

BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS IN ENGINEERING FOR RURAL DEVELOPMENT

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Abstract. Bibliometric analysis of publications allows to quantify researchers' interests in this specific topic. This method enables the identification of key authors, who are publishing in this area. It is necessary to define research trends, which have developed in this specific field. It enables to determinate the main research topics, discoveries and correlations in the global knowledge network. The purpose of this work was to identify the trends and research topics in engineering for rural development. The modified method of bibliometric analysis was used, bibliometric analysis of the key word frequency of occurrence and the linkages between the key words. The analysis was performed using bibliometric post-conference materials of the International Scientific Conference Engineering for Rural Development in Jelgava in the years 2012-2017 downloaded from Web of Science database. The data have been processed and cleaned, then analysed in VOSviewer. This program is used for creating and graphic visualisation of bibliometric maps. VOSviewer utilized the method of „visualization of similarities” VOS. In this work the program was used to create maps of terms in the version of „thermic maps”. The main research topics have been presented in the form of associated networks. The last stage was detailed topical analysis and classification into groups according to selected criteria. The provided research enabled an identification of lines of the research. The main research topics in all research period were: energy qualities of plant materials, alternative fuel (biomass, biodiesel, biogas), renewable energy sources, modelling, optimisation and stimulation of processes, mechanisation of plant production and many more. This analysis can be used as a literature review in the selected knowledge area.

Keywords: bibliometric analysis, research trends, scientometric, literature review.

Introduction

The pace of scientific development forces researchers to learn about current research trends in a given discipline, such as engineering for rural development. This knowledge is needed to plan future research. The continuous following of current research trends in selected disciplines helps increase the effectiveness of research. It is necessary to define a new global research trends that have developed in the discipline in order to determine the major research topics, discover and global knowledge networks. This necessity is emphasized by many authors of scientific publications. Bibliometric studies are widely applied in the analysis of research trends [1-7].

The bibliometric analysis was first used by Pritchard in 1969 as a method of mathematical and statistical analysis applied to books, organizations, persons and other communication media. Citation and content analyses are now widely used bibliometric techniques. Broadus defined bibliometry as a quantitative analysis of physically published units or bibliographic units. Bibliometric techniques have many advantages. The most important is the ability to conduct quantitative analyses objectified based on the codified knowledge – measurable, objectified, consistent and accessible data. Hence, bibliometrics is an effective and important tool to determine the trends of research in various fields of science [8]. Bibliometric studies include a number of quantitative and visual procedures to generalize patterns and dynamics of publications [7].

The goal of the work was to determine the main topics and research trends in engineering for rural development. The method of bibliometric analysis was applied.

Materials and methods

One of the most widely used databases for bibliometric analysis of publications is the Web of Science (WoS), which contains articles, proceeding papers with the highest level of quality. Therefore, in this study the WoS database has been used as a data source [8].

The scope of research included publications in materials from the International Scientific Conference: Engineering For Rural Development organized by the Latvia University of Agriculture in Jelgava, which have been included in Web of Science - Core Collection (WoS-CC). All publications in the WoS for PUBLICATION NAME: „Engineering for Rural Development”. The years 2012-2017 were analysed.

A modified bibliometric analysis method proposed by Rizzi [9] and Leydesdorff [10] was applied in the work. The following stages of analysis were adopted:

1. Identifying documents in the Web of Science for PUBLICATION NAME : "Engineering for Rural Development".
2. Uploading all publications of the selected journal in the analysed period of time and extracting bibliometric data (authors, title, year of issue, key words, additional key words, publishing house).
3. Construction and analysis of term maps (VOSviewer software).
4. Identifying the most frequently found key words in the analysed period of time.
5. A topic analysis of the publications, which were identified with the use of the most frequently occurring key words (topic: biomass and biogas).

Bibliometric analyses were performed with the use of the freeware, VOSviewer. This program is used for creating and graphic visualisation of bibliometric maps. VOSviewer utilized the method of „visualization of similarities” VOS. The program allows to create maps of authors, journals etc. [11].

In this work the program was used to create maps of terms in the version of „thermic maps”.

Such maps allow for analysing concentrations in a simple way.

The key words with the highest occurrence frequency are displayed in a bigger size font and they are placed in the „hot” area (yellow, orange, red range of colours).

The words with the lower frequency of occurrence, on the other hand, have smaller font and they are presented in „colder” areas (green colour range).

VOSviewer is widely used for bibliometric analyses, mainly to analyse research trends [12-15], but also to visualize certain fields of knowledge [16].

Results and discussion

In the examined period, 938 documents were analysed in total (according to WoS-CC database). Figure 1 shows the number of published documents and the number of citations indicated by two foreign scientific databases: WoS-CC and Scopus. The number of publications was around 125 between 2012 and 2015, while in the last two years, it increased to more than 225. Both scientific bases show an upward trend for the numbers of citations. It can be noted that the number of citations in the Scopus database is almost twice as high as in the WoS-CC database.

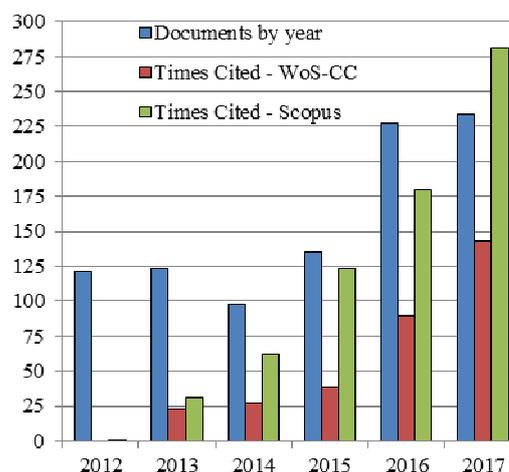


Fig. 1. Number of documents and citations in WoS-CC and Scopus

In the analyzed period the main authors were: Aboltins A. (29 documents), Kic P. (27 documents), Ivanovs S. (26 documents), Jasinskas A. (23 documents) and Novak P. (18 documents). The authors come from Latvia (479 documents), Czech Republic (179 documents), Russian Federation (83 documents), Lithuania (75 documents), Poland (61 documents). In the analyzed period, the most documents were published: Latvia University of Agriculture (332 documents), Czech University of Life Sciences Prague (152 documents), Riga Technical University – RTU (97 documents), Aleksandras Stulginskis University – ASU (69 documents), Stavropol State

Table 1

Result of the topic analysis of publications in the period (2012-2017)

THEME GROUPS	SUBJECTS DISCUSSED (the last / most current examples of documents)
1 Biomass	<p># combustion technique -number of publications19 - analysis of the combustion process: for biomass mixtures ([21; 22]), - analysis of the quantity and composition of ash and its melting process when burning biomass mixtures ([23]), - the impact of electric and magnetic fields and air movements on the combustion process (example documents ([24; 25]), - new design solutions: burner, optimisation of efficiency of heating system devices([26])</p> <p># energy properties of biological materials – number of publications 27 - the impact of the fertiliser standards on the chemical composition of biomass ([27; 28]), - energy crops: cereal straw, common cane, rapeseed straw, canary cane, vine-processing residues, Japanese knotweed, fibre hemp and fibrous nettle, grass, palm oil nutshells and others ([29-34]), - analysis of the impact of selected parameters (moisture content, particle size) ([35])</p> <p># biomass agglomeration – number of publications 19 - modelling the agglomeration process ([36]), - application of new binding materials ([37]) - formation of agglomerates from different types of biomass, determination of production parameters and examination of mechanical properties of briquettes ([38])</p> <p># fertilisation – number of publications 6 - use of biomass and processing waste as green manure ([39]), - soil phytoremediation ([40])</p> <p>#cultivation technologies – number of publications 6 - application of image analysis techniques to support the cultivation process - examination of the impact of cultivation technology and climate on plant yielding([41])</p> <p># others – number of publications7 - legislation and evaluation of the RES sector in different countries ([42])</p>
2 Biogas	<p># biological raw material for biogas production – number of publications 20 -plants used for biogas production: grass, hay, Canadian cane, straw, algae leaves, fast-growing forests (poplar), freshwater algae - energy crops, biologically processed sawdust, mixtures of hardwood sawdust and rapeseed straw ([43]), -other biological material used for biogas production: waste from the fishing, wine, distillery, bakery, sugar, food and beverage industries (crisps, salad beetroot, production of coffee), dairy industry, cow and pig manure, sewage sludge, power plants, processing waste ([44; 45])</p> <p># process technology and parameters–number of publications 14 - production technology, impact of parameters (temperature, particle size, initial batch treatment), use of additives: (enzymes, catalysts), MM1 (Melafen and Melaferm) additive ([46]), - bioreactor design (mechanical mixing, various types), technological combination of dry and wet fermentations ([47])</p> <p># others – number of publications5 - assessment of the fuel and economic sector in different countries, RES legislation and production forecast ([48])</p>

The searched documents on biomass are divided into 6 groups (Table 1: Theme Group: BIOMASS), namely: combustion technique, energy properties of biological materials, agglomeration, fertilization, cultivation technologies and another group, which includes documents on legislation and assessment of the RES sector in different countries (7 documents).

As part of the combustion technique, the researchers' greatest interest is focused on studying the impact of electric and magnetic fields and air movements on the combustion process (8 documents) and the analysis of the quantity, composition and process of ash melting during biomass combustion (5 documents). Within the energy properties group, most of the papers concerned the analysis of the possibility of using different energy crops (15 documents) and the impact of fertilization on selected biomass properties (6 documents) and the impact of selected characteristics, such as particle size or moisture content, on selected energy parameters (6 documents). The main research topics in agglomeration included the analysis of agglomerates from different biological materials and studying their selected properties (17 documents). Within the fertilization group, the articles concerned the analysis of the possibility of using biomass as green manure (5) and soil phytoremediation (1 document). The cultivation technologies group included documents, in which the authors discussed

issues such as the use of image analysis techniques to support the cultivation process (2 documents) and studying the impact of cultivation technology and climate on plant yielding (4 documents).

In turn, the documents on biogas were divided into 3 groups (Table 1: Theme Group: BIOGAS): biological feedstock for the production of biogas, process technology and parameters, and others. Within the biological material group, most of the documents covered the subjects of the use of different plants (7 documents) and other biological materials (10 documents) for biogas production and the use of fermentation residues as fertilisers (3 documents). Within the technology and parameters group, the scientists mainly discussed topics such as the influence of selected parameters and additives on the amount of obtained biogas (11 documents) and the influence of machine design and the technological combination of various fermentation methods (3 documents). The other group included documents on the evaluation of the fuel and economic sector in various countries, RES legislation and production forecasts (5 documents).

The main research directions concerning biomass determined using the bibliometric analysis have been and continue to be carried out by the research staff of our Department of Mechanical Engineering and Agrophysics [49] and in cooperation with other research centers in Poland [50-53] and the Czech Republic [54].

Conclusions

1. WoS-CC and Scopus databases show an upward trend in the number of citations. It can be seen that the number of citations in the Scopus database is almost twice as large as in the WoS-CC database.
2. Research on biomass as a solid fuel focuses on combustion problems, the energy properties of solid biofuels produced from different plants and biomass agglomerations.
3. Research is also being carried out into the use of biomass as fertilizers and the optimization of energy crop cultivation techniques. The subject matter of the research connected with the use of biomass as a feedstock for biogas production includes the search for new optimal mixtures of biomass used in biogas production and optimization of the parameters of the biogas production process.
4. The paper shows that the use of IT tools (VOSviewerprogramme) for bibliometric analysis aimed at identifying the main research topics in the selected research area allows to efficiently process large amounts of bibliometric data and present the obtained results in a clear and visually attractive graphic form.

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