BIBLIOMETRIC ANALYSIS ON WATER, ENERGY, AND FOOD (WEF) SECURITY NEXUS

ANALISIS BIBLIOMETRIK TENTANG KETERKAITAN KETAHANAN AIR, ENERGI, DAN PANGAN

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ABSTRACT

This literature trend analysis focused on the water, energy, and food (WEF) security nexus-related topics that are increasingly discussed in global society, academia, business, and policy. The objective of this study is to examine the trends of scientific publications in this issue using the Scopus Database and Google Scholar during the period of year 2000 to 2019. It was conducted by employing six searching phrases with three selected categories i.e. year of publication, subject area, and type of documents in Scopus search engine (SCO) and one category of year of publication in Google Scholar (GOS). The results indicate the increasing number of research document over time on WEF security topic either in the separated three sectors or in the integration of them in the perspective of nexus. Additionally, the use of different searching phrases which represent both sectoral and integrated approach indicates the perspective changes of scientific community in observing water, energy and food resources. Furthermore, interconnectedness between WEF system and other exogenous factors such as climate, population, forest, industry, and other economic developments have been revealed through the existing studies. All the findings are expected to bring a better insight for the researcher in conducting research on this topic and broaden the scope instead of only WEF system without considering other exogenous factors. Further study on the applicability of the nexus concepts in any level including local context is needed to prove that this concept is not only 'on paper' but also can be well-implemented to assist policy-makers in managing WEF resources.

Keywords: water-energy-food security, nexus approach, Scopus, research trends

ABSTRAK

Analisis tentang tren literatur yang terkait dengan topik penelitian nexus ketahanan, air, energi, dan pangan saat ini meningkat pembahasannya dilingkup masyarakat global, akademisi, bisnis, dan kebijakan publik. Tujuan dari penelitian ini adalah untuk menganalisis tren pubikasi ilmiah yang terkait dengan isu tersebut menggunakan Database Scopus dan Google Scholar selama periode tahun 2000-2009. Penelitian dilakukan dengan menguji enam kata kunci dan tiga pilihan kategori yaitu tahun publikasi, subyek penelitian, dan jenis dokumen dalam mesin pencari Scopus (SCO) dan satu kategori tahun publikasi dalam Google Scholar (GOS). Hasil analisis menunjukkan peningkatan jumlah dokumen penelitian terkait topik ketahanan air-energi-pangan baik sebagai tiga sektor terpisah, maupun sebagai satu kesatuan dalam perspektif keterkaitan (nexus). Selain itu, penggunaan kata kunci yang bervariasi yang merepresentasikan pendekatan sektoral maupun terintegrasi mengindikasikan perubahan perspektif dari komunitas ilmiah dalam mengkaji sumber daya air, energi, dan pangan. Lebih jauh, keterkaitan antara sistem air-energi-pangan dan faktor eksternal lainnya seperti iklim, populasi penduduk, hutan, industri, dan sektor pembangunan lainnya telah berhasil dikaji melalui studi eksisting. Hasil temuan diharapkan dapat memberikan pemahaman yang lebih baik dalam melakukan kajian terkait topik ini, khususnya dengan mempertimbangkan faktor eksternal. Studi lebih lanjut terkait penerapan konsep nexus dalam semua level termasuk dalam konteks lokal diperlukan untuk membuktikan bahwa konsep tersebut bukan hanya diatas kertas namun dapat pula diimplementasikan untuk mendukung pengambil kebijakan dalam mengelola sumber daya air-energi-pangan.

Kata kunci: ketahanan air-energi-pangan, pendekatan nexus, scopus, tren penelitian

1. INTRODUCTION

The food security according to the World Food Summit in 1996 can be defined as a condition when physical and economic access to food can be afforded by all people at all times to meet their basic nutritional and health needs (FAO, 1996). Similarly, UN-Water describes water security as a situation where all people are able to have a

sustainable access to quality water to maintain their health, livelihoods, well-being and socio-economic development and to protect themselves from pollution and water-related disasters (UN-Water, 2013). In regard to energy security, the International Energy Agency (IEA) in 1974 interpreted it as “a condition where the availability of energy sources can be accessed by the people continuously and at an affordable price. Resources availability is not the one and only factor of security. Accessibility and quality are also crucial to be considered. Resource availability can be defined as the physical existence of the resource to meet demand at all levels (from household to national level). Furthermore, accessibility of resources means that the resource is easy to obtain (due to the existence of transport infrastructures) and at an affordable price. Meanwhile, the quality aspect refers to the resources that meet the quality standard which has been set for a certain purpose. One of the main references on this issue is the guideline established by World Health Organization on on drinking water quality (WHO, 2017). Other guidelines on river surface and ground water quality can also be gained from international and national standards.

A number of authors have reported trend analyses in various issues employing the Scopus database in the literature. The topics that have been discussed in those review papers were related to scientific productivity, science education, natural hazard and climate change, foreign language learning, personal information privacy, and labour among others (Djalante, 2016; Rodrigues et al., 2016 ; Miguel et al., 2016; Uzunboylu and Genc, 2017; Choi et al., 2017; Salmerón-Manzano and Manzano-Agugliaro, 2017; El Khaled et al. 2018). Additionally, several studies have attempted to do comparison between Scopus database with other scientific publication sources e.g. Web of Science, Google Scholar, and Scimago database (Burnham, 2006; Gavel and Iselid, 2008; Kulkarni et al. 2009; Aghaei Chadegani et al., 2013). In terms of WEF security nexus concepts, a number of studies have recognized the concepts and frameworks and put them into consideration for the future resource management (Albrecht et al., 2018; El Costa, 2015; Endo *et al.*, 2017). However, the use of scientific databases to analyse the trends of some specific terms of water, energy, and food security nexus in a separated and integrated ways has not been addressed sufficiently. It is also important to understand the perspective changes of the scientific communities to see these three main resources.

This paper seeks to identify the WEF security nexus-related publications existed around the world by analysing the trends of scientific documents number listed by *Scopus Database (SCO)* and *Google Scholar (GOS)* within the period of year 2000 to 2019. Section 2 describes general methods employed in this study. The trends analysis of the scientific documents and some findings were resulted and discussed in section 3. The compilation and review of existing frameworks in WEF security nexus are presented in section 4. In the section 5, summary and conclusion of all the findings were explicitly stated.

2. METHODOLOGY

2.1. Scopus Database (SCO)

As one of the biggest abstract and citation databases in the world, SCO plays important role in assisting scholars and researchers to do literature review and analysis of scientific publications. SCO consists of more than 22,700 journals along with selected book series’ and conference proceedings maintained by Elsevier that covers multi-disciplinary research topics ranging from health sciences, physical sciences, social sciences, and life sciences (Walters 2017; Elsevier 2018). Additionally, several smart features within the system enable the users to conduct much better tracking, analysis, and visualisation of the research database. By employing a literature search in Scopus, the user can observe the most relevant

documents and scientific information rapidly, with several recent filter search such as document, author, affiliation, advanced, refine results, and language interface search. Figure 1 shows the document search interface in Scopus.

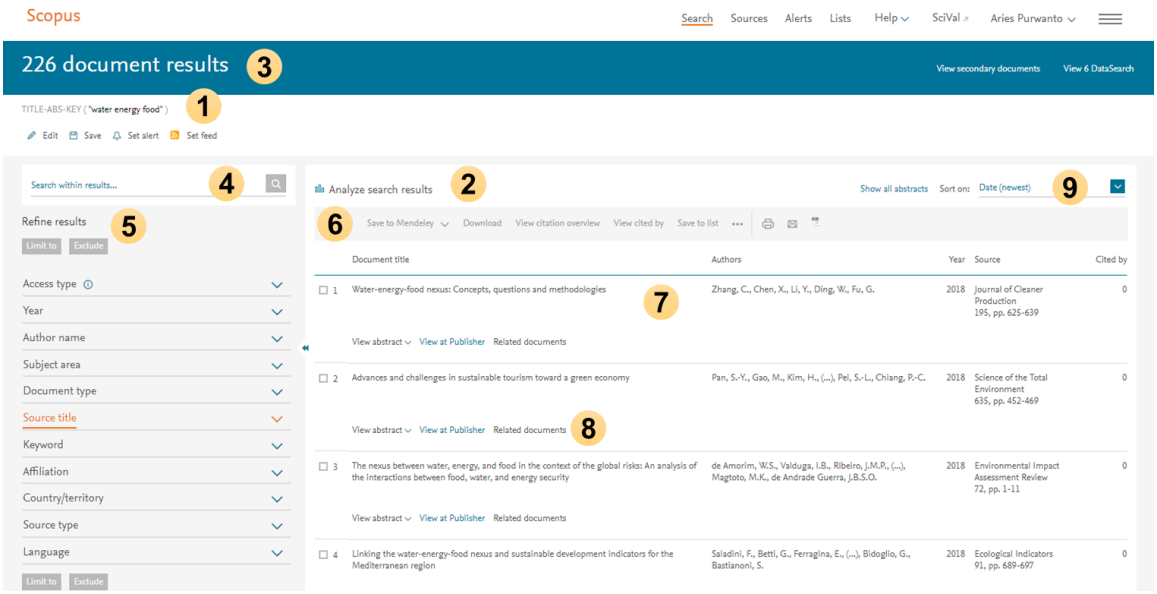

Figure 1. The document search interface in Scopus. (1) fields and keywords, (2) analyse search result, (3) number of search result, (4) search within result, (5) result, (6) batch processing result, (7) display document details page, (8) link to full text, (9) sort option (adapted from Elsevier Science Publishers, 2015, www.scopus.com, accessed on 10 June 2020)

User-friendliness is one of the key advantages in using Scopus search engine (Burnham 2006). It can be easily used even by the novice researcher that well-known with general searching tool features. Additionally, it is noted that the multidisciplinary approach in Scopus makes the user obtain more comprehensive insight from other disciplines that may not show in other search facilities. The trend analysis through Scopus database is highly relevant due to its progress in citation coverage and functionality (Gavel and Iselid 2008). The rules in conducting search and analysis in Scopus database are covered in Table 1.

Table 1. General searching rules in Scopus database

General Rules	▪ Not case-sensitive ▪ Search for both singular nouns, plural nouns and possessives with exceptions ▪ Search for variation of Greek letters (a OR alpha, b OR beta) ▪ Search for either variations of *British* or *American* spellings
Search of Phrase	▪ Multiple words set off by spaces will be analysed with the AND operator. ▪ Put it in double quote marks or curly brackets for searsching as a phrase ▪ Double quotes (“..”) → (1) Fuzzy phrases, (2) both singular and plurals, (3) symbols are ignored, (4) wildcards can be used. Ex: “heart-attack” will search for heart-attack, heart attack, heart attacks, etc. ▪ Curly brackets ({..}) → (1) Specific phrases, (2) specified character string, (3) symbols can be used. Ex: {heart-attack} will only search for heart-attack

Wildcards	▪ (*) → This sign will replace any number of characters, toxi* will search for toxin, toxic, toxicity, toxicology, etc. ▪ (?) → This sign will only replace one character, saw t??th will search for "saw tooth" and "saw teeth"
Logical operators	▪ *And* → It contains both words water and energy ▪ *Or* → It contains either or both words document or article ▪ And Not → not containing the following words tumor and not malignant

Source: adapted from Elsevier Science Publishers, 2015

Scopus database search engine was used and accessed on 10 June 2020, to identify, analyse, and visualize the number of scientific documents and publications related to WEF security nexus topics. There were six searching phrase within quotation marks being browsed in the fields of article title, abstract, and keywords as following: (a) "water security", (b) "energy security", (c) "food security", (d) "water energy food nexus" (e) "water energy food security", (f) "water energy food security nexus".

The first three searching keywords were the individual sectors then continued with the keywords indicating the integration of WEF system. The purpose of this order was to observe the previous separated concepts of security and compare it with the nexus ones as one of novel approaches. Furthermore, all the results were examined in three categories i.e. year of publication, subject area, and type of documents or publication.

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2.1.1. Google Scholar (GOS)

According to Walters (2017), the coverage of GOS is the most comprehensive in the sciences, where the majority of the scholarly literature is available online. It consists of approximately 87% of all the English-language scholarly documents are available on the web such as journal articles, conference papers, preprints, research reports, theses, among others. Additionally, Walters (2017) explained that its bibliographic records and citations are mostly taken from three main sources i.e. (1) freely available web documents that "look scholarly" to the GOS web crawlers; (2) GOS's partner agencies such as scholarly societies, publishers, , database vendors, and academic institutions; and (3) citations extracted from the reference lists of previously indexed documents.

GOS provides a very simple searching methods for researcher to find relevant research outputs from many academic publishers, online repositories, professional communities, , universities and other web sites with various disciplines (Google, 2020). The search results are normally sorted by relevance, not by date. However, by using "Custom range", year by year scientific documents can be obtained. Double quotes ("…") is used to find more specific phrase contained in the titles, abstracts or documents. In this study, the same six specific searching phrases with Scopus analysis were also used to get the number of scientific documents on the field of water, energy and food security nexus.

This study does not include the results from other scientific databases such as Web of Science and Scimago due to the lack of access to those databases and also time limitation of the analysis. The analysis of other databases may improve the accuracy

and quality of this comparative research trend analysis.

3. RESULT & DISCUSSIONS

3.1. Scopus database analysis

3.1.1. Year of Publication

Overall, the number of publications on WEF security nexus-related topics both individually by resource security (e.g. water security alone) and in the combination of resource security increased over time. Based on the year of publication, the water security topic has emerged since the year 2000 with 24 scientific publications rising to 2678 outputs by 2019 with the total of publications during the period reaching 14,458 documents (Figure 2*a*). Compared to water security, food security and energy security issues were higher in total number of publication with 25,663 and 118,963 documents respectively (Figure 2*b* and Figure 2*c*). By the year 2000, the research outputs on food security topic already reached 585 documents. It indicates the prevalence of this topic over two other research interests on water and energy security. It was most likely caused by the main global or national concerns on food sector during that period compared with the water and energy sectors.

The number of publications on the topic of water, energy, and food security nexus were much less and appeared later than the separated ones (Figure 2*d* and Figure 2*e*). It shows that this research topic is relatively new compared with sectoral topic investigations. The term “water energy food nexus” occurred by 2012 with 1 document and gradually increased until 598 documents in 2019 (Figure 2*d)*. Furthermore, the “water energy food security” topic started to increase from 6 to 158 scientific documents between the years 2013 and 2019 (Figure 2e). While the phrase “water energy food security nexus” can be seen in the Scopus database since 2013 with 4 documents and started to increase until 113 by 2019 (Figure 2*f*). The total number of scientific documents occurred during the period of 2000-2019 using those three specific phrases were 1,458, 485 and 372 scientific documents respectively.

The comparison between the research outputs using six different searching phrases in the Scopus database can be seen in Figure 2g. The food security issue (green line) shows a significant escalation in the number of scientific research documents compared to other issues during that period. Based on the analysis, the other five issues have also increased, but the number is not as big as the food security issue.

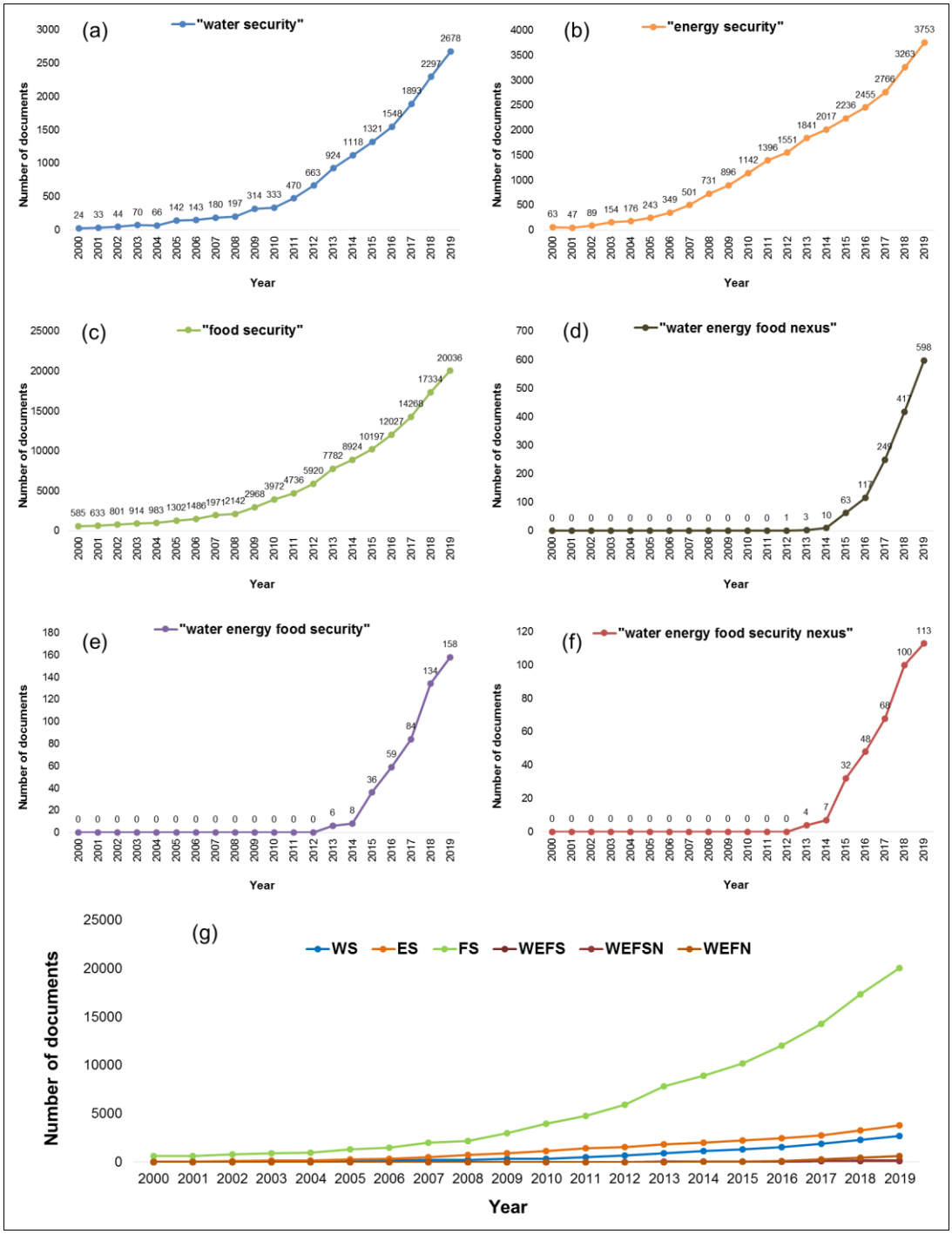

Figure 2. The number of scientific publication by year of publication on the topic of water, energy, and food security nexus listed in the Scopus Database

3.1.2. The subject area

Figure 3 illustrates the number of scientific documents on the topic on water, energy, and food security nexus in the Scopus database based on the related subject area. It is clear that the top- five of the subject area on this topic were: (1) environmental sciences; (2) agricultural and biological sciences; (3) social sciences; (4) energy; and (5) engineering. The occurrence of environmental, social, and economic perspectives in the scientific publication on WEF security nexus indicates the importance

of these factors to be considered in the analysis of WEF security. It also demonstrates that taking a narrow perspective is insufficient to achieve the WEF security targets in a region.

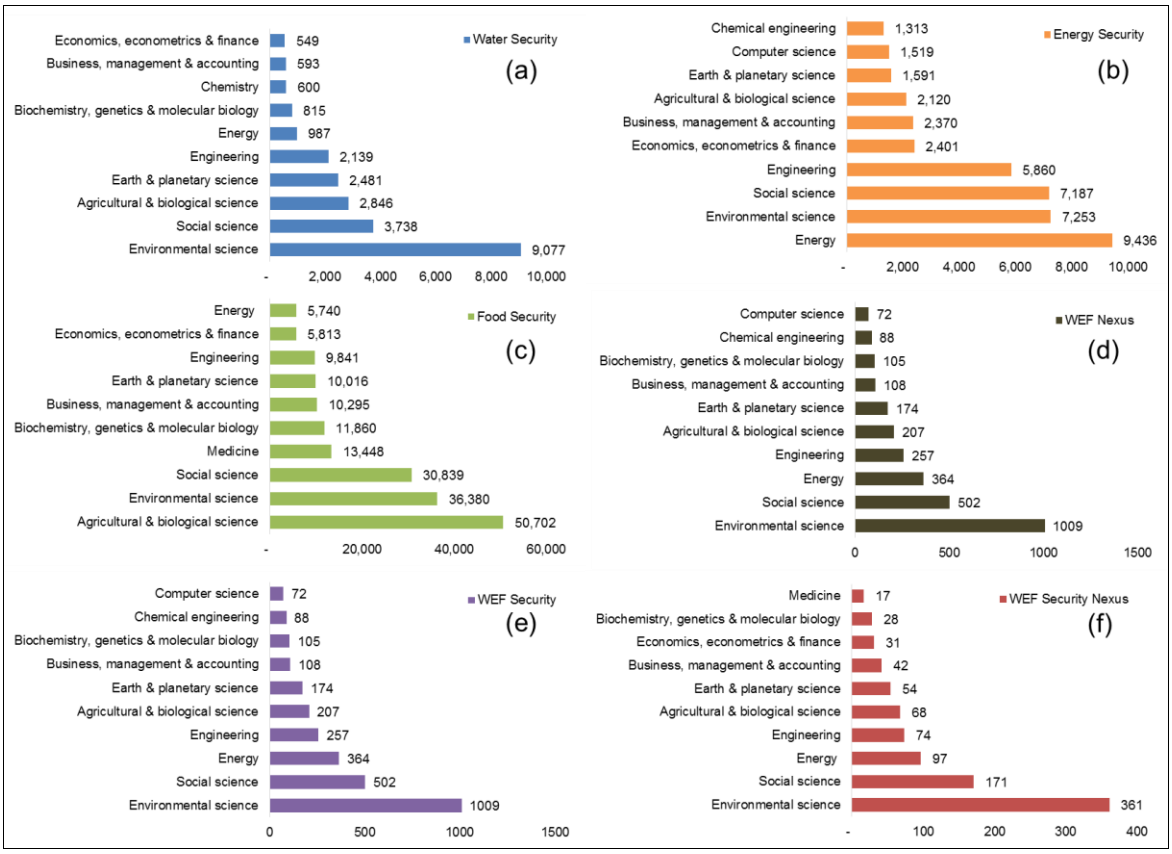

Figure 3. The number of scientific publication by subject area on the topic of water, energy, and food security nexus listed in the Scopus database

3.1.3. The type of document

The existence of scientific publications by the type of documents is shown in Figure 4. Academic journal articles dominated the number of publications in all of keywords related to WEF security nexus topics in the Scopus database with around 58% to 71%. The conference papers (4%-15%), book chapters (9-11%), reviews (8%-14%), and books (2%-4%) were the other top-five document types in this source respectively. The remaining, less number of documents divided among editorial, note, letter, conference reviews, short survey, and erratum.

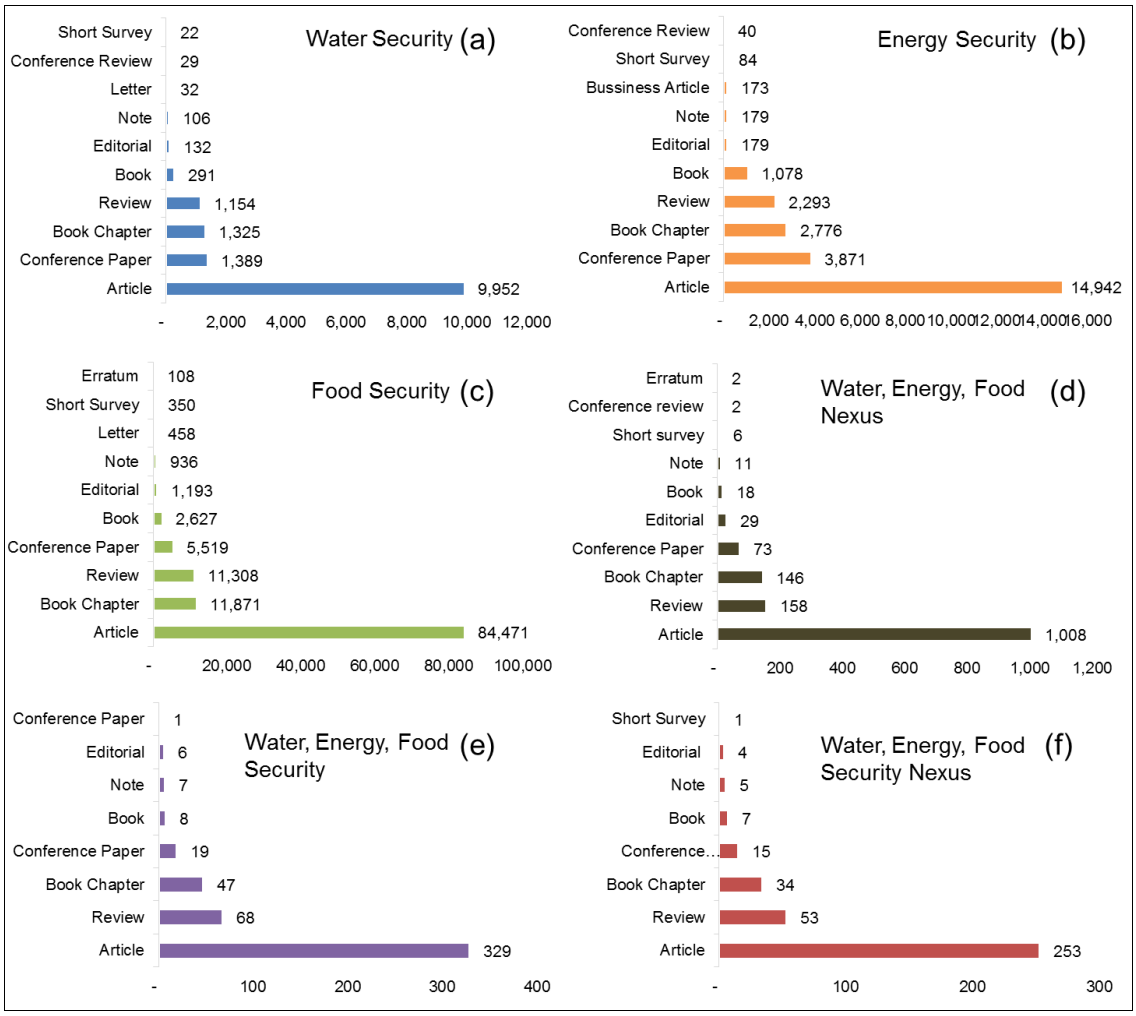

Figure 4. The number of scientific publication by type of document on the topic of water, energy, and food security nexus listed in the Scopus Database

3.2. Google Scholar analysis

Google scholar analysis shows a significant difference in the number of scientific documents output compared with Scopus database. However, almost similar results regarding the trends in WEF security nexus topics research (except ‘‘food security” topic) within both databases can be seen clearly in Figure 5 and Figure 6.

The number of research documents related to the topic of ‘water security’ has gradually increased from 360 research outputs by 2000 to 9,070 research output in 2019 (Figure 5a). A similar trend happened in the topic of ‘energy security’ with 936 documents in 2000 to 19,000 documents in 2019 (Figure 5b). Such anomaly occurred on the topic of ‘food security’ where the amount of research output has fluctuated and finally decreased from 2014 to 2019, in contradiction with results from SCO (Figure 5c). The number of research documents by using searching phrases of “water energy food nexus”, “water energy food security” and “water energy food security nexus” can be seen in Figure 5d, Figure 5e and Figure 5f. A significant increase has been shown since 2011 until the end of the period with the number of research outputs on those three research topics reaching 1,330, 311 and 216 documents respectively by 2019.

Figure 5g illustrates the comparison of the amount of research output between six searching words. The topic of ‘food security’ shows the dominance of the amount of

research output compared to the other four, although in terms of trends it actually shows fluctuations and declines at the end of the period of analysis.

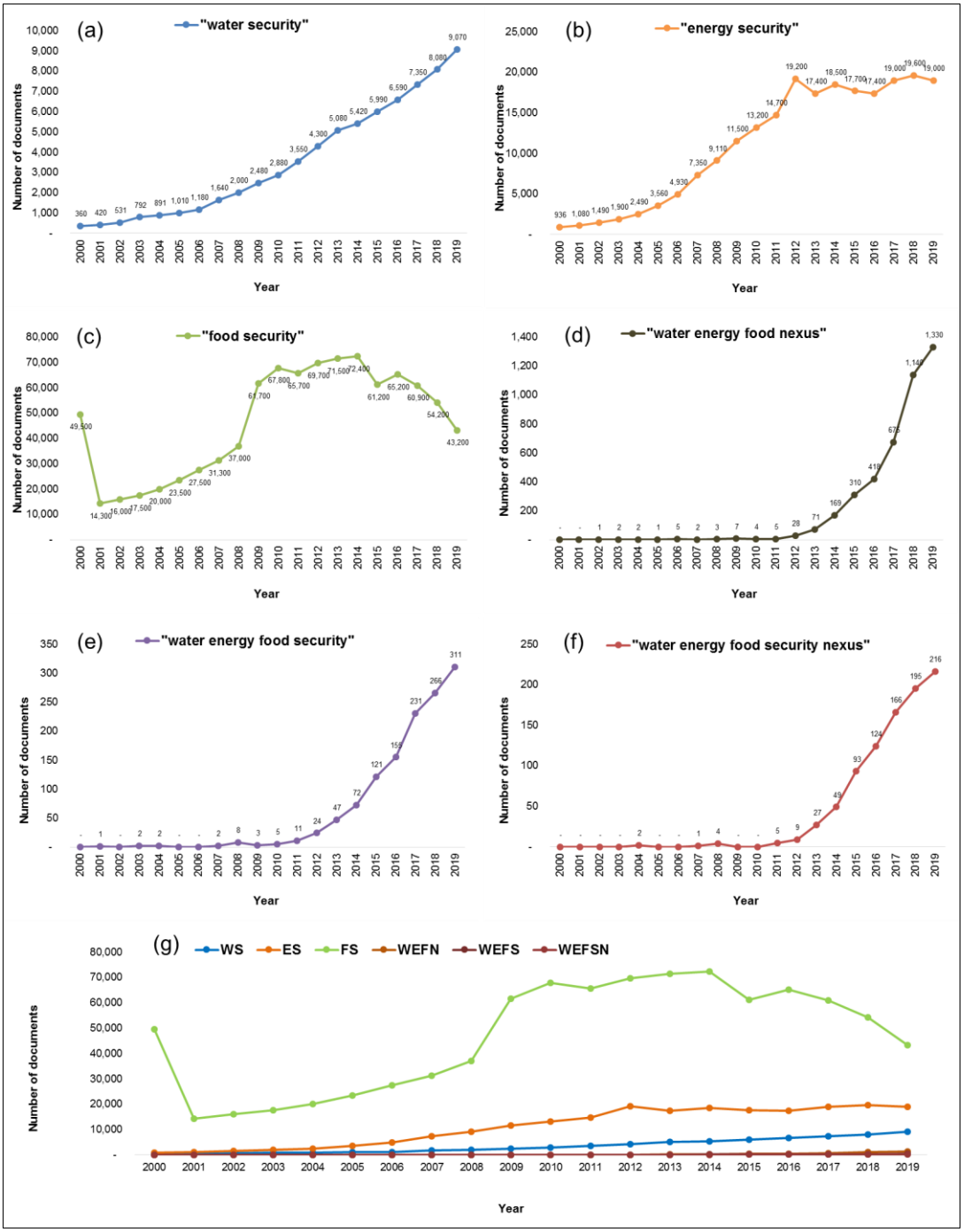

Figure 5. The number of scientific publication by year of publication on the topic of water, energy, and food security nexus listed in the Google Scholar (GOS)

3.3. SCO vs GOS Analysis

Figure 6 compares the results of the Scopus Database (SCO) and Google Scholar (GOS) analysis using exactly the same searching keywords related to the WEF security nexus. As can be seen from the charts below, almost all results (Figure 6a to Figure 6f) show a similar upward trend in the number of scientific documents produced each year. Only 'food security' shows fluctuations in the amount of research output. The GOS displays a significantly larger number of documents compared to SCO with a difference of 100 to 23,000 research outputs at the end of 2019. It is not surprising since SCO considers only peer-reviewed articles, while GOS includes not only peer-reviewed and but also non-scientific publications such as reports, thesis, preprints, etc.

Research output related to 'food security' shows the largest number of differences between SCO and GOS with around 23,164 scientific outputs (Figure 6*c*), while 'energy security' (Figure 6*b*) and 'water security' (Figure 6*a*) are in the second and third largest positions with a difference of 15,247 and 6,392 documents respectively. The smallest difference can be seen in 'WEF security' (Figure 6*e*) and 'WEF security nexus' (Figure 6f) with 103 and 153 documents.

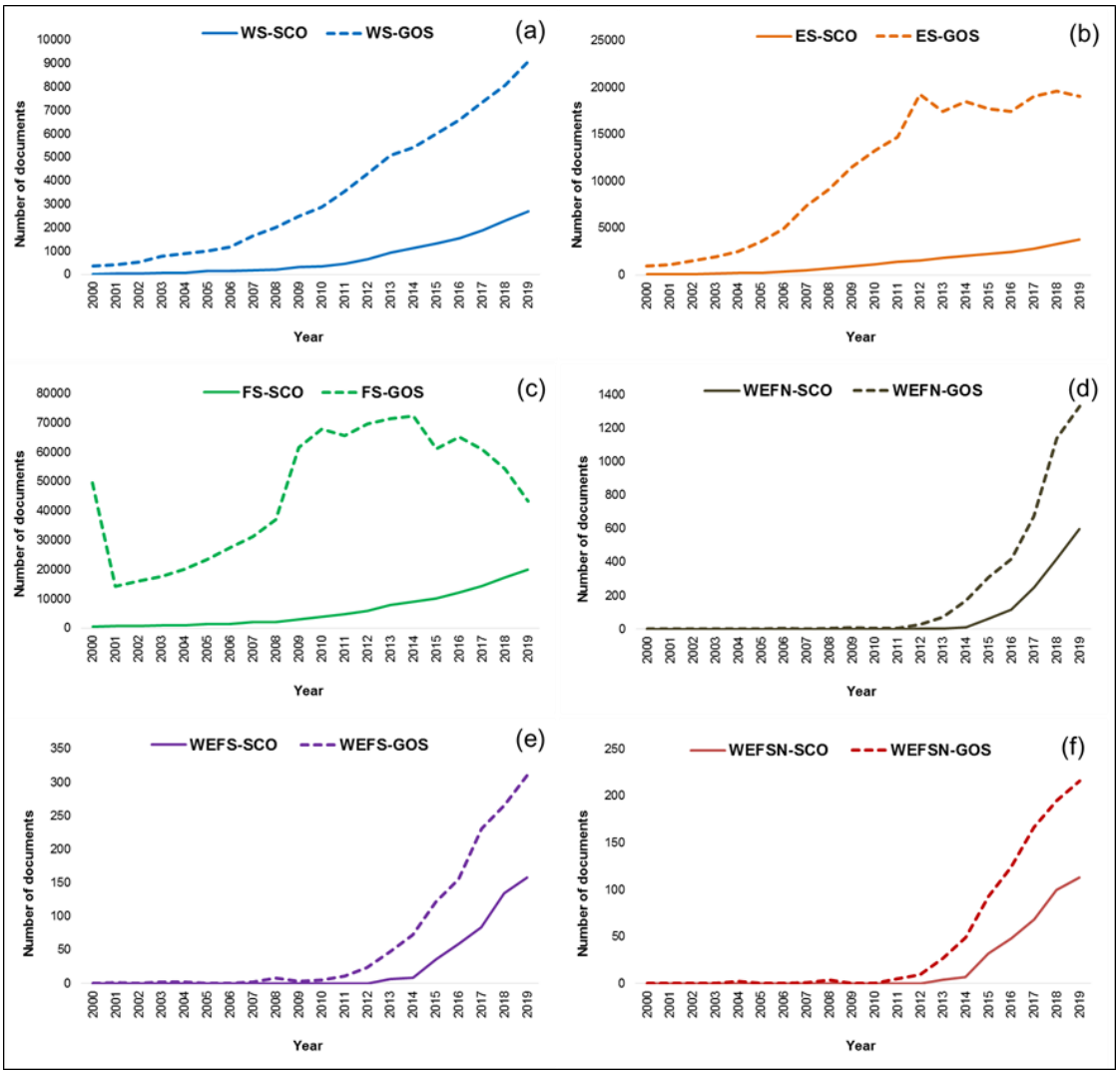

Figure 6. The comparison of number of publication on water, energy and food security nexus year to year in the Scopus Database (SCO) and Google Scholar (GOS)

This study was conducted to analyse the trend of the number of scientific research outputs contained in the two databases namely Scopus (SCO) and Google Scholar (GOS) related to the topic of WEF security Nexus in the period of twenty years (2000 to 2019). Beside the number of documents, this analysis also attempts to show the new perspective on integrated and nexus approach in WEF topics which also increases. Additionally, the association of WEF research with other research areas such as environment, social and economic subjects was revealed from the documents by subject area Figure 3 and the existing WEF frameworks.

The findings are consistent with those of other studies and suggest that SCO and GOS can be employed by researcher to have a better insight in doing literature review and analysis. Based on this study, by comparing the number of research outputs included in each database, it can be concluded that GOS provides a larger coverage compare with SCO database (see Figure 6. The present finding also accords with other previous studies such as Kulkarni et al. (2009) and Walters (2017). It might be caused by the differences of the method employed by GOS database in extracting scientific documents. GOS also includes non-scholarly and non-peer reviewed sources such as university theses, student handbooks, administrative notes, and preprints which is different with the SCO database that only considered peer-reviewed sources. Unfortunately, unlike SCO, GOS does not yet provide several other option categories besides the number of scientific documents based on year of publications. In SCO, researchers are able to conduct further analysis with several categories such as year of publication, subject area, type of documents, author's country of origin, affiliation, etc. These multiple options can help us to further analyse the current scientific sources. For instance, subject area will show researchers how wide the scope of their research topic is. Additionally, author's country of origin and affiliation will help the funder to determine the partners in doing certain research topics.

The research topic on the partial sectors of water, energy, and food security were higher in term of number of scientific documents and far earlier regarding the year of publication compared to the integrated WEF system using nexus approach. This is most likely marked by the emergence of the Background Paper for the Bonn 2011 Nexus Conference entitled "Understanding the nexus" compiled by Holger Hoff. In that paper, some initial evidence on how a nexus approach can improve the security of water, energy and food resources by increasing efficiency, reducing trade-offs, building synergies and improving governance across sectors, including several policy recommendations were introduced. A comprehensive study conducted by Endo et al. (2017) and Albrecht et al. (2018) stated that the background paper by Holger Hoff and the World Economic Forum meeting in 2011 (WEF 2011) has brought the topic and concept of the WEF security nexus to the centre of global attention.

Regarding subject categories, this study also revealed the interrelation between the term water, energy and food security nexus with other disciplines (see Figure 3). Environmental, social and economic subjects, which are part of three important components in sustainable development concept, have been found in all issues related to WEF security nexus with different proportions. For example, environmental issues dominated the subject categories for searching phrases 'water security', 'WEF security' and 'WEF security nexus' with the proportions of 33.6%, 36% and 35.6% respectively. Social science is the second subject category which has the percentage of 13.8%, 17.1% and 17.4% using the similar searching phrases. Whereas economic-related discipline has not yet become the dominating subject area, although it appears in each issue of WEF security nexus. Additionally, agricultural & biological science is the dominating subject in 'food security'

with around 23.2%, while energy-related discipline has the highest percentage (19.8%) in 'energy security' keyword.

3.4. WEF Nexus Concept in the context of sustainable development in West Java Province

This finding confirms the association between the WEF system and the sustainable development concept that shown in several frameworks developed by several international organizations and research institutes. Almost all the frameworks indicate that other external factors need to be considered in managing water, energy, food resources in an integrated manner. The main differences of the existing frameworks are among others the key principles with regard to the main concern of each organization, various scales of each framework, and in terms of exogenous factors that influence and be influenced by WEF system. Some of them proposed economy, social, and environmental-related issues as the major components to be considered in managing the resources.

In the context of West Java Province's development, the concept of WEF nexus is expected to assist local stakeholders, particularly planners and decision makers in increasing WEF resources supply, reducing trade-offs, and building synergies during the process of development. For instance, a study conducted by Purwanto *et al.* (2019, 2020) in Karawang Regency suggests that collaborative action plan during the process of planning may improve the achievement of WEF security targets in any levels of government. The involvement of related stakeholders to define the problems, to identify potential trade-offs, and to find a better sollution is effective to respond such dynamic situations in the management of resources. This can also be implemented in the provincial level of government, including West Java Province.

In the policy-making processes, the existence of trade-offs cannot be avoided. By building synergies amongst institutions, policies, and stakeholders, it might be reduced. Synergies may also increase the ability of decision makers to take advantage of the positive sides and avoid the negative impacts of one or more policies they make.

4. CONCLUSIONS

The findings are consistent with those of other studies and suggest that SCO and GOS database can be used as one of the options to have a better insight in doing literature review and analysis. The research topic on the partial sectors of water, energy, and food security were higher in term of number of scientific document and far earlier regarding the year of publication compared to the combined WEF system or WEF nexus approach. Additionally, the environmental, social, and economic subject areas in the issue of water, energy, and food security indicates the close interrelations between WEF system and other exogenous factors such as climate, population, forest, industry, and other economic developments. This study also confirms the change of scientific community perspective on how to see water, energy and food sectors from only sectoral perspective to an integrated approach considering its interlinkages. This study is also expected to broaden the perspective on the research topic of water, energy, and food security nexus. However, the scope of this study was limited in terms of database source that only relying on Scopus database and Google Scholar, without comparing with other scientific databases such as Web of Science, Scimago and others that might be explored in the further study. The main reasons are the lack of access to the other scientific databases and time limitation.

Further research on this topic need to be more comprehensive by considering all potential exogenous factors that will influence and also influenced by water, energy and food sector such as ecosystem services, socio-cultural and economic development. In addition, local and specific-based research and analysis may bring a better impact and

also make the WEF nexus approach really 'grounded', not only part of the theoretical term, but also can be implemented properly in the WEF resource management.

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