www.ees.uni.opole.pl
ISSN paper version 1642-2597
ISSN electronic version 2081-8319
Economic and Environmental Studies
Vol. 17, No. 4 (44/2017), 1035-1050, December 2017

Sustainable Development Issues in Scientific Publications

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Abstract: The objective of the article is to present the results of bibliometric analysis of the scientific studies concerning the issue of sustainable development (SD). The analysis allowed identifying the main territories in the context of the above issues. For the purposes of the analysis was used bibliometric examination of the data available in the Web of Science database, the investigation of trends, in terms of number of publications, the method of co-occurrence of words, cluster exploration and also mind mapping method. In the analysis was used software VOSviewer. The analysis lets us extending the area of research relating to the issue of sustainable development to the following four sub-areas: (1) education for sustainable development, (2) resource efficiency, (3) technological solutions geared towards sustainable development and (4) regional scale sustainable development.

Keywords: sustainable development, education, resource, technology, region

JEL codes: Q01, Q25 Q55, Q56, R11

https://doi.org/10.25167/ees.2017.44.25

1. Introduction

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987: 54)". Sustainable development (SD) is a term that is spoken in different contexts when discussing, for example, the management of natural resources, biodiversity, human rights and business development. The idea of sustainable development is to find a balance between economic growth and benefit sharing, social development and the state of the environment, other words finding a balance between economic, social, and environmental dimensions (United Nations, 2015: 1).

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Nonetheless, Holden, Linnerud and Banister suggest a model for sustainable development based on three moral imperatives: satisfying human needs, ensuring social equity, and respecting environmental limits (Holden et al., 2017: 213).

In international, national and local documents can be find references to sustainable development. One of the most important documents for sustainable development is currently the Sustainable Development Goals (SDGs), officially known as Transforming our World: the 2030 Agenda for Sustainable Development (United Nations, 2015). On September 25th, 2015, countries adopted a set of goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda. The General Assembly, the main deliberative, the policymaking and the representative body of the United Nations resolved to meet the goals by 2030. There are a set of 17 Global Goals with 169 targets between them which make up the SDGs.

Taking the above into account, sustainable development is debated all over the world and is met with great interest by scientists representing various scientific disciplines. As noted, the category of sustainable development is interdisciplinary and cannot be a stand-alone object of research in a single discipline (Famielec, Famielec, 2016: 48).

The basic stage of the process of acquiring scientific knowledge from a given area is bibliometric analysis. It is the basis for reliable, in-depth scientific research and the starting point for research projects. The aim of the paper is to present the results of bibliometric analysis of scientific research on sustainable development. This study identifies the main areas of interest of the researcher. This analysis uses the data available in the Web of Science (available at http://webofknowledge.com), analyzed the number of publications, the co-occurrence of words that became the basis for clustering analysis and thought mapping. VOSviewer software (available at www.vosviewer.com) is used for this publication.

2. Methodology

The bibliometric analysis was used for the purpose of valuing the sustainability studies. Bibliometric methods are used to analyse literature and assess scientific status. In this case the Thomson Reuters Web of Science (WoS) database was used. The research applied searching

criteria to meet specific requirements. This study focuses on results of researches on texts published between 1995 till 2017[1].

The research was divided into the following stages: the Web of Science database searches based on defined criteria, export bibliographic descriptions, linkage mapping and clustering analysis, and performance analysis.

The Web of Science database was searched according to keyword method such as "sustainable development" in the titles and publications in the period from 1995 to the date of analysis, i.e. till 12.06.2017. This resulted in the separation of 10550 publications which were identified as complying with the aforementioned criteria. However, for comparative purpose, it is worthy to mention that Scopus has identified 12989 publications isolated by the same search standard applied. The further analysis is based on the Web of Science database only.

In the next step, data was exported including records, i.e. author, title, source, abstract text file. A one-time export data from the WoS database allows only for 500 bibliographic records. Considering that the database detected 10550 records, this step is repeated twenty-one times, generating twenty one text files.

The research was shared into two phases:

- the earlier stage of the study - basic bibliometric analysis,
- the later stage of the study - in-depth analysis with the identification of four sub-areas of research.

Using specialised software, the following maps were developed:

- a map of the strength of the relations between words,
- a map of the concentration of clusters.

Maps of links were made using software VOSviewer version 1.6.5[2], which is related with all twenty one text files imported and stored records from the WoS database. The process of creating maps takes into account the following in the right order:

[1] As 12.06.2017.

[2] The software VOSviewer (Visualising Scientific Landscapes) is the Open Source software used for the analysis of bibliometric network. The software allows you to work on text files containing descriptions of bibliographic records are exported from the Web of Science databases, SCOPUS and PubMed, and is available at www.vosviewer.com. The software was developed at the Centre for Science and Technology Studies - CWTS at Leiden University in the Netherlands. Technical details and possibilities of using VOSviewer to analyze text are presented in numerous publications designers of this software (van Eck et al., 2010: 523-538; van Eck et al., 2011: 50-54).

- extracting of concepts, indicating the concepts, for which the repeatability of bibliographic descriptions is at least 10; for the case identified 94416 concepts of which 2748 occurred at least 10 times; VOSviewer software uses the Binary Counting method;
- refine keyword analysis, for which the repeatability of bibliographic descriptions is at least 60; as a result it limited set of terms to 517;
- a 517 set of words to calculate the coefficient of appropriateness (relevance), from which will eventually emerge 310 terms, representing 60% of the most appropriate words;
- elimination of a set of concepts of technical terms, unrelated to the assets of the analysed research area, for example, teacher, expert, researcher, student, implication, actor, paper analyse, sample, interview, individual, lesson, topic, survey, programme, practice, science, focus, review, question, chapter, period, theory, history, method, approach, data, etc., which caused in a reduction of the examined words to 188;
- develop a map of links, the strength of the relationship among words and map of clusters of research parts.

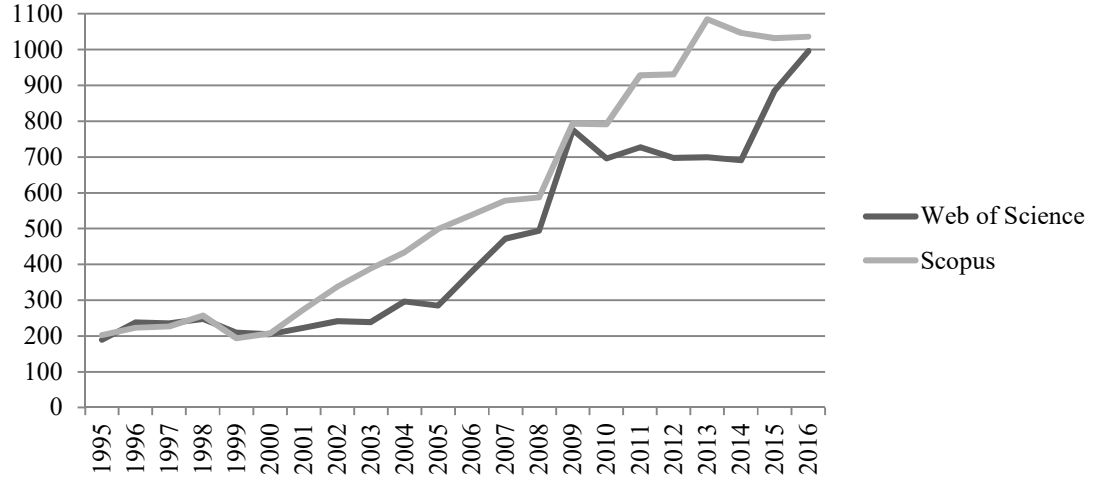
Analysis of the outcomes was done on the source of the map obtained. In the steps described above, bibliometric analysis methods used coexistence of words, mind mapping, and clustering analysis. Step by step, by introducing every major part of the study running, the analysis points out changes in the amount of publications about the occurrence being under investigation in a given period.

3. The research results – the earlier stage of the study

By examining the Web of Science database using the term "sustainable development" contained within titles it identified 10550 publications (in the period from 1995 to the date of analysis). Observing the changes in the quantity of publications over this period, it can be pointed out that there is a growing trend of this amount which indicates the development of interest in the discussed matters. Figure 1 shows the sum of publications related to sustainable development in a given year in the Web of Science and in the Scopus database between 1995 and 2016[3].

[3] The figure shows the data for the full years.

Figure 1. The number of publications related to sustainable development in a given year in the Web of Science and the Scopus database in the years 1995-2016



Source: Author's own elaboration.

As can be noticed from above Figure 1, in 2016 is the largest increase publications on sustainable development issues, which in total represents almost 9.8% of all publications on the subject in the period 1995-2016. The leading periodical on this subject is Sustainable Development, followed closely by Advanced Materials Research and Problems of Sustainable Development[4]. Table 1 contains the list of scientific sources representing 11.78% of main number of publications on corporate social responsibility reporting among this period.

Table 1. List of scientific sources with the prime number of publications on corporate social responsibility reporting in the Web of Science database in the years 1995 to 2017 (the date of the search 12.06.2017)

Source Titles	Record Count	% of 10550
Sustainable Development	182	1.725
Advanced Materials Research	158	1.498
Problems of Sustainable Development	138	1.308
Journal Of Cleaner Production	132	1.251
Sustainability	122	1.156
International Journal of Sustainable Development and World Ecology	118	1.118
Natural Resources Forum	115	1.109
Applied Mechanics and Materials	106	1.005
Ecological Economics	86	0.815
Procedia Social and Behavioral Sciences	84	0.796

Source: Author's own elaboration based on: https://webofknowledge.com. Accessed 16 June 2017.

[4] The original title in Polish: Problemy Ekorozwoju.

A study of the publications placed in a geographical system exposed that the authors writing a report of corporate social responsibility are mostly from China, USA and England. Table 2 shows a geographical sharing of the authors in the WoS database. In summarising the data in this table, these 10 countries represent 63.63% of the total number of publications found in the database.

Table 2. The geographical spread of the authors (in the set of countries) who frequently issue in the Web of Science database in the years 1995 to 2017 (the date of the search 12.06.2017)

Countries/Territories	Record Count	% of 10550
China	1977	18.739
USA	1245	11.801
England	904	8.569
Canada	445	4.218
Romania	414	3.924
Australia	401	3.801
Germany	391	3.706
Netherlands	323	3.062
France	316	2.995
Poland	297	2.815

Source: Author's own elaboration based on: https://webofknowledge.com. Accessed 16 June 2017.

4. The research results – the later stage of the study

The later phase of the study presents the map of the intensity of relations among words (Figure 2) and the map of clusters of research fields (Figure. 3).

The analysis was lead to spreading the area of research relating to the matter of sustainable development to the following four sub-areas: (1) education for sustainable development, (2) resource efficiency, (3) technological solutions headed for sustainable development and (4) local scale sustainable development.

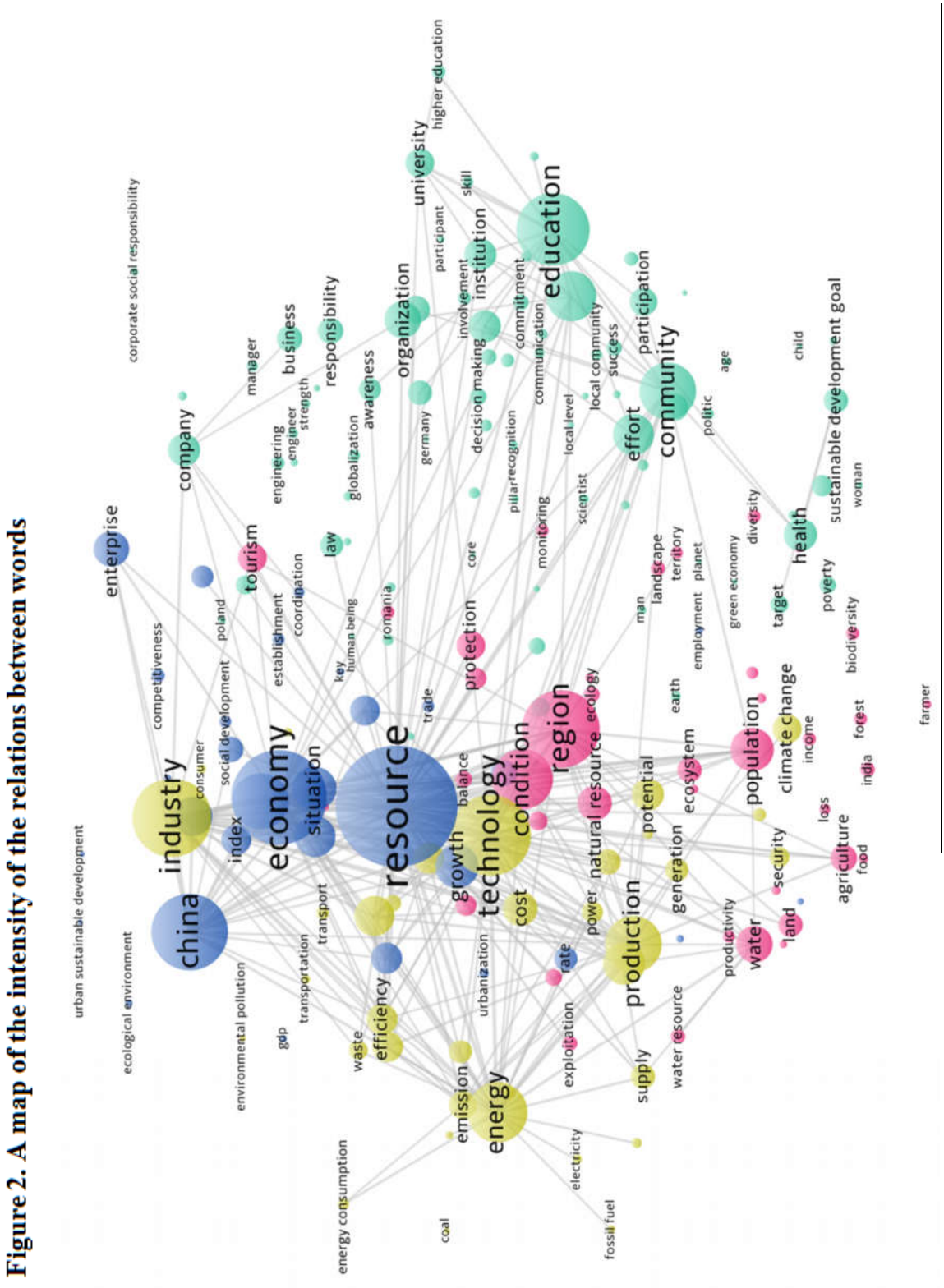
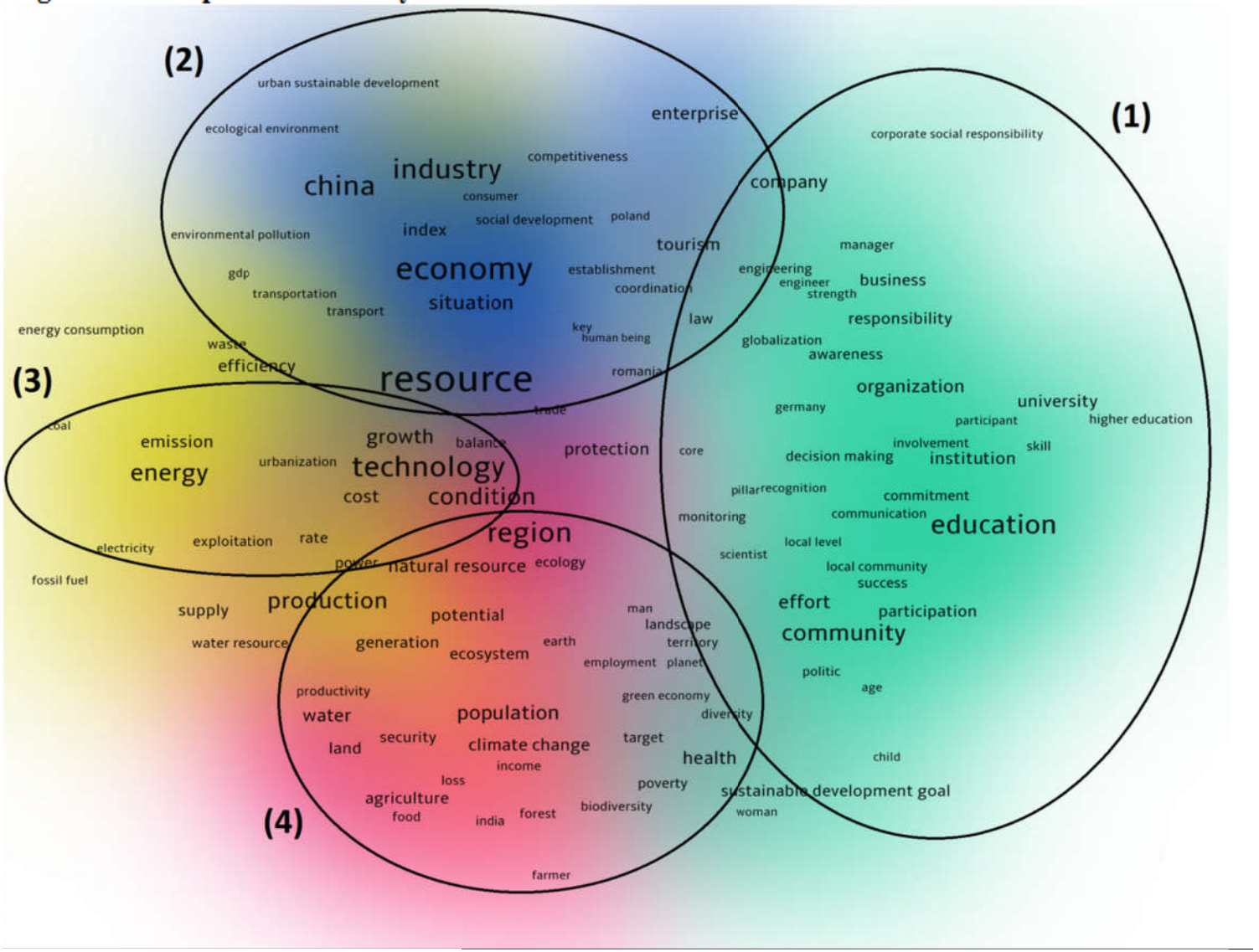


Figure 2. A map of the intensity of the relations between words

Source: Author's own elaboration.

Figure 3. A map of the intensity of clusters



Source: Author's own elaboration.

The further part of this publication performs a qualitative bibliometric analysis. It is an important element in the analysis of scientific publications, as it is the basis for further research. Table 3 lists the articles with the highest times cited in each sub-area.

Table 3. The highest times cited publications according to selected sub-areas (from Web of Science core collection)

Sub-area	Publication	Times cited
education for sustainable development ("education" in title)	Jickling, B.; Wals, A. E. J. (2008). Globalization and environmental education: looking beyond sustainable development. *Journal of Curriculum Studies* 40 (1): 1-21.	97
resource efficiency ("resource" in title)	Sophocleous, M. (2000). From safe yield to sustainable development of water resources - the Kansas experience. *Journal of Hydrology* 235 (1-2): 27-43.	169
technological solutions geared towards sustainable development ("technology*" in title)	Binswanger, M. (2001).Technological progress and sustainable development: what about the rebound effect? *Ecological Economics* 36 (1): 119-132.	222
regional scale sustainable development ("region*" in title)	While, A.; Jonas, A. E. G.; Gibbs, D. (2010). From sustainable development to carbon control: eco-state restructuring and the politics of urban and regional development. *Transactions of the Institute of British Geographers* 35 (1): 76-93.	108

Source: Author's own elaboration.

The most widely cited publication is Binswanger (2001) (last 180 days: 3; since 2013: 73). Nevertheless, While et al. (2010) publication is labelled Highly Cited Paper[5] in the WoS database, the cited number of this article is 108 (last 180 days: 12; since 2013: 85). Sophocleous (2000) is cited 169 times, and Jickling and Wals (2008) 97 times. Analysis of the content of major publications (the first ten with the highest number of citations in each area) draws attention to the most important issues raised by the authors of these publications.

The scientific publications related to the first isolated area are often abbreviated as ESD, precisely from the concept of education for sustainable development. The abbreviation is used in publications include: Mogensen and Schnack (2010), Kopnina (2012), Karatzoglou (2013), Barth

[5] As of January/February 2017, this highly cited paper received enough citations to place it in the top 1% of the academic field of Social Sciences, general based on a highly cited threshold for the field and publication year.

and Rieckmann (2012), Burmeister, Rauch and Eilks (2012). When analyzing ESD publications highlighted the importance and role of two leading journals: the Journal of Cleaner Production and the Environmental Education Research.

Jickling and Wals (2008) study points out that environmental education is changing fundamentally through the globalization of forces, demonstrating the effort to transform ecological education into sustainable development education. This study presents heuristics that help promote a better understanding of the relationship between sustainable development, ecological thinking, democracy and education (Jickling, Wals, 2008: 1).

Alma (2009) study points out that education should play an important role in the development of the nation. Education is the key to creating, adapting and disseminating knowledge in age of technological transformation. Primary and secondary education allow learning and interpretation of information while higher education is responsible for producing higher levels of workforce, creating new knowledge and improving knowledge produced elsewhere. Many countries have made progress in education. Nevertheless, some of them have not retained their development either because they have not provided the required qualified workforce for emerging economies due to globalisation and the sharp change in economic structure. It now forces decision-makers to prioritise the production of qualified workforce that can contribute to sustainable development. Some countries that have achieved sustainable development at the highest current level have given high priority to scientific and technological education in formulating educational policies (Alma, 2009:1260-1261).

The article Karatzoglou (2013) is an important publication on the ESD list (cited 47 times). Universities influence is an inherent part of the implementation of regional sustainability initiatives for more than two decades. The complex nature of sustainable development (SD) designates universities as key partners for all relevant activities, permanently in strong collaboration with other local players. A considerable number of articles presenting relevant university experience have been published in scientific journals all over the world. A review of the literature and critique of these articles, published between 2003 and 2011, following the announcement of the United Nations Decade of Education for Development (DESD), is also presented in the paper. Although the document provides a wider analysis of relevant literature, *ipso facto,* highlights the main role and contribution of two primary journals in the field, Journal of Sustainability in Higher Education and Journal of Cleaner Production. The paper states that published ESD studies cover a wide range

of areas, themes, methodologies and conclusions. The paper points out that dominant methodological approaches are mainly theoretical in case-study articles. Also the paper pay attention to conclusion that some of publications experience a rigorous shortage of conceptual frames or are characterized by descriptive character, which can inspire and encourage future efforts but with limited added value to the development of theory (Karatzoglou, 2013: 44).

The issue of the importance of universities in education for sustainable development is also addressed by Lozano et al. (2013), Barth and Rieckmann (2012), Gough and Scott (2007). The total number of citations of all three publications is 136. Based on these publications it can be concluded that this topic is developmental from the perspective of scientists. Implementing education for sustainable development (ESD) in university curricula poses a new challenge to the academic system (Barth, Rieckmann, 2012: 28). Higher education for sustainable development aims to contribute to a more sustainable future (Barth, Rieckmann, 2012: 34). Universities have played many roles in transforming societies, educating decision-makers, leaders, entrepreneurs, and academics. However, education and research on sustainability in universities is an early stage in many institutions (Lozano et al., 2013: 3).

An important problem (as indicated by the number of citations: 50) is that the implications of the shift of environmental education (EE), towards education for sustainable development (ESD), is addressed by Kopnina (2012). This article discusses the implications of shifting environmental education (EE) into education for sustainable development in the context of ecological ethics. While many perspectives ESD encourage both practitioners and researchers to the EE, there is also the risk that such pluralism can sustain dominant political ideologies and consolidated power, resulting in unclear environmental concerns. Encouraging many interpretations of ESD can, in fact, lead to environmentally misinformed teachers and students who have been legalized by the dominant neo-liberal ideology in order to compromise the eco-centric perspective. It is argued that the ESD, focusing on prosperity, equality, rights and fair distribution of resources, is a radical departure from the EE goal set out in the Belgrade Charter, as well as a clear shift towards anthropocentric education. This article has two aims: to demonstrate the importance of environmental ethics for EE in general, and in particular ESD, and to advocate for a return to instrumentalism, based on the assumption that environmental issues are serious, and education of ecologically-oriented students could help solve them (Kopnina, 2012: 699).

The topics of resource efficiency in the context of sustainable development are taken by such authors as: Sophocleous (2000), Alam (2009), Foody (2003), Clark et al. (2016), van Wilgen et al. (1997), Kundzewicz (1997), Tilton (1996), Escobar and Vredenburg (2011), Calabro et al. (2014), van der Velde et al. (2007). The subject that often appears in the publications of these authors is water resources. The availability of water in sufficient quantity and quality is a necessary circumstance for sustainable development. Water, the elementary component of the life support system of the planet, is crucial to sustaining any form of life and almost every human activity (Kundzewicz, 1997: 468). Four publications (Sophocleous, 2000; van Wilgen et al., 1997; Kundzewicz, 1997; van der Velde et al., 2007) often most frequently cited, (286 total mentioned), concentrate in the area of resource efficiency with concern on water matters in the sustainability field. Authors of these publications address topics primarily related to specific regions of the world (Kansas, Western Cape, and Tongatapu).

The most popular technology article is Binswanger (2001). The publication was devoted to the rebound effect. Taking into account the number of citations of this article, he is very popular with scientists. Many of sustainability concepts emphasize the importance of improving efficiency through technical progress. Technology is helping us to promote a society in which it is possible to maintain and even increase its present standard of living, while using less resource, especially less energy (see, for example, von Weizsäcker et al., 1997). These concepts are based on the assumption that increase efficiency by 1% will lead to less or more resource reduction by 1%. This is not usually the case because technological advances cause behavioral reactions. Often increasing the efficiency by 1% will reduce resource consumption by well below 1% or, sometimes, it can even increase the use of resources. Among economists of energy this singularity is known as the rebound effect, but it has not been thoroughly investigated by ecological economists (Binswanger, 2001: 120).

In the most cited articles (from 6 to 10) technological aspects are taken into account in the context of energy. This is also confirmed by the analysis of the maps developed: the intensity map of the relationship between words (Figure 2) and the cluster intensity map (Figure 3). Technological change has become a key theme of environmental policy, as well as of energy and climate policy. More and more knowledge is emerging about how technological change can affect environmental constraints and how environmental policy can influence it (Vollebergh, Kemfert, 2005: 133).

Conte et al. (2001) deal with the issues of the hydrogen economy. Sustainable energy is becoming a worldwide problem. The quick growth in global climate change, coupled with fears of lack of energy supply, leads to significant consensus on the potential benefits of renewable energy. Human-derived carbon dioxide (CO_2) emissions, the main greenhouse gas (GHG) are the subject of global debate on sustainable energy development and global climate stability (Conte et al., 2001: 171).

Highly Cited Paper from the regional scale sustainable development is the publication of While, Jonas and Gibbs (2010). The document is intended to make a clear impact to theoretical work on the state of an environmental rule and the developing spatial dimensions of climate policy. The authors' reflections concern the idea of eco-state restructuring (ESR), which the authors define for publication's purposes as a reorganisation of state power, capacity, regulation and territorial structures around institutional pathways and strategic projects which are (at least from the point of view of state interests at a given moment) considered less harmful to the environment than previous trajectories (While et al., 2010: 80). Authors include issues such as carbon dioxide control and the development of cities and regions. Managing carbon dioxide emissions represents a certain perspective for sustainable development as a principle of organising socio-environmental regulation. The work of the characteristic low-carbon state as a project of the ideological state is explored and searches its potential implications for the regulation of economic and environmental relations in the urban and regional scale. Coal control seems to introduce a new set of values for state regulation, which can open up the possibility of eliminating the main ways of developing cities and regions in an impossible way in the context of sustainable development. But low-carbon restructuring also suggests strengthened uneven development, new methods of state control mechanism, and unequal treatment of relations between states. To investigate these issues, we begin by developing a framework for the conceptualisation of an environmental regulation based on the idea of ecological restructuring of the state. This idea is presented to capture conflicts, power struggles and tactical selectivity as governments seek to settle environmental protection with many other pressures and difficulties. In general, work tends to make a clear contribution to the theoretical work on state environmental regulation and the spatial dimensions of climate policy (While et al., 2010: 76).

Final remarks concern the linking of separate topics. It is obvious that there are no limits to addressing specific issues. The role of scientists is among others, to demonstrate links between the

various phenomena and develop the knowledge of society in this way. The issue of sustainable development on a regional scale in the context of education, especially in the context of the role of universities, was raised by Sedlacek (2013). This article addresses how universities can serve as a linking institution between government, business and society to promote sustainable regional development. The basic idea is that universities as higher education institutions fulfil three core functions (education, research and management) that qualify them as facilitating sustainable development (Sedlacek, 2013: 82). Alam (2009) discusses the issue of education and resource efficiency. Examples may be given. The conclusion, however, is that one should look for specific issues in a given area of research on issues that may be of added value to the scientific world.

5. Conclusion

The main aim of the article was to present research sub-areas identified in the area of sustainable development. Based on the preliminary analysis of the most frequently quoted texts, the individual sub-areas were briefly characterized. This publication may serve as a guide for other authors to explore research issues in the area of sustainable development and may be an inspiration for exploring a given sub-area.

Analysis using specialized software (VOSviewer) has allowed isolating major sub-research areas. The qualitative analysis of the content of the most frequently cited scientific texts, in turn, allowed to identifying specific issues. In the field of education for sustainable development these specific topics are universities. Higher education plays a key role in achieving the 2030 Development Agenda and related Sustainable Development Goals – SDGs (United Nations, 2015). In the area of resource efficiency, much attention is paid by the authors of the water resource, in the field of technology to the specific topic of energy. The European Union is pushing for resource efficiency, which means using resources in a more sustainable way. Raw materials like i.e. water need to be managed more efficiently throughout their life-cycle, from when they are first extracted to when they are finally disposed of. Green technologies and renewable energy, eco-industries and recycling can help in pursuit of sustainable development. Highly Cited Paper from the regional scale sustainable development is an eco-state restructuring and carbon control. This article may constitute a contribution to further studies intended for solving research queries recognized and realized in presented papers.

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Zagadnienia dotyczące rozwoju zrównoważonego w publikacjach naukowych

Streszczenie

Celem artykułu jest przedstawienie wyników bibliometrycznej analizy badań naukowych dotyczących kwestii rozwoju zrównoważonego (ang. sustainable development - SD). Analiza pozwoliła zidentyfikować główne obszary badań w ramach powyższego zagadnienia. Do celów analizy wykorzystano analizę bibliometryczną danych dostępnych w bazie danych Web of Science, analizę trendów pod względem liczby publikacji, metodę współwystępowania słów, analizę klastrów, a także metodę mapowania myśli. W analizie wykorzystano oprogramowanie VOSviewer. Analiza pozwoliła wyodrębnić cztery podobszary badawcze w ramach badań związanych z rozwojem zrównoważonym, a były to następujące podobszary: (1) edukacja na rzecz rozwoju zrównoważonego, (2) efektywność wykorzystania zasobów, (3) rozwiązania technologiczne nastawione na rozwój zrównoważony i (4)) rozwój zrównoważony w skali regionalnej.

***Słowa kluczowe**:* rozwój zrównoważony, edukacja, zasoby, technologia, region

Kody JEL: Q01, Q25 Q55, Q56, R11

https://doi.org/10.25167/ees.2017.44.25