

**Результаты изучения и влияние эффективности научных исследований  
по проблеме глобального потепления и литература 1980–2007 гг.  
Информетрический анализ**

**Research Output and Scientific Impact of Global Warming Research Productivity  
and Literature from 1980–2007. An Informetrics Analysis**

**Результати вивчення та впливу ефективності наукових досліджень  
щодо проблеми глобального потепління та література 1980–2007 рр.  
Інформетричний аналіз**

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Дается определение глобального потепления с использованием как дескрипторной, так и оценочной информетрических технологий. Эффективность научных исследований по проблеме глобального потепления оценивается по количеству опубликованной литературы, отраженной в базах данных *Web of Science* (преимущественно *Science Citation Index*), *Social Sciences Citation Index* и *Arts and Humanities Citation Index*, а также в базах данных Южно-африканской библиографической сети (*South African Bibliographical Network, SABINET*). Такой массив исходного материала дает возможность оценить национальную/местную продуктивность научных исследований в конкретной стране, например, в ЮАР. Исследование охватывает период с 1980 по 2007 г. Исследование охватывает все публикации по проблемам глобального потепления, отраженные в выбранных базах данных. Результаты исследования содержат полезную информацию по поводу политики проведения научных исследований, оценки феномена глобального потепления, а также сравнительные данные для оценки для оценки национального и международного вклада в проведение исследований. Результаты исследования также представляют интерес для информационных служб.

**Ключевые слова:** глобальное потепление; информетрия; библиометрия; исследования; научный вклад

The paper recognises global warming and uses both descriptive and evaluative informetric techniques to analyse Global warming research using the published literature as indexed and reflected in three key bibliographic databases of Web of Science, namely Science Citation Index, Social Sciences Citation Index and Arts and Humanities Citation Index in addition to South African Bibliographical Network (SABINET) databases that represents local/national research productivity in South Africa for example. The period of study is 1980 to 2007. The study covers all publications on global warming appearing in the selected databases. This paper provides useful information for research policy and evaluation on global warming and comparative data between national/local and international databases for research productivity measurement in the burgeoning domain that is likely to benefit information services.

**Key words:** Global Warming; Informetrics; Bibliometrics; Research; Scientific Impact

Подано визначення глобального потепління із використанням як дескрипторної, так і оцінкової інформетричних технологій. Ефективність наукових досліджень щодо проблем глобального потепління оцінено за кількістю опублікованої літератури, відображеної в базах даних *Web of Science* (переважно *Science Citation Index*), *Social Sciences Citation Index* та *Arts and Humanities Citation Index*, а також в базах даних Південно-Африканської бібліографічної мережі (*South African Bibliographical Network, SABINET*). Така кількість вихідного матеріалу дає можливість оцінити національну/ місцеву продуктивність наукових досліджень у конкретній країні, наприклад, у ПАР. Дослідження охоплює період із 1980 до 2007 р. Дослідження охоплює усі публікації із проблеми глобального потепління, що відображені у вибраних базах даних. Результати дослідження містять корисну інформацію щодо політики проведення наукових досліджень, оцінки феномену глобального потепління, а також порівняльні дані оцінки національного та міжнародного внеску у проведення досліджень. Результати дослідження також можуть зацікавити інформаційні служби.

**Ключові слова:** глобальне потепління, інформетрія; бібліометрія; дослідження; науковий внесок

## 1. Introduction

Global warming may be defined as the «observed and projected increases in the temperature of Earth's atmosphere and Oceans» (Time for Change: ND)<sup>1</sup>. A more generally held view is that global warming is an ethical issue arising from human-induced activities that affect climate change (Brown, 2003). Scientifically, the cumulative increase of greenhouse gases leads to solar radiation being trapped within the earth's atmosphere, which in turn enhances the greenhouse effect, warming the earth up. Ultimately, the planet's entire ecosystem, plants, animals and humans alike, are increasingly exposed to danger in a number of ways<sup>2</sup>, such as «*the increase of the temperature on Earth by about 3° to 5° C (34° to 41° Fahrenheit) by the year 2100, and rise of sea levels by at least 25 meters (82 feet) by the year 2100*». It is predicted that nations that are already faced with a myriad of challenges, such as those in Africa, are likely to suffer most from the effects of global warming. Among other reasons, it is believed that these countries would get involved in interventions too little, too late. For example, «*Africa lost over 9% of its trees between 1990 and 2005. This represents over half of global forest loss, despite the fact that the continent accounts for just 16% of global forests*», according to the UN Survey of World Forests (Van Reenen, 2007: 6). Separate reports predict that regional water supplies will decline, livestock and human diseases will increase, flood related diseases will increase, and animal and crop production will decline. Other affected areas will include coastal zones, fisheries and biodiversity. Perhaps it makes sense to adhere to the advice by G8 president Angela Merkel (Van Reenen, 2007: 7) who stated that «*we need to work together to get as many countries across the world as possible to undertake to do something about global warming*». Thus information providers and researchers from as many different disciplines as possible should engage in attempts to tackle problem.

Walther et al. (2002) have revealed that freeze-free periods in most of the mid-and high-latitude regions are lengthening. Satellite data has revealed a 10% decrease in sun cover and ice extent since the late 1960's, which has also exacerbated the spatial and temporal regime of precipitation affecting organisms with diverse geographical distributions (Walther et al. 2002). Some of the ecological impacts of climate change were revealed in the phenological patterns of and trends of birds, butterflies and wild plants, where, earlier breeding or first singing of birds, earlier arrival of migrant birds and earlier appearance of butterflies are attributed to the early timing of spring activities (Walther et al. 2002). **Invasions** of non-native species from adjacent habitats and a **shift** in community composition (like the recent increase in woody shrub density, extinction of previously common animal species and increases in formerly rare animal species) in the Sonoran desert of the southwestern United States have been catalyzed by recent climatic shift (Walther et al. 2002). In his lamentation on climate change, Mathews (2007) wrote an article on seven steps to **curb global warming**, and he reiterates that all the initiatives aimed at curbing further man-made catastrophes should be focused on driving down greenhouse gas emissions by 2020. This view is also supported by Tim Flannery (cited in Mathews 2007) in his book on global warming ('The Weather Makers'), where he opined that we should reduce our CO<sub>2</sub> emissions by 70% by the year 2050<sup>3</sup>. Some of the steps outlined are as follows:

1. Designing a system that imposes tax on carbon emissions, ratified by a global treaty and enforced by a newly created global authority with preference to the Kyoto model that operates outside the UN system.
2. Monitoring greenhouse gas emissions through global satellite monitoring. This mechanism would ensure that there is honesty in operating hybrid carbon permits and tax systems.
3. Compensating developing countries for preserving a vast area of tropical rainforests that act as an important source of 'carbon sink'.
4. Promoting the development of biofuels as a global alternative and supplement to fossil fuels. This, if implemented by the various governments and industrial agencies, will significantly increase the use of biofuels by 10% in 2010, and account for 20% by 2020, rising to 50% of (reduced) consumption of transport fuels by 2050.

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<sup>1</sup> See <http://timeforchange.org/definition-for-global-warming-what-is-global-warming>

<sup>2</sup> See <http://timeforchange.org/effects-of-global-warming>

<sup>3</sup> <http://timeforchange.org/CO2-emissions-by-country>

- Promoting the production of renewable energy by setting up markets for solar or wind energy and biofuels (vegetable sources, *Jatropha*, palm oil, soy bean etc.), which have great potential in tropical countries. The development of these sources for alternative electricity and fuel should not be limited to expanding the market but also to the ability to enhance initiatives that remove trade barriers in marketing the alternative and supplementary energy sources (Mathews 2007:4247).

The two most renowned global initiatives currently under the UN convention are the Intergovernmental Panel on Climate Change (IPCC) – mandated with designing a framework where successive scientists report on global warming; and the UN Framework Convention on Climate Change (UNFCCC), adopted in 1992 at Rio Earth summit and agreed upon by the Kyoto protocol which originated from the UN Conference on Climate Change held in Kyoto, Japan, 1997, to directly reduce the emission of CO<sub>2</sub>

According to Lancaster (1991), evaluating research productivity involves three processes, namely: an analysis of the number of publications produced and the quality of the sources in which the published material appears; assessing how much of the work is individual, group or organizational; and determining the quality of the citations of the published works. Informetric research provides an opportunity for research diversification and for the support of global warming research because it presents up-to-date research and publication indicators using multiple variables that include international, regional, national, disciplinary and individual issues, trends and challenges. This study analyzes and evaluates the patterns and trends of global warming research according to publications that appear in the Web of Science database (Science Citation Index-SCI, Social Science Citation Index-SSCI and Arts and Humanities Citation Index-AHCI) from 1980 – 2007 in order to inform research policies, evaluations and decisions on global warming. This paper compares the research output according to several variables and the scientific impact of authors, institutions and countries. The study identifies the most prolific and influential researchers, countries and institutions involved in research on global warming, and compares the productivity and scientific impact of institutions and countries. The paper attempts to answer the following eight research questions: Which countries are involved in global warming research in general and in Africa in particular? Which are the most productive countries in this research domain? Where is research on global warming largely published? Which are the most productive organisations and institutions in global warming research? Who are the most productive authors of global warming research publications? What is each author's scientific influence? Which is the most cited research publication? And what are the trends and patterns of the growth of citations vis-à-vis the papers?

## 2. Method and materials

This paper uses both descriptive and evaluative informetric techniques to analyse global warming research using published literature as indexed and reflected in three key bibliographic databases selected from the Web of Science, namely the Science Citation Index, the Social Sciences Citation Index and the Arts and Humanities Citation Index. The Web of Science (SCI, SSCI & A&HCI) indexes the most important, credible and influential research publications, mainly in the form of articles, that are assumed to exhibit a significant impact factor on a given discipline. It consists of over 8,830 titles of records from 230 disciplines with 6,125 active journals and 145 highly cited book series from SCI, 1800 active journal titles and 30 highly cited book series in SSCI and 1,130 active journals and 15 highly cited book series in A&HCI. The study covers all the publications on global warming that appear in the selected databases and all the different types of documents in which the publications appear. The country in which each journal was published was used as an indicator of the origin of global warming research output, and institutional productivity was calculated by counting the frequencies of the institutional occurrences in the authors' address field. The geographic distribution of authors was established in order to determine the author's country of origin and to find the most productive country and geographical region by using authors' addresses. Whereas it was possible to use several related search terms on the subject, such as the greenhouse effect and climatic change, among others, these search terms captured fairly limited records and most of the records were duplicated in the global warming search term. We therefore settled on 'global warming' for the search term because of its encapsulation of the research theme. Data analysis largely depended on ISI data sets, where relevant data was mined by using the search term 'global warming' and limited to records published between 1980 and 2007, and thereafter presented under the categories fea-

tured in Tables 1-6 and Figures one and two below. Further analysis was done by using citation analysis and h-index for impact factor determination. Rousseau (2008:252), defines *citation analysis as that «subfield of bibliometrics where patterns and frequencies of citations, given as well as received are analyzed. Such an analysis is performed on the level of authors, journals, scientific disciplines and any other useful unit or level. Citation analysis further studies relations between cited and citing units (documents, authors, countries etc.)»*. As far as h- index is concern it was developed by Jorge Hirsch, ‘a physicist at UCSD, as a tool for determining theoretical physicists' relative quality’. It is an *«index that quantifies both the actual scientific productivity and the apparent scientific impact of a scientist. The index is based on the set of the scientist's most cited papers and the number of citations that they have received in other people's publications. The index can also be applied to the productivity and impact of a group of scientists, such as a department or university or country» (h-index 2008)*<sup>4</sup>

### 3. Discussions and Conclusions

Global warming is increasingly becoming a major area of multidisciplinary research right so because of the growing interest and concern of the causes and consequences of the emerging catastrophe that requires proactive intervention before it is too late. This concern has raised scientific latitude among scholars, countries, institutions and information providers on the emerging need to diagnose climate change as a human induced incident. The study found that a total of 116 countries produced one or more publications on global warming, with the USA (2572; 35. 7%), England (834; 11. 6%) and Japan (546; 7. 6%) leading the pack with 3952 (54. 85%) publications. In contrast, while the contribution of African countries to global warming research exists, the results indicate that it is insignificant, as noted by the participation of 18 (of 53) countries, with South Africa (46), Kenya (14) and Egypt(7) being among the contributors. It is further noted that an overwhelming number of journals originate from English speaking countries such as the USA and the UK. The contribution of non-English [first] language speaking countries such as Japan, Germany, France, China, the Netherlands and Sweden was, however, found to be significant, as these six countries were in the list of the world’s top ten contributors. English in itself dominates because more countries publish their research using the language. We noted that the number of publications in English is higher in non-English speaking countries and institutions when compared to the publication output in home languages such as Japanese, French, German and Russian. For example, China’s country and institutional counts surpass the publication count in Chinese by many folds, suggesting that increasingly, the Chinese could be publishing their research in English. We also believe that the increase of publications in English could also be attributed to an increase in international collaborative research and co-publications, where English becomes the ‘compromise’ language of publication. Also, the use of the English language increases visibility, accessibility, collaboration and publication in international scholarly research outlets that are both web and print based.

The multidisciplinary nature of global warming research is confirmed by the variety of journals found in the domain. The top five journals, out of a total 1558, were Nature (199; 2. 8%), that also accounts for the highest impact factor in the domain, Geophysical Research Letters (175; 2. 4%), Climatic Change (161; 2. 2%), Science (137; 1. 9%) and New Scientist (116; 1. 6%). The subject distribution of the records was also diversified, with a strong representation from environmental sciences and studies, meteorology and atmospheric sciences, multidisciplinary sciences, geosciences, ecology, energy and fuels and engineering sciences. The subject coverage was largely in the pure sciences, followed by applied sciences. Records originating from social sciences and humanities appear insignificant.

Most (75%) of the publications are in the form of journal articles. The rest (25%) appear in 15 other document types, with editorial material, reviews, letters, news items and book reviews topping the list with more than 100 records respectively.

Noted further that a large part of Global warming research takes place within the Universities. Although Chinese Academy of Science leads in item/publication counts (see table 4), the number of citations and the h-index scores is lower when compared to those reflected for top institutions (e. g in Table 4). The highest h-index scores are found in the USA institutions suggesting sustained quality research output in the domain. This augurs well for a country known for the highest global warming emissions.

<sup>4</sup> . [http://en.wikipedia.org/wiki/Hirsch\\_number#Definition\\_and\\_purpose](http://en.wikipedia.org/wiki/Hirsch_number#Definition_and_purpose)

We noted that research on global warming is growing rapidly. For example, the growth of research publications in the domain since 1990 has increased by over 300%, with insignificant rises and falls from 1990 to 2002. and steady growth from 2002 to 2007. Also, that whereas there is a correlation between total cites, average cites per item and per year and the h-index, as reflected on tables 1,2,4 and 5, ( e. g on country, source, institution, author) there is no correlation between the four variables and the item counts. It is therefore suggested that more attention be given to citations and h-index for impact factor and item quality judgment for policy decisions.

We conclude, by reflecting on reviewed literature and research on Global warming, that focuses on Global warming characteristics, causes, consequences or effects, preventions, that Global warming is an international, multidisciplinary problem of growing magnitude. It presents major challenges to research, policy, recordal system or documentation, knowledge sharing and interventions of all kinds. Countries and institutions that are currently lagging behind in global warming research such as those in Africa, particularly those that are known for high greenhouse effect emissions should get more involved in active research in the domain. Bibliometric and informetric research provides useful information for the development of political. economic, social and technological policy in general as well as research policy and evaluation, in particular, in a burgeoning domain that is likely to benefit and shape, politics, research, and research policy and information services. We also believe that Library services can benefit from such studies as they would have a positive impact on library collection development, information retrieval and user services. We recommend that information professionals and librarians serving the research and scholarly/academic community should take cognizance of, and be engaged in informetric research in their specialist subject domain to strengthen information retrieval capacity and effective service delivery. In depth research and analysis is ongoing in the highlighted areas under the results section of this paper, including work on collaboration in global warming research

#### **Notes:**

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