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Carlo Cavicchia, Rosanna Verde**



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Evolution of scientific literature on climate change: a bibliometric analysis

Evoluzione della letteratura scientifica sul cambiamento climatico: un'analisi bibliometrica

Gianpaolo Zammarchi¹, Giulia Contu¹, Maurizio Romano¹

Abstract Climate change represents one of the biggest challenges of our time. We conducted a scientometric analysis of articles on climate change indexed in Web of Science to identify the most productive countries and relevant sources. Through a topic modeling analysis of the abstracts conducted using Latent Dirichlet Allocation (LDA), we identified the main topics and their evolution during time. Through an analysis of 263,197 articles published from 1989 to 2022, we showed an increase of articles related to consequences on living beings and habitats as well as to potential actions against climate change. Our analysis provides a comprehensive picture of studies conducted on this relevant topic in the last thirty years.

Abstract *Il cambiamento climatico rappresenta una delle sfide maggiori del nostro tempo. Abbiamo condotto un'analisi scientometrica degli articoli sul cambiamento climatico indicizzati su Web of Science, per identificare i paesi che hanno prodotto il maggior numero di articoli e le fonti più rilevanti. Tramite un'analisi di topic modeling degli abstract condotta tramite Latent Dirichlet Allocation (LDA), abbiamo identificato i temi principali e la loro evoluzione. L'analisi di 263.197 articoli pubblicati tra il 1989 e il 2022 ha permesso di evidenziare un aumento degli articoli relativi alle conseguenze sugli esseri viventi e gli habitat e alle possibili azioni contro il cambiamento climatico. La nostra analisi offre una panoramica degli studi condotti su questo importante tema negli ultimi 30 anni.*

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Key words: climate change, scientometrics, topic modelling, LDA, general sentiment decomposition

1 Introduction

The expressions “climate change” and “global warming” refer to the rapid and recent global rise in temperatures caused by the increase in CO₂ and methane levels due to human activities (e.g. agriculture, industrial production, overbuilding and deforestation). In 2018, the Intergovernmental Panel on Climate Change (IPCC) reported that human activities have increased global temperature from 0.8 to 1.2°C (since the pre-industrial era) and, if current levels of greenhouse gas emissions will not be reduced, the temperature will increase constantly. For these reasons, under the 2015 Paris Agreement, several nations agreed to keep warming under control, but in order not to cross the threshold of 1.5°C, it would be necessary to halve emissions by 2030 and to achieve net-zero emissions by 2050 [1]. Climate change has also profound repercussions on economic outcomes. In fact, extreme events (i.e. floods, droughts, heat waves) and other effects of the climate change (i.e. rising temperatures and sea-level) can cause wealth destruction or reduction of income [2], especially on minorities and other vulnerable groups. In addition, climate change is a problem that affects all countries. Some of its main and most severe repercussions concern anomalous heat waves and other extreme weather events, increasing number of wildfires, ice melting, deserts expansion and extinction of animal species. Human beings will also be in danger as migration flows, diseases, floods, food and water shortages and economic losses will occur in the next decades [3]. It is therefore understandable why the climate change literature has expanded rapidly in recent years [4].

In this work we conducted a scientometric analysis of scientific studies investigating climate change. Through topic modeling of retrieved abstracts, we discuss the most explored aspects as well as trends in their temporal evolution.

2 Materials and methods

We conducted a bibliometric analysis on the Web of Science Core Collection (WoS) online database, searching for studies mentioning the terms “climate change” OR “global warming” in titles, abstracts, author keywords or keywords plus (“Topic” option in WoS), published up to 29th of January 2022. A document type restriction (only Articles) and a language filter (only English) were applied. From each identified article, the following characteristics were extracted: title, abstract, keywords, authors’ affiliations, year of publication, journal title and the number of citations. We used the Bibliometrix package [5] version 3.1 in R version 4.1.1 to

Evolution of scientific literature on climate change: a bibliometric analysis

display the annual scientific production, identify the most relevant sources and the most active countries. Next, the corpus of documents was preprocessed with tm [6] and quanteda [7]. A co-cluster analysis of 1,000 randomly sampled abstracts was conducted with blockcluster [8]. We tested a range from 1 to 5 clusters to find the number that allows to maximize the pseudo-likelihood. Next, we used Latent Dirichlet Allocation (LDA) in topicmodels [9] to perform topic modeling on the whole dataset. Topic names of the clusters were defined using K-means clustering over the word embeddings representation [10] in Python for dimensionality reduction (merging words with different representation but the same meaning) [11].

3 Results

We retrieved 263,197 scientific articles published from 1989 to 2022. The scientific production observed an annual percentage growth rate of 26.18 (Figure 1).

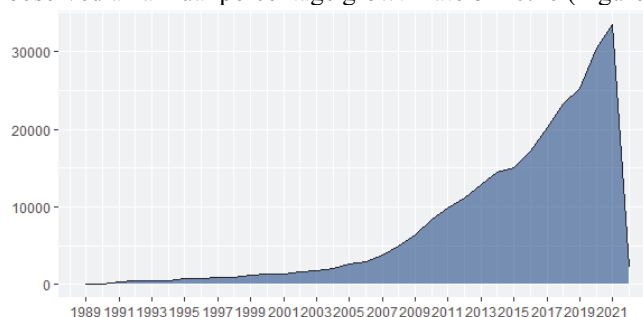


Figure 1. Annual scientific production growth of articles on climate change

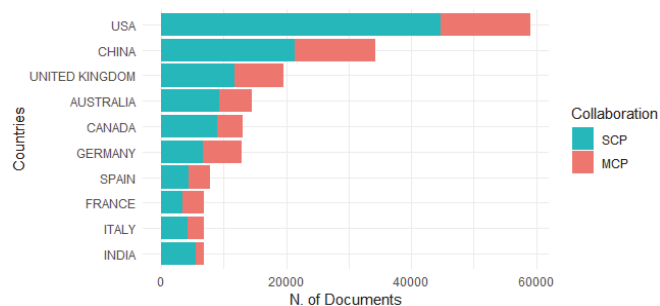


Figure 2. Most productive countries based on the affiliation of the corresponding author

United States were the country in which most articles were published, based on the affiliation of the corresponding authors, followed by China and United Kingdom (Figure 2). Single country publications (SCP) and multiple country publications (MCP) (i.e. articles with international collaborations) are also shown. The five most relevant sources based on the number of published articles are shown in Table 1.

Table 1: Most relevant sources based on the number of published articles

Journal name	Articles
Science of the Total Environment	4,272
Sustainability	3,705
Global Change Biology	3,640
PLOS ONE	3,633
Climatic Change	3,474

Analyses conducted with blockcluster on 1,000 randomly sampled abstracts showed that a five-cluster partition was able to maximize the pseudo-likelihood (Table 2).

Table 2: Pseudo-likelihood for clusters in a range from 1 to 5

Metric	1 cluster	2 clusters	3 clusters	4 clusters	5 clusters
Pseudo-likelihood	-374,555	-373,198	-409,632	-372,792	-340,785

Based on this, we set to five the number of clusters for the topic modeling analysis conducted with LDA on the whole dataset. The first ten words for each topic based on LDA are shown in Table 3. The first 100 words for each topic were used to assign topic names based on the word embeddings representation. The most representative five words based on this representation are also shown in Table 3.

Table 3: Topics and relative words identified by LDA and word embeddings

Topics	LDA	Word embeddings
Topic 1 “Ice”	model, changes, water, temperature, data, precipitation, models, results, study, surface	ice, seasonal, lake, winter, surface
Topic 2 “Community”	species, temperature, may, population, populations, effects, environmental, changes, distribution, habitat	community, populations, habitat, biodiversity, sea
Topic 3 “Fire”	soil, forest, carbon, water, vegetation, growth, increased, temperature, plant, drought	fire, season, response, forest, nitrogen
Topic 4 “Energy”	energy, emissions, carbon, production, environmental, gas, results, study, emission, system	energy, heat, power, fuel, electricity
Topic 5 “Natural resources”	management, research, environmental, adaptation, can, policy, study, risk, development, paper	natural, resources, water, human, environmental

Since LDA is a probabilistic model, any abstract will be assigned to the topics with different probabilities. For each abstract, we selected the topic with the highest probability and then plotted the number of abstracts assigned to each topic (Figure 3). We can observe that Topic 1 (“Ice”) is the most represented among our articles, followed by Topic 5 (“Natural Resources”) and Topic 2 (“Community”).

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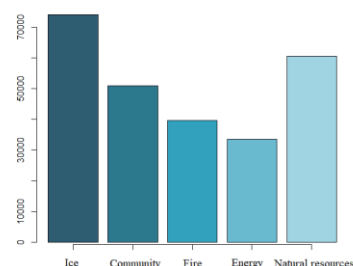


Figure 3: Number of articles for each topic

Next, we plotted the temporal evolution of probability distributions for each topic in order to observe their change over time (Figure 4). It can be observed how the probability of Topic 1 decreased during the years, the probability of Topics 2 and 5 observed an increase while that of Topics 3 and 4 remained somewhat stable, with the latter observing a slight increase from 2020.

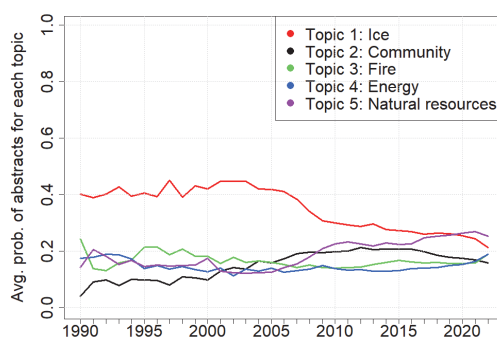


Figure 4: Number of abstracts assigned to each topic

4 Discussion

In this article, we conducted a bibliometric analysis of studies investigating climate change. We reported how the literature has grown, especially in the last two decades. This growth can be explained by the increased relevance that this topic has gained since the Kyoto Protocol signed in 1997. In particular, in recent years, activists such as Greta Thunberg have attracted the attention of newspapers and TV, also shifting the attention of public opinion towards this topic.

We built a corpus using the abstracts of the articles retrieved from the search and used a topic modeling approach to identify the main topics present in the corpus. When we plotted the temporal evolution of the topics' probabilities over the entire time span, we found Topic 2 (including words related to community) and Topic 5

(including words related to natural resources and potential actions) to slightly increase. The latter finding might be explained by the growing international efforts into providing policies and instruments to manage and reduce climate change. On the other hand, while overall Topic 1 (including words related to ice, water and precipitations) was the most represented in our dataset, its probability showed a decrease from 40% to around 20%. Studies assigned to Topics 3 (including words related to fire and vegetation) or Topic 4 (including words related to energy) remained somewhat stable. As future developments, we plan to compare results obtained using different methods for topic modeling, such as seeded LDA.

To conclude, our analysis of the large body of scientific literature on climate change provides an updated and comprehensive picture of studies conducted on this relevant topic in the last thirty years and highlights relevant trends with regards to investigated topics.

References

1. Tollefson, J.: IPCC says limiting global warming to 1.5 [degrees] C will require drastic action. *Nature*, **562**, 172-174 (2018)
2. Deryugina, T., Hsiang, S.M.: Does the environment still matter? Daily temperature and income in the United States. NBER Working Paper 20750 (2014)
3. TOL, Richard S.J.: The economic effects of climate change. *Journal of economic perspectives*. **23**, 29—51 (2009)
4. Edenhofer, O (ed.): *Climate change 2014: mitigation of climate change*. Cambridge University Press (2015)
5. Aria, M., Cuccurullo, C.: bibliometrix: An R-tool for comprehensive science mapping. *Journal of Informetrics*. **11**, 959--975 (2017)
6. Feinerer, I., Hornik, K., Meyer, D.: Text Mining Infrastructure in R. *Journal of Statistical Software*. **25**, 1--54 (2008)
7. Benoit, K., Watanabe, K., Wang, H., Nulty, P., Obeng, A., Müller, S., Matsuo, A.: quanteda: An R package for the quantitative analysis of textual data. *J. Open Source Softw.* **3**, 774 (2018)
8. Singh Bhatia P., Iovleff S., Govaert G.: blockcluster: An R Package for Model-Based Co-Clustering. *J. Stat. Softw.*, **76** (9), 1--24 (2017).
9. Grün, B., Hornik, K.: topicmodels: An R Package for Fitting Topic Models. *Journal of Statistical Software*. **40**, 1--30 (2011)
10. Mikolov, T., Sutskever, I., Chen, K., Corrado, G. S., Dean, J.: Distributed Representations of Words and Phrases and their Compositionality, in *Proceedings of the 26th International Conference on Neural Information Processing Systems—Vol 2*, Curran Associates Inc. (USA), 3111–3119 (2013)
11. Romano, M., Mola, F., Conversano, C.: Decomposing tourists' sentiment from raw NL text to assess customer satisfaction. In: *ASA 2021 Statistics and information systems for policy evaluation*. 147-151, FIRENZE:Firenze University Press, ISBN: 9788855183048, (2021)