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Compiling and Mapping an International Climate Change Database: Worlds of Gaps and Unevenness

Stanley D. Brunn

Department of Geography, University of Kentucky, Lexington, Kentucky, USA
Email: stan.brunn@uky.edu

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Abstract

Daily and weekly reporting events of climate change and impacts on populations, cultures, economies and politics at local, national, regional and international scales suggest the need to construct databases that will be useful in future scientific inquiry and global human/environmental policies. That need is evident in constructing a geographic or locational knowledge base that examines countries, regions and cities. This study constructs a database on the impacts of climate change using Google Scholar entries for 200 countries and capital cities. A series of maps reveal the vast unevenness in the database, especially between Global North and Global South countries. The discussion explores these sharp differences and suggests future research topics for much-needed global, interdisciplinary and international research.

Keywords

Climate Change Maps, Capital Cities, Knowledge Gaps, Climate Impacts, Global Climate

1. Introduction

From time to time, it is desirable for scholarly communities investigating interdisciplinary and international topics to construct and analyze a database on what or how much we know about a subject that is transdisciplinary and international. This generalization can apply to researchers studying sustainability, gender equity, pandemics as well as climate change. Climate change in the past two decades has expanded from a research subject of primary interest of scholars in meteorology and atmospheric physics to include research by those in political science, economics, geography, biology and sociology as well as the print and

visual literature: music, drama and the visual arts. It is in the expanding global interest in climate change, global warming, and mega-disaster impacts and unexpected anomalies that we are constructing and analyzing a global database about what we know.

What we know about climate change will help us understand something about its causes and the impacts on populations, economies and environments within a country, a region, and also at global scales. Constructing an international knowledge database will also likely reveal what we do not know and what would be desirable to know as scientists, politicians and economists move forward raising further inquiries into mapping the multiple major causes and impacts. If such a database included a geographical perspective, that is, data about countries or cities and regions, we could construct maps about the degree or level of our understanding or knowledge base. In short, mapping key features of climate change related to countries and cities would not only aid in our quest to identify major and minor "geographical gaps" in our thinking, but also call attention to the national and international scholarly communities addressing distinctive features and impacts in specific countries or regions. Climate change is better examined in global contexts rather than for an individual country; weather and climate are transboundary environmental features.

The major objective is to construct a database about global climate change and locations, specifically with reference to countries, capital cities and rural areas. The following section reviews recent interdisciplinary research on climate change, drawing especially on measuring and mapping changes at national and global scales. This discussion is followed by constructing a database using Google Scholar hyperlinks that can be used to map and examine variations between countries, capital cities and rural areas. The final section summarizes the findings and offers some suggestions for subsequent research.

2. Research on Climate Change and Maps

As noted above, climate change is an international and interdisciplinary research field that attracts scholars from the social, natural and physical sciences as well as those interested in the visual and environmental humanities. In the past couple of decades sessions at international, national and many regional conferences in these fields have identified climate as a long-standing subject meriting more scholarly attention as well as new topics, transdisciplinary in nature, that are worth pursuing. The same holds true for new journals with titles and subtitles about climate change and global warming and for single-authored and edited volumes on climate change topics. Even a collective casual examination of recently published research in major journals reveals that the authors increasingly cross-disciplinary lines and come from regions across the globe. What is noteworthy in the knowledge base that is emerging are two major features: the recognition of interdisciplinary research published in inter- and transdisciplinary journals and the recognition that maps and mapping are considered central

parts of many inquiries. The challenges facing scholars have been addressed by [1] [2] [3] [4]. The innovative atlas by Dow and Downing [5] represents a pioneering effort to integrate the research efforts in many fields. Similar questions are raised by [6] [7]. Mapping approaches and analyses have been integral parts of studies that focus on regions and individual countries. Recent examples include the Arab world [8] [9], Iraq and Jordan [10], India [11] and Pakistan [12]. Other countries and regions are also investigated, including Africa [13]; the Asia-Pacific region [14], Southeast Asia [15], Europe [16], Central America [17] and the Arctic [18]. The cartographic/climate change intersections are also surfacing in various research agendas by scholars in the social sciences and the humanities. These include contributions exploring the measurement and meanings of vulnerability [2], social media [19], poverty [13], migration [20], gender [21], health and disease [14] [22], ecosystems [23]; drama [24], music [25] [26], law and justice [27] [28] [29]; architecture [30]; postage stamps [31] [32]; tourism [33], and religion [34] [35].

Without question, current research on visual features (maps, social media images, advertising, etc.) is presenting scholars with many topics and approaches for studying present and future climate research. Scholars need to appreciate and welcome the new approaches, methodologies and findings that emerge from more interdisciplinary research, especially in research linking climate change in the social sciences and humanities studying transborder migration, gender, tourism, geopolitics, spiritual communities and the short- and long-term impacts of natural hazards.

3. Constructing a Database

Keeping in mind these emerging and evolving frameworks to study and map climate change worlds and impacts, our overriding purpose is to construct and develop a global knowledge database about climate change and location. The locations can be individual countries or regions or global in nature. Multiple sources can and might be used to construct such a database, that is, using books, chapters, conference proceedings, research grants, and articles in major disciplinary and interdisciplinary journals. Each of these has advantages but also some disadvantages, viz., that the published research is often "dated" when it appears in print. Such may be the case for a topic like climate change which attracts scholars from many different fields and countries who write in different languages and seek to be referenced and used in contemporary research inquiries. What is desirable is a global database that not only includes scholarly research published in different languages, disciplines and subfields, but more importantly that the database is current.

The shortcomings identified in the previous paragraph can, in part, be overcome by using a Google Scholar database. This source includes up-to-date references to articles, books, chapters, proceedings, databases, websites, reports and presentations written by authors from well-known and less well-known univer-

sities and governmental/intergovernmental agencies and from countries around the world. The source is constantly updated with new or additional materials; the number of entries is likely to be updated from day to day and even within the same day. That the entries are ranked using an industry formula is also important for those wishing to identify, access and use the entries with the greatest value. The entries (hyperlinks) can be very recent research as well as important historical studies. Between the Google Scholar search bar and the display of results is a horizontal bar that provides the total number of hyperlinks on the subject (e.g., "About 692,000 results (0.13 sec)) and some information about each entry (author, title, year, a short description, number of citations). There are usually ten sources on each screen page.

In short, the Google Scholar database can be used to construct a database about "what or how much we know" about a given subject. The search can be for general topics, such as climate change or global warming or extreme weather events, or more narrowly defined topics such as climate change in the tropics, global warming and rising sea level, or extreme weather events in Southeast Asia or Mediterranean Europe. Each search will yield the total number of hyperlinks in the Google Scholar database about the subject/topic searched. These numbers can be compared, analyzed, graphed and mapped.

3.1. Climate Change Database Compilation

English-language geographical databases were constructed on 4-7 July 2022 using Google Scholar and the names of 200 countries and several keywords or phrases about climate change. The geographical entries included not only familiar names of countries such as the Netherlands, Pakistan, Uruguay and Lesotho, but also many small countries such as Federated States of Micronesia, Liechtenstein, St. Lucia and Andorra. Google Scholar was searched for the name of each country followed by a keyword, for example, Italy + climate change, Argentina + climate change, etc. An Excel spreadsheet was prepared for subsequent numerical and cartographic analysis. The next step was to include the name of a country and climate change and another term, for example, Ukraine + climate change maps, Malaysia + climate change maps, etc. The purpose task was to obtain the number of hyperlinks about climate change. Examples include Cuba + climate change impacts, Ethiopia + climate change impacts. Next, we were interested in climate change hyperlinks with respect to cities and rural areas and constructing appropriate databases. For this task, we entered the name of a country followed by cities for one database and rural areas for another. Examples include Belgium + climate change + cities, Belgium + climate change + rural, New Zealand + climate change + cities, New Zealand + climate change + rural.

The city database was for capital cities as these are the centers of government and, for many countries, and are the most important economic and political cities in a country. In most countries, the capital city is the largest and one likely to have the most hyperlinks in the constructed database. Examples of countries where the largest city or next largest city is not the capital include Mumbai and

Kolkata in India, São Paulo and Rio de Janeiro in Brazil, Sydney and Melbourne in Australia, Istanbul in Türkiye and Cape Town in South Africa, Shanghai in China, Washington, D.C. in the United States and Lagos in Nigeria. For each capital city, we entered the name followed by climate change, maps and impacts. For example, Dublin, Ireland + climate change; Dublin, Ireland + climate change maps, Dublin, Ireland + climate change impacts; Jakarta, Indonesia + climate change; Jakarta, Indonesia + climate change maps; Jakarta, Indonesia + climate change impacts.

Once the spreadsheets were compiled, we compiled another database in which the countries were ranked from 1 to 200 in the total number of hyperlinks; we did the same for all the capital cities, that is, from most to fewest in the number of hyperlinks for maps and impacts of climate change for each capital city. Another database was created with urban and rural populations, for example, Kenya + climate change + cities or Kenya + climate change + rural. From these data, we calculated the percentages that were urban. As will be noted below, in some countries, there were more rural than urban hyperlinks about climate change. Also, we ranked the countries and capital cities from the one with the most in a subject category to the one with the fewest hyperlinks. We also calculated the percentage of each country's total to the total of all entries in the category, for example, in the country + climate change category, and then we ranked these entries from the most to the fewest hyperlinks.

3.2. Major Questions

With the foundation data collected regarding climate change entries for countries and capital cities, we were interested in presenting the numerical results and constructing a series of maps to address the following six questions:

1) How many entries are in the Google Scholar database about climate change?

2) How much disparity is there in our global climate change database? Is there much or very little? Is there much "evenness" or much more "unevenness?"

3) What do the constructed maps reveal about the volume of hyperlinks for each country and each region? Are there minor or major regional/geographical divides and differences? Are there distinctive regional patterns for Europe, Africa, Latin America and Asia?

4) How much diversity is there in the database regarding the impacts of climate change? Are the impacts more similar or dissimilar and are there predictable regional differences?

5) What do the results reveal about the hyperlink volumes of capital cities and climate change?

6) What do the results reveal about hyperlink volumes of maps and impacts of capital cities? Do the maps reveal any consistent regional patterns or is there vast diversity among the cities? Answers to these and other questions emerged in examining the data and the maps that were constructed. It is important to keep in mind that the constructed database will help present-day scholars undertaking

similar and subsequent research at all levels, local to global, but also the topics and regions that most need our immediate and future attention.

4. Results

We discuss the results for countries first, then for capital cities. The total number of Google Scholar hyperlinks for all 200 countries was almost 119 million. The geographic regions with the most countries are Europe (49), followed by Sub-Saharan Africa (40), and North Africa and the Greater Middle East (includes five Central Asian states) (34) (Table 1). There are 26 countries in Asia (12 in Southeast Asia, 8 in South Asia and 6 in East Asia), and 20 in Latin America (12 in South America and 8 in Central America), and 14 in the Caribbean. North America includes the U.S. and Canada; Russia is included as a single country category. The combined population of all countries in these regions was 7.7 billion; 25% in South Asia, 22% in East Asia, 12% in Sub-Saharan Africa, 10% in North Africa and the Middle East, 8% in Europe and 8%in South and Central America combined, and 7% in Southeast Asia. At the other end of the population numbers were the U.S. and Canada (5%), Russia (2%) and less than 1% for Australia and the Pacific Islands and the Caribbean combined. The countries in each region are listed in Table 2.

4.1. Hyperlinks for "Country + Climate Change"

The 200 countries are ranked into six categories according to their total number of climate change hyperlinks. The categories are 1 - 34, 35 - 67, 68 - 100, 101 - 133, 134 - 166 and 167 - 200 (Figure 1). Another perspective is gained by looking at the mix of countries in each category by region (Figure 2). The leading country in the total number climate change hyperlinks was South Africa (4 million), followed by Canada, Germany and the U.S. (each 3.5 million). Another five countries (China, France, Australia, Japan and India) had more than 3 million hyperlinks. Together these nine countries had 31 million hyperlinks or 26% of the total. Eleven countries had more than 2 million hyperlinks each: Italy, Mexico, the Netherlands, Spain, United Kingdom, New Zealand, Brazil, Sweden, South Korea, Russia and Ireland. The combined total of the top 20 countries was 27 million. The 20 leaders combined had 58 million or 49% of all country hyperlinks. At the opposite end of the continuum were 40 counties, each with fewer than 5000 hyperlinks in the database. Their combined total of 1.6 million hyperlinks, which is about the same as Indonesia and Switzerland, ranked 24th and 25th on the total list. Most of the countries with low numbers were in Europe, Sub-Saharan Africa, North Africa and the Greater Middle East. Not all were ministates in population or size.

4.1.1. Hyperlinks for "Country+ Climate Change + Maps"

The total number of country hyperlinks for climate change maps was 32 million (Figure 3). The leading country by far was the United States with 2.4 million. The other countries with more than 1 million hyperlinks were, in order, South

Table 1. Regional totals: population, climate change, maps and impacts.

Region	# of Countries	Population 2021	Population %	Climate Change	Climate Change Maps	Climate Change Impacts
Europe	49	652,582,573	8%	40,384,700	11,169,060	20,541,160
Sub-Saharan Africa	40	943,500,174	12%	13,603,300	3,974,614	10,382,500
North Africa and Middle East	34	765,431,408	10%	11,228,160	2,287,700	4,960,000
Australia and Pacific	14	33,349,599	0%	6,516,000	2,134,890	5,693,000
South America	12	433,939,599	6%	6,164,400	1,369,700	3,674,500
Caribbean	14	39,658,035	1%	1,151,600	412,400	733,800
Central America	8	177,500,987	2%	4,119,400	1,208,900	3,650,300
South Asia	8	1,929,573,641	25%	6,343,760	2,238,000	4,613,700
Southeast Asia	12	581,018,660	7%	8,569,200	1,295,200	5,018,400
East Asia	6	1,678,682,413	22%	8,569,200	1,295,200	6,401,000
Russia	1	145,912,045	2%	2,130,000	413,800	2,000,000
North America	2	370,978,920	5%	7,110,000	5,470,000	6,630,000
Totals	200	7,752,128,054	100%	115,889,720	33,269,464	74,298,360

Table 2. Countries in each region (in alphabetical order).

Region	Countries/Areas
Australia and the Pacific	Australia, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, New Caledonia, New Zealand, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu
Caribbean	Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Netherlands Antilles, St. Kitts & Nevis, St. Lucia, St. Vincent and Grenadines, Trinidad and Tobago
Central America	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama
East Asia	China, Democratic Republic of Korea, Japan, Mongolia, Republic of Korea, Taiwan (China)
Europe	Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye, Ukraine, United Kingdom, Vatican City
North Africa and Greater Middle East	Algeria, Bahrain, Cape Verde, Chad, Djibouti, Egypt, Eritrea, Ethiopia, Iran, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Lebanon, Libya, Mali, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tajikistan, Tunisia, Turkmenistan, United Arab Emirates, Uzbekistan, Western Sahara (disputed territory), Yemen
North America	Canada, United States
Russia	Russia
South America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela

Continued

South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
Southeast Asia	Brunei, Cambodia, East Timor, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Singapore, Thailand, Vietnam
Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Comoros, Cote d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Eswatini, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Niger, Nigeria, Republic of the Congo, Rwanda, São Tome & Principe, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe

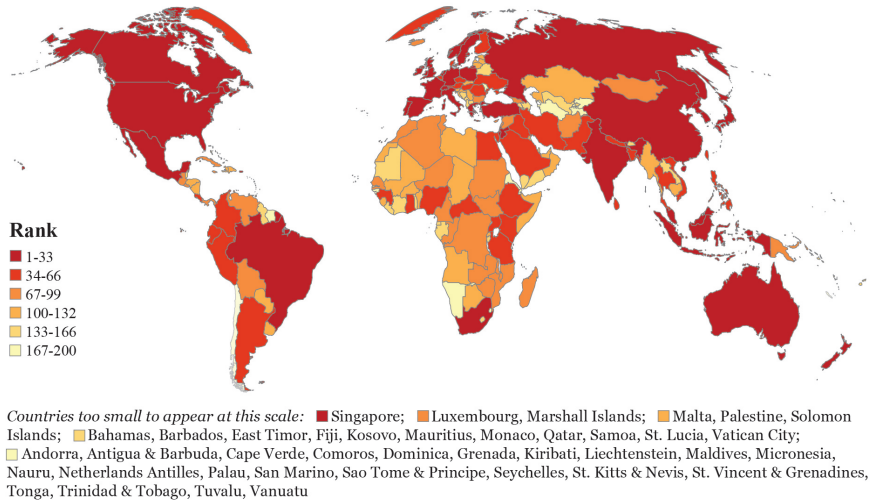

Figure 1. The 200 countries ranked into six categories according to their total number of Google Scholar hyperlinks for "Country + Climate Change" (lower numbers/darker colors have more hyperlinks).

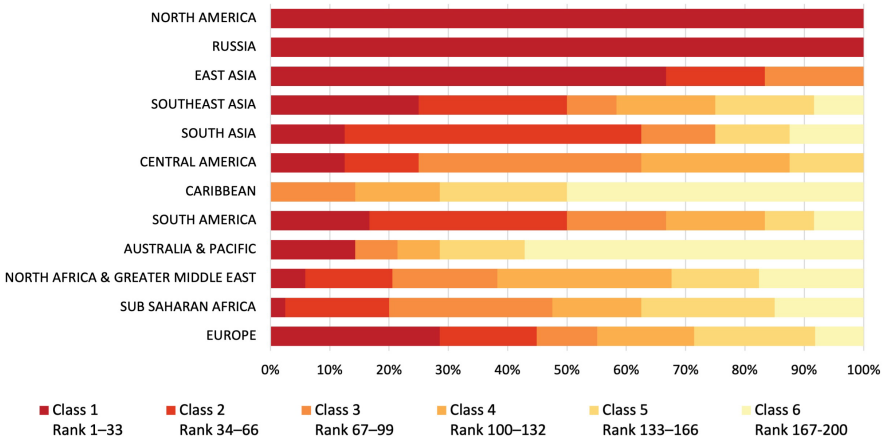

Figure 2. Percentage of Google Scholar hyperlinks by region in six ranked categories (lower numbers/darker colors have more hyperlinks).

Africa, China, Australia, Canada, Germany, India, France and the Netherlands. These nine together had 12 million hyperlinks or 30% of the total. If we add the next ten countries, which had between 400,000 and 1 million hyperlinks, the top

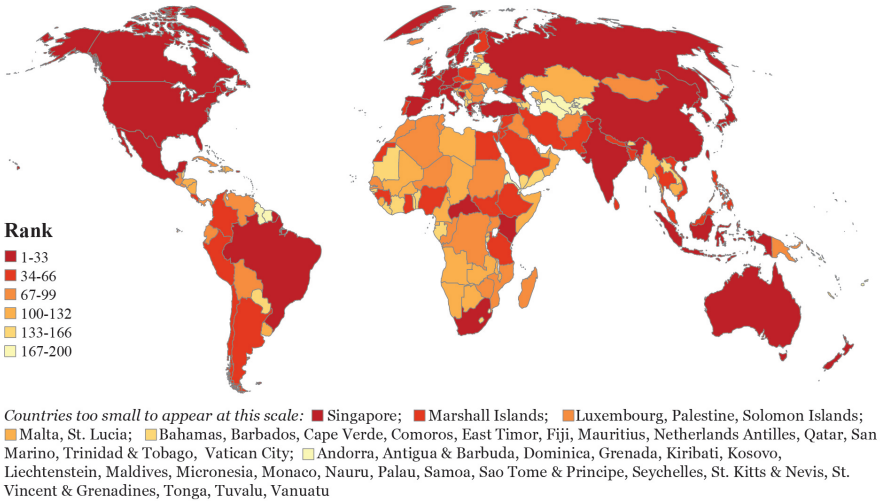

Figure 3. Total number of Google Scholar hyperlinks for "Country + Climate Change + Maps".

19 countries had 18 million hyperlinks or 57% of the total. Nine of these, including Russia (19th), were in Europe. At the other end of the spectrum were many countries with few climate change maps. There were 25 countries with less than 20,000 hyperlinks each. Five of these, Kiribati, Tuvalu, Nauru, Liechtenstein and Andorra, had less than 10,000 each. The combined number of map hyperlinks for these 25 countries was 354,000, which was similar to the United Kingdom's total of 359,000; it ranked 21st among all countries.

4.1.2. Hyperlinks for Country + Climate Change + Impacts

The total number of hyperlinks for the countries for climate change + impacts was 80 million (**Figure 4**). The countries with the most hyperlinks were the United States (4.3 million), South Africa (4.2 million), the United Kingdom (3.6 million), New Zealand (3.1 million), Spain and Mexico (2.7 million each) and the Netherlands, Canada and China (each about 2.4 million). These nine had 52% of all the hyperlinks for climate change + impacts. Another 12 had from 1 to 2.3 million hyperlinks associated with climate change. Altogether, the 21 countries accounted for 49 million or 62% of all countries. Nine, including Türkiye and Russia, were in Europe.

4.2. Hyperlinks for "Capital City + Climate Change"

There were 29.7 million hyperlinks for the capital cities (**Table 3**). The number varied by region, from Europe (12 million or 41% of the total) to North America (U.S. and Canada) with 4.4 million (15%) and Asia also with 4.4 million (15%), to Australia and Pacific Islands with 528,000 (2%), and Caribbean Islands with 185,000 (only 1%). How the capital cities ranked in the six categories is shown in **Figure 5**.

The leading capital city was Washington, D.C. (3.9 million) followed by London (3.1 million) and Mexico City (2.7 million). The next leading cities were Paris, Berlin, Singapore, Bangkok, Beijing and New Delhi, each with from

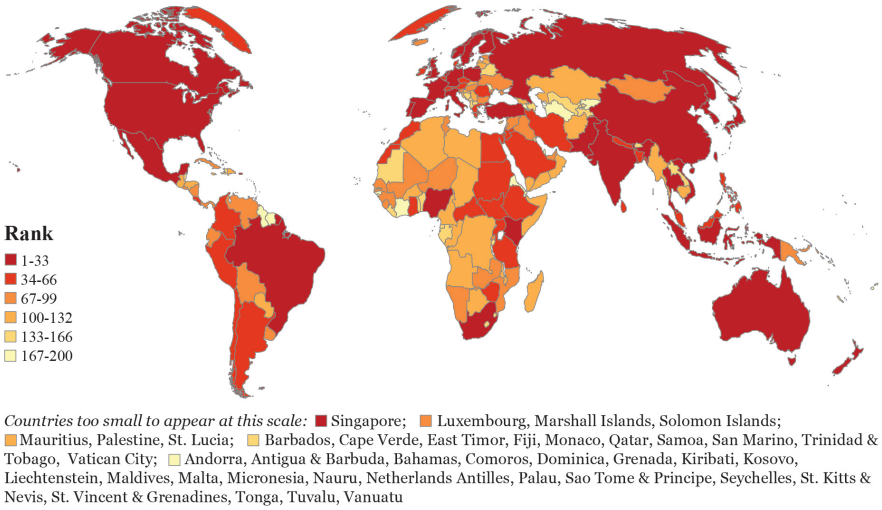

Figure 4. Total number of Google Scholar hyperlinks for "Country + Climate Change + Impacts".

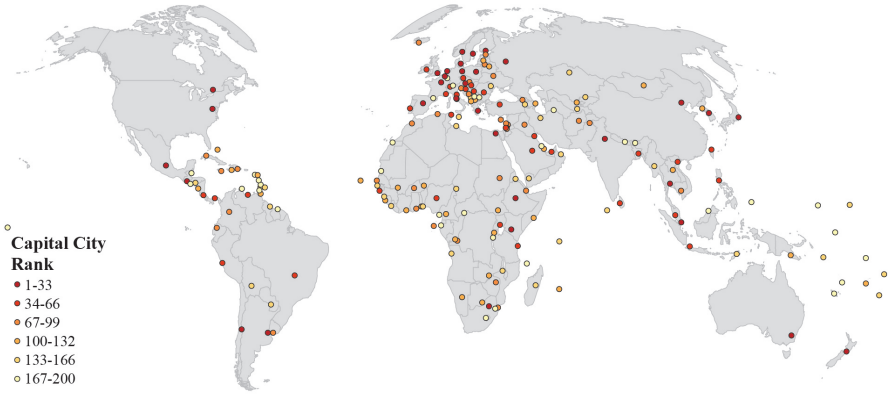

Figure 5. Capital cities ranked by total number of Google Scholar hyperlinks on "City + Climate Change + Impacts".

Table 3. Ranking the number of hyperlinks for climate change and capital cities.

Rank	No. Hyperlinks	% of Total
1 - 33	25,347,000	85
34 - 66	2,469,900	8
67 - 99	1,003,000	3
100 - 133	570,500	2
134 - 166	275,170	1
167 - 200	88,770	1
TOTAL	29,754,340	100

921,000 to 2.3 million hyperlinks. Altogether these cities had 18.5 million hyperlinks or 62% of the total. Another eight cities had from 300,000 to 540,000 hyperlinks. Altogether, the 17 largest cities had 22 million hyperlinks or 74% of the total. At the other extreme, there were 62 capital cities that had less than

10,000 hyperlinks each. Their combined total was 319,000 which was about the same as Stockholm, which was ranked sixteenth in most hyperlinks.

4.2.1. Hyperlinks for "Capital City + Climate Change + Impacts"

The total number of capital city hyperlinks related to climate change + impacts was 16.3 million. Again, Washington, D.C. was the leader with 2.7 million or 17% of the total. The next three leaders were London with 1.1 million and Berlin and Paris, each with over 900 million. They were followed by Mexico City, Bangkok, Singapore, Madrid, Rome, Stockholm, Amsterdam, Beijing and Vienna (300,000). The top 13 cities had 8.9 million or 53% of all climate change +impacts hyperlinks. Not unexpectedly, there were many cities with very few impact hyperlinks. There were 36 capitals that had less than 10,000 each; their combined total was 166,000, which is about the same as Seoul. That number was 1% of the total.

4.2.2. Hyperlinks for "Capital City + Climate Change + Maps"

There were far fewer total hyperlinks for climate change + maps than for impacts. The total number of map hyperlinks was 9 million. The leader, again, was Washington, D.C. with 991,000 or 11% of the total. The other leading countries were the same as mentioned above: London (669,000) and Paris (626,000) followed by Berlin, Mexico City, Rome, Bangkok, Singapore, Madrid, Vienna, Beijing, Stockholm, Amsterdam, Moscow, Canberra and Tokyo. Each had more than 100,000 hyperlinks. Altogether these sixteen capital cities had 5.1 million or 58% of the total. And, not unexpectedly, there were 37 capitals that had less than 5000 hyperlinks each related to climate change and maps. The combined number of hyperlinks of these capitals was 101,000 or less than 1% of the total. This total was slightly more than for Nairobi and Copenhagen; they were ranked 19th and 20th of all capital cities.

4.3. Cities and Rural Areas and Climate Change

We sought to discern if there were any differences in the knowledge base between cities and rural areas and also in references to maps and impacts. For the 200 countries, the total number of hyperlinks of countries, climate change and cities was slightly more than 53 million; for rural areas, the total was slightly less at 46.4 million. The countries with the largest combined totals (countries + climate change + cities) were essentially the same as those mentioned above when discussing countries + climate change. The leaders were the U.S. (4.2 million), India (2.4 million), China (2.3 million), France (2.2 million) and South Africa (2.1 million). Next were Canada, Australia, Japan, United Kingdom, Germany, Mexico, Netherlands, Italy and Spain. The 14 leading countries had 27 million or 51% of all cities' hyperlinks. If we consider the 21 counties that have more than 200,000 hyperlinks associated with cities, the number reaches 42 million or 79% of the total. There are a number of regions with countries having more than 200,000 hyperlinks about cities. The regions with the most countries were Eu-

rope (17), North Africa and the Greater Middle East (7), Southeast Asia (6), East Asia (5) and South America (4). There are, thus, many countries that have few hyperlinks about cities and climate change.

Of the 46 million hyperlinks associated with rural areas and climate change, the U.S. ranked first (3.8 million), South Africa second (2.8 million), India third, Australia fourth and China fifth. Seventeen countries had more than 500,000 each for a total of 22 million hyperlinks or 48% of all rural hyperlinks. The rural leaders were the U.S. (3.8 million), South Africa (2.8 million), Australia (1.8 million) and China (1.7 million). The total number of urban climate change hyperlinks was 52 million. Twenty-one countries had 31 million or 59% of the total. The leaders were the U.S. (4.2 million), Indonesia (2.4 million), China (2.3 million), France (2.4 million) and Canada (2.0 million). As the map shows, many of the countries with the most city climate change hyperlinks were also leaders in rural hyperlinks. The patterns for rural African, Asian and Latin American countries revealed some countries with approximately the same numbers in each category and others where there were many more rural than urban hyperlinks.

There were 17 countries that had less than 20,000 hyperlinks each. Most were small in area and/or population in Sub-Saharan Africa, Europe and the Pacific. The combined number of hyperlinks for these countries was 251,000 or almost equal to the total number of hyperlinks for Norway or Malaysia. Altogether there were 65 countries with 50,000 or fewer rural hyperlinks associated with rural areas; the total number was 1.6 million which was almost equal to Canada's rural hyperlinks total of 1.7 million.

Comparing the countries with the most and fewest hyperlinks about cities and rural areas reveals a point made above about the vast differences or disparities in the global knowledge database about climate change. With eleven countries having half the total hyperlinks, it means that almost 190 countries share the other half! That generalization holds true both for cities and for rural areas.

Another perspective on urban-rural differences is gained by looking at percentages on a world map (**Figure 6**). Three categories are shown: an urban percentage of climate change and cities greater than 52%, a second category where the percentages are almost equal (48% - 52%) and a third category rural or less than 48% urban. There are 105 countries in the first category, 41 in the middle and 45 in the third category. The results are not that surprising for North America, Europe, Australia, New Zealand and some Pacific Islands. Other countries with high urban percentages were Afghanistan, France, Germany, Japan, Italy, Türkiye, Australia, Finland, Israel, Poland, Ukraine, Jordan and Austria, but also Armenia, Libya, Lebanon, Saudi Arabia, Malta, Qatar and Bahrain. However, the map clearly shows variations in the Climate Change knowledge base in African countries, for example, between South Africa, Namibia and Botswana, or between most West African and North African countries and between Central and Southern African countries. Small island states are in all three categories. Singapore, some ministates in Europe, the Pacific and the Caribbean are in the first category; the middle and third categories also have states in the same regions.

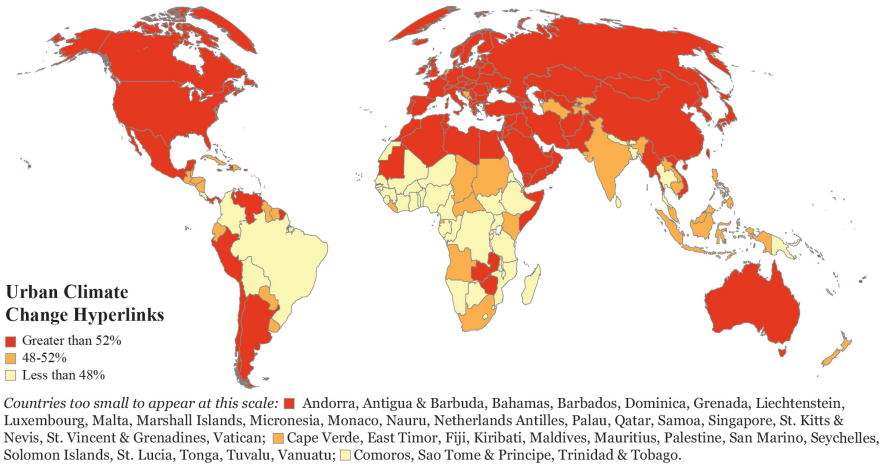

Figure 6. Ranking of countries by total number of Google Scholar hyperlinks for "Country + Climate Change + Urban".

5. Analysis

Based on the data gathered, analyzed and mapped there are six conclusions that emerge when looking at climate change data on national, regional and capital city scales.

First, the number of hyperlinks about climate change reveals major disparities when looking at global scales. The top 33 countries in volume have 78 million or 65% of the world's total of 119 million hyperlinks. The countries ranked 167 - 200 (at the bottom) in total hyperlinks have 1.3 million hyperlinks and only 1% of the total; that total is equal to the number of hyperlinks for Portugal (ranked 32nd) which also had 1.3 million hyperlinks.

Second, countries with the most hyperlinks in the top 33 are in these regions: Europe, North America (U.S. and Canada), East Asia, and Southeast Asia as well Russia, Australia and New Zealand. These regions have 65 million hyperlinks or 55% of the total. At the other extreme are 100 countries in Sub-Saharan Africa, North Africa and Central Asia which have only 8 million hyperlinks and 7% of the world total, a percentage equal to the two countries with the most hyperlinks, South Africa and Canada. If we added the hyperlink totals of Sub-Saharan Africa, North Africa and the Greater Middle East, and Central America (except Mexico), the total would be 21.5 million hyperlinks or 18% of the world total or slightly more than half the total for all European countries.

It is useful to keep these results and others in a broad global perspective (Table 4). Canada and Germany have slightly more climate change hyperlinks than China and France combined, and Japan and India have more than the 12 countries in South America combined. In addition, the U.S. has slightly more than China and the hyperlink totals for Switzerland and Japan exceed that of the 14 Caribbean countries.

When considering maps of climate change, there is also much unevenness in the 32 million total for all countries. The leading countries are very similar to the

Table 4. Comparative facts about climate change hyperlinks of countries and capitals.

Category	Facts
Climate Change	Russia and Ireland have about equal numbers (2.4 m)
	Canada and the U.S. (7.1 m) have more than South America countries (6.3 m)
	Brazil (2.3 m) has about the same number as Sweden (2.1 m)
	China and France (3.3 m) have the same number
	Caribbean islands and Denmark (1.1 m) have the same number
Climate Change + Maps	Sweden (1.6 m) has more than South America (1.4 m)
	The U.S. (3.5 m) has almost the same as Sub-Saharan Africa (3.8 m)
	Canada and the U.S. (5.5 m) have many more than China (1.4 m) and India (1 m) combined
	Australia (1.2 mi) has more than India (1.1 m)
	Russia (413 m), Switzerland (433 m) and South Korea (427 m) are similar
	Europe (11.1 m) has slightly more than Sub-Saharan Africa (3.8 m), North Africa & Greater Middle East (2.3 m), South Asia (2.2 m), South America (1.4 m), Southeast Asia (1.3) and Central America 1.2 m) combined
Climate Change + Impacts	Singapore (1.4 m) has a similar number as Indonesia (609 m) and Vietnam (816 m) combined
	Türkiye (1.3 m) has slightly more than Norway (1.2 m)
	Japan and France (both 1.8) have almost the same number
	South Africa's total (4.1 m) has 40% of Sub-Saharan Africa's total
	China's total (2.4 m) is the same as the Netherlands (4th most in Europe)
	United Kingdom (3.5 m) is almost equal to Central America (3.6 m)
	Caribbean (734 m) have slightly more than Finland (658 m)

leading countries in total hyperlinks: U.S., Canada, South Africa, China, Germany, France, the Netherlands, India and Ireland. That unevenness is evident in the 20 leading countries which have 24 million hyperlinks and 69% of all the maps on climate change. Most are rich countries in the Global North. The 34 countries with the fewest maps of climate change, that is, those ranked 167 - 200, have a total of only 540,000 hyperlinks (about the same number as New Zealand) or less than 2% of the total.

The results are nearly identical when we consider the impacts of climate change. The top 20 countries have 45 million hyperlinks and 62% of the total. The bottom 34 countries have only 1 million hyperlinks and 1% of the total.

A third notable observation is that in most world regions, there are usually one or two leading countries and many others with far fewer hyperlinks. Examples include Mexico in Central America; Cuba in the Caribbean; Brazil in South America; China and India in Asia; South Africa in Sub-Saharan Africa; Israel,

Egypt, Jordan and Iran in North Africa and the Greater Middle East, Germany and France in Europe, and Australia in Australia and Pacific. In North America, the U.S. and Canada are co-leaders. Brazil has four times more total climate change hyperlinks than Colombia and three times more than Argentina. Both Iran and Egypt have about 1.3 million climate change hyperlinks whereas Turkmenistan, Qatar and Mauritania have less than 100,000. Similar vast disparities exist when comparing hyperlinks about maps and impacts.

A fourth observation relates to capital cities. Not surprisingly, the countries that were leaders in total climate change hyperlinks as well as maps and impacts were basically the same for capital cities. In most cases, the capital city is the largest city in a country and would be expected to have the most hyperlinks. Examples of countries where the capital is not the largest city include the U. S., Canada, Brazil, South Africa, Australia, India, Türkiye and New Zealand. Santiago, Chile has four times more climate change hyperlinks than Caracas, Venezuela; Pretoria, South Africa has fifteen times more than Lilongwe, Mali.

Fifth, the unevenness in the number of hyperlinks at the country level extends to a global examination of all capital cities. Six of these are in Europe (London, Paris, Berlin, Rome, Amsterdam and Vienna), two in Asia (Beijing and Singapore), one in the U.S. (Washington, D.C.) and one in Latin America (Mexico City). The top 10 capitals have 4 million hyperlinks or 45% of the total; the top 20 capitals have 4.3 million hyperlinks and 48% of the total. The capital cities with the 20 fewest climate change hyperlinks together had only 31,000, which was less than 1%. These were in scattered locations including capitals in Europe (Vaduz and Andorra), Latin America (Belize), the Caribbean (St. Kitts and Nevis and Dominica), the Pacific (Palau and Tonga), and Sub-Saharan Africa (Comoros).

Similar unevenness exists when looking at maps of capitals and impacts of climate change. The five leading capitals in a number of hyperlinks for maps are Washington, D.C., London, Paris, Berlin and Mexico City; they had 3.3 million hyperlinks or 36% of the total (9 million). The five leading cities for impacts were the same; they were Washington, D.C., London, Berlin, Paris and Mexico City which had 6.6 million hyperlinks or 40% of the total (16.4 million).

6. Summary and Paths Ahead

The major finding in the construction and analysis of a global Climate Change database is the vast unevenness in the number of Google Scholar entries for 200 countries. It is not just that there were differences, but that those differences were significant when looking at total Google Scholar hyperlinks for individual countries as well as for maps about climate change and the impacts of climate change. Most of the Global North or developed world countries are in the first (usually) and second categories while most of the countries in Central and South America, the Caribbean, Africa, the Greater Middle East, South and Southeast Asia and the Pacific are in lower categories.

The sharp cleavages in the numerical database, which are revealed in the maps

as well, are worth additional scholarly inquiry by both international and interdisciplinary scientists. Subsequent research might examine where the climate scientists come from and who is conducting research in the well-studied and less-well-studied regions. It would also be worth exploring the sources of research funding and which areas are identified as high and low priority. The maps themselves raise questions about which areas or regions are over- and understudied and funded. The locational foci of climate change research funding would also be worth knowing, as well as comparisons between European and African funding sources, funding for research on oceans and low latitudes, and funding for research on metropolitan areas. Clearly, location needs to be a major focus for continued study as well as mega-urban areas.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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