table 5. The top 13 most influential institutions of the JEELM publications

Rank	Institution	TP	TC	AC	H-index	≥40	≥20	≥15	≥10	≥5	≥1
1	Vilnius Gediminas Technical University	129	1187	9.2	19	2	18	25	46	70	122
2	Aleksandras Stulginskis University	20	96	4.8	6	0	0	1	3	10	19
3	Nature Research Centre Lithuania	18	53	2.94	5	0	0	0	2	5	13
4	Vilnius University	15	54	3.6	5	0	0	0	1	5	13
5	Klaipėda University	9	62	6.89	4	0	1	1	3	4	7
6	Lithuanian Research Centre for Agriculture and Forestry	9	26	2.89	3	0	0	0	0	3	9
7	Vytautas Magnus University	9	46	5.11	5	0	0	0	1	5	8
8	Institute of Geology and Geography	7	26	3.71	3	0	0	0	1	2	6
9	University of Wolverhampton	7	24	3.43	3	0	0	0	1	2	5
10	Gheorghe Asachi Technical University of Iasi	6	75	12.5	5	0	2	2	2	5	5
11	Kaunas University of Technology	6	34	5.67	4	0	0	1	1	2	6
12	Martin Luther University Halle-Wittenberg	6	46	7.67	3	0	0	1	3	3	5
13	Moscow State University of Mechanical Engineering	6	16	2.67	2	0	0	0	0	1	5

Table 6. The top 12 most influential authors of the JEELM publications

Rank	TP	TC	AC	H-index	Author	Percentage
1	26	299	11.5	12	Baltrėnas, P.	6.45%
2	15	179	11.93	9	Vaitiekūnas, P.	3.72%
3	12	98	8.17	7	Butkus, D.	2.98%
4	10	85	8.5	6	Baltrėnaitė, E.	2.48%
5	8	33	4.13	4	Booth, C. A.	1.99%
6	7	57	8.14	5	Vasarevičius, S.	1.74%
7	7	45	6.43	3	Paliulis, D.	1.74%
8	7	44	6.29	4	Girgždys, A.	1.74%
9	6	176	29.33	4	Zavadskas, E. K.	1.49%
10	6	49	8.17	3	Kern, J.	1.49%
11	6	46	7.67	3	Glaser, B.	1.49%
12	6	38	6.33	4	Girgždienė, R.	1.49%
Total	116	1149	–	–	–	28.78%

the boundaries" (Ghinea, Petraru, Bressers, & Gavrilescu, 2012) focuses on stressing in the optimal waste management alternative, system boundaries which are important for the life cycle impact assessment process.

The main author collaboration network of JEELM research is shown in Figure 6. We notice that Zavallonic, Jeffery, Baston, Mankasingh, Zanchettin, Tammeorg and Verheijen connect closely with other authors. In order to make a further investigation of the authors who contribute more to JEELM, a visualization of the author co-citation network is shown in Figure 7. We can reveal that Baltrėnas and Butkus are both cited most by other authors. Table 6 lists the top 12 most influential authors in JEELM. From Table 6, we know that Baltrėnas, as the editor-in-chief, has the highest TP, TC, and the highest H-index. Zavadskas has only published 6 papers. However, he has the most AC with 29.33 which are more than twice that of the second-ranked author. Compared with Table 3, there are 5 articles written by Zavadskas who is the first author or co-author. Thus, his publications on JEELM are greatly influential to the later authors.
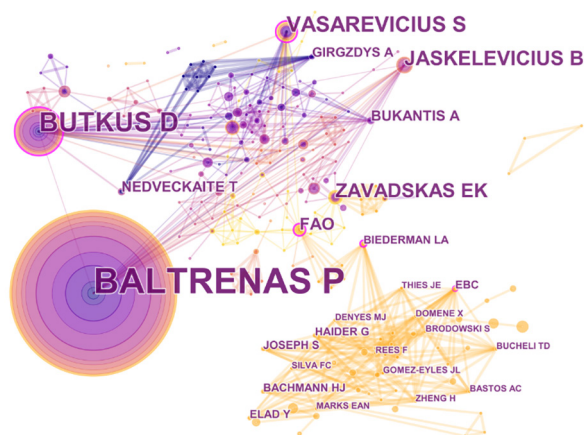

Figure 7. A visualization of the author co-citation network

4. Burst detection analyses of the cited authors and the cited journals

Citation burst detection reflects the explosive data that attracted attention by the academic in a certain period of time (Kleinberg, 2002). Table 7 lists the 11 frequently cited authors with the strongest citation bursts. We can derive the author who owns the longest citation burst duration is Baltrėnas, the duration is 5 years from 2008 to 2012. Moreover, the citation burst of Jaskelevičius is the closest to the present.

The top 25 cited journals with the strongest citation bursts are presented in Table 8. Here, the cited journals are the ones receive frequent citations by JEELM in a certain time period. The citation bursts of the cited journals of Journal of Environmental Radioactivity and Chemical Engineering Journal have the longest duration with 6 years. Journal of Environmental Radioactivity focuses on any aspect of the occurrence radioactivity in natural systems, and its impact factor is 2.263. Chemical Engineering Journal mainly pays attention to three parts of chemical engineering about chemical reaction engineering, environmental chemical engineering, and materials synthesis and processing. The journal aims to introduce discussions on new developments in chemical engineering, interpretative reviews, and original fundamental research. Among the cited journals with the strongest citation bursts, Atmospheric Environment, Aplinkos Inzinerija, Environmental Engineering and Journal of Environmental Radioactivity started in 2007, it is the earliest. The durations of cited journals with the strongest citation bursts of Chemical Engineering Journal, Environment Impact Assessment, Thesis, and Environmental Earth Sciences are up to now, which illustrate these journals still have an impact on JEELM and might even determine this journal's future research directions.

References with the strongest citation bursts are shown in Table 9. The reference of the earliest citation burst is "Investigation on the impact of transport exhaust emissions on the air" (Baltrėnas, Vaitiekūnas, & Mincevič, 2004).

Table 7. Top 11 cited authors with the strongest citation bursts

Cited Authors	Year	Strength	Begin	End	2007–2019
Baltrėnas, P.	2007	14.3957	2008	2012	
Butkus, D.	2007	4.4122	2008	2012	
Oškinis, V.	2007	2.8489	2008	2010	
Jankauskaitė, M.	2007	3.016	2009	2010	
Jankaitė, A.	2007	2.8171	2009	2011	
Laškova, T.	2007	2.9438	2009	2011	
Baltrėnaitė, E.	2007	3.032	2010	2012	
Kvasauskas, M.	2007	2.9217	2010	2013	
Stravinskienė, V.	2007	3.0484	2010	2011	
Jaskelevičius, B.	2007	4.3012	2011	2015	
Alkan, H.	2007	2.7704	2012	2013	

This paper points out that the intensity of motor transport traffic could directly influent the concentrations of CO and aerosol particles. The reference "Investigation into the air treatment efficiency of biofilters of different structures" (Baltrėnas & Zagorskis, 2010) has the longest citation burst duration with 4 years. Baltrėnas and Zagorskis (2010) studied the dependences of the treatment efficiency of biofilters with different structures, concentration, and the

Table 8. Top 25 cited journals with the strongest citation bursts

Cited Journals	Year	Strength	Begin	End	2007–2019
Atmospheric Environment	2007	5.6882	2007	2009	
Aplinkos Inzinerija	2007	10.0576	2007	2010	
Environmental Engineering	2007	5.5297	2007	2011	
Journal of Environmental Radioactivity	2007	3.7635	2007	2012	
Applied Geochemistry	2007	2.7869	2008	2011	
Journal of Bioscience and Bioengineering	2007	3.2058	2008	2010	
Energetika	2007	3.4439	2008	2012	
Journal of Environmental Engineering and Landscape Management	2007	18.1356	2008	2012	
Ekologiya	2007	6.6876	2008	2012	
Aplinkos Tyrimai Inžinerija Ir Vadyba	2007	3.4439	2008	2012	
Ecology	2007	3.2766	2008	2011	
Geografijos Metraštis	2007	3.2058	2008	2010	
Forest Ecology and Management	2007	3.7007	2009	2011	
7th International Conference Environmental Engineering	2007	2.7087	2010	2011	
Geologija	2007	4.6019	2010	2012	
Construction and Building Materials	2007	2.7728	2013	2015	
Journal of Environmental Engineering-Asce	2007	2.9719	2013	2015	
Journal of Hazardous Materials	2007	2.7259	2014	2016	
Environmental Engineering and Management Journal	2007	2.8845	2014	2016	
Process Biochemistry	2007	3.7446	2014	2016	
Chemical Engineering Journal	2007	3.0421	2014	2019	
Environment Impact Assessment	2007	2.8013	2015	2019	
Thesis	2007	5.6552	2015	2019	
Environmental Earth Sciences	2007	3.9306	2015	2019	
Journal of Environmental Management	2007	3.6958	2015	2017	

Table 9. Top 7 references with the strongest citation bursts

References	Year	Strength	Begin	End	2007–2019
Investigation on the impact of transport exhaust emissions on the air	2004	3.3204	2007	2008	
Mathematical simulation of solid particle dispersion in the air of Vilnius city	2008	3.5428	2009	2011	
Investigation of seaport air dustiness and dust spread	2007	3.5964	2010	2011	
Research on anaerobically treated organic waste suitability for soil fertilisation	2009	2.913	2011	2013	
Experimental investigation of biogas production using fatty waste	2008	2.913	2011	2013	
Investigation into the air treatment efficiency of biofilters of different structures	2010	2.7818	2011	2014	
Investigation of influence of lapse landfill leachate on ground and surface water pollution with heavy metals	2009	2.913	2011	2013	

filtration rate of the pollutant. Remarkably, the reference "Investigation of seaport air dustiness and dust spread" (Baltrėnas, Fröhner, & Pranskevičius, 2007) has the shortest duration, nevertheless, its strength is the strongest, which means that the reference is frequently cited from 2010 to 2011, and greatly assists the research for the two years. The paper investigates the causes of dust generation

Figure 8. A visualization of the keyword network

Figure 9. Cluster network of keyword research of JEELM

and analyzed the main factors affecting dust concentration.

5. Keyword network and timeline view analysis

In order to directly clarify the current hot topics in the field of JE, the keyword analysis is essential. Figure 8 illustrates a visualization of the keyword network. We can easily find these keywords of most occurrences from it. The keywords of "heavy metal", "soil", "plant", "nitrogen", "water", and "impact", which occur frequently, belong to the field of engineering. Figure 9 lists the cluster network of keyword research of JEELM. It could help us know more about the hot topics. As can be seen from Figure 9, all the keywords are divided into 10 clusters. The biggest cluster is "waste management scenario"; hence waste management is a key and hot issue in the field of environment management. The second largest cluster is "air treatment efficiency", thus it can be seen that the issue of air is also vital to environmental management research. The third largest cluster is "vegetation species". It indicates that the research of vegetation species is a key to the development of the journal and the field. The timeline view of keywords shows the main keywords of JEELM's research at different time periods, leading us to know more about the trend of the hot topic in the corresponding field. Figure 10 is the timeline view of keywords for the JEELM publications since 2007. It could be found that the journal focuses more on the keywords of "heavy metal", "soil", "removal", "nitrogen management", "plant", "performance", "environment", "degradation" between 2007 and 2010. The keywords of "area", "water", "impact", "water pollution", "remediation" occurred most between 2010 and 2013. From 2013 to 2016, the journal pays more attention to "vegetation", "sorption", "quality". The main keywords between 2016 and 2019 are "biochar", "restoration", "aqueous solution". We can see that keywords continually change
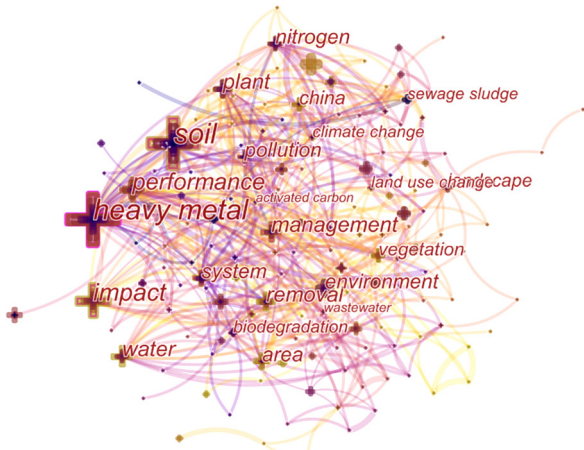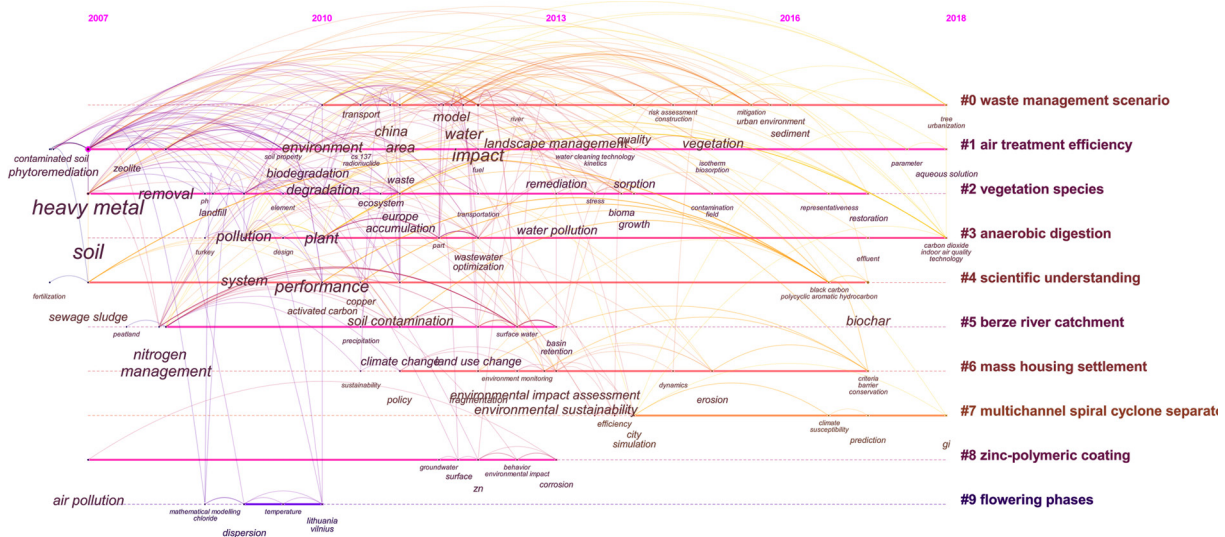

Figure 10. The timeline view of keywords for the JEELM publications

over time, and people begin to care more about how to restore ecology instead of investigating and studying the detailed information of pollution sources before.

Conclusions

In this paper, we have made a comprehensive overview and clearly visualized analysis of JEELM. We have analyzed the current status and development trends of JEELM's research. There are 403 publications retrieved from WoS between 2007 and May 2019. Through analyzing the results given by CiteSpace, our findings are concluded as follows: The number of publications reached the peak in 2010. Besides, the article entitled "Sustainable construction taking into account the buildingimpact on the environment" (Medineckienė et al., 2010) is the most influential paper with 67 citations. Lithuania is the most influential country. As the publishing institution, there is no doubt that Vilnius Gediminas Technical University is the most influential institution. As the Editor-in-Chief, Baltrėnas is the most influential author.

The citation bursts of the cited journals of Journal of Environmental Radioactivity and Chemical Engineering Journal have the longest citation burst duration with 6 years. The citation burst of the paper "Investigation into the air treatment efficiency of biofilters of different structures" has the longest citation burst duration with 4 years. As for the analysis of keywords, the keywords "heavy metal", "soil", "plant", "nitrogen", "water", and "impact" occur in JEELM frequently. In the cluster network of keyword research of JEELM, the biggest cluster is "waste management scenario". Moreover, from the timeline view of keywords, we have derived that people begin to care more about how to restore ecology instead of investigating and studying the detailed information of pollution sources before.

By providing the knowledge domain of JEELM, the current status and the future trends of development of the JEELM publications can be comprehensively learned which helps more researchers to know this journal and its research scope. Finally, we hope that more useful and comprehensive information, methods, factors, directions can be found in further investigations.

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