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Articles

Analysis of water security and its worldwide context, 2000-2019

Análisis de la seguridad hídrica y su contexto en el mundo, 2000-2019

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Abstract

The water security (WS) approach must be practical and measurable to address water-related challenges. Since 2000, the term Water Security has been regularly mentioned worldwide. However, nowadays, there is still not an accepted definition either for a country or for a region. This research conducted a meta-analysis in the context of renewable water and global water stress, evaluating 873 scientific papers and 26 definitions of WS, using bibliometric network analysis, geographic information systems, and data mining to analyze the state of the art of WS. The results indicate that the definitions of WS have an anthropocentric character. The term economic in the context of WS definitions is the most relevant, and the term ecosystems are the least relevant. Less than 30 % of the definitions analyzed are operationalized through some measurement instrument. The most researched topics on WS are evaluation, management, and impact. On the frontier of study are the issues of water footprint, operation of springs, and awareness. In the world, countries such as the United States, China, and the United Kingdom, with little renewable water in their respective continents, are the ones that publish the most and try to define the concept of WS. Therefore, it is concluded that the main problem of WS definitions worldwide is that they cannot be operationalized in some local indexes, hindering their implementation. In addition, the environment has not been relevant in WS research and definitions.

Keywords: State of the art, meta-analysis, water stress, renewable water, bibliometric network analysis.

Resumen

Para enfrentar los desafíos relacionados con el agua, el abordaje de seguridad hídrica (SH) debe ser práctico y medible. En el año 2000 se hablaba de SH en el mundo; sin embargo, hoy no existe una definición aceptada para un país o región. Esta investigación realizó un meta-análisis en el contexto de agua renovable y estrés hídrico mundial, evaluando 873 documentos científicos y 26 definiciones de SH, utilizando análisis de redes bibliométricas, sistemas de información geográfica y minería de datos, con el objetivo de analizar el estado del arte de la SH. Los resultados indican que las definiciones sobre SH tienen un carácter antropocéntrico. El término económico en el contexto de las definiciones de SH es el más relevante y el término ecosistemas presenta la menor relevancia. Menos del 30 % de las definiciones analizadas son operacionalizadas a través de algún instrumento de medición. Los temas más investigados sobre SH son evaluación, gestión e impacto. En la frontera de estudio se encuentran los temas de huella hídrica, operación de manantiales y sensibilización. En el mundo, países como EUA, China y Reino Unido, con poca agua renovable en su respectivo continente, son los que más publican y tratan de definir el concepto de SH. Por tanto, se concluye que el principal problema de las definiciones de SH en el mundo es que no pueden operacionalizarse en algún índice local, impidiendo su implementación. Además, el medio ambiente no ha sido relevante en las investigaciones y definiciones de seguridad hídrica.

Palabras clave: estado del arte, meta-análisis, estrés hídrico, agua renovable, análisis de redes bibliométricas.

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Introduction

On our planet, approximately 110 thousand km^3 of water precipitates annually. Of this amount, 56 % is lost to evapotranspiration of forest ecosystems and 5 % to rainfed agriculture; the remaining 39 % (43,000 km^3) is converted into superficial and subterranean waters, constituting the renewable resources of water in the world (UN, 2019).

Between 1970 and 2010, water extraction rose from 2 500 km^3 to 3 900 km^3. From 2000 to 2012, 70 % of the world's extracted water was used for agriculture, 19 % for the industrial sector, and 11 % for domestic use (Oberle *et al.*, 201). Due to this immoderate extraction, water scarcity affects more than 40 % of the world population; more countries resent the increase in droughts and desertification, worsening these tendencies. In 2015, 29 % of the world's population (884 million people) still lacked drinking water. This water stress affected more than 2 billion people (UN Water, 2017).

These challenges can be appreciated in the definition of water security (WS): "Every human being, now and in the future, should have enough clean water for drinking, appropriate sanitation, and enough food and energy at a reasonable cost. Moreover, providing adequate water to meet these basic needs must be done in an equitable manner that works in harmony with nature" (GWP, 2000). However, although water security has gained international attention over the years, a surprisingly broad array of related topics have not been investigated in-depth. Therefore, an urgent need exists to carry out extensive research, among others, on emerging issues, future projections, and case studies at national and regional levels (UNESCO i-WSSM, 2019).

More than 1 billion people worldwide have no access to drinking water, and 2.6 billion lack adequate sanitation (Glantz, 2018). Furthermore, it is expected that by 2050, more than 650 million people will have water shortages, and 800 million will be vulnerable to floods (UCCRN, 2018). The above figures were based on population growth, economic development, and consumption patterns. Besides, water quality has been reduced due to contamination since 1990. And this situation is occurring in most of the rivers in Latin America, Africa, and Asia. In addition, extreme hydrometeorological phenomena provoke floods, and droughts worldwide, which are expected to increase due to climate change (WWAP/UN-Water, 2018). Moreover, by 2050, the global demand for food will also increase by 50 %, and crop yields could reduce by up to 30 % due to the effects of climate change (Culimann *et al*., 2019).

For these same reasons, water security is currently compromised and at risk mainly due to fierce competition over the population's use and demand, combined with agricultural and energy use (Martínez & Vallejo, 2018). Therefore, it is necessary to ensure the ecological integrity of natural freshwater systems and focus on the resilience needs of all the water-dependent sectors, given that wetlands, forests, and other essential ecosystems, including 90 % of the big cities' watersheds, are in serious trouble (GCA, 2019).

Despite all of this, there is no deep reflection on the specific objective water safety should have, reflected in the vast number of definitions of the term and the lack of measurement indexes (Peña, 2016). Nevertheless, water security in the territories will remain deficient due to the increasing demand for renewable water, water stress, and pollution, among other factors. Hence, the current challenge for humanity is to address the imminent water crisis by pushing for water security as a global objective (GWP, 2000). The water crisis represents one of the five main risks due to the severity of its worldwide impact in the next ten years (World Economic Forum, 2020). If water security is not achieved, our planet will not be able to respond to the challenges of human development, more populated cities, climate emergency, food, and energy security, to name a few. This situation represents a challenge for many countries that still have complex water management problems, availability, demographic growth, and other related issues, exerting unprecedented pressure on such vital liquid (The World Bank, 2019).

For these reasons, the objective of this research was to analyze the state of the art of water security in the world, in the context of renewable water and water stress, to identify the strengths, weaknesses, challenges, opportunities, and specific characteristics of WS.

Materials and methods

A meta-analysis was carried out in:

1. Scientific documents produced on water security (WS), obtaining: a) Regression of the annual numbers of publications versus time, b) Publications per continent, c) Publications per country, d) Density of occurrence of the terms of the publication, and e) Number of citations per author.

2. Definitions on WS, obtaining: a) Number of definitions per year, b) World clouds on the frequency of thematic attributes, c) Co-occurrence of the terms in the definitions, d) Term relevance, e) Number of thematic attributes, and f) Regional context and measurement proposal.

The search for information about the topic took place from the year 2000 to 2019 (April) given that, at a worldwide level under the motive of the II World Water Forum in The Hague, Netherlands, from March 17 to March 22, 2000, the concept of water security (WS) begins to be identified and clarified for water management (Peña, 2016). Therefore, the procedure was divided into three contexts to carry out the investigation's objective (Figure 1):

1) Worldwide renewable water and water stress.

2) Definitions of water security in the world.

3) Scientific production about water security in the world.

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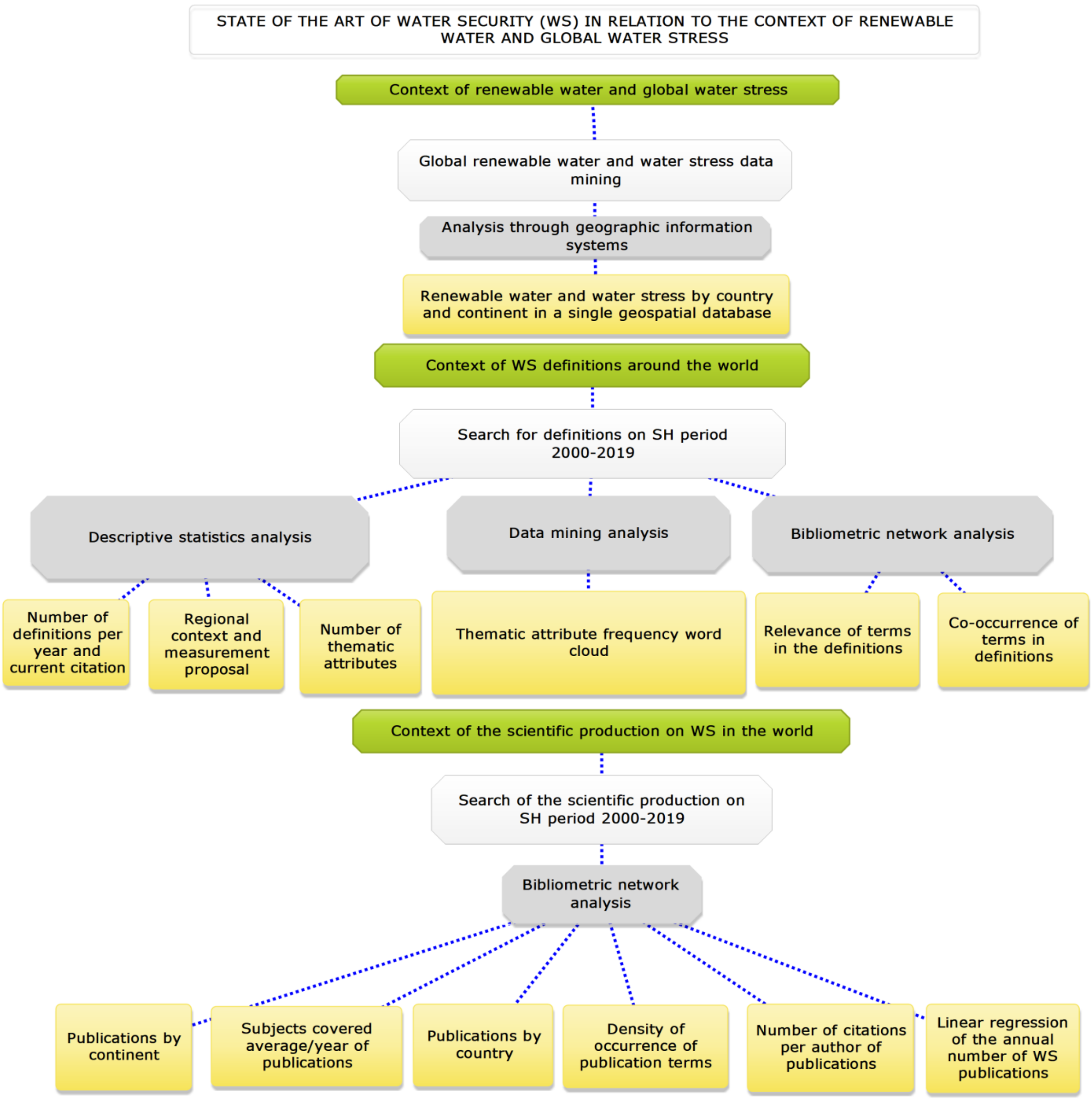

Figure 1. Diagram of the research procedure.

Achievement and Analysis of Water Renewal Data and Global Water Stress

The data system (FAO-AQUASTAT, 2019) of the Food and Agriculture Organization of the United Nations was consulted to obtain world data on water renewal *per capita*. Once downloaded, these data were linked to digital cartographic files with the ArcMap module of the *ArcGis* geographic information system (ESRI, 2019), through the standard code of each country, to later analyze the renewable water figures per capita.

The worldwide water stress data were obtained from the World Resources Institute website and correspond to the *Aqueduct Global Maps 3.0* data set. Water stress was defined as the number of available water resources and the quantity extracted for domestic, agricultural, and industrial uses (Hofste *et al*., 2019). Once the data were downloaded, they were analyzed to obtain the water stress baseline per country. Then, with the baseline identified, the water stress was linked to the countries' limits.

The digital cartographical limits of the countries were obtained from the *Natural Earth Data* (V 4.1, 2018) (Natural Earth, 2018). This data correlates the country's names with the standard codes of the United Nations statistical division, which facilitated the union of the renewable water layers and water stress in a single cartographic database (Natural Earth, 2018).

Renewable water and water stress were used to explain the hydrological context in which the literature on water security and its definitions are being published.

Achievement and analysis of water renewal data and global water stress

Four groups of databases were consulted to select the literature on water security. First, the databases of *Europe PMC* were reviewed, finding 5.8 million records, *PubMed* with 19 million records, *ScienceDirect* with 15 million records, and *Dimensions* with more than 101 million records. After being reviewed, *Dimensions* was selected (Digital Science & Research Solutions, 2019) for containing the highest number of available documents. Moreover, it is relevant to mention that *Dimensions* has an export system for bibliometric analysis with open software (*Vosviewer* and *CiteSpace*). Finally, the English language was used for the search of scientific documents in Dimensions, given that the most significant number of publications were found in this language. The search pattern was the following:

a) Search topic: *Water Security.*

b) Period: *2000-2019 (April).*

c) Researchers: *All.*

d) Fields of research: *Environmental Science and Management, Physical Geography and Environmental Geoscience, Environmental Engineering, Applied Economics, Public Health and Health Services, Ecology, Policy and Administration, Political Science, Soil Sciences, and Plant Biology.*

e) Type of Publication: *Articles and book chapters.*

f) Source title: *Nature Nanotechnology, Water Policy, Water, American Water Works Association, Journal of Environmental Management, Water Science & Technology, Water Research, Water Resources Research, NATO Science for Peace and Security Series Environmental Security, International Journal of Environmental Research and Public Health, The Science of The Total Environment, PLoS ONE, Philosophical Transactions of The Royal Society A Mathematical Physical and Engineering Sciences, Water Security in a New World, Water Security, Journal of Water Security*.

Afterward, the data search was downloaded to accomplish a regression analysis through *Excel* (Microsoft, 2019), searching for the curve that represented the best adjustment through the highest determination coefficient, based on the number of publications by year of the period 2000-2019 of the literature about water security.

The information obtained from *Dimensions* was used to analyze the bibliometric networks using the *VOSviewer* software (van Eck & Waltman, 2010), which has backup documentation and scientific literature to build, analyze and visualize bibliometric networks. These networks include journals, researchers, or individual publications on citations or coauthor relations. The general characteristics of the bibliometric network analysis were:

a) A minimum number of term occurrences: three.
b) Analysis method: Full count.
c) Percentage of used terms: 100 %.

Achievement and analysis of the definitions of water security

Derived from the review of various articles that proposed water security definitions, the most relevant ones were focused on the period 2000-2019 (until April). Later, the language was unified to analyze them through data mining, bibliometric networks, and thematic attributes.

For the analysis through data mining, the software *Orange* version 3.24.0 (Demšar *et al*., 2013) from the Ljubljana University of Slovenia was used. The objective was to elaborate a workflow to obtain world clouds used by some authors of water security definitions, such as Cook and Bakker (2012) and Sun, Staddon, and Chen (2016), in the field studies of hydrology, environment, and sustainable development, geography, and agriculture.

From the analysis of bibliometric networks, the text analysis of the *VOSviewer* software was used to build and visualize co-occurrence networks of important terms extracted from the scientific literature on water security, using the following parameters:

a) A minimum number of term occurrences: two.
b) Analysis method: Full count.
c) Percentage of terms used: 100 %.

For its interpretation, network visualization was used. In these networks, the terms are represented by their label and, by default, with a circle. The article's weight determines the label's size and the article's circle. The heavier the weight of an article, the larger its label and circle. The color is determined by the cluster to which the term belongs. The lines between the articles represent links (van Eck & Waltman, 2019).

With *VOSviewer*, an analysis of relevance or selection of the most relevant substantive noun phrase was made. First, for each citation (nominal), the co-occurrence distribution in all the expressions is determined. Then, this distribution is compared to the global distribution of co-occurrence on phrases. The higher the difference between both distributions (Kullback-Leibler distance), the greater the relevance of a nominal expression. This way, the terms with the highest score represent specific topics, unlike terms with low scores, which tend to be generic and non-representative (van Eck & Waltman, 2019).

The analysis of the definitions through their thematic attributes was carried out to identify the repeated properties since they tend to accumulate (or reduce) attributes over time, suggesting a progression of thought. Therefore, analyzing the ideas they concentrate on (Gerlak *et al*., 2018) is essential. This analysis identified the definitions that proposed some measurement instrument (index or indicator) in its geographical reference space.

In analyzing scientific literature and definitions on water security, a review of texts and words was conducted, selecting only the relevant and coherent ones, and eliminating words or prepositions in the case of definitions.

Results

The analysis found 873 publications on water security (WS) during 2000-2019, from which 25 % (218) were concentrated between 2017 and 2018, as demonstrated in Figure 2.

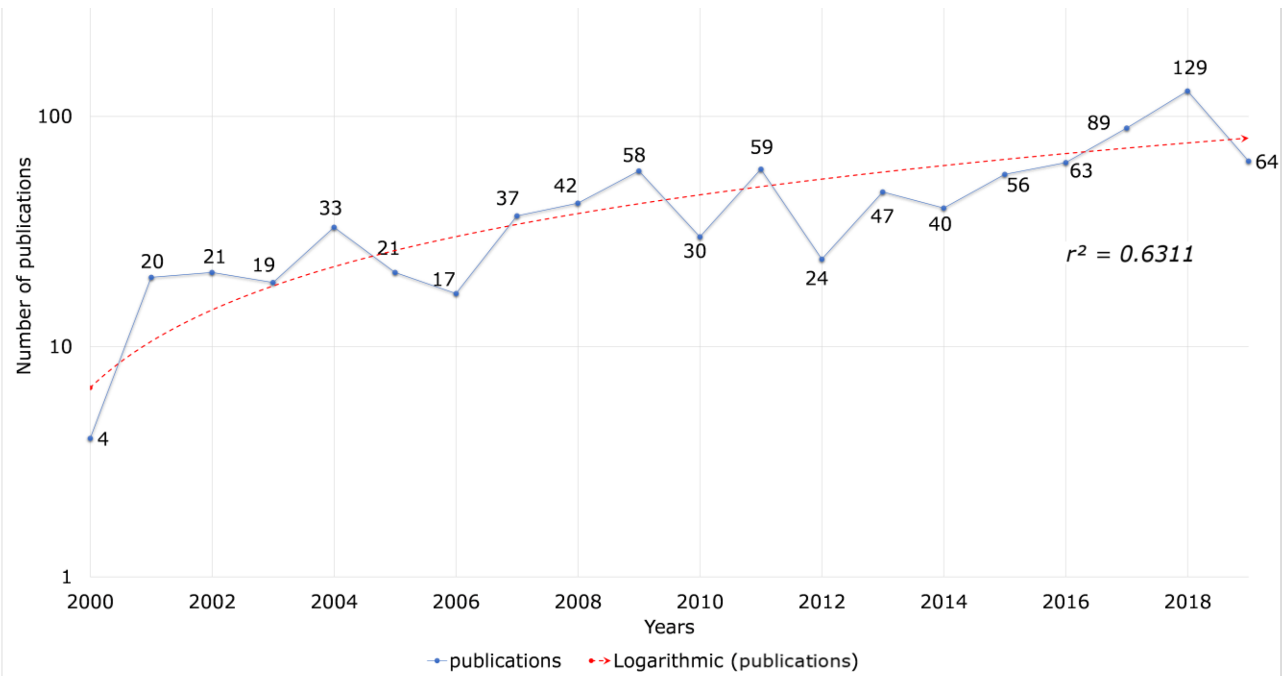

Figure 2. The logarithmic trend of the scientific production of WS in the world, from the period 2000-2019, was obtained through the formula:

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$y = b * +c$. Own elaboration based on Digital Science & Research Solutions (2019).

Of the 873 publications on WS, it was possible to identify the continent of origin of 83 % of the investigations (727 documents). The European continent stood out with 35 % of the publications (Figure 3), taking the fourth place (of the six continents) of renewable water with an average of 7 640 m^3/inhabitant/year, as well as low-medium water stress. In contrast, South America barely produces 1 % of the publications and ranks first in renewable water of the analyzed continents with an average of 41 316 m^3/inhabitant/year and low water stress.

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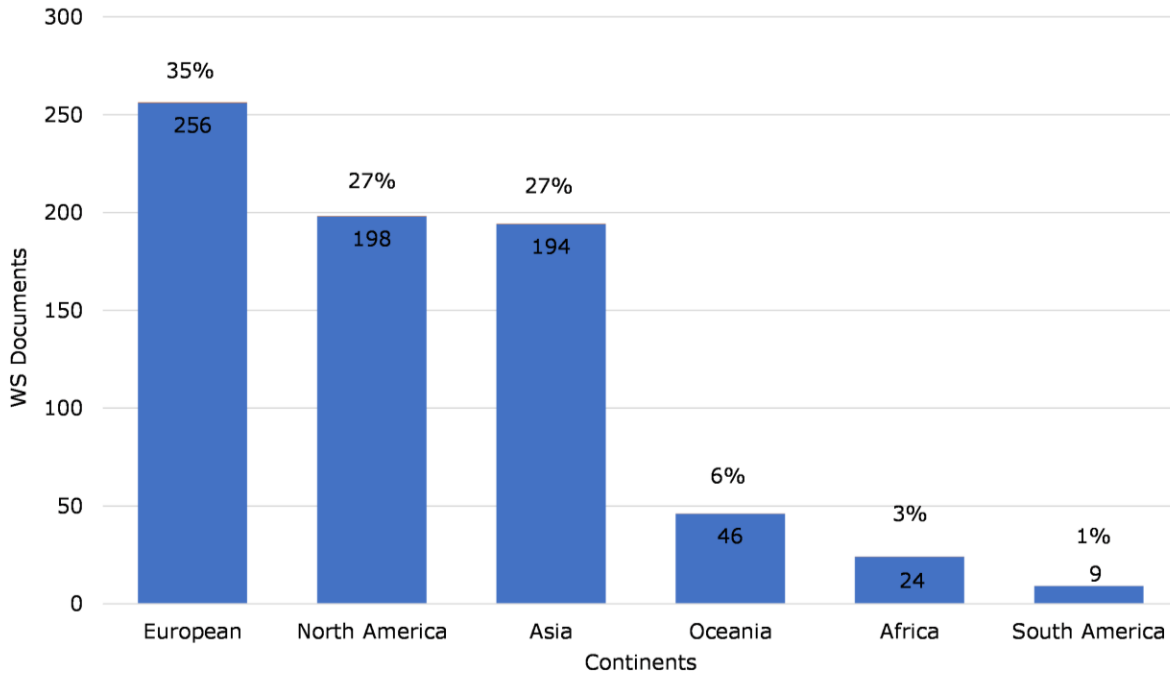

Figure 3. Scientific production on water security in the world by continent, from 2000-2019. Own elaboration based on Digital Science & Research Solutions (2019).

The publications on water security (727) are published in 38 countries (Figure 4). Four countries produce 50 % of all the publications: the United States (21 % of the publications) ranks fourth place (of four) in the North American continent with 9 459 m^3/inhabitant/year of renewable water and low-medium water stress level, China (15 % of the publications) ranking ninth place (of 17) in the Asian continent with 1 971 m^3/inhabitant/year of renewable water and a medium-high water stress level, United Kingdom (8 % of the publications) in twelfth place (of 14) in the European Continent with 2 221 m^3/inhabitant/year of renewable water and a low-medium water stress level, and Australia (6 % of the publications) in Oceania with 20 123 m^3/inhabitant/year of renewable water and a medium-high water stress level.

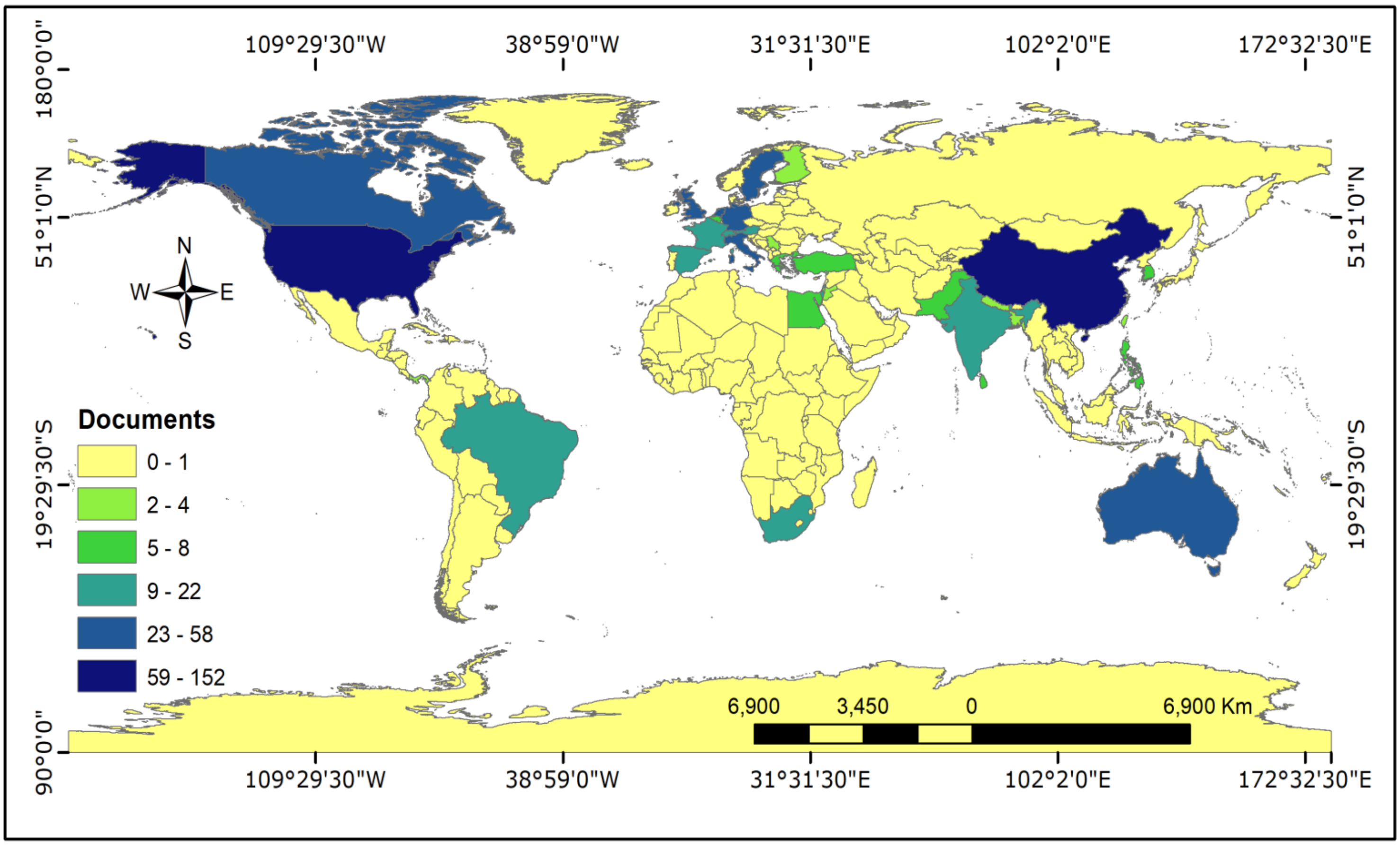

Figure 4. Scientific production on water security in the world from the period 2000-2019. Own elaboration based on Digital Science & Research Solutions (2019).

In the diachronic analysis (average/year) of WS publications, the ten highest values address issues related to integral evaluation (2018), water footprint (2018), water insecurity (2017), operation of springs (2017), awareness (2017), nutrition (2017) concerning health and food, soil (2017), evidence (2017), potential (2017) and ecosystem services (2016).

In the analysis of the density of occurrence visualization (Figure 5), ten terms stand out for being found in the study border of the analyzed publications: the water-energy-food nexus, awareness, worldwide food security, evapotranspiration, water footprint, operation of springs, human rights, world security, viability, and equity, respectively.

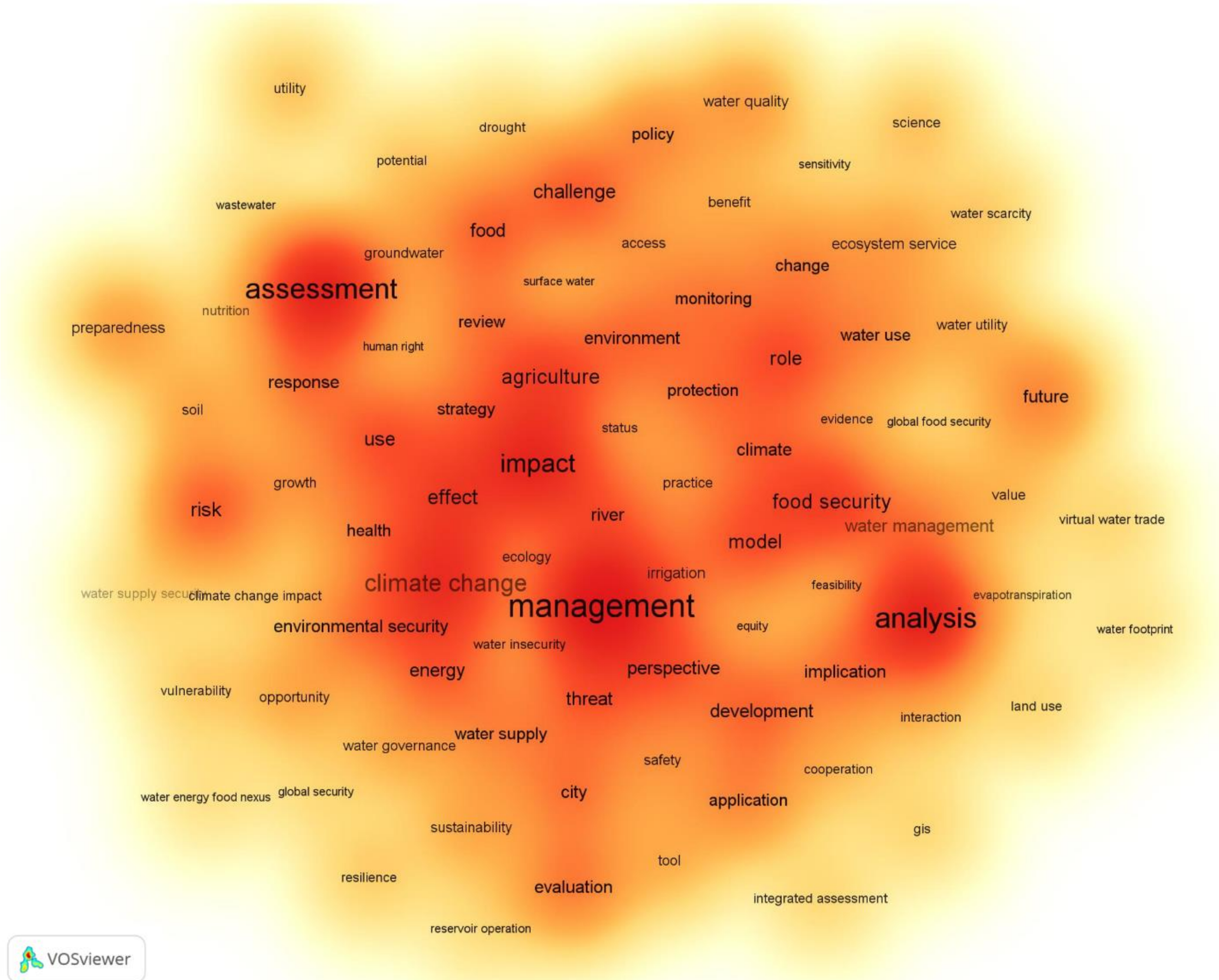

Figure 5. Visualization density analysis of the occurrence of the terms of the publications on water security 2000-2019. Own elaboration based on Digital Science & Research Solutions (2019).

Regarding the analysis of authors per citations (Figure 6) through the visualization of networks, the publication of Grey and Sadoff (2007) stands out, "Sink or Swim? Water security for growth and development", which has been cited 320 times; followed by Wagener *et al*. (2010), "The future of hydrology: An evolving science for a changing world," cited 305 times; and Zhang, Zhang, Zhao, Rustomji y Hairsine (2008), "Responses of streamflow to changes in climate and land use/cover in the Loess Plateau, China," cited on 236 occasions.

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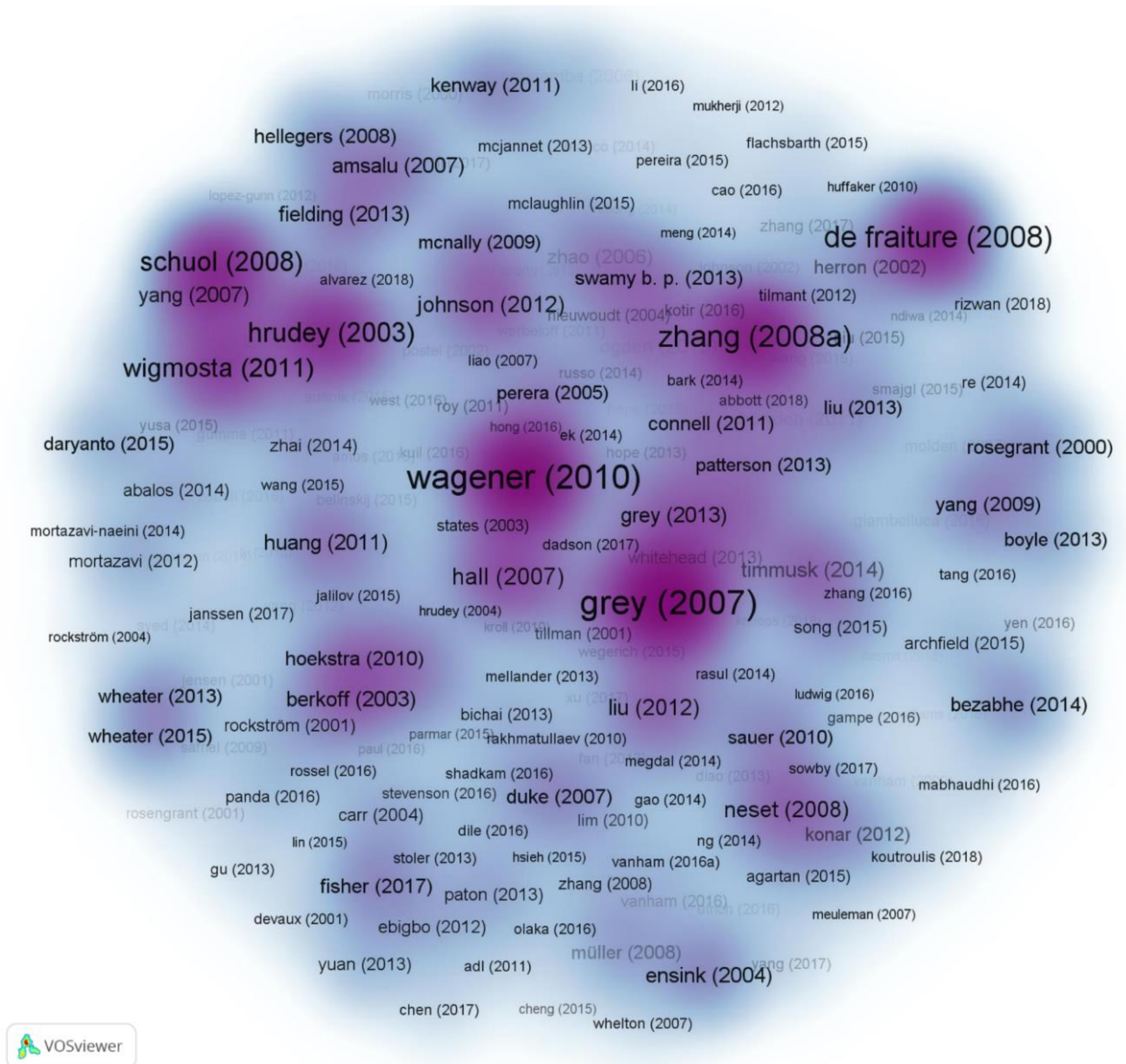

Figure 6. Authors Analysis per citations of the publications on WS 2000-2019. Own elaboration based on Digital Science & Research Solutions (2019).

Achievement and Analysis of the Definitions of Water Security

Twenty-six definitions of water security (WS) were obtained from the period 2000-2019 (April), where 54 % of these were published from 2012 to 2016 (Figure 7).

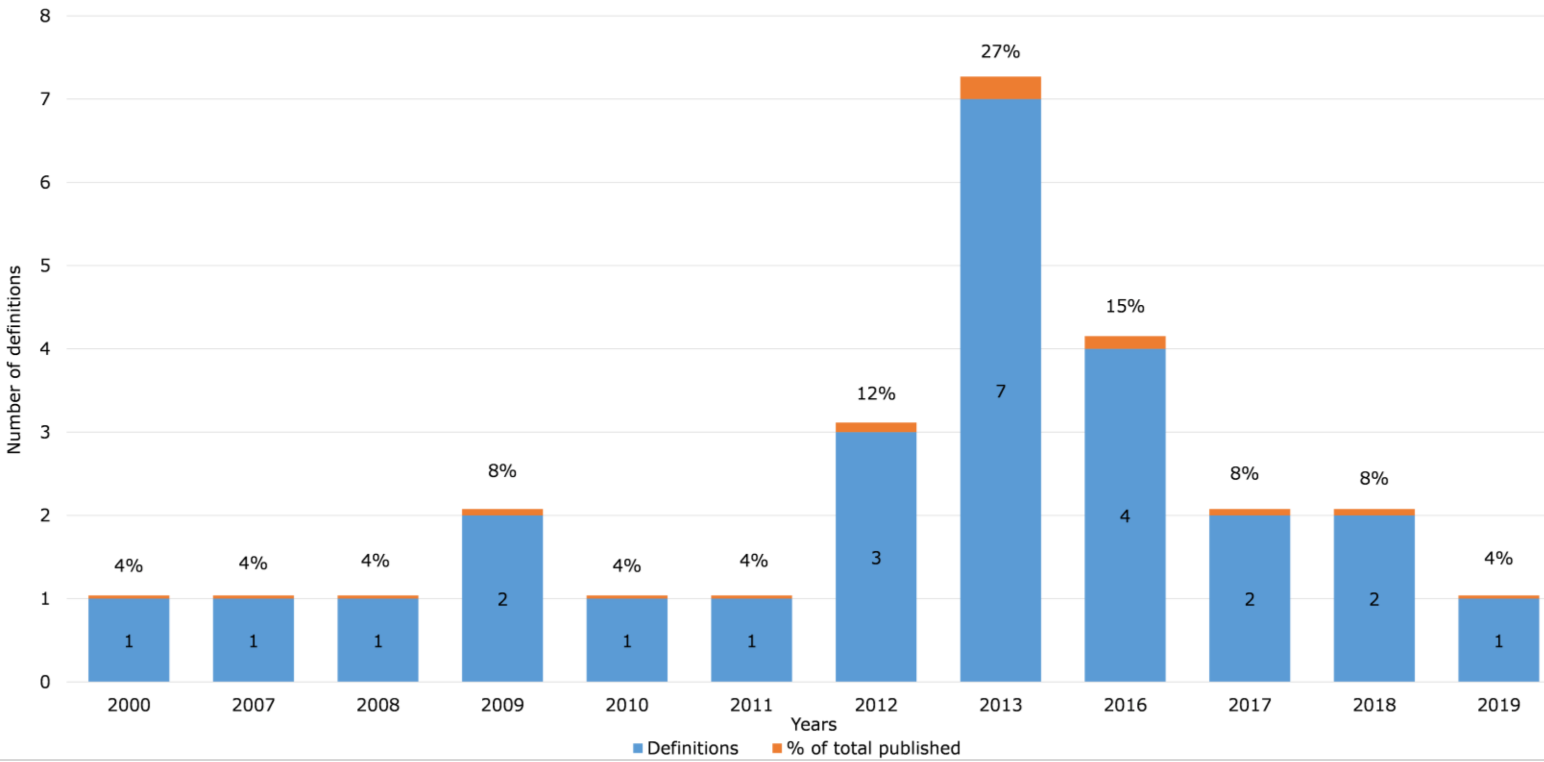

Figure 7. Number of WS definitions per year. Own elaboration based on Google Scholar, Digital Science & Research Solutions (2019), and Research Gate.

The three most cited WS definitions in the world can be appreciated in Table 1.

Table 1. Most cited WS definitions.

Author/year	Definition	Citation count to 2020
Grey and Sadoff (2007)	"The availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems, and production, coupled with an acceptable level of water-related risks to people, environments, and economies."	865
Bakker (2012)	"An acceptable level of water-related risks to humans and ecosystems, coupled with the availability of water of sufficient quantity and quality to support livelihoods, national security, human health, and ecosystem services"	343
UN-Water (2013)	"The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability"	92

Source: Own elaboration based on Google Scholar.

A world cloud was obtained derived from the analysis with data mining to the 26 water security definitions, where the terms ecosystems (frequency: 17), quality (frequency: 16), and capacity (frequency: 12) stand out due to their higher frequency (Figure 8).

Figure 8. World cloud of water security definitions. Own elaboration based on Google Scholar, Digital Science & Research Solutions (2019), and Research Gate.

From the co-occurrence analysis through the visualization of networks (Figure 9), the terms ecosystem, security and capacity stand out.

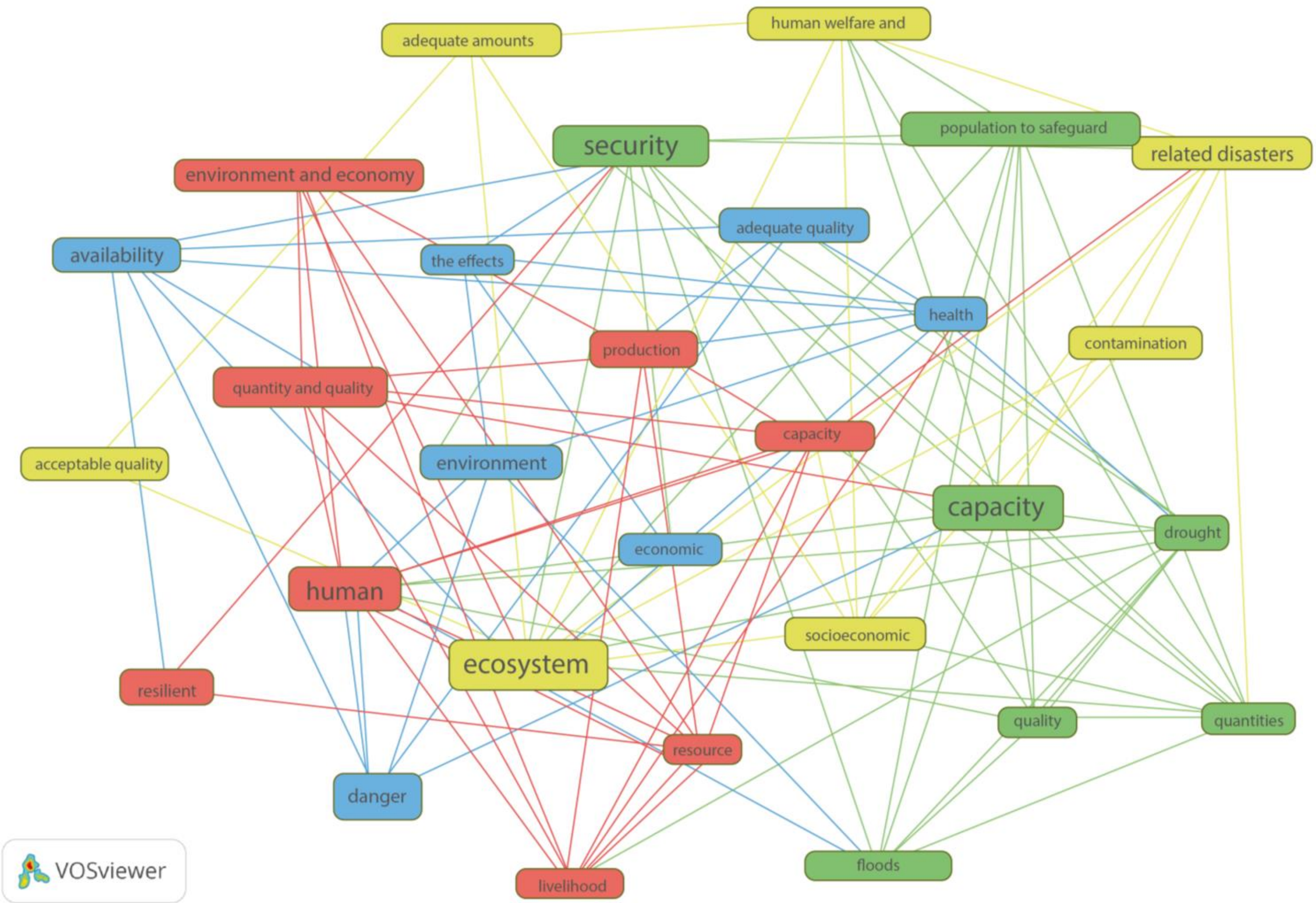

Figure 9. Co-occurrence analysis of the terms of water security definitions. Own elaboration based on Google Scholar, Digital Science & Research Solutions (2019), and Research Gate.

Derived from the analyses of the relevance in the context of water security definitions (Figure 10), economic, acceptable quality, and effects stand out. It should also be noted that the term ecosystem ranks in last place of 29.

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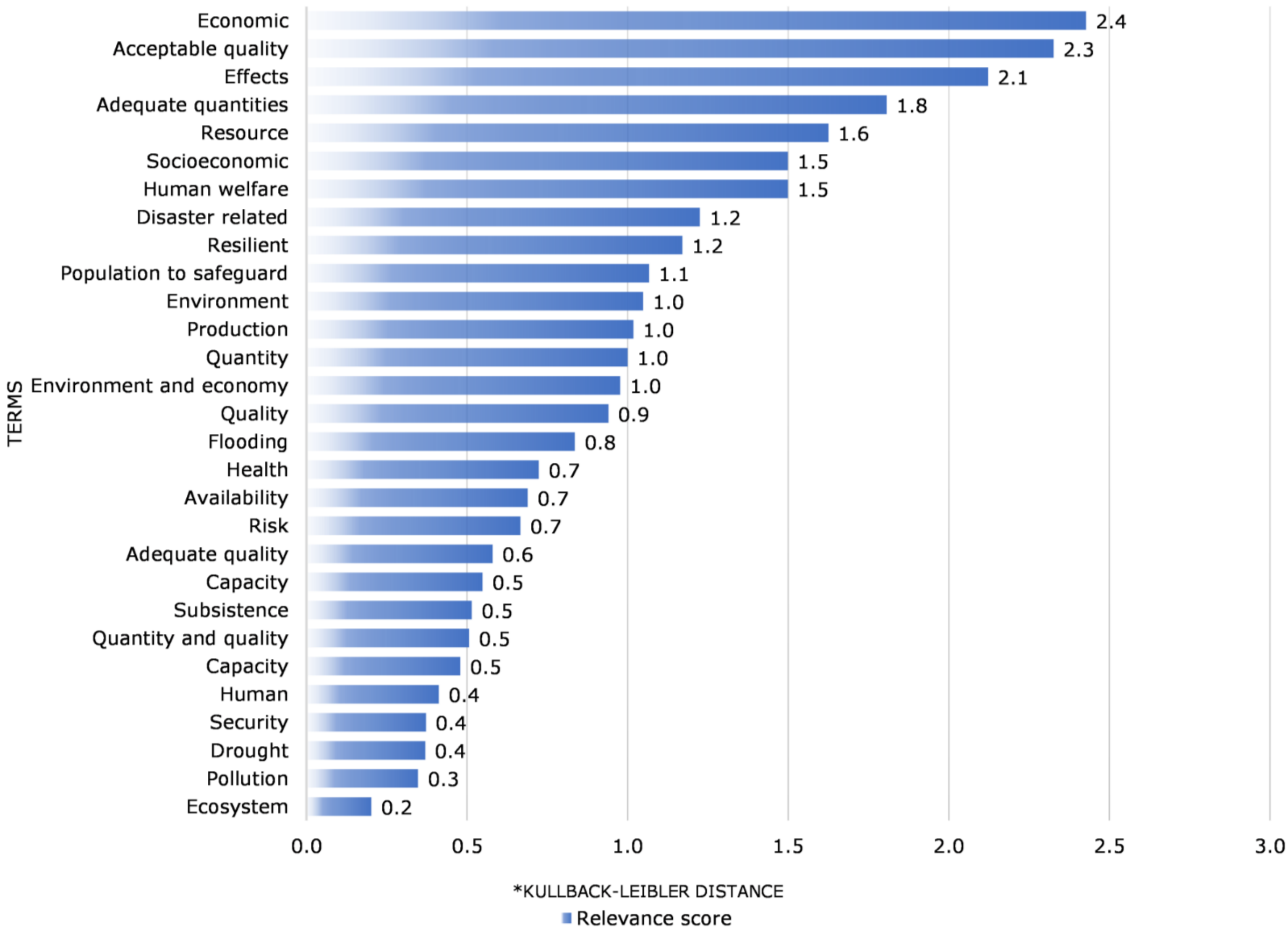

Figure 10. Term relevance of the water security definitions. Own elaboration based on Google Scholar, Digital Science & Research Solutions (2019), and Research Gate.

Regarding the analysis of definitions through their thematic attributes, 15 definitions (of 26) present the most thematic attributes (Figure 11) from which the definitions of Gleick and Iceland (2018), and Fuster, Escobar, Astorga, Silva and Aldunce (2017), and Bakker (2012) stand out, respectively. The same analysis shows the most frequent thematic attributes in the definitions, from which ecosystems, amount, and quality stand out.

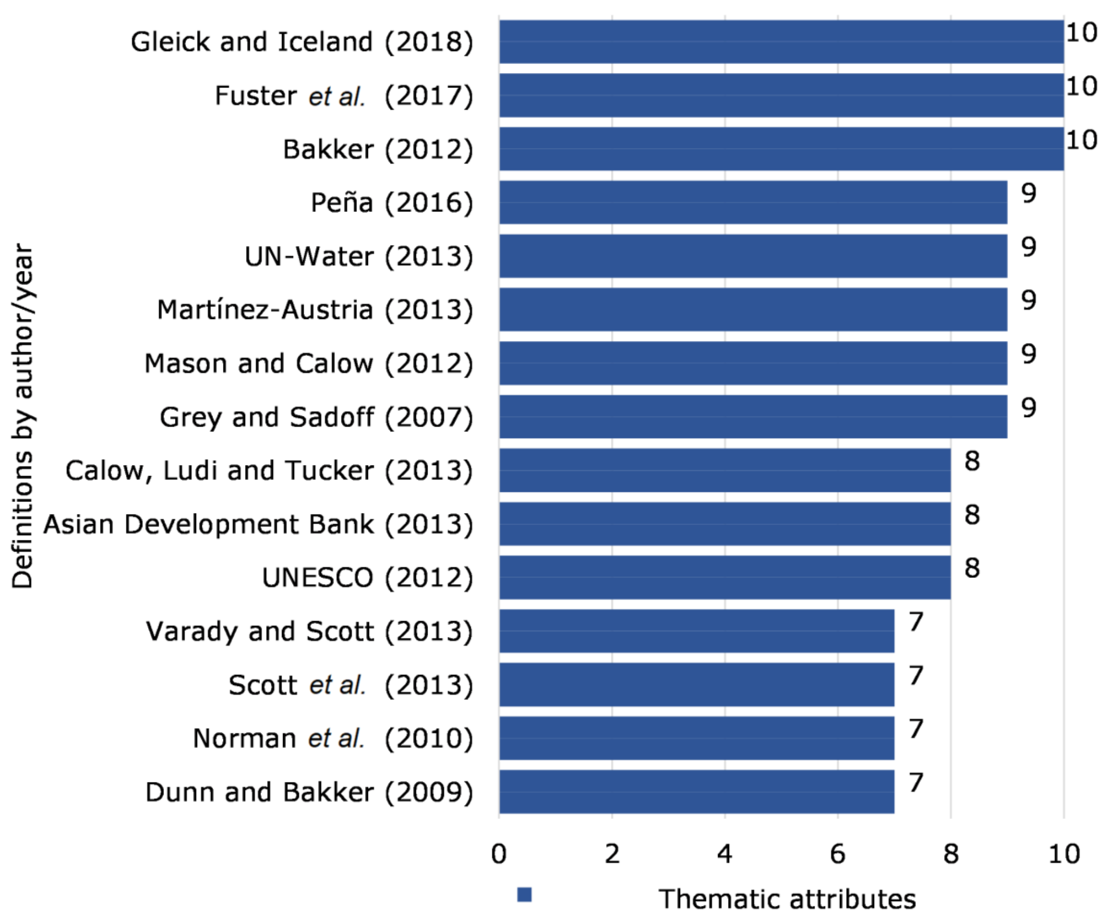

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Figure 11. Number of thematic attributes in the water security definitions. Own elaboration based on Google Scholar, Digital Science & Research Solutions (2019), and Research Gate.

From the analysis of the definitions proposing any measurement instrument, out of the 26 analyzed definitions, 27 % (seven definitions) propose some index or indicator. It should be noted that only 29 % of the definitions at a regional level have a measurement proposal (Figure 12). In contrast, in the definitions of the country context, 25 % propose an instrument to operationalize the definition.

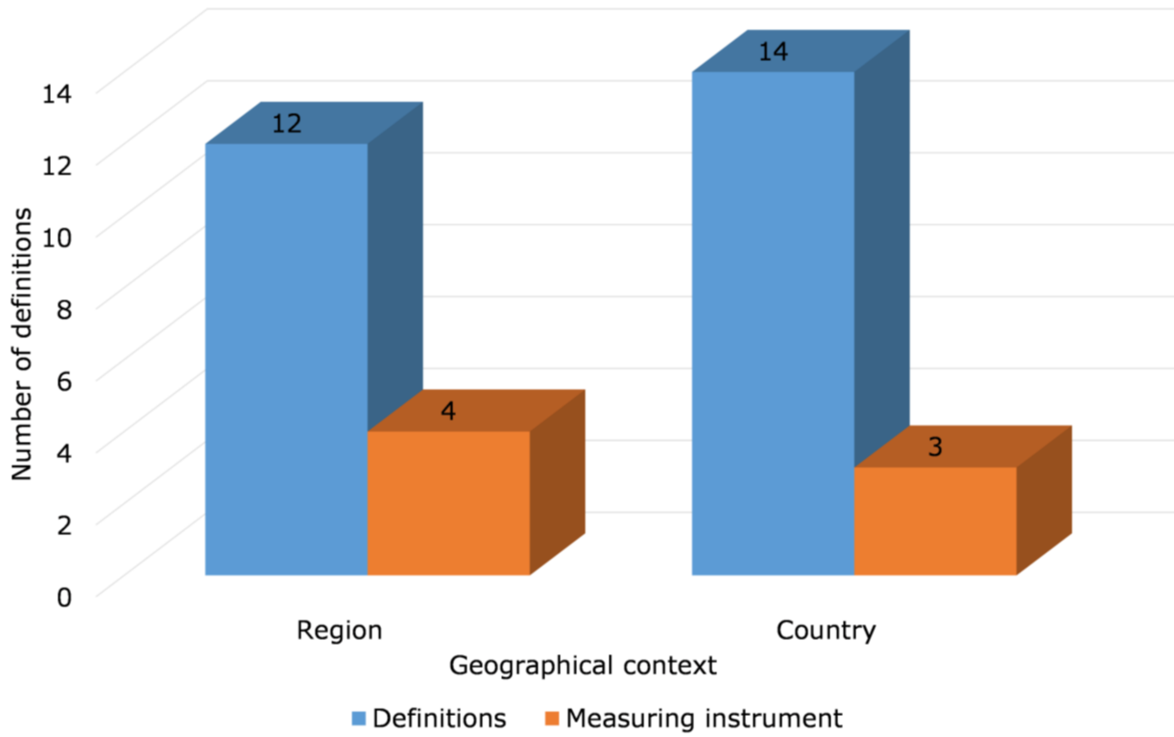

Figure 12. Measurement instruments in the analyzed water security definitions. Own elaboration based on Google Scholar, Digital Science & Research Solutions (2019), and Research Gate.

Discussion

Despite having analyzed 873 publications of various branches of study, perspective, dimension, and analysis, some not yet published or incorporated into *Dimensions* may be missing. Nonetheless, an increase in the annual publications on the issue is observed, reflecting a scientific, social, and political interest.

By incorporating the terms renewable water and water stress, it was possible to correlate the context in which the research on water safety in the world was produced. For example, Europe, the fourth of six continents in renewable water *per capita* and with economic resources to publish, has 35 % of all the scientific production on the issue. This tendency is repeated at a country scale, where the United States, China, and the United Kingdom publish 44 % of the scientific production, and in each one of their continents, they show low to very low values of renewable water.

In this sense, by comparing the data on the amount of renewable water per continent and per country (in the continental context), it is evident that there is a relationship between renewable water *per capita* and the number of publications on water security without implicating the water stress that measures the relationship between the amount of available water and the amount extracted for various uses. This situation manifests an anthropocentric tendency based on the amount of the hydric resource as the guiding axis of research. Authors like Gunda, Hess, Hornberger, and Worland (2019) coincide with these analysis results.

The diachronic analysis (average/year) and the visualization density analysis of occurrence show three fundamental topics being addressed recently: integrative evaluation, water footprint, and awareness. These topics are found in the border of water security science, with the characteristic that all three depart from multidisciplinary research. Authors like Varis, Keskinen, and Kummu (2017) agree that water security is a multidimensional concept that can be observed in food, energy production, supply in quantity and quality of service, risk management of hydrometeorological disasters, society resilience, vulnerability, and sustainability, among others.

Regarding Grey and Sadoff's definition (Grey & Sadoff, 2007), the most cited definition on water security to date, it is noteworthy that they were able to establish a definition with understandable terms, although challenging to operate. Their concept has influenced at least 46 % (12) of the 26 analyzed definitions, which can be confirmed through the Digital Science & Research Solutions database (2019), indicating that 45 % of its citations have been received in the last two years, thus suggesting that it is currently gathering substantial attention.

Unlike the scientific production on water security, more than half of the definitions on the issue were published from 2012 to 2016, with a record year of publications in 2013, implying six years of great interest in deciphering the concept. Although such attempts have not ceased, the decline from 2016 to 2019 in trying to define water security is notorious. The latter is due in part to the existing number of publications and the lack of assertiveness or appropriation of the concept by any public entity to transform it into a universal concept and a public policy that results in the operation of the definition.

It is essential to mention that constantly including the terms *ecosystem*, *environment*, or *sustainability* in water security definitions is insufficient, as the mining data and co-occurrence analysis show. In this case, the importance of the word within the context of the definition is determinant, and the analysis of the relevance of the term shows that it has not been a specific topic nor relevant in the researched definitions, unlike the *economic*, *acceptable quality*, *the effects* and *adequate amounts* term. The aforementioned indicates that the definitions of water security in the world mostly have an anthropocentric tendency, linking water mainly to the satisfaction of human needs. Authors like Zeiton

(2011); Cook & Baker (2012); and Bizikova, Roy, Swanson, Venema, and McCandless (2013) have detected and criticized this tendency.

For this reason, it is not odd that terms such as *resilience* and *groundwaters* are part of the border of science since they constitute a line of research more linked to sustainability and ecosystem, unlike those being developed currently, agreeing with Srinivasan, Konar, and Sivapalan (2017).

Definitions of the concept of water security in the world are evolving and incorporating more elements; from 2009 to 2012, they consisted of seven thematic attributes compared to 2017 to 2018, which have ten terms, which allows inferring an attempt to build a comprehensive definition, suggesting a progression of thought as indicated by Gerlak *et al*. (2018).

Nowadays, there is a tendency to develop the concept of water security through the world or continent definitions (46 % of the analyzed definitions). Implying that they may be only slightly operational, showing different scales and metrics that are complex to apply and measure over time, as pointed out by Cook and Bakker (2012) aside from Gerlak *et al*. (2018). Of these supranational definitions, only four propose an instrument to operationalize the concept. In this sense, Whittington, Sadoff, and Allaire (2013) agree that these generic water security estimations are inefficient in guiding national or regional decisions, which could lead to a lack of utility for public policy implementation. Authors such as Dunn, Cook, Bakker, and Allen (2012); Garrick and Hall (2014);

Van Beek and Arriens (2014); Garfin, Scott, Wilder, Varady, and Merideth (2016), and Kauffer and Gallardo (2019) agree that wanting to measure and define water security through large scales is not convenient. Instead, they recommend a local index constructed from various indicators in various dimensions that allow its operation, measurement, and improvement.

The same tendency is repeated in the definitions analyzed at the country scale (54 %), where only three propose some instrument to operationalize the definition of the concept. In regard to this, authors like Gain, Giupponi, and Wada (2016), in addition to Zeitoun (2011), indicate that a conceptual tool that can be implemented is better than the published definitions of water security since these are narrow, focusing on the human being or they encompass too much, to the point that they cannot be put into practice.

Conclusions

Countries are disseminating scientific knowledge on water security; however, the interest in the issue reflected through the number of publications depends on the renewable water they can access, which relegates water use to a second place. This situation explains why countries with either low or high-water stress produce documents and definitions on water security with low renewable water levels in their respective continents.

Currently, most water security definitions cannot be operationalized due to two characteristics: the first is that they are laid out at a regional continental or world level, which makes them diffuse when comparing data at a local level. The other characteristic is that less than 30 % of the definitions propose some measurement instrument, which prevents its application and tracking. Thus, although more local regions are preferred to evaluate water security, it is very complex to find an index or indicators proposal starting from the local to the global.

Therefore, it is recommended to address water security with an integral local approach, evaluating at least the three basic dimensions of sustainability with *economic*, *environmental*, and *social* indicators. In this sense, it is essential to reassess the environment in terms of water security efficiently. Moreover, it should be approached as a dynamic system due to the traits of the study subject and the current velocity at which the information and its analysis can be improved.

Given the lack of depth of the environmental issue in water security, three variables remain absent in the research on water security: a) availability of groundwater, b) possible pollution of surface waters and groundwaters, and c) wastewater discharge.

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Lastly, and as a form of reflection, the term water security is relatively new; therefore, the concept has not managed to permeate, or the means to measure it lack the environmental dimension in depth. Water is still being seen as a good ready for use, and it is in the face of the scarcity of this vital liquid, that it is researched, and diverse definitions are proposed. The latter occurs without reflecting over fundamental questions such as 'why is there a certain amount of water in a territory?' or 'if there is water, why is it not accessible for use?', given that both questions are only answered with the environmental dimension immersed in the response, in addition to an integral diagnosis on a smaller scale unlike those that have arisen so far.

Since water security is still an issue under exploration, it is possible to break paradigms and fully complement the deficiencies presented in the last 20 years for future generations and avoid falling into imminent water insecurity.

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