

*Full Length Research Paper*

# **Climate change study in Burkina Faso from 1987 to 2018: An online systematic review for future directions**

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**In this paper, we perform a bibliometric analysis of published climate change research in Burkina Faso for the period of 1987 to 2018. More specifically, this article aims at (1) revealing the temporal, and categorical patterns in climate change research; (2) summarizing the global research trends from multiple perspectives; and (3) providing an alternative demonstration of research advancements about climate change which may serve as a potential guide for future research in Burkina Faso. Scopus, ISI Web of Science, and Google Scholar were used to collect publications data. The initial search yielded five hundred and sixty-six publications. After removing duplicated documents and application of inclusion/exclusion criteria, 349 documents were retained for analysis. The study reveals that since the beginning of this century, the study on climate change is increasing in the scientific community, and publications are widely distributed in a large number of journals. Climate change has been studied in connection with other topics such as agriculture, health and diseases, water resources and wetlands. These results suggest that research productivity in the area of climate change in Burkina Faso has increased since the beginning of this century. However, there is a lack of studies connecting climate change and aquatic fauna in Burkina Faso. These results could help to orient the national research in the matter of climate change and its implications.**

**Key words:** Climate change, bibliometrics, West Africa.

## **INTRODUCTION**

Nowadays, the climate change concept is increasingly used in the scientific community over the world (Lukwale and Sife, 2017). Burkina Faso like many countries in Africa is vulnerable to the impacts of climate change (Ouedraogo et al., 2010). The country is a predominantly

agricultural economy (Zougmore et al., 2018). The sector contributes to 30% of GDP and occupies 90% of people (FAO, 2015). This implies that its economy and development depend mainly on natural resources that are vulnerable to climate variability and change (Sarr,

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2012). In a context that climate change poses a critical threat to the survival of our planet (Smith et al., 2012; IPCC et al., 2013) and occupies a central place in most environmental subjects (Epule-Epule et al., 2017), scientists are tackling a lot of questions about it (Marx et al., 2017). Policy-makers are also aware of climate change challenges (CCNUCC, 2009). Many studies already demonstrated that climate change affects water resource in Burkina Faso (Bambara et al., 2013; Bodian et al., 2013; Greimel et al., 2018) and food security (Clover, 2003; Vermeulen et al., 2012). Then, climate change has been approached in the literature in various ways. Nevertheless, information is sparse and there is a need to collect, analyze the structure and characteristics of scientific publications, and to synthesize them to orientate future research. Moreover, there are no bibliometric studies on the trends of research concerning the climate change area. Therefore, the present study, which is a knowledge synthesis analyses the climate change research trends by attempting to provide answers to questions about the structure and characteristics of climate change research in Burkina Faso by assessing the past and current state of knowledge on the subject of climate change in Burkina Faso using bibliometric research. Otherwise, National adaptation strategies should base on important scientific research (CCNUCC, 2012). The main questions are about (1) research that has been already done, (2) information need to be collected, and (3) future orientation of climate research in Burkina Faso. Bibliometric research is a branch of Bibliology widely used to analyze the products of scientific research contained in various types of journals (Perea-Moreno et al., 2018). It is a statistical method used for assessing trends in a specific subject (Mao et al., 2018) and a good tool to analyze the structure and characteristics of scientific publications, collect data and orientate future research (Barbosa and Schneck, 2015; Liang and Gong, 2017; Mao et al., 2018).

## MATERIALS AND METHODS

### Study area

Burkina Faso is located in the center of West Africa between latitudes 09°20'N and 15°N and longitudes 05°03'W and 02°30'E with an area of 274 200 km<sup>2</sup>. It is a continental country without direct access to the sea. Its climate is the Sahelo-Sudanian type and is characterized by extremes of temperature oscillating between 15 and 40°C with an average of 28.8°C (Mouhamed et al., 2013) as well as considerable rainfall variations ranging from an average of 350 mm in the North (Sahelian climate) to 1200 mm in the South-West (Ouédraogo et al., 2010). This situation over the country has been characterized for several decades by a decrease, irregular rainfall, and a weakening of ecosystems (Ki et al., 2013).

### Search strategy

The knowledge synthesis consists of two parts: a literature review and bibliometric analysis. For the literature review, the data were

collected online for four weeks, from the 1st to the 28th of September 2018 at the University of Groningen. The data collection used three well-known bibliometric search engines to collect scientific publications from several journal databases. These were Web of Science (WoS), Elsevier Scopus (Scopus), and Google Scholar for relevant publications. These research engines provide comprehensive and standardized data and have been widely used by academia (Gao et al., 2016; Lukwale and Sife, 2017). The period of publications covered by the three-search engine during this research lasted from 1987 to 2018, for a total of 31 years. We did not use Google Scholar directly because it tended to include other items that are not useful for our study. So, Google Scholar has been only used when the document was not accessible on WoS or Scopus. These search engines were retained because of their accessibility to an important number of publications (Perea-Moreno et al., 2018; Tessier et al., 2016). Our search in WoS and Scopus focused on seven (07) keywords in two languages (English and French): 'Climate change', 'Changement climatique', 'Global change', 'Changement global', 'Global warming', 'Rechauffement global' and 'Burkina Faso'. The choice of these two languages is because Burkina Faso is a French-speaking country and then, the national language is French. Concerning English, it is since this language constitutes nowadays the main language used in the scientific community (Ferguson et al., 2011). Each keyword linked to climate change has been paired with the country name "Burkina Faso" and has been entered into the search box of each search engine and listed articles were downloaded. In the Web of Science search field, each of the keywords is linked with Burkina Faso using the "\*" symbol. In Scopus and Google Scholar, the Boolean operator "AND" has been used for keyword matching. When the article is not accessible on these engines, we copy the title and launch the Google Scholar search. If access still not possible, we just copy the title, the abstract, the year of publication, the names of the authors and the name of the journal into a Word file. Article which summary is not accessible are discarded from analysis.

## Inclusion and exclusion criteria

### Inclusion

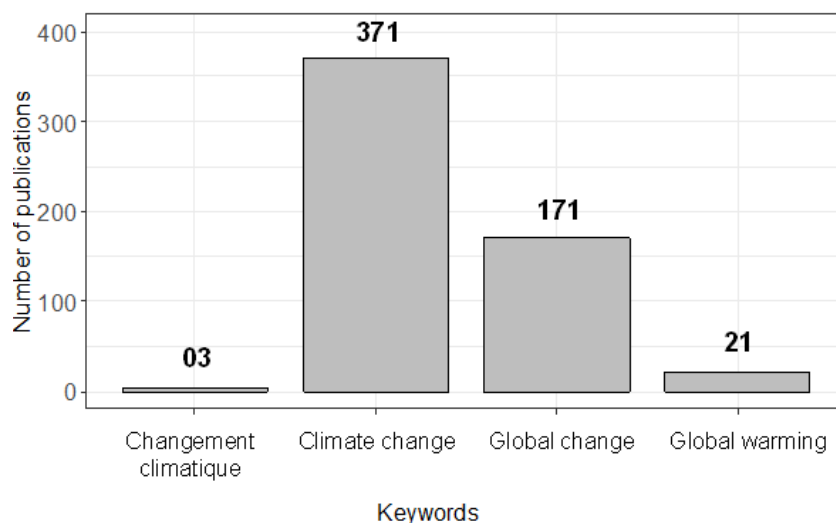
The search was restricted to studies conducted in Burkina Faso or a geographical area including Burkina Faso. After the raw data collection, only the publications having Burkina Faso, Africa, the world, or a part of the world including Burkina Faso as a field or subject of study were considered for the bibliometric analysis. The second criteria to include publication was the topic addressed.

### Exclusion

The publications where Burkina Faso was not concerned by the study were excluded even if the author(s) are from Burkina Faso. The studies that had no publication date nor the author(s), nor journal name were also removed. We have also excluded the duplicated publications and only one of these documents was retained for analysis.

## Data organization and analysis

After downloading, the publications are listed on an Excel sheet with the following information: Publication title, first author name and et al., document type, study area, research topics, journal name (where the paper has been published), keywords used, and search engine used. For the Bibliometric analysis, we first analyzed downloaded documents by type (article, poster, books, conference paper, etc), year of publication, and locality. Secondly, we analyzed



**Figure 1.** Number of publications by keywords.

the publications according to the research topic, to highlight favorite topics. We also determined the total number of published papers (TP) and growth index (GI) for each subject of the top 10 considering publications dating from 2000 to 2018. The delimitation of this period in the calculation of GI is because, during this period, the published papers are more homogenic than the period before where papers are sparse, minor, and which consideration could make bias in the result interpretation. The growth index shows, for 2 periods of the same duration, which period has an increase in the number of publications (Picard-Aitken et al., 2015). To do that, we first determined the date (year) of the first and last publications during this century as the global period of each top 10 main subjects. After that, we subdivided this period into two sub-periods with the same length when the number of years is paired and  $x+1$  (for the first period) and  $x$  (for the second period), when the number is impaired. This formula has been used to determine growth index:

$$GI = \frac{\sum_{P2(cd)} \text{Published papers}}{\sum_{P1(ab)} \text{Published papers}}$$
 Where  $P_2$  means second sub-period beginning in  $c$  year and ending in  $d$  year;  $P_1$  means first sub-period beginning in  $a$  year and ending  $b$  year. The relative growth rate (RGR) was calculated using this formula:

$$RGR = (\ln N_2 - \ln N_1) / (t_2 - t_1)$$
 where,  $N_2$  and  $N_1$  are the cumulative number of publications in the years  $t_2$  and  $t_1$ . The RGR is the increase in the number of publications per unit of time. For our analysis, we have just considered the period covering 2000 to 2018 as before that period, data are discontinuous. The software R version 4.0.2 was used to carry out statistical analysis.

## RESULTS

Our initial search on WoS, Scopus, and Google Scholar databases yielded 566 publications. After application of exclusion criteria, only 349 publications have been submitted to bibliometric analysis.

### Keywords research

According to keyword research, “climate change” has

yielded the most publications with 371 documents (61.66%). No document has been downloaded by “Changement global” and “rechauffement global” (Figure 1). Then, only 3 documents were found using French word with “Changement climatique”.

### Study areas

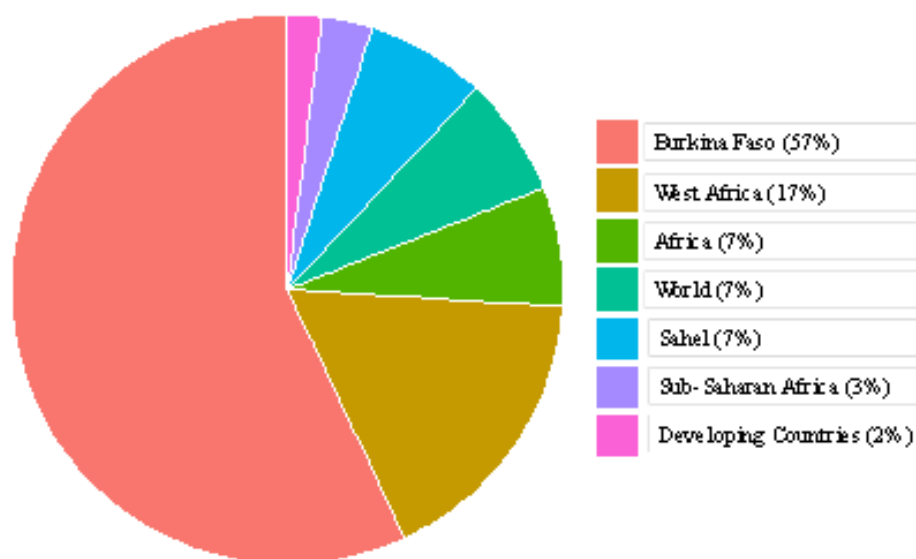
Six regions (study areas) were encountered in addition to Burkina Faso: Africa, Developing Countries, Sahel, Sub-Saharan Africa, West Africa, and World. Most papers are focused on Burkina Faso, up to 57%. About 17% of the documents deal with the West Africa region, 7% for Africa, 7% for World and 7% for the Sahel. Only 2-3% and of the studies concern respectively Sub-Saharan Africa and developing countries including Burkina Faso (Figure 2).

### Types of publications

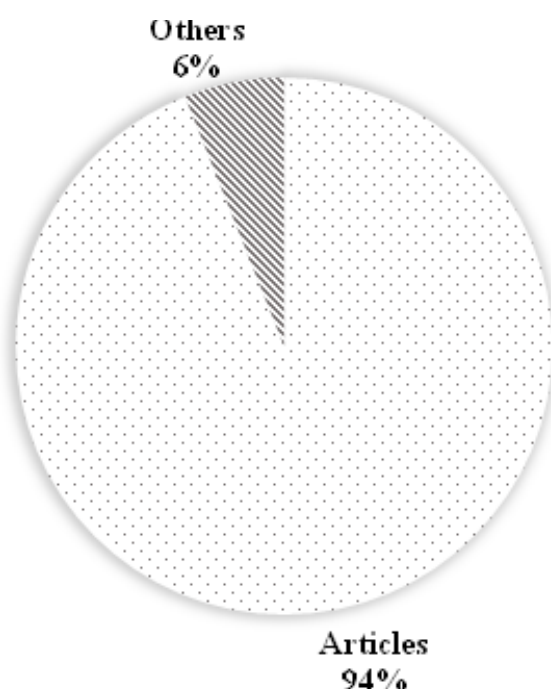
As part of the work done on climate change concerning Burkina Faso, most documents, up to 94%, were scientific articles. The remaining 6% are books, parts of books, conference papers and posters, or reports (Figure 3).

### Trend of total publications

The analysis of publications per year revealed a rapid growth in research on climate change in Burkina Faso since the beginning of the 21<sup>st</sup> century (Figure 4). The histogram shows a fast growth that can be assimilated to exponential growth; going from above one publication per



**Figure 2.** Proportion of publications according to the covered area.



**Figure 3.** Proportion of publications according to the type of publication.

year to more than 35 publications after 2011.

### Main topics of publications

The various themes discussed have been grouped into 23 topics according to their similarities (Figure 5). The most widely emerging topic is agriculture with 16% of

publications. Around 80% (278) of publications are concerning the top ten topics: Agriculture, Health and Disease, Adaptation, Forest, Land use and Land change, Water resource and wetlands, drought and assimilate, Food and nutrition, Temperature-rainfall, and Animal and Livestock.

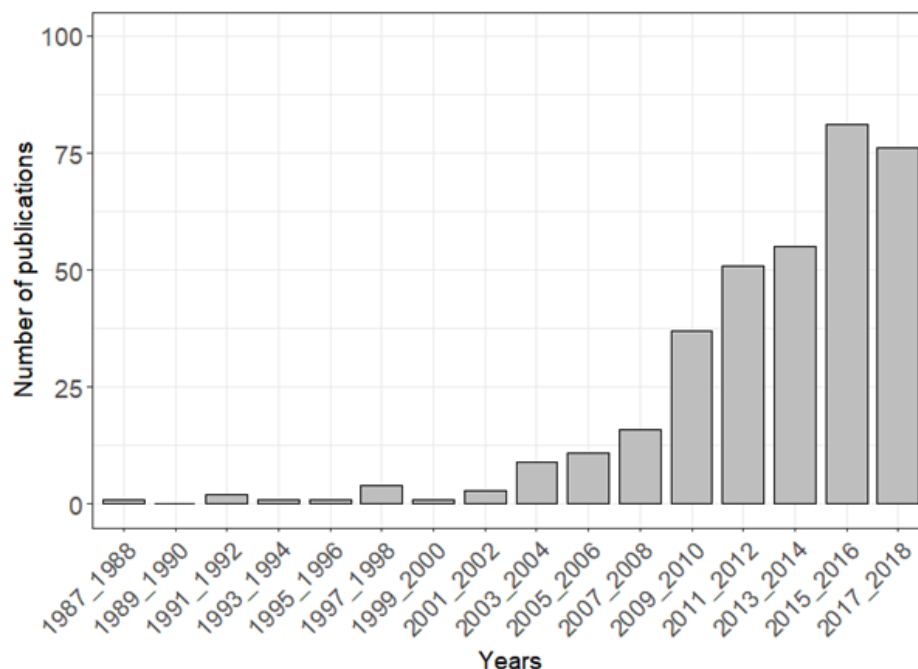
### Relative growth rate

All publications output in the field of climate change collected are represented in Figure 6. It shows that the rate of publications decreases gradually from 2003 (RGR=1.012) to 2018 (RGR=0.109).

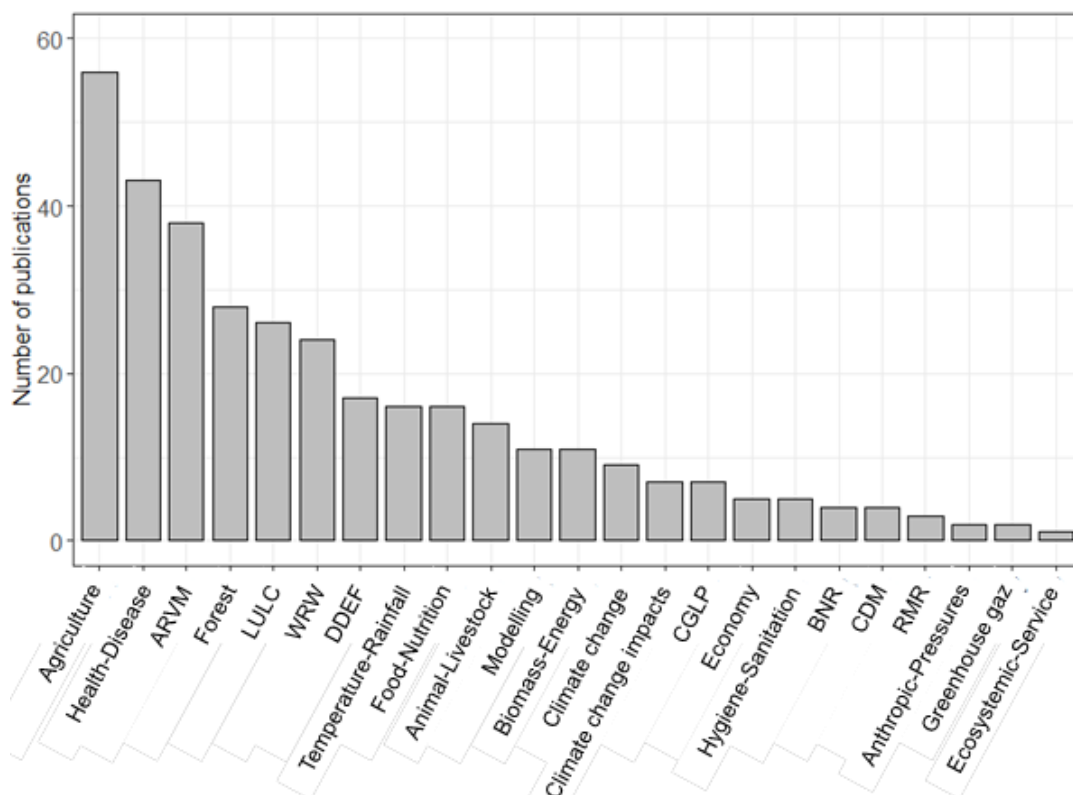
### Growth index (GI)

The analysis of the top 10 main topics GI' shows that all of them have registered an increase during their second period, which explains the fact that GI is superior to 1. Except for 'Health and Disease' which occupies third place, the six other themes that have been widely disseminated in research are closely linked to Agriculture. In order of importance, we have: 'Temperature and rainfall', 'Food and nutrition', 'Land use and land change', 'Forestry', 'Water resources and wetlands' and 'Drought, desertification...' (Figure 7).

The variation tendency of each main topic related to climate change is illustrated in Figure 8. This figure reveals that the discussion of 'Agriculture' and 'Food – Nutrition' register best-fitting exponential increasing. However, the publications related to 'Temperature and Rainfall' and 'Animal and Livestock' decrease slowly. The others are increasing slowly and linearly.

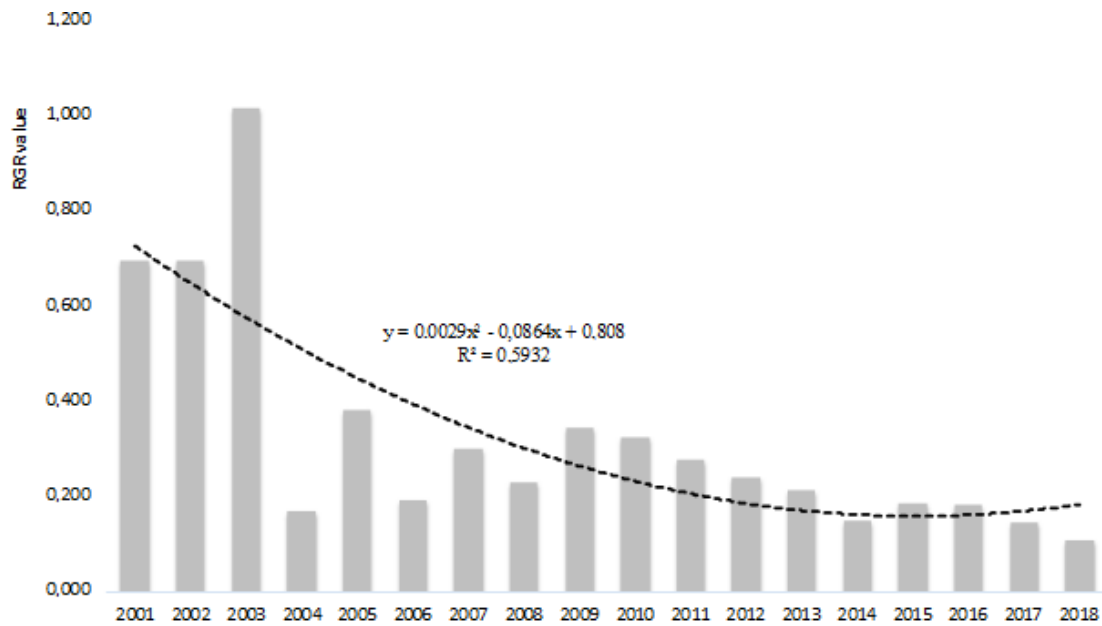


**Figure 4.** Trend of total publications according to the years.

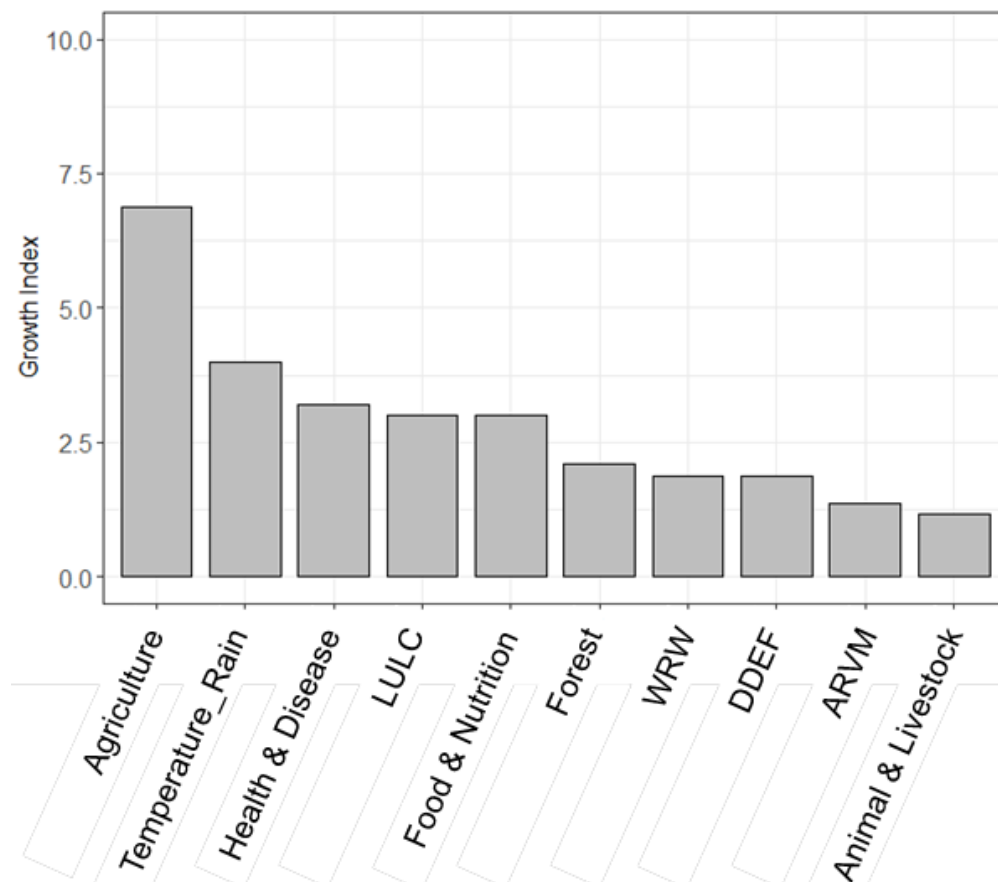


**Figure 5.** Number of publication per main topics.

**Labels:** BNR: Biodiversity and Natural Resources; CDM: Conflicts and Decision Makers; DDEF: Drought, Desertification, Evapotranspiration and Fire; CGLP: Culture, Gender and Local Perceptions; ARVM: Adaptation, Risks, Vulnerability and Migration; WRW: Water Resources and Wetlands; RMR: Research, Mercure and Relief; LULC: Land Use, Land Cover.



**Figure 6.** Relative growth rate of publications.



**Figure 7.** GI of top 10 main topics.

**Labels:** LULC: Land Use and Land Cover; WRW: Water Resources and Wetlands; ARVM: Adaptation, Risks, Vulnerability and Migration; DDEF: Drought, Desertification, Evapotranspiration and Fire.

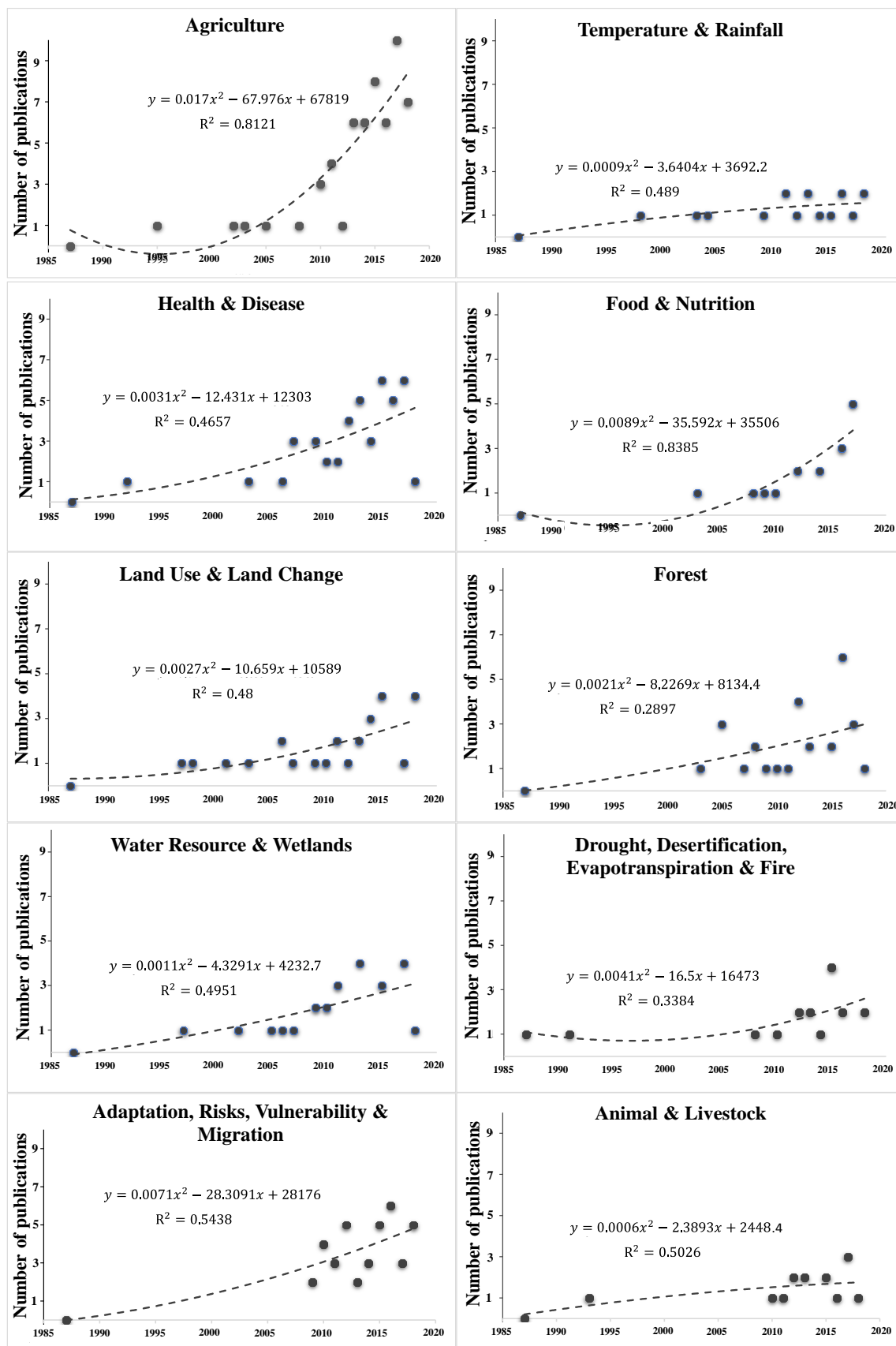


Figure 8. Trend of the number of publications per main topics.

## DISCUSSION

The general results of this study indicate an exponential increase in the number of publications on climate change in Burkina Faso from 1987 to 2018.

### Keywords research and types of publications

In general, the bibliometric research on climate change by keywords in Burkina Faso is more favorable by using the English term as most publications are in English. This means that English was by far, the dominant language in the field of climate change research. The bibliometric research on climate change conducted by Sangam and Savitha (2019) also showed a large predominance of publications in English, that is, 97.78%. This result is similar to those of Yevide et al. (2016) who have also found 97% of articles published in English. Although Burkina Faso uses French as the national language, scientists are aware that it is important to communicate the results of their researches in English. Indeed, it is now recognized that most scientists use English to publish their results (Ferguson et al., 2011). This fact can be an important gap to the vulgarization and the dissemination of the research results, as a policymaker in Burkina Faso are less use English. Tao et al. (2016) have also shown that the fact that most articles are published in one language constitutes a disadvantage in the development of worldwide academic research.

According to the types of publications, we observe a high number of scientific publications (articles) which represents 94% of documents downloaded. This proves that researchers are aware of the climate change reality in Burkina Faso and work to find the best conditions for people and decision-makers. The fact that there are few books compared to articles shows also that the concept of climate change has not yet reached a certain level of popularization. This could also constitute a gap in the dissemination of the results since the majority of Burkina Faso people are illiterate.

### Study area and main topics

Studies regarding climate change have mainly focused on Agriculture and climate change Adaptation-Vulnerability-Resilience. Climate change will affect negatively agriculture and will increase from southern West Africa with -13% to northern West Africa with -18%. In the context of Burkina Faso, the fact that rainfed agriculture constitutes the source of economy in Burkina Faso (Zougmore et al., 2018) with more than 85% of the population who are farmers (Roudier et al., 2014), and because of the vulnerability of this sector to climate change, could explain the importance of studies about climate change impact on agriculture. According to Challinor et al. (2007), climate change will negatively

impact on crop productivity in Africa because its agrosystems are vulnerable to climate variability. In 2012, Ouédraogo also showed that climate change would influence crops and livestock systems in Burkina Faso. Besides, developing countries are more vulnerable to climate change. Sathaye and Ravindranath (1998) showed that climate change will highly affect energy and forestry in developing countries. Adaptation to climate change constitutes the third most topic already examined in the different climate change studies in Burkina Faso. Indeed, developing countries are more vulnerable to climate change and they need to make more efforts in climate change adaptation (Mertz et al., 2009). Furthermore, the vulnerability of households who are dependent on livestock in drier areas of developing countries could increase and induce poverty and inequity in these populations (Thornton, 2010). Some research conducted in Tanzania also showed the most publication on climate change adaptation, impacts/implication, and vulnerability (Lukwale and Sife, 2017). This means that these topics attracted increasing attention from scientific communities. Therefore, even if there were many studies on climate change's impact on agriculture, it would be important to analyze these impacts on fisheries whose products are the main source of animal protein for people of this country. Using Web of Science and Scopus does not allow to find scientific research on climate change impacts on fisheries in Burkina Faso which means that, even if it could exist some studies, there is probably a few. This bibliometric search, found only one reference about vulnerability of freshwater fisheries in West Africa to climate change (Carr and Hughes, 2014).

### Trend of publications and growth index (GI)

The evolution of publications on themes related to climate change in Burkina Faso shows that the first publications concerned drought-desertification-evapotranspiration and bush fires in 1987 and 1992. Indeed, like many other countries of the sub-region, had just experienced the great droughts of the 1970s and 1980s, which led to famines can explain this fact. Considering global topics, we have noted an exponential increase of studies particularly since the beginning of this century. This trend is also approved by Theokritoff (2018) who has shown the commitment of the Burkina Faso Government to climate change over the past two decades. Many factors can explain this increase. Firstly, we noted that Burkina Faso signed the United Nations Framework Convention on Climate Change in 1993, before developing a National Strategy for the implementation of this Convention in 2001. Since then, the country has drafted several programs and policies to ensure a better adaptation of populations to climate change. Moreover, the RGR even if decreases along the time with some fluctuations, the value remains positive. This means a decrease in publications globally.



Climate change via global warming is recognized to drive temperature increase and disturb rainfall, particularly in tropical areas during this century (Deng et al., 2017). This situation leads many researchers to analyze their evolution.

While for all the themes, publications have progressed since 2000, it is not the same concerning 'Animals and Livestock' and 'Temperature and Rainfall' themes which, in addition to being the least addressed themes in the top 10, have also experienced a slight decrease in their publications, as shown by the negative slopes of their regression curve. However, the work of Kabore et al. (2017) showed high variability in rainfall in the North and Sahel of Burkina Faso. This therefore, highlights the need for research in this area to provide adaptation measures to local populations whose sectors of activity are highly dependent on climatic variables such as rainfall. The decrease in rainfall and temperature research is particularly contrary to the situation of the West African region. Indeed Sultan et al., 2015, showed an upward trend in research on these themes in the West African region over the last three decades. A lack of adequate financial support (Lukwale and Sife, 2017), a lack of data, or evidence of low interest in these areas could explain this decrease. Indeed, although agriculture occupies more than 80% of the population, uneducated farmers who are engaged in subsistence farming mostly practice it. As a result, there are hardly any statistical data available to provide a solid scientific basis. However, it is demonstrated that climate change will affect negatively agriculture (Döll et al., 2014). This agriculture occupies a central role in the economy of the country by providing employment (Belem and Saqalli, 2017).

The particular increase of the top 10 main topics is due to their implication in local population life. GI' shows that all of them have registered an increase during their second period. The themes with an index greater than or equal to 3 are closely related. Indeed, the practice of agriculture (GI=6.87) which is the main source of food (GI=3) for the populations requires land occupation (GI=3). Consequently, the lack of adequate food could constitute public health problems (GI=4.2). This agriculture is unfortunately rainfed, which makes it vulnerable to climatic hazards such as temperature and rainfall (GI=4). Since the beginning of the 21st century, Burkina Faso has been engaged in the implementation of agricultural development policies that have led to the strong production of policy documents (Traoré et al., 2018). It is demonstrated since Conference of party (COP21) in 2015 that agriculture could be affected by climate change by modifying plants' growth and the abundance of some harmful and beneficial organisms associated with crops. Moreover, these results are also similar to those of Saguez et al. (2017) who showed that in recent years, changes have also been observed in certain plant and animal species with variations in temperature and precipitation, thus favoring the dissemination and spread of certain diseases. This

observation reveals once again the need to pay special attention to these issues. The growing attention paid to these themes could also be explained by the demographic boom that the country has been experiencing since the beginning of the 21st century (Guengant et al., 2009), which has inevitably led to an increase in the number of researchers. In a nutshell, a greater number of published articles and a recent rapid increase in articles number related to climate change reveal the increased research focus on this topic.

## Conclusion

This study based on the bibliometric research has highlighted the topics already discussed in Burkina Faso linked to climate change. It examined the trends of climate change research using a bibliometric approach based on 349 cited English and French publications from 1987 to 2018. The main themes addressed so far about climate change in Burkina Faso revolve around Agriculture, Health and Disease, Adaptation, and others themes associated with agriculture such as rainfall, temperature, food, land use and vegetation. This work revealed that very few studies have been interested in the impact of climate change on the biodiversity specifically in animal in Burkina Faso. This study revealed that there is no study by now in the field of climate change impact on fish fauna in Burkina Faso. Overall, this study could help to a better understanding of the past trajectory of climate change research in Burkina Faso. It could help researchers to identify research gaps in the current research as well as help them to guide them in establishing future research directions.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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## REFERENCES

- Bambara D, Bilgo A, Hien E, Masse D, Thiombiano, A, Hien V (2013). Perceptions paysannes des changements climatiques et leurs conséquences socio environnementales à Tougou et Donsin, climats sahélien et sahélo-soudanien du Burkina Faso Producers perceptions of climate. Bulletin de la Recherche Agronomique du Bénin (BRAB) 16 p.
- Barbosa FG, Schneck F (2015). Characteristics of the top-cited papers in species distribution predictive models. Ecological Modelling 313:77-83.
- Belem M, Saqalli M (2017). Development of an integrated generic model for multi-scale assessment of the impacts of agro-ecosystems

- on major ecosystem services in West Africa. *Journal of Environmental Management* 202:117-125.
- Bodian A, Dezetter A, Dacosta H (2013). Impact du changement climatique sur les ressources en eau du haut bassin du fleuve Sénégal. *Rev. Géogr. Lab. Leid* 2515:236-251.
- Carr J, Hughes A (2014). PARCC West Africa A Climate Change Vulnerability Assessment of West African Species. UNEP-WCMC technical report. 59 p. <http://www.unep-wcmc.org>
- CCNUCC (2009). Rapport de la quinzième session de la Conférence des parties tenue à Copenhague du 7 au 19 décembre 2009. Additif Deuxième partie: Mesures prises par la Conférence des Parties à sa quinzième session Table. Page 46. Copenhague.
- Challinor A, Wheeler T, Garforth C, Craufurd P, Kassam A (2007). Assessing the vulnerability of food crop systems in Africa to climate change. *Climatic Change* 83:381-399.
- Clover J (2003). Food security in Sub-Saharan Africa. *African Security Review* 12:5-15.
- Deng J, Zhang Y, Qin B, Yao X, Deng Y (2017). Trends of publications related to climate change and lake research from 1991 to 2015. *Journal of Limnology*. <https://doi.org/10.4081/jlimnol.2017.1612>
- Döll P, Jiménez-Cisneros B, Oki T, Arnell NW, Benito G, Cogley JG, Jiang T, Kundzewicz ZW, Mwakalisa S, Nishijima A (2014). Integrating risks of climate change into water management. *Hydrological Sciences Journal* 60:4-13.
- Epule-Epule T, Ford JD, Lwasab S, Lepage L (2017). Climate change adaptation in the Sahel. *Environmental Science and Policy* 75:121-137.
- Food and Agriculture Organization (FAO) (2015). Evaluation du Programme de la FAO au Burkina Faso 2010-2014 Résumé, 18 p. <http://www.fao.org/3/a-bd463f.pdf>
- Ferguson G, Pérez-Llantada C, Plo R (2011). English as an international language of scientific publication: a study of attitudes. *World Englishes* 30:41-59.
- Gao C, Sun M, Geng Y, Wu R, Chen W (2016). A bibliometric analysis based review on wind power price. *Applied Energy* 182:602-612.
- Greimel F, Schülting L, Graf W, Bondar-Kunze E, Auer S, Zeiringer B, Hauer C (2018). Hydropeaking Impacts and Mitigation. *Riverine Ecosystem Management, Aquatic Ecology* 24 p.
- Guengant JP, Lankoande M, Tapsoba TVME, Zanou B (2009). Recensement général de la population et de l'habitation de 2006 (RGPH-2006): Thème 16: Projections Démographiques 2007-2050.
- Intergovernmental Panel on Climate Change (IPCC) (2013). *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA 1535 p.
- Kabore PN, Ouédraogo A, Sanon M, Yaka P, Some L (2017). Caractérisation de la variabilité climatique dans la région du Centre-Nord du Burkina Faso entre 1961 et 2015. *Climatologie* 14:82-95.
- Ki FT, Sankara-Bassonon SB, Congo M, Palm/Zowelengre EMS (2013). Les Agences de l'eau au Burkina Faso: Capitalisation du processus de mise en place. *Burkina Faso* 38 p. <https://www.oieau.org/eaudoc/system/files/33068.pdf>
- Liang L, Gong P (2017). Climate change and human infectious diseases: A synthesis of research findings from global and spatio-temporal perspectives. *Environment International* 103:99-108.
- Lukwale SR, Sife AS (2017). Climate change research trends in Tanzania: A bibliometric analysis. *International Journal of Biodiversity and Conservation* 9:224-231.
- Mao G, Huang N, Chen L, Wang H (2018). Research on biomass energy and environment from the past to the future: A bibliometric analysis. *Science of the Total Environment*. <https://doi.org/10.1016/j.scitotenv.2018.04.173>
- Marx W, Haunschild R, Bommann L (2017). Global Warming and Tea Production—The Bibliometric View on a Newly Emerging Research Topic. *Climate*. <https://doi.org/10.3390/cli5030046>
- Mertz O, Halsnæs K, Olesen JE, Rasmussen K (2009). Adaptation to Climate Change in Developing Countries. *Environmental Management*. <https://doi.org/10.3390/cli5030046>
- Mouhamed L, Traore SB, Alhassane A Sarr B (2013). Evolution of some observed climate extremes in the West African Sahel. *Weather and Climate Extremes* 1:19-25.
- Ouédraogo, M, Dembélé Y, Somé L (2010). Perceptions et stratégies d'adaptation aux changements des précipitations : cas des paysans du Burkina Faso. *Sécheresse* 21(2):87-96.
- Perea-Moreno MA, Hernandez-Escobedo Q, Perea-Moreno AJ (2018). Renewable energy in urban areas: Worldwide research trends. *Energies* 11. <https://doi.org/10.3390/en11030577>
- Picard-Aitken M, Côté G, Archambault É (2015). Étude bibliométrique sur la recherche tunisienne. *Science-Metrix Inc*: 96 p.
- Roudier P, Ducharme A, Feyen L (2014). Climate change impacts on runoff in West Africa: A review. *Hydrology and Earth System Sciences* 18:2789-2801.
- Saguez J, Gagnon AÉ, Kichou D, Rloux S, Zoghliami S, Blondlot, A (2017). Impact des changements climatiques et mesures d'adaptations pour les ravageurs présents et potentiels en grandes cultures au Québec. *Projet PV 3.2-DP-CÉROM-5 - Revue de littérature* 72 p. [https://www.researchgate.net/profile/Julien\\_Saguez/publication/319785539](https://www.researchgate.net/profile/Julien_Saguez/publication/319785539).
- Sangam SL, Savitha KS (2019). Climate change and global warming : A scientometric study. *COLLNET Journal of Scientometrics and Information Management* 13(1):199-212.
- Sarr B (2012). Present and future climate change in the semi-arid region of West Africa: A crucial input for practical adaptation in agriculture. *Atmospheric Science Letters* 13:108-112.
- Sathaye JA, Ravindranath NH (1998). Climate change mitigation in the energy and forestry sectors of developing countries. *Annual Review of Energy and the Environment* 23(1):387-437.
- Smith AL, Hewitt N, Klenk N, Bazely DR, Yan N, Wood S, Henriques I, MacLellan JI, Lipsig-Mummé C (2012). Effects of climate change on the distribution of invasive alien species in Canada: A knowledge synthesis of range change projections in a warming world. *Environmental Reviews* 20(1):1-16.
- Sultan B, Lalou R, Sanni MA, Arame M (2015). Les sociétés rurales face aux changements climatiques et environnementaux en Afrique de l'Ouest. <https://doi.org/10.4000/books.irdeditions.8914>
- Tao J, Wang DS, qi Chen K, Sui X (2016). Productive capacity of fish habitats: a review of research development and future directions. *Environmental Earth Sciences* 75(3):1-12.
- Tessier A, Descloux S, Lae R, Cottet M, Guedant P, Guillard J (2016). Fish Assemblages in Large Tropical Reservoirs: Overview of Fish Population Monitoring Methods <https://doi.org/10.1080/23308249.2015.1112766>
- Theokritoff E (2018). Linking science and policy for climate change adaptation : The case of Burkina Faso A stocktaking of the integration of scientific information on climate change into national adaptation and development policies. *Stockholm, Sweden* 49 p. <https://www.diva-portal.org/smash/get/diva2:1271334/FULLTEXT01.pdf>.
- Thornton P (2010). Climate change and livestock keepers in developing countries: what are the prospects? *Agriculture for Development*. (9):6-10.
- Traoré M, Nacro BH, Ouédraogo D, Sanou MR (2018). Dynamique et performance économique des systèmes de production agricole à base de coton dans les villages de Karaborosso et de Kotoura (Ouest du Burkina Faso). *Sécheresse* 24(2):115-128.
- Vermeulen SJ, Campbell BM, Ingram JSI (2012). Climate Change and Food Systems. *Annual Review of Environment and Resources* 37:195-222.
- Yevede ASI, Wu B, Khan AS, Zeng Y, Liu J (2016). Bibliometric analysis of ecosystem monitoring-related research in Africa: implications for ecological stewardship and scientific collaboration. *International Journal of Sustainable Development and World Ecology*. <https://doi.org/10.1080/13504509.2015.1129998>
- Zougmore T, Malo S, Kagembega F, Toguyini A (2018). Low cost IoT solutions for agricultures fish farmers in Afirca:a case study from Burkina Faso. Pages 1-7 2018 1st International Conference on Smart Cities and Communities (SCCIC). <https://doi.org/10.1109/SCCIC.2018.8584549>