Research impact of Food Security and Climate Change on a worldwide scale, using publication frequency maps.

Georgios Anastasiou
Wageningen University
Droevendaalsesteeg 3,
6708PB
Wageningen, Netherlands
ganastasiou85@hotmail.com

Sander Janssen
Wageningen
Environmental Research
Droevendaalsesteeg 3,
6708PB
Wageningen, Netherlands
sander.janssen@wur.nl

Abstract

Food Security and Climate change are societal challenges which are researched by researchers around the world. Climate Change is showing its effects in the long term, while Food Security is something tangible that already affects millions of people's life globally. The objective of this research is to understand the relative size of the body of knowledge spatially and temporally between these topics by analysing publications. To analyse the research conducted, lists of publications of the topics are studied to find their temporal and spatial meaning while visualizing the results into maps were needed. The lists of publications for the topics are acquired from Scopus®' database using a specific query for finding only the most related publications to the topics. For the processing part, R programming language is used to read, process using text mining techniques and extract results out of the datasets and finally the results are visualized using GIS software. On a worldwide scale, there has been conducted a lot more research about Climate Change than Food Security. The expected trend, of developed countries having less interest than developing countries in researching Food Security, relatively to Climate Change, is partially confirmed.

Keywords: text-mining, Scopus®, R, research impact, GIS

1 Introduction

The term Food Security (FS) was introduced back in the 1974's World Food Conference, and in 1996's World Food Summit, the term was renewed. Food Security *"exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". (*E/CN.4/1998/21)
FS and nutrition security combined, are about ensuring that everybody can access sufficient, affordable and nutritious food. This has also been a topic for research, to study obstacles and pathways to achieving food security, considering different local conditions.

Recently quite many reports on the state of food security were published in recent years, for example, a recent policy brief for the G20 meeting. With this interest in Food Security, it is important to understand the body of knowledge in supporting policy making both spatially and temporally. It seems also relevant to compare the relative size of the body of knowledge with another societal challenge, more specifically climate change.

Climate Change (CC) can be defined as a change in the statistical distribution of weather patterns when that change lasts for a prolonged period. Brown & Funk (2008) argue that in a few decades the impacts of Climate Change will be more than profound both in agriculture and food systems. In the same research, it is stated that more than 30% of the farmers in developing countries are food insecure due to changes in the climate e.g. global warming and lack of policies to protect them and give solutions. There is an urge to control the human influences on the climate. Researchers use observations and theoretical models to study CC scenarios using indicators and finding results that are within the next fifty to one-hundred years (IPCC, 2014). Using the results of those scenarios scientists in cooperation with the local governments and global organizations strive to mitigate the effect of CC using existing technologies and policies to lower GHG emissions (UNFCCC, 2008). Scientists use their findings as a reference to develop better climate adaptation strategies (Tan et al, 2017).

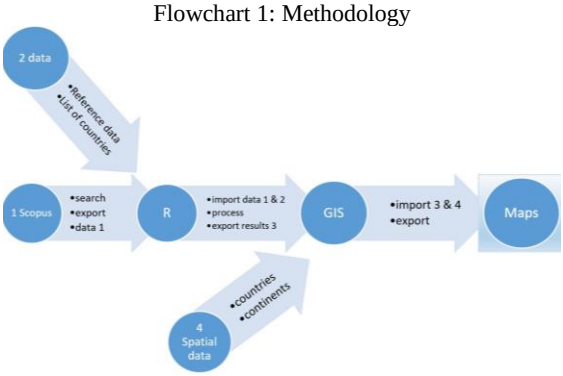
Although CC and FS are related to each other, in this study they will be opposed to comparing the relative sizes of their body of knowledge. Since the CC is expected to have its bigger impact in a few decades, and the FS impacts already millions of people daily, it is hypothesized that more publications will be on FS than on CC, as this is the more acute problem. Still in 2015, globally, 795 million people were undernourished, the 12.9% of the total population (FAO et al. 2015). This study proposes a way for evaluating the

body of knowledge through publication frequency on the topic of FS in comparison to CC's. and interprets the results temporally and spatially.

2 Methods

The proposed methodology is to firstly acquire the data in the form of lists containing all available information about the publications. Then import the data to R for processing it to

Flowchart 1: Methodology



Information flow diagram of the research

output a frequency table containing all the countries in the world and the number of publications found for each. This table is imported into GIS software, where maps can be created visualizing the results. In this way, publications are analysed to estimate the spread of research conducted on the topics spatially and temporally. A brief representation of the methodology can be found in Flowchart 1

2.1 Search Query

Searching in, Elsevier's solution, Scopus® database, queries were used to get the most relevant publications on the two topics (Table 1).

Two techniques were followed, searching the fields title-abstract-keywords (TAK) or only the keywords (OK) field. To find the largest number of relevant publications the TAK technique was used initially, but if the number of publications was larger than one hundred thousand, then the OK technique was used. In this way, the results were reduced in a consistent way on all the searches making the number of publications comparable.

2.2 Data acquisition

The search results are downloaded in the form of CSV files. The publication's lists were downloaded on chunks of max 2000 (a limitation for downloading from Scopus®) by manually selecting them and then merging the parts of the data to create the final list for use in the next step. The lists exported from Scopus® included all the available information on each publication, found in Table 2.

A reference list of countries worldwide is required that will be linked to the data of the publications' list. The list of countries' names and their ISO codes have been retrieved from the NationalOnline.com website. while a reference spatial dataset of the counties' borders is retrieved from ThematicMapping.org. The continents reference spatial dataset is found on ArcGIS.com.

2.3 Process and visualise data

All the related CSV files are read in R. The pre-processing phase of publications' list, covers the elimination of any duplicate entries and the creation of a corpus out of the information needed to be used for each case. This corpus is processed to set all letters into lowercase, excluding commonly used words and eliminating special characters. From the countries' CSV, a list of only the country names is extracted and a simple pre-process is done to set all letters into lowercase and eliminate special characters.

The corpus created out of the publications' CSV is text-mined to find the frequency of country names occurrences in the address section. The result is, for the case studied, a table with the frequency of publications found for each country.

The reference spatial dataset of the countries' borders and the newly created CSV result file are imported into ArcGIS. Then the attribute table of the spatial dataset is merged with the CSV file using a column with common attributes, the ISO3 counties' code is used for that purpose.

3 Results

To test a wider range of applications of the produced publication's frequency tables and to have a better

Table 1: Search Queries

Topic	Query	Case used	Search field	Period
food security	"food security" OR "food insecurity" OR "food access" OR "food accessibility" OR "food utilization" OR "food stability" OR "food sovereignty"	1	keywords	1999 - 2016
		3	article title- abstract-keywords	2011 - 2016
climate change	"climate change"	2		
climate change and food security	"food security" OR "food insecurity" OR "food access" OR "food accessibility" OR "food utilization" OR "food stability" OR "food sovereignty" AND "climate change"	4	keywords	

understanding of the results, four cases are studied. The first three cases make use of the publication's frequency tables to understand better how research on FS evolved in time, the difference in using TAK or OK when searching for publications and the sorting in CC research can be done using text-mining. The fourth case compares the publications found on the two topics.

Table 2: Publications' list, included information

type	information
Citation information	Author(s), document title, year, source title, volume, issue, pages, citation count, source and document Type, DOI
Bibliographical information	Affiliations, serial identifiers (e.g. ISSN), doi, pubMed id, publisher, editor(s), language of original document, correspondence address, abbreviated source title
Abstract and Keywords	Abstract, author keywords, index keywords
Fund Details	Number, acronym, sponsor, funding text
References	References
Other information	Tradenames and manufacturers, accession numbers and chemicals, conference information

3.1 Case 1: Food Security through time.

In Table 3 is shown the number of publications written about FS for the past eighteen years (1999-2016) in three six-year steps. The target of this case is to study the evolution of research on FS during this period. What can be observed is a seemingly gradual increase in the number of publications on FS. The number of publications is growing in a similar manner in all continents except Australia which seems to have a bigger growth on publications' numbers, mainly explained by the lower numbers on the first two steps. On the other side, Africa seems to have the lowest rise in percentage for the last six years, mainly explained by the bigger number of publication in the second step, percentage-wise, and a high number of the first step.

Table 3: Results of Case 1

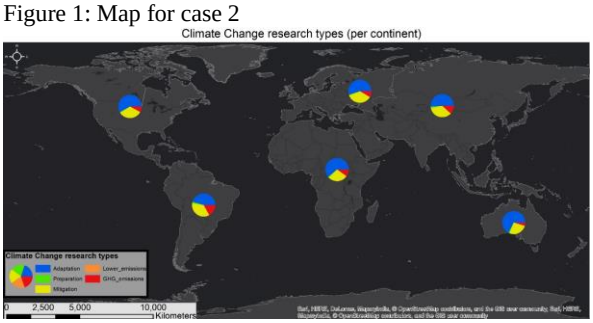
Case 1 / **Continent**	**Year 99-04 / % per continent**	**Year 05-10 / % per continent**	**Year 11-16 / % per continent**
Africa	185 / 8.1%	681 / 29.7%	1428 / 62.2%
Antarctica	0	0	0
Asia	264 / 6.9%	812 / 21.2%	2759 / 71.9%
Australia	41 / 4.1%	197 / 19. 8%	756 / 76.1%
Europe	408 / 9.2%	1088 / 24.6%	2928 / 66.2%
North America	537 / 9.7%	1345 / 24.3%	3654 / 66%
South America	31 / 5.1%	155 / 25.6%	420 / 69.3

There is initially a higher interest in North America and Europe, but a rising interest in the developing world.

3.2 Case 2: Climate Change research types.

For this case, publications used are from the period between 2011 and 2016. There were selected five terms commonly used in CC research to categorize the results. Those terms are adaptation, preparation, mitigation, lower emissions and greenhouse gasses (GHG) emissions. By searching those terms, through text-mining, in the abstract of each publication in the list, differences in the attention to CC adaptation, mitigation, and GHG emissions can be observed (table 4 & Figure 1) across the continents.

Figure 1: Map for case 2



Source: created in ArcGIS out of processed data

Table 4: Results for Case 2

Case 2 / **Continent**	**Adaptation / % per continent**	**preparation / % per continent**	**mitigation / % per continent**	**lower emissions / % per continent**	**GHG emissions / % per continent**
Africa	337 / 61.2%	6 / 1.1%	154 / 27.9%	0 / 0%	54 / 9.8%
Asia	744 / 51.2%	29 / 2%	505 / 34.8%	3 /0.2%	172 / 11.8%
Australia	472 / 67.6%	10 / 1.4%	183 / 26.2%	0 / 0%	33 / 4.7%
Europe	1935 / 54.5%	50 / 1.4%	1253 / 35.3%	10 / 0.3%	301 / 8.5%
North America	1097 / 57.7%	21 / 1.1%	621 / 32.7%	10 / 0.5%	151 / 7.9%
South America	107 / 45.1%	5 / 2.1%	83 / 35%	2 / 0.8%	40 / 16.9%

Table 5: Results for Case 3

Case 3 **Continent**	**TAK**	**OK**	**(TAK / OK) * 100**
Africa	1431	710	49.6
Asia	2780	1250	45.0
Australia	757	400	52.8
Europe	2960	1601	54.1
North America	3678	2195	59.7
South America	425	225	52.9
Total	12031	6381	53.0

3.3 Case 3: Search-field comparison, using Food Security publications.

In this case, a comparison was performed to find what the different in numbers is when searching using either technique mentioned earlier. The results were, from the total number of publications found using TAK, using OK was found the 53%. On the continents, individually, the result is close to the 53% of the total.

Interpreting these results means that about half of the publications do not have the FS as a keyword but they have it as part of their title or abstract. This can be explained by the fact that typically when the main topic's term is not part of the keywords since it is already part of the title. One way to interpret this is that ½ of the publications have as their main target to study FS, while the rest ½ are probably studying issues related but not directly the FS.

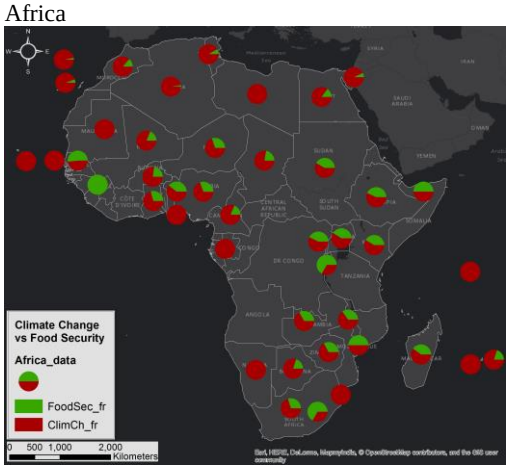
3.4 Case 4: Comparison between Food Security and Climate Change publications.

Table 6 shows the number of publications found in FS and CC research and the percentage, per continent. This table reveals the large difference in the number of publications on CC in comparison to FS of comparing research on developed and developing countries.

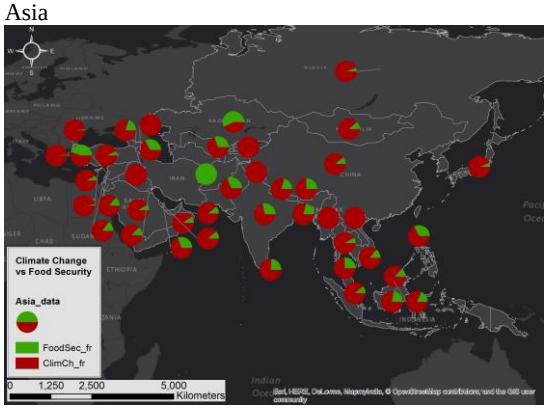
These results are visualized in maps of continents, showing distribution per country. For developing countries in Africa, Asia, and South America, it is expected to find relatively more research on FS since it constitutes an everyday problem for many of them. From Figure 2, it can be observed that Africa has more interest in conducting research on the FS topic than CC, however, its total number of publications is extremely small compared to North America, Europe, and China.

Figure 2: Maps for case 4

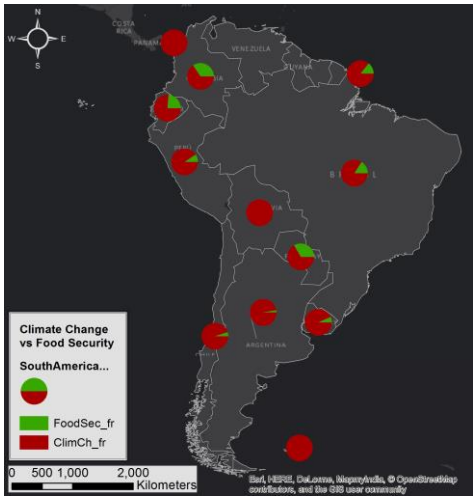
Africa



Asia

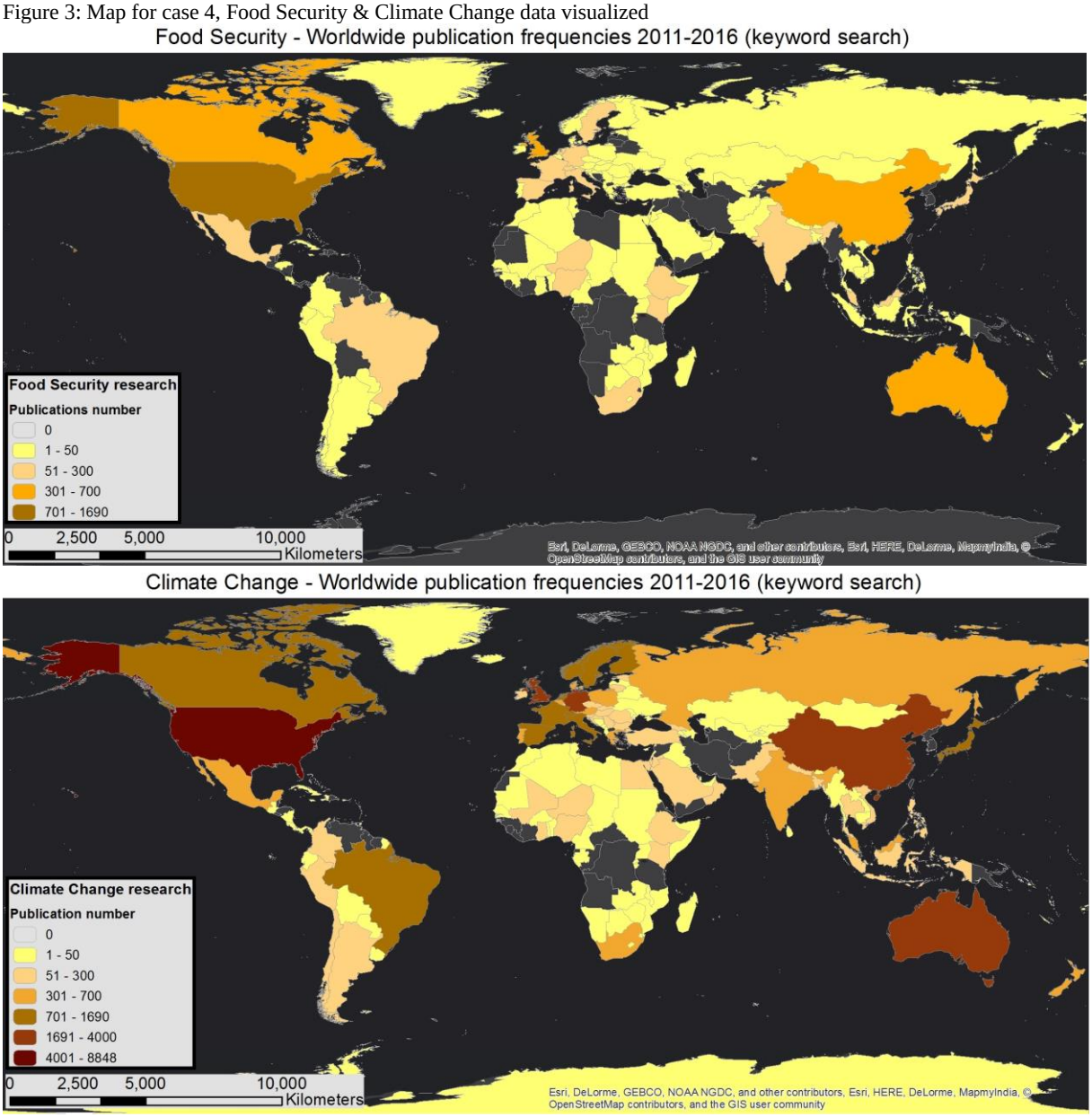


South America



Source: created in ArcGIS out of processed data

Figure 3: Map for case 4, Food Security & Climate Change data visualized



Source: created in ArcGIS out of processed data

Table 6: Results for Case 4

Case 4 / **Continent**	**CC number / % per cont.**	**FS number / % per cont.**
Africa	1675 / 70.2%	710 / 29.8%
Asia	8172 / 86.7%	1250 / 13.3%
Australia	2977 / 88.2%	400 / 11.8%
Europe	16990 / 91.4%	1601 / 8.6%
North America	11126 / 83.5%	2195 / 16.5%
South America	1409 / 86.2%	225 / 13.8%

Considering individual countries found on the map, there can be seen some having research on FS comparable to the research on CC and others having no research on FS whatsoever.

Although a similar trend was expected in Latin America or Asia it doesn't appear to be like that. For Asia, this can be partially explained because developed and developing countries coexist and there is a more intensive use of the land in comparison to Africa. For Latin America, the reasons are like Asia with more industrialized agriculture and fewer smallholder systems. After consulting closely, the maps of Asia and South America (Figure 2), it appears to be small interest on FS research.

Out of the same data, there were two more maps created, found in Figure 3, showing the number of publications per country. By using the same scale and colour scheme, the

publications between the two topics are directly comparable. This comparison confirms the initial conclusion from Table 5, that the number of publications on CC is significantly larger than the number of FS. With developed countries producing the vast majority of the publications on both topics.

4 Conclusions

Our research demonstrates that using relatively simple methods the size of the body of knowledge can be investigated from studying publications' numbers. The results can also provide an insight into the development of the body of knowledge temporally and spatially.

From the results, it can be derived that 1. Many more publications have been produced on climate change than food security over the previous years; 2. A steep increase in the number of publications over FS topics can be observed during (almost) the last two decades; 3. Priorities in the developing world should be different from the developed world, but still, they both conduct more studies about CC; 4. The developed world is producing the vast majority of publications in comparison to the developing world on both societal challenges.

Many more different analyses can be done with these resulted lists. For example, in case 2, the use of text-mining can enable a further investigation on the topics focusing each time on what is of greater importance for specific regions. More specifically, sub-fields/terms like food access, food quality, nutrition could be studied within FS and help us understand further how those relate.

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