Tampere University

Sofie Lagerroos

ASYMMETRIES IN GLOBAL SCIENTIFIC KNOWLEDGE PRODUCTION: REGIONAL REPRESENTATIONS IN CLIMATE CHANGE RESEARCH

Faculty of Management and Business
Master’s thesis
February 2023

ABSTRACT

Sofie Lagerroos: “Asymmetries in global scientific knowledge production: regional representations in climate change research”
Master’s thesis
Tampere University
Master's Programme in Politics, International Relations
February 2023

This study examines regional representations in scientific climate change research. More specifically, the aim of this thesis is to map the geographical distribution of case studies in adaptation and mitigation related research, as well as to determine whether certain economy, education, research, and development related factors correlate with said distribution. As a starting point for this endeavour, three central factors can be highlighted: the social organisation of knowledge, spatial or geographical contexts, and resources. These factors emerge from the theoretical discussion about structural power and inequalities in the global knowledge economy, and underlying them is the idea that knowledge production has social, spatial, and economic importance, which is all tied to structural power.

The data of this study comprises 10 000 scientific articles about climate adaptation and mitigation, published between the years 2018 and 2022 and collected from Scopus -database. In this sample, there are 6 844 case studies that form the final dataset. The first part of the analysis examines the geographical distribution of these case studies, whereas the second part looks into the existence and strength of possible correlations between the recurrence of case study locations and the following indicators: Research and Development expenditure (as a percentage of GDP), GDP per capita (PPP), government expenditure on tertiary education (as a percentage of GDP), the number of researchers per million people, Human Development Index, and Global Innovation Index.

One of the main conclusions of the analysis is that there is clear variation in the spatial distribution of case study locations: certain countries and regions are much more studied than others, and there are some regional “clusters” that stand out due to a very large or a very small number of conducted case studies. In the original dataset, population sizes clearly influence the observed regional representations, considering that countries with particularly large populations stand out: for example USA, China, Brazil, India, Ethiopia, South-Africa, and Australia. When the number of case studies per country has been population-adjusted, the highest proportions of case studies can be found from Oceania, Northern Europe (especially from the Nordic countries), Northern America, and Southern Africa. It is clear that in the dataset of this thesis, case study locations are not evenly distributed across the globe.

Another important conclusion is, as the correlation analysis shows, that there is a positive, albeit only weak to moderate, association between the recurrence of case studies and all of the chosen indicators. The strongest correlation can be found between the number of case studies and the number of researchers, but R&D expenditures and the Global Innovation Index demonstrate moderate correlations to the recurrence of case study locations as well. These three variables are, therefore, likely related to the levels of regional representation observed in the dataset. GDP per capita (PPP), tertiary education expenditures, and the Human Development Index, on the other hand, only show weak correlations, which would indicate a rather unsubstantial relationship between said variables and the number of case studies.

Keywords: adaptation, mitigation, climate change, knowledge production, regional representation, structural power, global knowledge economy, correlation analysis, Kendall’s tau, Spearman’s rho

TIIVISTELMÄ

Sofie Lagerroos: “Asymmetries in global scientific knowledge production: regional representations in climate change research”
Pro gradu -tutkielma
Tampereen yliopisto
Politiikan tutkimuksen maisteriohjelma, kansainvälinen politiikka
Helmikuu 2023

Tutkimuksessa tarkastellaan alueellisia representaatioita ilmastonmuutokseen sopeutumiseen ja päästöjen vähentämiseen liittyvässä tutkimuksessa. Tarkemmin ottaen tutkimuksen kohteena ovat aineisto-otannan tapaustutkimusten maantieteellinen jakautuminen sekä kyseisen jakautumisen mahdollinen korrelaatio joidenkin taloudellisten, tutkimuksellisten, koulutuksellisten ja kehityksellisten indikaattorien kanssa. Lähtökohdaksi analyysille voidaan nostaa kolme tekijää, jotka nousevat esiin myös työn teoreettisessa, rakenteelliseen valtaan ja globaalin tietotalouden eriarvoisuuteen nojaavassa keskustelussa: tiedon sosiaalinen organisointi, alueellinen konteksti, sekä resurssit. Näiden tekijöiden taustalla on ajatus tiedontuotannon sosiaalisuudesta, tilallisuudesta ja taloudellisesta merkityksestä, sekä niiden liittymisestä toisiinsa.

Tutkimuksen aineisto koostuu Scopus tietokannasta kerätystä 10 000 ilmastonmuutokseen sopeutumiseen ja päästöjen vähentämiseen liittyvästä tieteellisestä artikkelista, jotka on julkaistu vuosien 2018 ja 2022 välillä. Aineistossa tarkastelun kohteena on otannan sisältämien 6 844 tapaustutkimusten maantieteellinen ja maakohtainen jakauma, sekä sen suhde tutkimus- ja kehittämistoiminnan menoihin, bruttokansantuotteeseen, kolmannen asteen koulutuksen menoihin, tutkijoiden määrään asukaslukuun suhteutettuna, inhimillisen kehityksen indeksiin, sekä maailmanlaajuiseen innovaatioindeksiin.

Tutkimuksen johtopäätöksinä voidaan huomata, että tapaustutkimuspaikkojen alueellisessa jakautumisessa on selvää vaihtelua; joitakin maita ja alueita on tutkittu huomattavan paljon enemmän kuin toisia, ja runsaasti tai niukasti tutkitut maat muodostavat jonkin verran alueellisia ”klustereita”. Alkuperäisessä datassa väestömäärät vaikuttavat selvästi alueelliseen representaatioon, sillä esillä on erityisesti suurien väestömäärien maita kaikilta mantereilta (esim. USA, Kiina, Brasilia, Intia, Etiopia, Etelä-Afrikka ja Australia). Kun tapaustutkimusten määrä maittain on mukautettu väestömäärään, representaatio painottuu eniten Oseaniaan, Pohjois-Eurooppaan (erityisesti Pohjoismaihin), Pohjois-Amerikkaan, sekä eteläiseen Afrikkaan.

Lisäksi korrelaatioanalyysi osoittaa, että tapaustutkimusten määrän ja kaikkien valittujen indikaattorien välillä on positiivinen, vaikkakin vain heikko tai keskitason, korrelaatio. Vahvin korrelaatio havaittiin tapaustutkimusten määrän ja tutkijoiden määrän välillä, mutta myös tutkimus- ja kehittämistoiminnan menot ja maailmanlaajuinen innovaatioindeksi korreloivat kohtalaisesti tapaustutkimusten maakohtaisen toistuvuuden kanssa. On syytä päätellä, että nämä tutkitut muuttujat ovat yhteydessä tapaustutkimusten määrään. Loput muuttujista osoittivat vain heikkoa korrelaatiota tapaustutkimusten määrän kanssa, joten niiden suhteen ei voida kuvata olevan merkittävä tutkimuskontekstien esiintyvyyden kannalta tässä työssä analysoidun aineiston perusteella.

Avainsanat: adaptation, mitigation, climate change, knowledge production, regional representation, structural power, global knowledge economy, correlation analysis, Kendall’s tau, Spearman’s rho

Table of contents

1. Introduction

It is an increasingly appreciated fact that climate change poses one of the most severe threats to humanity to date — to the point that it has even been called the "defining issue of our time" (UN 2021: SC/14445). According to a robust body of cumulative scientific evidence, climate change is a serious threat to both human and planetary well-being (IPCC 2022: SPM33). Indeed, climate change has been shown to have observable, adverse effects both on the biophysical environment around us and on people all over the world: it increases the frequency and intensity of climate and weather extremes, reduces food and water security, increases the risk of biodiversity loss in many terrestrial, freshwater, coastal, and marine ecosystems, as well as threatens human health, livelihoods, and infrastructure (IPCC 2022: SPM8 – SPM13). Even amidst the global COVD-19 pandemic, scientists have adamantly characterised climate change as the number one threat to human health as phenomena such as air pollution, extreme heat, food insecurity, and infectious diseases undermine the health of people across the globe (McKeever 2021). More than that, however, climate change has consequences beyond its more direct impacts. It works as a "crisis multiplier" (UN 2021: SC/14445) by increasing instability and contributing to humanitarian crises especially in areas that are already marked with high vulnerability (IPCC 2022: SPM11). Related to this, climate change drives large-scale migration and displacement which together with intensified competition for resources can lead to increased insecurity and even to outright conflict (IPCC 2022: SPM11; Jones Parry n.d).

Considering all this, it is no wonder that climate change mitigation, as well adaptation when it comes to the effects that cannot be mitigated, require increasing attention in the fields of science and policy alike. As the current climate change is characterised by Anthropocene — that is, a geological era in which interconnected human influences on the Earth system are considered to be at the core of the processes of change on our planet (Allen et al. 2018: 53) — human agency and human–environment relations are key in the processes of mitigation and adaptation. Thus, scientific research that takes into consideration such elements has an important role in understanding and framing not only the global threat of climate change but also the mitigation and adaptation possibilities that are crucial in responding to the challenges posed by the changing environmental conditions. At the same time, it is worth noticing that the effects of climate change are not evenly distributed across the globe: there are "global hotspots of vulnerability" as the vulnerability of both different groups of people and different ecosystems greatly varies between, and even within, different regions (IPCC 2022: SPM11-SPM12). The most vulnerable who struggle the most to cope — such as groups faced with poverty, conflicts, lack of access to basic resources and services, as well as dependency on climate-sensitive livelihoods — will be hit first, and perhaps the hardest, by climate change (IPCC 2022: SPM12; Jones Parry n.d). Therefore, it is far from insignificant which regions and communities are being represented, and to what extent, by mitigation and adaptation related research.

For this reason, my thesis takes a look at regional representations in mitigation and adaptation related climate change research. Unlike much of existing research, this thesis is not focusing on where the research comes from (for example on the institutional affiliations), but rather on the regions that are being studied. The regional focus that is of interest is thus research subject-based, not author-based. As one of the aims of this study is to gain a better understanding of the levels of representation different regions have in mitigation and adaptation related climate change research, the first research question that guides the thesis is as follows: *Which regions have been studied, and to what extent, in the sample of articles in my dataset?* This question is approached by analysing and categorising a sample of scientific articles that have a regional focus. Mapping the distribution of case studies may well reveal something about differing research interests, activities, and capacities on a global scale.

Regarding the distribution of regional focuses in climate change research, it is worth noticing that this study, limited as it is, is not focusing on any individual numbers — the proportional differences in representation between different regions that have been researched is of primary interest. With a sample of different size and nature, the obtained numbers would likely look different: however, I believe there may well be some patterns in proportions that can be generalised regarding climate change research on a broader scale. Moreover, despite the fact that my study looks into scientific knowledge production, I find it important to point out the diversity of sources of information related to climate change: scientific research is only one such set of sources. Indeed, there are plenty of other sources that are equally relevant, for example indigenous and local knowledge that might not have the same weight or audience that scientific research generally has in the international academia. While case studies can offer the possibility to involve local actors outside of the scientific community in negotiating and presenting the realities of climate change, the dataset that is under scrutiny in this thesis does not and cannot by any means represent all possible knowledge on climate change or on mitigation and adaptation. Rather, it is a small glimpse into one kind of knowledge produced to better understand, and to respond to, the global threat of climate change.

A second research question that operates as a driving influence behind my inquiry goes deeper into the matter of regional representation in climate change research: *Is the observed distribution of case studies associated to certain research, economy, and development related factors?* With the help of this question, I try to understand the regional distribution of case studies that the first research question uncovers. My aim is to answer the second question by taking a look at a handful of economic, developmental, and demographic indicators that are directly or indirectly related to research, while trying to find possible correlations between them and the case study distribution. Finally, a third question — not a research question but a contemplative kind — aims to unveil the importance of regional representation in climate change research: *Why do differences in the distribution of case studies matter?* While this is undeniably a complex question that cannot be answered thoroughly in this thesis, one of the aims of this study is to reflect on the significance of varying levels of research interest towards, and activity in, different regions in the context of climate change mitigation and adaptation.

When it comes to the structure of the thesis, my study has been divided into eight sections. This introductory chapter is followed by a brief overview of the contextual background and the importance of the chosen research subject. The third section presents the theoretical basis of this thesis. The theoretical chapter consists of an International Political Economy (IPE) approach to knowledge and power, as reflected by Susan Strange's theoretical framework of structural power, deepened with a discussion about knowledge power and inequalities in the global knowledge economy. The fourth and fifth sections introduce the data and the methodological framework of my study, while the sixth chapter comprises the analysis. The analysis section is divided into two parts: the first looks into the regional distribution of case studies, whereas the second examines potential correlations between said distribution and the chosen research and economy related factors. The seventh chapter, in turn, reflects on potential wider implications of the distribution of regional representation in climate change research. Finally, the eighth and final section draws the main points and findings together into a conclusive discussion.

2. Setting the context: why study the regional representation in climate change knowledge production?

In this section, I will briefly discuss the importance of this study and situate it in a wider context, framed by some observations on relevant, previously conducted research. First of all, related to the context of this thesis, it is worth pointing out that a considerable amount of existing research about climate change related knowledge production relies on bibliometrics by analysing large sets of data using primarily quantitative methods. The main points of interests in such research are, among others, publication rates based on the number of publications in temporal and spatial contexts, the distribution of and relationships between references, the spatial or regional distribution of publications, as well as the distribution of research topics and keywords. The previously conducted research that this study might be associated with can be, roughly speaking, divided into "author-oriented" and "subject-oriented" research. The first category comprises studies that focus on *who* (people, organisations, institutions etc.) produces knowledge in a specific field. There is often a regional focus of some kind in this kind of research. The second category consists of studies that are interested in the *nature and evolution* of a given field or topic. It is important to keep in mind, however, that I raise this self-constructed division merely to illustrate the nature of some existing research and its relation to my own study: such categories are not by any means clear-cut, and they may overlap.

When it comes to the first category — more directly linked to this thesis — a number of existing research (see for example Karlsson *et al.* 2007; Pasgaard *et al.* 2015; Biermann & Möller 2019; Erfanmanesh *et al.* 2017) examines the regional focus or distribution of climate change knowledge production on a global scale. Other studies (see for example Uchiyama *et al.* 2020; North *et al.* 2022; Zyoud & Fuchs-Hanusch 2019; Ji *et al.* 2014) are interested in a specific location, such as a continental or a transcontinental region. Although plenty of studies have been conducted with the aim to examine regional distribution of scientific climate change research, their "author-oriented" nature usually drives them to ask questions about where the research comes from and what institutional affiliations are behind publications. There seems to be little existing research that is interested in the regional distribution of climate change research from a "subject-oriented" perspective, asking thus questions about what regions are being studied rather than from which regions given research originates from (institutionally speaking). This is not to say, of course, that these two questions wouldn't be interrelated: in fact, there may well be clear parallels between them. However, my thesis aims to add to the "subject-oriented" approach by examining the spatial contexts of some conducted research. I treat the geographical context of research as key in knowledge production, as it may reveal something important about geographical asymmetries in research interests and activities in relation to "international" academia.

One of the reasons why the subject of this thesis should be studied is linked to the significant role adaptation and mitigation have in the context of global climate change. As mitigation and adaptation are an unavoidable part of responding to the challenges posed by climate change, *what* and *how* we know about mitigation and adaptation in relation to the effects of climate change in a given context is of great importance. For example, such knowledge can have considerable practical significance for policies and governance, investments, technology and innovations, and so on. The regional representation in adaptation and mitigation related research, in turn, becomes all the more significant as the vulnerability to climate change, as well as the capacity to respond to environmental changes, vary considerably between and within different regions and ecosystems. It seems clear that since the contexts from which the efforts to adapt and mitigate arise differ, knowledge production on the matter should mirror this variation. Ideally, climate change research would take into consideration challenges and solutions from and for different (regional) contexts to keep the knowledge about mitigation and adaptation as heterogenous as possible. As is clear by this point, there is no region outside of the influence of climate change, although the ways in which its effects are felt and responded to differ to some extent. Consequently, it is of my personal opinion that there should be no region left outside of relevant climate change research either.

Another reason to study this subject is related to the significance of knowledge production itself. This thesis rests on the assumption that scientific research, like any form of knowledge production, is always intertwined with the society it stems from. Therefore, it is worth noticing that the extent to which different regions are being represented in research is hardly coincidental; regional representation is based on *choices* that, in turn, are influenced by different kinds of social conditions. Indeed, in the context of this study, knowledge production is conceptualised as a part of societal structures, having therefore the ability to reflect and to maintain power and social realities. And herein, above all, lies the importance of this study: what and how we know about the world around us is never insignificant in the social and societal spheres of life. Different levels of regional representation in climate change research go beyond just mere representation on paper — this representation reflects, on the one hand, and influences, on the other, the social reality in which knowledge production takes place.

3. Theoretical framework: IPE approach to knowledge and power

This chapter provides a theoretical base for approaching the topic of the thesis and, on a broader scale, for the analysis and the drawing of conclusions. As the analysis in this thesis takes into consideration several economy-related factors, international political economy (IPE) offers some useful insights into knowledge production and research on a global scale. Because knowledge is conceptualised in my thesis as inherently social, having the ability to construct, on the one hand, and reflect, on the other, power structures, Susan Strange's theoretical framework of structural power offers a relevant theoretical base for this study. I will deepen this framework by discussing knowledge power and the global knowledge economy, as well as certain inequalities and asymmetries of global knowledge production. I have chosen a theoretical framework that builds a connection between knowledge, power, and global (political) economy because this study assumes there to be, generally speaking, a connection of some kind between economic factors and knowledge output. Therefore, the aim is to examine whether the distribution of case studies correlates, to any extent, with factors such as GDP or certain research and education related expenditures. I will take into consideration some other factors as well, but even so, a framework encompassing power and knowledge production in the context of an economic system offers a relevant basis for my analysis.

This theoretical section proceeds as follows: first, I will present Susan Strange's structural power framework that conceptualises structural power within the international political economy through four dimensions; security, production, finance, and knowledge. Strange's idea of power lays a helpful foundation to an analysis of knowledge production that takes into consideration the inherently structural nature of both knowledge power and economic power. Second, as a complement to Strange's framework, I will contemplate the nature of knowledge power in the global knowledge economy, taking into consideration the asymmetries and inequalities inherent in the production and in the circulation of knowledge — especially of a globally organised kind. This will help me to figure out which factors to keep an eye on when trying to understand the distribution of spatial representation through case studies in my analysis.

3.1. Susan Strange's theoretical framework of structural power

As I have mentioned before, I treat knowledge production as intertwined in societal structures, having the ability to reflect and to maintain power and social realities. Power, hence, is a central aspect in my work: I can hardly examine knowledge production and the distribution of spatial representation without paying attention to the role of power. In fact, it is often said that knowledge "is power" and, more than that, it is also socially constructed. According to Haggart (2019: 27), among others, knowledge is created through social processes and cannot thus be outside of human agency and interpretation. As a consequence, understanding the relationship between knowledge and society is crucial in understanding knowledge in the context of the global political economy (Haggart 2019: 28). One helpful framework for forming such an understanding is Susan Strange's framework that focuses on structural power and on fundamental power structures, offering a useful foundation for an analysis that assumes knowledge and knowledge-related systems to be inherently social and subject to political contestation, rather than "natural" or "fixed" (Haggart 2019: 46).

As a premise to her theoretical framework, Strange (2015: 26) argues that there are two kinds of power, *relational power* and *structural power*, that are exercised in a political economy. According to her, relational power, which is characterised as the ability to get someone to do something they would not otherwise do, has become less significant in the world system compared to structural power (Strange 2015: 27). Strange describes structural power as follows:

> Structural power - - is the power to shape and determine the structures of the global political economy within which other states, their political institutions, their economic enterprises and (not least) their scientists and other professional people have to operate. - - This structural power, as I shall explain it, means rather more than the power to set the agenda of discussion or to design - - the international regimes of rules and customs that are supposed to govern international economic relations. - - Structural power, in short, confers the power to decide how things shall be done, the power to shape frameworks within which states relate to each other, relate to people, or relate to corporate enterprises. (Strange 2015: 27).

This distinction between relational and structural power is proposed instead of a much more ambiguous distinction between political and economic power. Such a structural approach offers perhaps a more easily approachable, and more in-depth, view on the complexity of (global) knowledge production.

At the core of Strange's theory of structural power is its four-faceted nature. Strange (2015: 28-29) argues that structural power is found in four distinct but interacting structures: control over *security*; control over *production*; control over *credit (finance);* and control over *knowledge, beliefs and ideas*. These structures are not only found in large scale systems, such as the world system or the global political economy, but also in much smaller systems, such as human groups and communities (Strange 2015: 29). All these structures have relevance to the kind of knowledge production I examine in this thesis, although the knowledge structure corresponds most directly to my study. What adds to the relevance of all four structures is the fact that they are intertwined; one can hardly be fully understood without the others. Therefore, I will proceed by presenting all of them, discussing the knowledge structure slightly more in detail.

First, the ***security structure*** portrays one of the most fundamental human needs: security. As long as there are factors that threaten personal security, those who provide security to others by protecting them from these threats are able to exercise power both in security and non-security related matters. This power lets the protectors wielding it determine the range of choices and options available to other actors and, importantly, it also allows those who are able to provide security to gain advantages in the production and consumption of such matters as wealth and privileges in social relations. It is worth noticing that although there is a whole myriad of actors, the security system is usually linked to the system of states in the modern world system. It is the institution of the state, after all, that maintains political authority and the monopoly of legitimate violence. Further, as states exist in relation to each other, forming a “society of states”, the security structure, as well as the world economy, are influenced by the relations between states. (Strange 2015: 32; 49-50).

Aside from spatial factors, Strange’s work conceptualises security in relation to three types of threats to it: natural forces, human agency and, perhaps most importantly, conflicts of authority (Strange 2015: 51-52). In the context of my thesis, the security structure of the structural power framework can be seen as manifesting through the interplay of all these three. Climate change threatens security through natural forces, but this threat is inextricably linked to human agency and to negotiations — even conflicts — of authority when it comes to contributing, on the one hand, and adapting and mitigating, on the other, to the effects of climate change. Knowledge, as I will discuss later, is hardly irrelevant in this process: what we know, or do not know, about climate change, adaptation, and mitigation may well influence actions for example through policies, recommendations and warnings, personal convictions, and so on. Although my analysis will not address security per se, security is relevant specifically in relation to our future with climate change. It is widely accepted that climate change poses a significant risk to individuals, states, and humanity alike, and the way I see it, providing security from this risk is directly linked to knowledge: we cannot efficiently respond to climate change if we do not understand it and how to react to it.

Before moving on to the second structure, I find it important to bring up one of the questions Strange suggests being asked when discussing security: *Do markets, industrialisation, and the stage of economic development play a role in the provision of security?* (Strange 2015: 50). I find this question of interest not only in the context of security, but in relation to all the structures of Strange’s structural power. It would seem probable that these kinds of factors may well be significant for enabling and shaping security, production, credit, and knowledge, as well as for producing and maintaining structural power on a wider level. The question Strange asks feels relevant in the context of climate change mitigation and adaptation as well, and my analysis would likely benefit from addressing some of the mentioned factors, in one form or another, to understand scientific knowledge production in the global knowledge system.

Secondly, the ***production structure*** in Strange’s structural power framework comprises the matter of who determines what is produced, by whom and for whom, by what means and on what terms, and so on. The production structure is important, as the vast majority of political economies have their foundations on production and on the wealth people produce by working. Moreover, the production structure and power in society are closely intertwined. When the existing power structure changes, changes in the production structure — in who produces, what is produced, and who benefits — are bound to take place. Similarly, when the production structure changes, social and political power are distributed differently as a consequence. (Strange 2015: 70). In the same vein, aside from production and power, production and knowledge are also interlinked. For example Hveem & Iapadre (2011: 13) point out the mutually reinforcing relationship between production and knowledge: knowledge and information are key inputs in the production processes of modern economies and constitute, in fact, one of the most important sources of competitive advantage.

To get back to Strange's production structure, she raises a point related to production that may be worth paying attention to in my own work: the relationship between population size and production, which plays a role both in terms of population that *produces* and that *need to be produced for* (Strange 2015: 75). This is certainly important in material production, but I believe it might have relevance in other kinds of production as well, such as in knowledge production. Especially if one considers the size and number of academic institutions and communities, researchers, university teachers and students preparing to conduct research, publishers and so on, population size may well be relevant to knowledge production. Therefore, aside from purely economic and developmental factors, it may indeed be wise to consider the role of certain demographic elements in my analysis, especially if knowledge creation — scientific research, in this case — is conceptualised as a certain kind of *production* process; naturally, it would then share certain features with more material production processes, such as the need for "labour".

As is the case with the security structure discussed above, there are certain parallels than can be drawn between production in an economic sense and the type of production most relevant for my thesis, that is, *knowledge production*. While production is, as expected, primarily discussed through certain materiality in Strange's framework, like in IPE theories in general, I extend the idea of production to knowledge and action. Hence, the production structure of structural power could manifest, in the context of my study, primarily through the production of knowledge, but also through the "production" of responses and mechanisms to adapt and to mitigate, on a larger scale. Knowledge and production are not a farfetched match; some characterise knowledge production as a sort of "economy" — not necessarily as a metaphor but quite deliberately. From this point of view, knowledge can be viewed as made through the labour of intellectual workers, having thus a workforce as well as mechanisms of production and trade (see for example Connell *et al.* 2018b: 43). When knowledge creation and circulation are viewed as being part of social and societal structures, they must be organised in some way. It would hardly be surprising, then, if this organisation would be partially rooted in factors related to economy and production, as described above.

Thirdly, the ***financial structure*** has at its core the power to control and create credit. According to Strange, the financial structure might be the structure that has been the least understood by Marxist and others who have highlighted the role of production — yet the importance of the financial structure has increased faster than any other structures. According to Strange, there are two central characteristics to the financial structure: first, it provides the structure through which credit is created; and second, it constitutes the monetary system that shapes the relative values of the different currencies in which credit is denominated. Hence, the financial structure, essentially, constitutes all the ways in which the availability of credit is governed and the terms on which currencies are exchanged. In the topic of credit, it is worth highlighting that instead of the accumulation of capital, Strange proposes the creation of credit as a key requirement in an advanced economy. The power to create credit can determine outcomes in the other three structures in structural power — security, production, and knowledge. Moreover, it can regulate the possibilities of people to exercise purchasing power and influence markets for production. (Strange 2015: 33; 99).

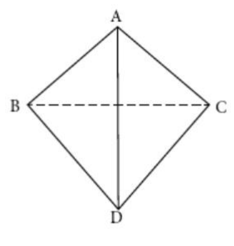
In the context of my thesis, the power to create and control credit can be viewed as a power to execute the three other facets, being inseparably linked to the resources with which climate security, production of adaptation and mitigation responses, as well as the establishment of a climate change related knowledge system are achieved. The financial structure is important for knowledge production because producing and diffusing knowledge and ideas, for example through conducting scientific research, requires monetary funds and investments. It is not only individual research projects that need money but, on a deeper level, establishing and maintaining a whole academic and educational infrastructure is needed to fully take part in a global, and competitive, knowledge system. Hence, research and education related expenditures, at the very least, may well bear significant relevance in my analysis. It would not be surprising if financial power would translate to the power to conduct more (and more wide-spread) research, as well as to set the geographical, social, and political contexts for said research, thus creating a link — if not even a correlation — between financial power and knowledge power.

Finally, the power obtained from the ***knowledge structure*** has been the most overlooked of Strange's four structures, despite its significance. Possessing the power to control the access of others to knowledge, as well as the channels through which said knowledge is communicated, is by no means less substantial than the other three sources of structural power. What is known and believed, and through which channels the beliefs and knowledge are communicated, are at the core the knowledge structure. Just as the production structure determines what is produced, by whom and for whom, by what means and on what terms, the knowledge structure determines "what knowledge is discovered, how it is stored, and who communicates it by what means to whom and on what terms" (Strange 2015: 134). Moreover, power and authority are granted to those who possess key decision-making positions, be it in the production structure or in the knowledge structure. (Strange 2015: 34; 131-132).

Despite its importance, the knowledge structure has, according to Strange, certain features that have made it less understood as a structural power. First, it is more subtle and elusive by nature compared to other forms of structural power. Second, the power of the knowledge structure is often diffused and, compared to security, production, and creation of credit — marked by their positive capacity to provide and to create —, its power lies as much in its negative capacity to deny knowledge or access to it as in its positive capacity to convey knowledge. Thus, the knowledge structure and questions of inclusion and exclusion are intrinsically linked. Third, power obtained through the knowledge structure is essentially unquantifiable. The authority of actors in the knowledge structure is subjective, and coming to view the knowledge said actors possess as valid, "right" or important is a result of subjective judgement. (Strange 2015: 34; 131-132).

These features, however, do not erase the growing importance of the knowledge structure, nor the importance of understanding just how it affects our societies and the global knowledge systems. In this context, Strange points out three developments in relation to the knowledge structure that are all significant to the world system, or to the international political economy, in their own ways. Firstly, the competition between states is characterised more and more in terms of competition for leadership in the knowledge structure. Secondly, there is a more prominent asymmetry between states as political authorities when it comes to gaining and accessing knowledge. As an example, Strange points out the dominance of the United States in all of the sectors related to the knowledge structure: American universities and research centres have a somewhat hegemonic status, and English has become the "lingua franca of the global economy and of the transnational social and professional groups". Thirdly, the changes and developments in the knowledge structure can be associated with new distributions of power, influence, and social status both within and across societies and states. According to Strange, the biggest and most significant difference between different societies and states is the share of population that receives higher education. Indeed, Strange maintains that power is passing from the "capital-rich" to the "information-rich", and what follows is that it is no longer just the possession and accumulation of capital that gives access to credit, but *information*. (Strange 2015: 150-152). All this points to the fact that studying knowledge creation and research is a worthwhile endeavour, as the importance of knowledge in relation to power can hardly be ignored.

Now that the four structures haven been presented, two conclusive points about Strange's four-faceted model of structural power are worth mentioning. Firstly, an inherent feature of all the four structures mentioned above is that those who acquire power from said structures are able to influence, often in a rather subtle way, the choices that other actors have. The available choices may be extended by offering opportunities or restricted through risks or costs these actors would not have otherwise. Consequently, some choices become easier while others become harder, and the power to steer this process is a form of structural power (Strange 2015: 34). Secondly, none of the four structures in the model work in isolation, but they interact with each other. Moreover, while in some sense each structure provides a base the others rely on, none is inherently dominant or have a priori importance (Strange 2015: 34). Strange describes this with the model below:



Here, ACD represents the production structure; ABD the security structure; ABC the finance structure; and BCD the knowledge structure.

Illustration of the four structures of structural power (Strange 2015: 30)

The interrelatedness of these structures can be extended to the context of my research as well. As mentioned previously, Strange's four facets of structural power bear all at least some relevance to my thesis and can be framed in ways that complement climate change knowledge production specifically: *security* may well be conceptualised as security over future with climate change by having the power, resources, and knowledge to respond to the threats it poses; *production* does not have to be strictly material, as knowledge, instruments, and mechanisms related to adaptation and mitigation can be produced as well; creation and control over *credit*, in this context, is urgently needed to execute the three other facts; and producing *knowledge* about climate change, adaptation, and mitigation — thus influencing what is known and in what ways, by whom and for whom, on what terms and through which channels — is key to activity or inactivity, inclusion or exclusion, in any area related to the three other structures. In conclusion, structural power described by Strange may well manifest itself through how, where, and by whom research, as well as adaptation and mitigation on a broader scale, are planned and executed, and what kind of conditions and assumptions may be behind them. Moreover, structural power is surely important when it comes to shaping the frameworks within which actors, such as states, relate to each other in this context.

Although Strange's framework offers a decent base for analysis as it is, certain complementary, and occasionally critical, remarks are in order. First of all, Haggart (2019: 29) points out, importantly, that while Strange's framework is about "structures", human agency is still central: the power exercised through these structures, and the power to set these structures in the first place, is always keyed to actors, state and non-state kind. Indeed, just as I have conceptualised knowledge production as social by nature, (structural) power, on a wider scale, is as well. The importance of agency cannot be ignored: the described structures and changes in them do not just happen, but are influenced, experienced, and responded to by agents that have different interests, capacities, and contexts shaped by social, historical, cultural, and political forces.

Secondly, even though Strange herself does not give primacy to any of the four structures in her structural power framework, Haggart (2019: 31-32) argues that, given that socially constructed knowledge shapes the way in which actors engage with the surrounding world, the knowledge-legitimation structure should, in fact, have a certain precedence. Strange hints something slightly similar by pointing out that the knowledge structure has a high importance as "the power exercised over the nature of knowledge to be acquired, and over the means used for its storage and communication, is a necessary complement to power exercised through the other three structures" (Strange 1989: 166, cited by Pustovitovskij & Kremer 2012: 291). Hence, the knowledge structure helps to shape processes in the three other structures. Moreover, it is likely that an actor that is powerful in the knowledge structure will be powerful in the other structures as well (Pustovitovskij & Kremer 2012: 291). This goes the other way round, as well: Haggart (2019: 32) maintains that the connectivity Strange proposes between the knowledge structure and the other three structures implies that events in said other structures may well influence knowledge-legitimation processes and the power obtained from them. This proposed interconnectivity of the structures is an important reason why I will take into consideration factors from these other structures in relation to knowledge production in my analysis. I believe it will allow the most in-depth look at the particular knowledge production I analyse in this study.

Thirdly, it is worth acknowledging that Strange's theoretical framework is not by any means outside of criticism. For example, the diversity of the elements associated with the knowledge structure has been criticised (Guzzini 1993, in Below *et al*. 2014: 120). Moreover, some have suggested the existence of tensions in the relationship between structures and the values that motivate action (David & Meersohn Schmidt 2019: 25), and difficulties in the very conceptualisation of the knowledge structure have been presented as a fundamental shortcoming in Strange's work (May 1996: 167, David & Meersohn Schmidt 2019: 25). Nonetheless, Strange's theoretical framework is useful for orienting oneself to examine knowledge and power in our globalised world through a structural understanding of power. If knowledge is viewed as socially constructed, a structural focus seems rather enticing. Indeed, Strange does not dismiss the importance of "hard" capabilities when it comes to power over external actors, but she does not reduce power to an instrumental use of resources either. What she underlines instead is the distribution of power within structures (Below *et al*. 2014: 120). What is more, I believe that the interconnectedness of one kind of structural power, such as one related to knowledge, with other structures offers a fruitful basis for an analysis that actively aims to take into consideration possible correlations between different structural factors.

3.2. Knowledge power and inequalities in the global knowledge economy

In this section I deepen Strange's structural power framework by discussing knowledge power and the global knowledge economy, paying special attention to certain inequalities and asymmetries of global knowledge production. The points discussed here are closely related to Strange's framework, occasionally even borrowing for her. My aim is not to contest the theoretical frame presented above, nor to offer an alternative way of approaching my analysis, but rather to add to the understanding of knowledge and power that builds the very foundation of this thesis. Although Strange's work on structural power implies the existence of asymmetries and inequalities inherent to the knowledge structure, I find it necessary to bring them more to light. Moreover, complementary points about power, knowledge, and the role of economy — put here as "knowledge economy" — might well add more depth to the IPE-based theoretical approach, as well as to the eventual observations and conclusions drawn from the data.

First, addressing "knowledge power" benefits from a further, albeit brief, look into power. Although Strange's structural power has been rather clearly defined, it may be useful to situate it in a wider context of power conceptualisations in the field of International Relations. Pustovitovskij & Kremer (2012: 60-62) mention three broad understandings of power that have been prominent in this field. First, realist and neorealist approaches view power as "the overall amount of capabilities possessed by a state" (Pustovitovskij & Kremer 2012: 60). This approach prioritises what is generally considered "hard power", in this case mainly military power and pure economic power. Moreover, this understanding of power assumes that obtaining more relevant resources — related to territory, population, military size, GDP, and so on — means obtaining more power and, consequently, more security for the state-actor in the international system.

Second, another understanding of power sees power as a relational concept, and after Max Weber's conception of power as "the probability that one actor within a social relationship will be in a position to carry out his own will despite resistance" (Weber 1947, cited by Pustovitovskij & Kremer 2012: 61), power is viewed in this approach as something related to the relationship between different actors. Thus, power, and the capabilities it encompasses, stem from its relational context. Third, an alternative approach to power views power in terms of structures: power, therefore, goes hand in hand with the creation and control over structures. One of the prominent writers developing, and in many ways popularising, such a concept of structural power was indeed Susan Strange whose framework works as a guideline for this thesis as well. As implied in the first section of this chapter, one of Strange's key views is prioritising "power over structures" rather than "power from resources" (Strange 1996: 25-30, Pustovitovskij & Kremer 2012: 61). Hence, the value of economic and military resources and capabilities is not taken for granted but, rather, reconsidered in the context of structures. In this view, power is not as much tied to shaping interstate relations through material or ideational factors, as to shaping the *structures* in which states are rooted in and, by extension, to defining much of the very foundations of interstate relations (Pustovitovskij & Kremer 2012: 61-62).

Although different conceptualisations of power have their strengths in different contexts, structural aspects turn out to be important in understanding the knowledge system. As an example bearing direct relevance to this study, Below *et al*. (2014: 118-119) point out that many econometric indexes and rankings that aim to measure knowledge and innovation performances position the actors they describe, such as countries, in direct competition with each other, as if they had a more equal footing than they do in reality. However, if one pays attention to *structural* variables instead, global knowledge competition is still notably marked by significant differences. As a consequence, understanding "knowledge power" requires taking structural aspects into consideration. To take this idea further, Below *et al*. borrow from Susan Strange's structural power framework by suggesting that there is a *global knowledge-structure* in which the position of its actors reflects a certain power-dimension (Below *et al*. 2014: 119). This global knowledge-structure is described as follows:

> The global knowledge-structure consists of the power-relevant set of knowledge-related processes, practices and interactions. The power effects, which arise through the knowledge-structure, termed as "knowledge power", derive from the occupation of a certain position within the global knowledge-structure. (Below *et al*. 2014: 121).

The position that an actor has in this structure has a great significance to its access to expertise, (scientific) knowledge and technologies. Below *et al*. (2014: 121-122) list four structural elements central to the global knowledge-structure. First, national performance in education and other "basic capacities" that are a prerequisite for science, as well as possession of exclusive knowledge. Second, production or possession of highly advanced artifacts with which scientific data is gathered and stored. Third, embeddedness in global informational infrastructures. And fourth, participation in processes of negotiation and standardisation regarding global issues. To clarify what this means in practice, the first component encompasses indicators of the national performance in "basic knowledge capacities", for example related to education, innovation, and human capital. The second component comprises indicators of the distribution of “cutting-edge artifacts” that are used to store data and gather scientific knowledge. The third component consists of indicators of embeddedness in global information-flow related infrastructures. The fourth and final component includes indicators of national participation and influence on global knowledge regulation. (Below *et al*. 2014: 123-124). It is worth noticing that these four components are intertwined: “knowledge power” is not about one single element by itself, but it manifests through the entire knowledge-structure, that is, through all these different components and their interaction (Below *et al*. 2014: 122).

In the context of my thesis, especially the first component of this structure seems to be of use in my study. When it comes to cross-country differences in the distribution of “basic knowledge capacities”, such as technological and innovation capabilities, Below *et al*. (2014: 125) point out the significance of variables related to the national human capital base, considering that technology and innovation -related activity requires well-skilled human capital. Public spending on education, the number of researchers per employed people, university rankings, and knowledge-output related indicators, such as patents as well as scientific and technical journal articles, are mentioned as examples of grass-roots indicators that can bring some light into the knowledge structure (Below *et al*. 2014: 125-126). Some of these indicators, such as educational expenditure and the number of researchers, will be featured in my analysis as well. A related indicator not mentioned here, research and development (R&D) expenditure, might also offer some useful insight into the knowledge structure and the production and distribution of “global” knowledge. In any case, it will be interesting to see if there is any correlation between the distribution of “basic knowledge capacities” or national human capital -related variables and the distribution of case studies in my data sample.

Related to these musings, Below *et al*. (2014: 127-128) make two conclusions in their work that bear relevance for this thesis as well. Firstly, they point out that states’ investment in knowledge-input requires time to influence knowledge-output (Below *et al*. 2014: 121). What follows is that the asymmetry inherent in knowledge-structure will not be overcome in a short timeframe. The way this may influence my analysis is that the indicators I will examine in relation to scientific knowledge production may show correlation to scientific publishing in a delayed manner. Therefore, there might be regions that do not demonstrate direct connotations between input investments and knowledge-output in the analysed data and in the used indicators at the current moment. For example, if a country has invested in knowledge-input relatively recently, it might not yet be translated into actual knowledge-output. Secondly, many European and Western countries have a long-term and persistent structural advantage that can be traced all the way back to the historical emergence of the global knowledge-structure (Below *et al*. 2014: 121). These countries have been able to invest in knowledge-input for centuries and have, moreover, shaped the very structures that exist today. To explain these structural advantages and the reason why knowledge distribution has tended to be asymmetric throughout history, Below *et al*. raise the concept of *path-dependency* that assumes that change “is tied to previous decisions and existing institutions” (Wilsford 1994: 252, cited by Below *et al*. 2014: 121). Thus, decisions are built on previous decisions, and each new decision adds to a possible pattern of choice for the future. In other words, path-dependency creates a certain continuity that leads to a competitive advantage for those agents that have dominant positions within the structure. Structural advantages are, hence, not only persistent, but they are also important in explaining and understanding the asymmetries, as well as possible changes and continuities of these asymmetries, in the global knowledge-structure.

To give a concrete example of a structural advantage, the matter of language is worth bringing up. The global scientific language is, to a large extent, English, and research universities all over the world are required to have high enough competence in it to participate effectively in the global knowledge network (Altbach 2013: 325). Of course, there are exceptions to this in certain regions, such as in Latin America and in Africa, where the primary international publication language may be Spanish, Portuguese, or French, as well as in many Middle Eastern countries where Arabic may have a dominant position as the most important academic language. Still, English is widely recognised as the *lingua franca* of "international" academia, which became clear in my data gathering process as well. As mentioned before, the dominant position of one language is not unproblematic: focusing on English as the dominant academic language means less attention to scientific and academic discourse in other, local languages. This may lead to local research and knowledge being de-emphasised, especially when it focuses on issues that are of interest to the local community, but not so much to the "international" audience, that is, to the leading institutions setting the paradigms (Altbach 2013: 326). However, it is worth pointing out that language does not work as a structural advantage in isolation from geographical, historical, social, and cultural contexts. This becomes noticeable with the variation of advantage among English speaking countries: for example, the dominant status of the US can hardly be compared to that of many countries in the "Global South" where English is an official language or a common language of education. Language, as any other factor, is an advantage — or a hindrance — in interaction with the wider structure.

Moving from "knowledge power" to "global knowledge economy", the relationship between knowledge and economy is worth clarifying. As is demonstrated by an extensive body of literature about the history and sociology of science and technology, factors such as knowledge, technology, and innovation have been closely linked to the political economy (Pustovitovskij & Kremer 2012: 289). Some argue that knowledge creation is key in economic success and in political stability in the globalizing world (Fasenfest 2010: 484). Indeed, knowledge is conceptualised to an increasing extent as a key economic asset of advanced economies (Yarrow 2022: 227). Such a view on the association between knowledge and economy has two layers: firstly, investment in education has become more and more central to future competitiveness, and secondly, securing global market share requires education to be capable of honing skills that offer as much "value for money" as possible. As a consequence, a particular focus on "human capital" has been re-established in global economic and development discourse. This means, essentially, that knowledge formation is understood as a form of national investment that has strategic importance. (Yarrow 2022: 227-228). These ideas fit together with Strange's view on power being passed from the "capital-rich" to the "information-rich" as states compete more and more in terms of leadership in the knowledge structure (Strange 2015: 150; 152).

Moreover, Nathan (2021: 3) points out that all societies are knowledge-based, having one way or another to create, access, distribute, and use knowledge. Therefore, all societies also have a knowledge economy, defined here as "the ensemble of its social institutions and processes producing and reproducing the knowledge at its disposal, and, in particular, the knowledge on which its reproduction as a society relies" (Renn 2020: 7, cited in Nathan 2021: 3). When discussing scientific research specifically in the "global knowledge economy", its role is often brought up through the significance of universities: some argue that there is an increasing "horizontal integration" of politics, economics, and universities that leads to universities being conceptualised as somewhat independent systems that steer the "new knowledge based economy" that reins today (Fasenfest 2010: 484). Indeed, research universities, despite constituting only a small part of the entire academic environment, have a central role in the global knowledge economy, as well as in the national higher education system: they have a significant involvement in the production of research and in the training of future researchers (Altbach 2013: 316). Research universities can be defined as those academic institutions that create and disseminate knowledge in a multitude of disciplines and fields, as well as have the required infrastructures to teach and conduct research at the highest possible level (Altbach 2013: 316).

This definition, however, raises questions about equality and possible asymmetries of possibilities. An underlying stance behind this thesis is that the global knowledge production should be inclusive rather than exclusive: actors and institutions around the world should have a possibility to access — or better yet, to contribute to — global knowledge and knowledge production. Indeed, knowledge creation and diffusion should spread internationally, and the knowledge network should offer a role for all the regions in the world (Altbach 1987, in Altbach 2013: 317). Not every country, however, have the means to establish research universities that fulfil the criteria mentioned above, let alone research universities or other networks that contribute significantly to the "global" knowledge system. Of course, these countries can still often participate in "international" knowledge production, for instance by developing universities that have research capacity, even if they would not meet all the standards of a "research university" defined above. Moreover, countries with less resources and required infrastructures to conduct research can form regional academic alliances in order to build their capacity to participate in global science. (Altbach 2013: 317).

Nonetheless, it becomes increasingly clear that when discussing knowledge power, asymmetries and inequalities cannot be ignored: on the contrary, they are at the core of power questions. These asymmetries are inherent to knowledge production: the processes of production and circulation of organised knowledge is characterised by global inequalities (see for example Connell *et al.* 2018b: 42). As is pointed out by Altbach (2013: 319), among others, there is a hierarchy of knowledge in which legitimised scientific knowledge takes precedence. Such a legitimisation process is primarily controlled by "gatekeepers" and scholars in research universities that are situated in a central position in knowledge networks. While academics of less-renowned institutions, for example in the developing countries, can be part of and have access to these knowledge networks, it is usually much more challenging for them to participate directly in academic dialogues

(Altbach 2013: 319). A similar tendency is visible when it comes to globalisation in the context of knowledge production. Globalisation, in this case, is a double-edged sword: on the one hand, global networks and highly developed technology allow people anywhere to access and to use global knowledge — and academic communities to participate in international science and scholarship; but on the other hand, globalisation of the "academic marketplace" may entice students and staff to move to the "centres" that are favoured in such globalisation processes, as the dominant sources, legitimation standards, and criteria tend to place "peripheral" research institutions and communities at a disadvantage.[1] Thus, it is worth acknowledging that globalisation doesn't necessarily "open" the academic network or support the "democratization" of science and scholarship to the extent one might assume at first glance. (Altbach 2013: 323).

A further factor that may well undermine the "democratization" of science and scholarship is the pressure of academic and economic requirements in modern scientific networks. Engaging in globalised science means adapting to the dominant definitions and methodologies, as well as to the themes and subjects of interest, shaped by leading scientists and institutions primarily in the "centre". Needless to say, this may be problematic to the academic institutions at the "periphery". Moreover, research is more and more competitive, and entry into advanced scientific research while maintaining competitiveness is expensive. For those academic communities that are lacking required infrastructures to participate in the international scientific network, this cost may be a significant hindrance. (Altbach 2013: 324). If, as mentioned earlier, knowledge production and economic success and competitiveness are seen as more and more intertwined, investing in the needed infrastructure to participate in the "global knowledge economy" is indeed important, not least because of the matter of power: as Strange puts it, power is passing from the "capital-rich" to the "information-rich". However, it would seem that being "information-rich" in the global knowledge economy is difficult if one is lacking the financial means to reach such a status. In any case, globalisation of science, in conclusion, is both advantageous and disadvantageous. As knowledge, technology, and academic personnel circulate more freely, practically anyone can participate in the global "marketplace" of science, scholarship, and ideas. At the same time, however, said participating actors are restricted by dominant norms and paradigms that stem from an unequal global knowledge system. (Altbach 1987, in Altbach 2013: 324).

Related to economic pressure due to competitiveness, the global knowledge economy has some other, structural elements that may fuel inequalities, often illustrated by the Global North – Global South divide (or, as is the case above, by "centre" and "periphery"). For example, Connell *et al.* (2018a: 744) raise, importantly, the theme of resource inequalities in the global economy of knowledge; they point out that availability of funds and trained people, as well as public spending in science and technology, among other things, may contribute to resource inequalities, perhaps most notably between the Global North and the Global South. Aside from funding and institutional matters, resource inequality is also tied to prestige and recognition: for example, when it comes to publishing, Northern journals are often considered more

[1] n.b. Author's use of "centres" and "peripheries" presumably reflective of Immanuel Wallerstein's world-systems theory

“prestigious” than Southern ones, dominating thus academic communication (Connell *et al.* 2018a: 745). Indeed, Connell *et al.* (2018a: 748) describe a “hegemony” within the global economy of knowledge. According to them, the hegemony, although not static, is characterised by three factors: first, by the institutional centrality of the academic institutions, journals, and publishers of the global North; second, the global acceptance of a Northern cultural framework for knowledge production; and third, influence of and even competition between different agendas in the Southern academia. According to Connell *et al.* (2018b: 42), the “elite institutions” of the global North form the centre of the knowledge economy in the context of global reach. This is not only due to their volume of knowledge production, but also — and perhaps most importantly — their ability to enforce paradigms for knowledge related work in other regions, as well as to gain data from said regions.

This discussion does not aim to undermine the academic conventions and achievements of the “Global North”, rather, I find it important to pay attention to the ways in which, as Below *et al.* (2014: 118-119) point out, the actors in the “global knowledge economy” are not on an equal footing. Global knowledge production is, structurally speaking, marked by notable asymmetries, and these asymmetries may well be key to understanding the distribution of scientific research related representations, capacities, and resources. As San Martín (2021: 424) points out, paying attention to socio-epistemological disparities and the unequal nature of intellectual labour is important in global environmental research. According to him, power disparities in international scientific research stem from, among other things, policy frameworks, differential access to resources, specific research priorities, as well as institutionalised linguistic barriers. Importantly, the knowledge divide that follows said disparities cannot be overcome with more research — rather, it is a larger-scale issue that should be approached by reforming the ways in which knowledge networks outside of Northern institutions are legitimised and integrated. (San Martín 2021: 425-426).

Indeed, the existing asymmetries can be associated with the dominant position the Global North has in setting the international scientific agenda: differences in access to resources has led to a situation in which scientific institutions and networks from industrialised nations thrive over others, while issues and agendas from the “South” become less visible (San Martín 2021: 425). This is perhaps reinforced by the fact that the Southern researchers often prioritise research subjects that are of critical local importance rather than of “global” significance and, consequently, to bring these local agendas forth, or perhaps due to institutional or linguistic barriers, much of such research is published in local journals and languages (other than English) which makes their research have minimal attention on a global scale (San Martín 2021: 426). In any case, researchers and institutions beyond their more resource-rich and status-rich counterparts are not able to participate to global knowledge production on an equal footing. Reflecting the concept of structural power — and structures, in general — San Martín (2021: 426) posits that the uneven distribution of research capacities and expertise is produced actively and over a long period of time. According to him, this corresponds to a process of “epistemic colonialism”: coming to view Western research as an “institution of knowledge” is deeply rooted in colonisation and imperial expansionism (Smith 2012; San Martín 2021: 426-

427). Along the same lines, Walker & Martinez-Vargas (2022: 2) talk about "colonial epistemic structure" in this context, highlighting the unjust epistemic practices that follow. However, they point out that the Western epistemic system itself is not the problem — it's no less valid than any other system — rather, the issue is the historical roots and imposition of the Western episteme as offering a way to produce knowledge and to understand reality that is "universal" by nature (Soldatenko 2015; Walker & Martinez-Vargas 2022: 3). Whether or not one conceptualises the asymmetries and inequalities of global knowledge production as a form of colonialism, it can hardly be denied that they exist and, importantly, in a manner that is *structural.*

To recapitulate, knowledge is a structural factor in the creation of both equality and inequality. The spread of knowledge, on the one hand, can contribute to productivity growth and the reduction of inequality (Piketty 2013: 20; Nathan 2021: 1), but, on the other hand, knowledge can also play a significant role in creating and maintaining inequality, especially in relation to globalisation and the modern organisation of production (Tyson & Spence 2017: 171; Durand and Milberg 2019; Nathan 2021: 1). Moreover, knowledge production related inequalities can manifest themselves in many areas, such as in education and in science communication. According to Demeter (2020: 69), global inequalities in knowledge production are manifested, almost identically and in a mutually reinforcing fashion, in the input processes, such as in education, and in the output processes, such as in scientific publication. It is therefore worth paying attention to both input and output factors, and their interaction, in my own analysis as well. For example, as mentioned earlier in this chapter, taking into consideration education expenditure as an indicator — perhaps most relevantly tertiary education expenditure — may offer some insight into the relationship between input and output processes in global knowledge production.

More generally, choosing to examine the spatial distribution of case study representation with the help of different economic factors is not unfounded. Previous research indicates that certain economic indicators correlate with scientific output (see for example Demeter 2020; Demeter 2019; Karlsson *et al.* 2007), and this may apply to research contexts as well, especially considering the clear link between institutional affiliations and case study locations in my data sample. Hence, an analysis that draws from economy related approaches and indicators may indeed be useful in understanding the existing asymmetries and inequalities in global knowledge production. Moreover, aside from economic terms, the regional representation in global knowledge production is also a notable indicator of development (Ataie-Ashtiani 2017; Demeter 2020: 86), so there may or may not be possible correlations between knowledge production input and output processes and developmental factors. In any case, when it comes to economic indicators, Demeter (2020: 94) maintains that GDP per capita is the economic indicator that correlates the most with scientific output, and productivity and output should indeed, according to him, be population-adjusted. Population size does not in itself correlate with scientific output, and small countries can have a high output despite their size; however, the highest levels of knowledge production tend to happen in countries that have both a high production efficiency and a large population, such as in the United States and in the United Kingdom (Demeter 2020: 94). Whether my study demonstrates this remains to be seen.

4. Overview of data

This section presents the dataset chosen for this study more in detail. As mentioned in the introductory section, the chosen dataset consists of scientific articles through which the distribution of regional representation of case studies can be examined. A sample of 10 000 articles, filtered by order of relevance and published between the years 2018 and 2022, was collected from *Scopus* -database. The past five years were chosen as a timeframe for the data to allow some temporal variation for the sample of articles, despite the fact that the time-consuming nature of processing data manually restricted the scope and volume of research that could be included in the dataset. Regarding the temporal context of my data sample, it is worth taking into consideration that there may be some minor shifts in the (scientific) understanding and, consequently, framing of adaptation and mitigation within this timeframe. However, I will assume that the potential changes will not be so significant that they would considerably impact the findings and conclusions I will draw from the analysis. Out of the chosen sample, only articles that had one or more regional case studies were chosen: the final dataset comprises 6 844 collected articles that contain 7 826 regional cases. The search for a regional focus relied mainly on article titles, keywords, and abstracts. Most data was collected during June 2022, but the data comprising the articles from the year 2022 was collected during November of said year.

The research that this thesis focuses on is climate change research with a special attention paid to mitigation and adaptation. Thus, when forming the search phrase with which the sample of articles was eventually searched, two elements were taken into consideration: firstly, climate change or phenomena related to it that pose a risk to communities all over the world; and secondly, the response to climate change or said phenomena through adaptation or mitigation. Combining these search elements, the final search phrase was formulated as follows:

"mitigat*" OR "adapt*" AND "climat* change" OR "environment* change" OR "global warming" OR "biodiversity loss" OR "environment* degradation" OR "extreme weather" OR "extreme climate" OR "climate hazard*" OR "climate impact*" OR "climate risk*"

As a result, the sample of articles that forms the dataset pays attention, implicitly or explicitly, to mitigation and/or adaptation. This adds a layer of practical significance to the focus of this study.

Two further search conditions are worth mentioning, as they are limiting factors to the data. Firstly, to limit the vast number of search results, article was the only document type that was included into the dataset. Secondly, for the purposes of this study, only publications written in English were considered. The reason for the latter choice is that the proportions of search results in different languages were not comparable: a considerable number of the articles related to climate change mitigation and adaptation that can be found from *Scopus* are written in English, while the search results in other languages, such as in French and in Spanish, are meagre in comparison. To be able to make any remotely generalisable conclusions, a certain volume of articles is needed, and articles in different languages, in this case, need to be sufficiently comparable by size and by nature. Because the number of articles in different languages is significantly disproportionate, this thesis only takes into consideration articles published in English. Naturally, both the choice of language and the choice of document type mean that a lot of relevant data is automatically excluded. In the same vein, I want to point out that internationally oriented databases, including Scopus, generally only cover a small proportion of relevant literature due to their selective nature.

As the approach I have chosen for my study, together with the criteria with which I have collected and limited my dataset, have practical implications for what I can and cannot know about knowledge production relevant to my thesis — and, thus, for the following analysis — certain clarifying remarks are in order. First of all, as mentioned above, limiting the chosen articles to those published in English is a choice that has a direct bearing on the scope of research represented in my dataset. The somewhat hegemonic role of English as a scientific publication language is not unproblematic, and while my choice of language for the sample of articles I analyse is not unjustified, I find it necessary to address the role of language in knowledge production. Secondly, the "regional" focus in my sample of articles is worth discussing, as spatial definitions are not to be taken for granted. What constitutes a "region" in research is something to be negotiated, and the result of such a negotiation is not outside of the influence of the social world in which the negotiation takes place. I will further discuss these two points the sub-sections below.

Moreover, regarding the limits of my study, it is worth noticing that by paying attention to the number of articles published per country and per region, I measure knowledge production, and related regional representation, in a quantitative sense only. Therefore, this does not reveal more qualitative aspects of scientific knowledge production, such as indicators of the potential influence of conducted research or relationships and social relations between authors and institutions. Assuming that a higher number of articles produced translates directly to more power in the knowledge structure may be misleading. If, however, the aim is to look at the spatial distribution of case studies, and the proportions of representation that follow, I believe that certain patterns related to the production of articles — and perhaps production *capacities*, on a wider scale — can be unveiled. In the same vein, I also want to acknowledge that the participation to "international science" does not, naturally, cover all scientific knowledge production and does not necessarily correlate with the participation to national science. For example, although a country might show a low level of visibility in the sphere of research aimed at an international audience, the situation may be notably different in the national sphere. Also, the number of articles that are published may only correspond to a fraction of the research, let alone knowledge, produced. Indeed, the capacity to produce scientific knowledge is one thing, but the capacity to participate equally in the global knowledge system is a whole another endeavour with its own difficulties and restrictions, such as strict publication, editorial, and review criteria, the costs and fees of open publications, and so on.

4.1. Language in academia: implications of the language choice for academic publishing

Before going further in my inquiries, I find it important to briefly address the role of language in relation to research that is considered "international" by scope or by nature. As is argued by Kennedy (2014: 27), among others, the hegemony of English in defining scholarship is often taken for granted: English is the dominant language of foreign learning and knowledge production in many fields, although much knowledge escapes its sphere of influence. Creating "global" knowledge is hardly an even process, and it is worth acknowledging the different elements, such as language, that contribute to possible disparities of knowledge making. Hence, it is not my intention to overlook the hegemony of the English language in my dataset. Indeed, all the research that I analyse in my thesis is published in English — a choice dictated by availability of data in the platform from which the data is collected — and this is a noteworthy limit to my study. Having chosen a dataset comprising material only in English, it would come as no surprise to me to see many predominantly English-speaking regions standing out compared to regions that have different primary publishing languages. Therefore, my study does not have the means to address scientific knowledge production that happens in other languages, regardless of how significant a portion that knowledge production is in a given country. This naturally limits the conclusions that can be drawn about scientific knowledge production by analysing my chosen dataset, considering that an unknown, but hardly insignificant, number of relevant research is excluded from the scope of my analysis.

That being said, considering the dominant status of the English language in scientific publishing, the focus in my thesis offers a possibility to take a critical look at "international" scientific knowledge making that relies to a great extent on the English language in the current spatial and temporal context of "international" academia. The way I see it, the research in my data sample is not just published in one language out of many, but rather in a language that is in itself viewed as "global" to the point that it renders the knowledge it contains "global" as well. As a scientific publication language, English tends to cross over linguistic boundaries: its use is not limited to predominantly English-speaking communities. From this point of view, it would seem that there is no reason, in theory, why research published in English would not have a truly global coverage as a consequence. Whether this is the case in my dataset, however, remains to be seen.

4.2. Defining regions in research: political geography perspectives on spatial categories

"Regions" and "regional representation" are central in my research, as they offer a framing category for the analysis of this thesis. However, what a "region" means in research is not to be taken for granted: what constitutes such a category of analysis varies from context to context. There are many overlapping dimensions — geographical, political, social, historical, and so on — to spatiality, and to address this complexity, a brief discussion drawing certain points from political geography is in order.

First of all, geographers nowadays often view spatial relations as inseparable from society. All social relations are constituted spatially, and as a consequence, social science can never be “non-spatial”. The field of political geography maintains that human agency and strategic action, as well as the resources behind action, are always spatially organised in geographical contexts. Not only that, but space is itself a resource. Further, politics and the production of political identities and subjects are intrinsically geographical — bound in space. (Painter & Jeffrey 2009: 14). It seems thus clear that spatiality is intertwined with the social reality around us, and studying social phenomena can hardly exclude spatial contexts.

The relationship between space and the social reality, however, runs deeper still. A noteworthy point, also underlying this work, is that human geography and its sub-disciplines, such as political geography, are not only *about* social phenomena but they *are* social phenomena themselves: indeed, they are produced in and by historical, cultural, social, political, and economic contexts (Painter & Jeffrey 2009: 15). To take this idea further, spatiality itself is to a great extent social. This perspective is backed by many theoretical discussions on the field: political geography literature demonstrates, over time, a shift of understanding spatiality less in terms of distinct geographical forms, such as states, and more in terms of social practices and relations. According to the Francophone understanding of space in political geography, *territoire* (territory) is not limited to distinct geographical forms, but rather conceptualised as “the area of daily practices and relations” (Agnew 2015: 38-39). Further, “territory” can be defined as a zone that contains social and power relations (Cox 1991: 5-6). This understanding of space contributed to the concept of “place” in Anglophone literature in the 1970s and 1980s by adding social, cultural, and political dimensions to the view on spatiality. A more social understanding of “space” helped geographers to overcome the so called “territorial trap”, that is, certain ways of thinking about geographical spaces as “fixed units of sovereignty” or mere “containers of societies”. (Agnew 2015: 39). In conclusion, one can say that territories are “social processes in which social space and social action are inseparable” (Paasi 2003: 110; cited by Agnew 2015: 43).

The reason why this is relevant in my study is that spatial categories such as “regions” or “territories”, however one wants to call them, are rarely viewed as fixed and natural, outside of human perspective. Therefore, it is worth considering which regional categories or definitions are chosen over others and why. This choice, much like spatiality itself, has an inherently social dimension to it. Regarding my choice of spatial categories, it is worth noticing that the categorisation of regional distribution of representation relies a lot on states in my thesis. Sates constitute the most substantial spatial category, although this study maps regional representation also in terms of continental and sub-continental regions. However, in the chosen sample of articles, case studies with a too wide regional definition to map clearly, such as “Global South” or “Northern Hemisphere” have been left out. Such studies correspond only to a small fraction of the articles in my sample. In any case, despite relying on states as the primary spatial category, I recognise that reducing space and “regionality” to states is not unproblematic, and as the discussion above demonstrates, the ways in which space is construed have significant social (and political) dimensions. As is pointed out by Painter &

Jeffrey (2009: 21), states are the most prominent forms of political authority in the modern world — so prominent, in fact, that the way in which the world is mapped and conceptualised through states is easy to take for granted. However, states are not "natural" nor are they inevitable: they are human products, and rather recent at that, shaped by social and political processes (Painter & Jeffrey 2009: 21). It is not my intention to ignore the "hegemony" of state-centric approaches, nor to choose such an approach myself without reflecting on that choice. I find it important to acknowledge that despite focusing on states as spatial categories, I recognise the versatility and complexity of regional and spatial categories. The state-centric approach in mapping regional representation in my sample of articles stems from two factors: firstly, from the articles themselves that mostly present case studies through state categories; and secondly, from the fact that the resources, instruments, and policies to respond to climate change through adaptation and mitigation are situated, to a great extent, on a state level. These two factors direct my analysis towards state categories as well. I could, of course, present regional distributions within countries as well to add more depth into the spatiality that is under examination in this study. However, considering the limited nature of a thesis, focusing my analysis on a sub-country level on top of trying to cover the whole globe on a state-level would likely make too broad a focus in a study such as this. Nevertheless, this does give an idea for further research: examining regional representation of climate change related scientific knowledge production in non-state spatial categories, such as ecoregions, would offer an interesting perspective for future studies.

Aside from the articles in my data sample as well as the policies and instruments to respond to climate change, the indicators I examine regarding their possible associations to the observations drawn from my data are also often presented on a state level. This does not mean that other spatial categories or units of analysis would not be as relevant for my thesis, but merely that both the data and the layers of analysis have guided this study towards the state as the main spatial category of analysis. Still, there is a risk to lean on "methodological nationalism", meaning the nation-centred view that sets nation-states as "natural" units of analysis, synonymous to the unit of society, and even as the most fundamental category of political organisation (Amelina *et al.* 2012: 2; Beck 2007: 287). Wanting to avoid methodological nationalism does not, of course, mean that states would not be significant agents or frames for agency: they certainly have a role in global knowledge production, not least regarding funding and knowledge infrastructure related expenditures. However, when talking about representational matters, as well as injustices and asymmetries inherent in global knowledge production, there are many different categories of analysis, related to different social contexts, that are worth looking at. Smaller units of analysis, such as institutions and, perhaps even more importantly, human agents reveal some fundamental features of asymmetries of knowledge production: factors like gender, socio-economic class, ethnicity, language skills, prestige of education etc. may contribute significantly to asymmetries of representation at a micro-level. Although the limited scope of this study is not able to address these factors in the present analysis, I want to highlight their importance in forming a more comprehensive picture of global knowledge production.

5. Methodological framework: correlation analysis

In this section, I will briefly describe the methodological approach guiding the analysis. This work has a quantitative approach and, therefore, some of my inquiries rely on a correlation analysis. The first section of the analysis does not have a clear methodology: I merely create an overview of the distribution of case studies per country as well as per certain broader regions. This section has involved very simple numerical dimensions, such as calculating averages and percentages, neither of which has a special method to them. The second section, however, looks into different indicators and their potential correlation with the distribution of case studies in my data sample: this section, therefore, follows a correlation analysis. The reason why I have chosen correlation analysis for the second part of my analysis is that I'm interested in the relationships between different variables and the distribution of case studies in my data. Considering that my data is quantitative by nature, I aim to identify, through a quantitative approach, possible connections and patterns between different factors. This may give some insight into scientific knowledge output and reveal new questions for further research.

First, before discussing correlation analysis further, a brief description of how the research, data collection, and analysis has proceeded, and will proceed from here, is in order. I started by collecting and categorising the sample of articles that forms my dataset. I wrote down the regional category used in each case study with as much precision as each article allowed: continent or sub-continent, country, state/district/town, and so on. Although institutional affiliations and funding details are not analysed in this thesis, as my focus is on research locations, it became evident during the data collection and categorisation process that the vast majority of the (principal) institutional affiliations are located in the very countries that are being studied. There are some regional differences — compared to other regions, there seem to be slightly more "outsider" institutional affiliations especially in Africa, in Southern Asia as well as in some of South-eastern and Western Asia, and in small island developing states— but all in all, a considerable number of researchers are focusing their studies on the countries in which their affiliated institutions are located, or in the nearby areas. This may be related to funding, since nearly all of the funding for the research in my data sample comes from the government, organisations, or private sources within the country of affiliation. Therefore, it is justified to assume that the regional representation in adaptation and mitigation related research is linked to the locations of the research institutions conducting said research, as well as to the economic capacities to fund such academic endeavours. This is significant regarding the choice of variables for the correlation analysis: choosing indicators that have direct relevance to research institutions and research capacities, such as the number of researchers and tertiary education expenditure, may thus be revealing and worth looking at.

The first step in my analysis after data collection and categorisation is to situate the distribution of case study locations spatially. This is done through both numerical and visual forms: the proportions of different regions represented in the sample of articles chosen for the study are illustrated through drawing maps and charts that help to visualise the distribution of the regional contexts of research. These visual elements include some numerical information, and the full numerical data will be available for viewing in the attachment section at the end of this thesis. The first section of the analysis, all in all, answers the first research question about the regional distribution of representation in the data sample. The second part of my analysis approaches the second research question aiming to understand the relationship, and possible correlations, between the observed distribution of case studies and the chosen research and economy related factors. I will consider some economic indicators, such as GDP per capita, Research and Development (R&D) expenditure, and government expenditure on tertiary education, but also Global Innovation Index, the number of researchers per million inhabitants, as well as one developmental indicator, Human Development Index. Many of these indicators are, at least at first glance, more relevant for looking into the "authorship" dimension of knowledge output, but because there is such a strong parallel in my data between research locations and the locations of authors, institutions, and fundings, the chosen indicators work well enough for my analysis.

To get to correlation analysis, finally, it is a form of inquiry that is quantitative and statistical by nature. According to Reid (2014), statistical analysis is used above all for two interrelated purposes: to see the world more clearly and to think more clearly. As a part of these processes, descriptive statistics are used to understand and to communicate, in a succinct manner, the nature of a dataset by using figures and graphs (Knapp 2017). Regarding the nature of data, one of the features that is of interests is identifying relationships. There are, broadly speaking, two levels of relationships among variables: cause-and-effect relationships and associations (Reid 2014). My analysis focuses on the latter, that is, on the extent to which two variables are associated to each other. Association between variables implies that they *covary*: thus, knowing how one variable changes helps to predict how another changes in turn (Reid 2014). This association between variables means that they *correlate*.

Correlation is a statistical tool that helps to evaluate the degree of association between two quantitative variables. The degree of correlation is revealed by the ***correlation coefficient*** ("r") that takes a value between – 1.0 and + 1.0, indicating thus both direction and magnitude. The direction means that two variables either have a *positive correlation*, in which case the increase of the value of one variable leads to the increase of the value of the other, and the decrease of the value of one variable to the decrease of the value of another, indicating a shift in the same direction, or a *negative correlation*, indicating a shift to the opposite direction for the two variables, that is, if the value of one variable increases the value of the other decreases and vice versa. Variables with little to no detectable relationship have no correlation. The magnitude, on the other hand, reflects the strength of association; in other words, the extent to which two variables covary. A value of 1.0 corresponds to a perfect linear relationship between two variables, while a value of 0 implies that there is no linear relationship. Stronger correlations take values closer to 1.0 whereas weaker correlations are closer to the 0 mark. (Aggarwal & Ranganathan 2016: 187-188; Reid 2014).

When conducting a correlation analysis, two important, interrelated, limiting factors to said analysis should be noted. First, correlation analysis does not involve manipulating any independent variables or adding a control group to avoid extraneous variables (that is, variables not being investigated) that might affect the dependent variable and the results of the analysis. Therefore, correlational study does not allow drawing too strong conclusions; the relationship that can be observed between variables may be caused by, or associated to, an unmeasured variable that happens to change along with the measured variables. Second, to quote the popular statistical saying, "correlation does not imply causation". Indeed, an observed association between variables doesn't necessarily mean that one variable causes the other: correlation analysis does not offer a strong enough basis for declaring a cause-and-effect relationship merely because there is an association or correlation between two variables. (Aggarwal & Ranganathan 2016: 190; Reid 2014).

Another point that requires consideration when opting for correlation analysis is the choice of correlation coefficient for one's own data. There are several different types of correlation analysis, and correlations between variables can be measured using different coefficients, the most popular of which are *Pearson's coefficient* (r), *Spearman's rho coefficient* (r_s), and *Kendall's tau coefficient* (τ) (Hauke & Kossowski 2011: 87). ***Pearson's correlation coefficient***, the most commonly used out of all three, measures the strength of a linear relationship between variables and, as such, only indicates the strength of an association accurately when the variables in question have a linear relationship, following thus a straight line (Hauke & Kossowski 2011: 88; Reid 2014). The formula for calculating Pearson correlation coefficient, r, can be written as follows[2]:

$$\mathbf{r} = \frac{\mathbf{n}(\sum \mathbf{xy}) - (\sum \mathbf{x})(\sum \mathbf{y})}{\sqrt{[\mathbf{n}\sum \mathbf{x}^2 - (\sum \mathbf{x})^2][\mathbf{n}\sum \mathbf{y}^2 - (\sum \mathbf{y})^2]}}$$

In this formula, the two measured variables are named "x" and "y", n refers to the sample size, and $\sum$ marks the sum of the values of the variables, their squares, or their cross product. Pearson's correlation coefficient, like its alternatives, can be calculated with the help of Excel or programmes such as SPSS (Statistical Package for the Social Sciences) statistical software, which makes handling data easier, especially with bigger sets. However, the use of this correlation coefficient has some noteworthy criteria for the data that need to be met in order for the results of the analysis to be credible. Most notably, the variables should have a linear relationship and be normally distributed, the variance of the dependent variable should be the same for the whole data (=homoscedasticity), and there should be no outliers, meaning data points differing significantly from the rest, that can skew the results and indicate a false sense of association (Aggarwal & Ranganathan 2016: 189-190; Reid 2014; Knapp 2017).

[2] See for example: https://www.scribbr.com/statistics/pearson-correlation-coefficient/

If the data doesn't meet one or more of the mentioned criteria, a different correlation coefficient will yield more accurate results. A common option is ***Spearman's rho coefficient*** (r_s) that can be used by giving ranked values for each variable (for example from biggest to smallest). Indeed, Spearman's rank correlation coefficient is a distribution-free (that is, nonparametric) and ranking based, measuring the strength of a monotonic relationship between variables (Hauke & Kossowski 2011: 89). Therefore, whereas Pearson's correlation coefficient measures a linear association in which variables move together at a constant rate, Spearman's coefficient measures a monotonic relationship in which this movement exists as well but not necessarily at the same rate. The formula for calculating Spearman's rank coefficient, r_s, is shown below[3]:

$$r_s = 1 - \frac{6 \sum d_i^2}{(n^3 - n)}$$

In this formula, d_i means the difference between the rank of variables for each pair of data, *n* refers to the sample size, and $\sum d^2_i$ refers to the sum of the squared differences between the ranks of variables. Unlike Pearson's correlation coefficient, Spearman's rank correlation coefficient doesn't require the data to be normally distributed or outliers to be non-present, which makes it more suited for certain sets of data.

Kendall's tau coefficient (τ), in turn, is often used as an alternative to Spearman's correlation coefficient, and it shares many features with the aforementioned: it is also non-parametric and ranking based, but it measures the strength of association of two variables based on the difference between the probabilities of concordance and discordance between them (El-Hashash & Shiekh 2022: 38). In other words, Kendall's tau coefficient measures the "agreement" or "disagreement" regarding order between pairs of numbers (Kendall 1948: 7, in Hauke & Kossowski 2011: 87). The formula for calculating Kendall's coefficient (El-Hashash & Shiekh 2022: 38) is marked below:

$$\tau_{tau} = \frac{C - D}{n(n-1)/2} = \frac{2(C - D)}{n(n-1)}$$

In this formula, *n* refers to the sample size, *C* to the number of concordant pairs, and *D* to the number of discordant pairs. Before opting for this correlation coefficient as an alternative to Spearman's rho coefficient, it is worth noticing that, despite their similarities and shared underlying assumptions, they lead to somewhat different interpretations: regarding the proportion of variability, Spearman's correlation coefficient can be considered to be the regular Pearson's correlation coefficient, while Kendall's tau coefficient is characterised by a probability for the data to be (or not to be) in the same order (Hauke & Kossowski 2011: 88).

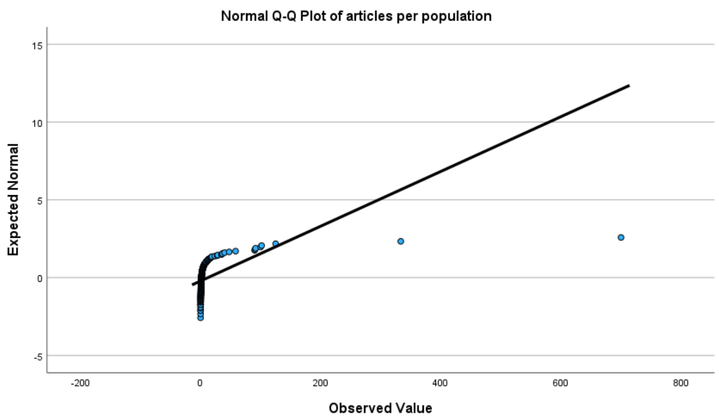
[3] See for example: https://www.scribbr.com/statistics/correlation-coefficient/#spearmans-rho

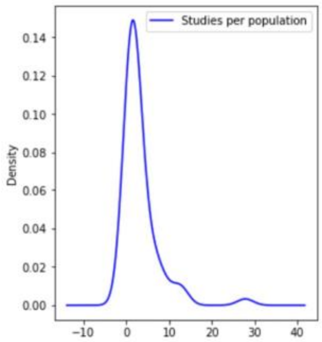
Related to different interpretations, the relationship between different correlation coefficients should be taken into consideration. As is pointed out by El-Hashash & Shiekh (2022: 37), using different correlation coefficients may lead to different conclusions, even if the data set is the same. It may be that the significance of one type of coefficient does not imply the significance of another: comparing Pearson's and Spearman's correlation coefficients, Hauke & Kossowski (2011: 92-93) point out that the significance of Spearman's correlation coefficient may well translate into the significance or non-significance of Pearson's correlation coefficient, but the same is not necessarily the case the other way round. They posit that there may even be a situation where the two coefficients indicate different directions for the same data and, therefore, the significance of Spearman's rank correlation coefficient as a measure of the strength of a relationship between two variables should not be overinterpreted.

Therefore, not only due to the differing qualities and criteria of different correlation coefficients, but also because of possible differences in results, choosing the best correlation coefficient for one's own analysis requires some careful consideration, including a further look into the data. Inspecting the data with scatterplots helps to look for nonlinear relationships, outliers, normal or non-normal distribution etc. and gives, therefore, an indication of what kind of correlation coefficient to use (see for example Aggarwal & Ranganathan 2016: 190). If the criteria for Pearson's correlation coefficient are not being met, Spearman's correlation coefficient or Kendall's tau coefficient will be a more viable option. In order to be able to choose the best coefficient for measuring potential correlations between the variables in my dataset — and to visualise my data — I will create scatterplots and other graphs looking for normal distribution, linearity, and outliers. The scatterplots and QQ-plots below are made with the SPSS statistical software and the Gaussian distribution graphs with Python. These plots correspond to each chosen variable: the number of articles (adjusted to population), Research and Development expenditure (as a percentage of GDP), GDP per capita (PPP), government expenditure on tertiary education (as a percentage of GDP), the number of researchers per million people, Human Development Index, and Global Innovation Index. With the help of the visualisations below, I will present brief observations about the linearity or non-linearity, normal or non-normal distribution, and possible outliers in the data. These observations will give an indication of what correlation coefficient might offer the most accurate measure of the relationship between different variables.

First, it is worth acknowledging that the plots and graphs presented below are for visual, and sometimes rather subjective, interpretation, not infallible proof of the qualities of the variables in my analysis. They will, however, offer a sufficient indication of what kind of correlation coefficient might be the most relevant for this data and context, and what challenges regarding the data might arise for the analysis. To visualise my variables, I have used two different kinds of plots: a quantile–quantile (QQ) plot and a scatterplot. Normal distribution, or deviation from it, is visualised for each variable with the help of QQ plots. This plot type compares two distributions, and like-positioned elements from them, by matching their same quantiles (Marden 2004: 66-67), giving thus a visual indication how a given data sample (one distribution) is positioned in relation to normally distributed data (another distribution), presented in the form of a straight line. The normal distributions in these plots are alternatively visualised with a Gaussian curve. The scatterplots below, on the other hand, visualise the spatial distribution of data and the relationship between quantitative variables: they help to identify, among other things, possible outliers and anomalies, nonlinear relationships, and correlations (Sarikaya & Gleicher 2018: 403-404; Aggarwal & Ranganathan 2016: 190). Visualising data in this way is, therefore, a useful step before realising a full correlational analysis.

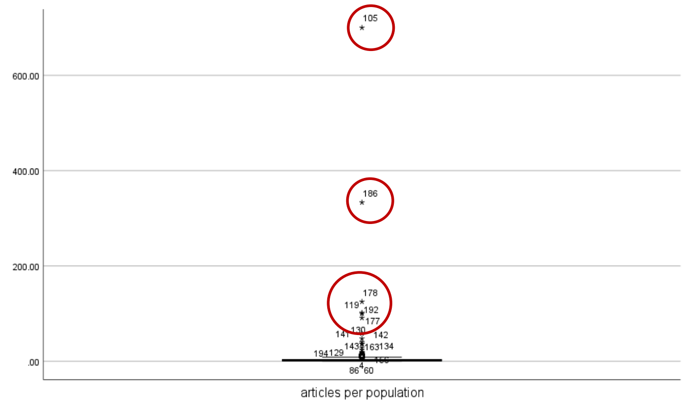
Starting from the **data set of articles**, the distribution of this data shows clear deviations from normal distribution, as is demonstrated by the QQ-plot and the Gaussian curve below.



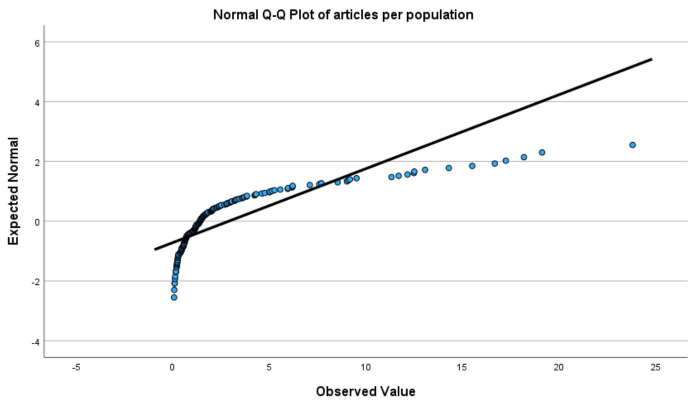


By looking at the plot, it seems that the distribution of the article sample is skewed especially from the tail-end. The SPSS program confirms this by generating a skeweness value for each plot: if this value differs significantly from zero, the data in question is not normally distributed. For the article sample, the skeweness value is 9.940. Hence, the distribution is highly skewed. As the value is positive, the skewness is also positive, also known as right-skew. Moreover, the QQ-plot displays at least two clear outliers on the right-hand side of the plot. Such outliers most likely indicate that the data comprises extreme values that do not fit into what would be a normal distribution. The outliers in question in this dataset are most likely disproportionately high case studies per population – numbers from countries with very small populations.

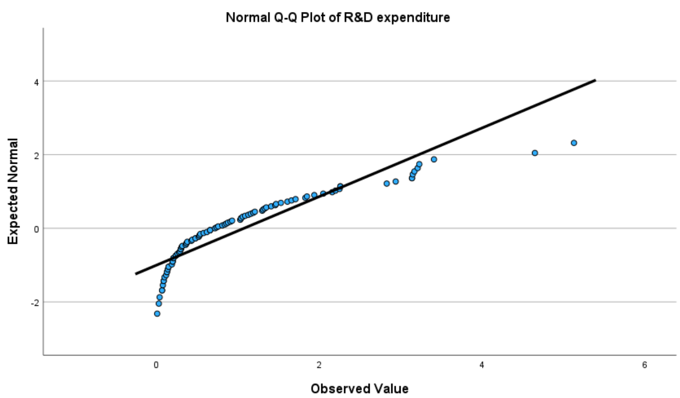
It seems that the existence of such strong outliers is what generates as high a skew as 9.940. It may be of interests to see what the distribution looks like if outliers are eliminated. As will be seen in the coming plots below, there are quite a few strong outliers present in almost all variables. Therefore, it may be interesting to see what difference — if any — removing outliers makes to the spatial distribution of data. Moving further, removing outliers for the correlation analysis can be questionable considering that those values, too, are part of my original data. I will not opt for this, if it can be helped, but to determine the exact nature of my data and the suitability of the different correlation coefficients I will take possible (skewing) effects of outliers into consideration. By creating a boxplot, extreme values can be detected (marked with stars and red circles), as shown below:

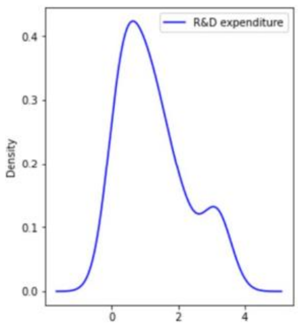


If these extreme values, likely corresponding to outliers in my data, are eliminated, the distribution of the article data sample is still non-normal, as the new QQ-plot below demonstrates. Granted, the skeweness value is much smaller, 2.619, but there is still a positive skew. Therefore, it is worth pointing out that eliminating extreme values in data does not necessarily make a significant change: for example, a non-normal distribution may well remain non-normal.

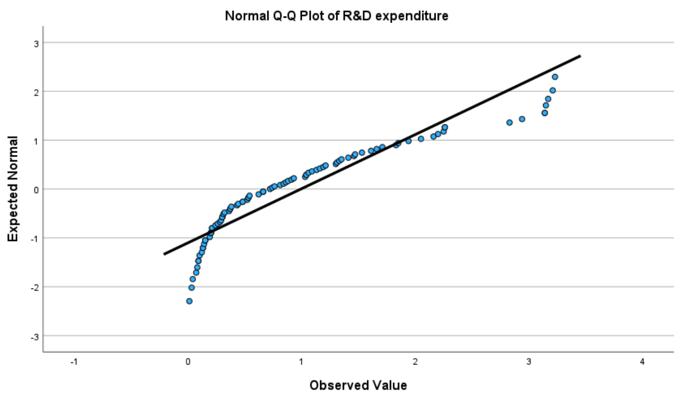


When it comes to the **R&D expenditure** -variable, its distribution follows the normal distribution line better in the middle of the graph, but the tail-ends curve off as well. The skeweness value for R&D expenditure is 1.514, which indicates the distribution to be skewed to the right, not following a normal distribution. Further, like is the case with the article variable, there are some outliers in this plot.

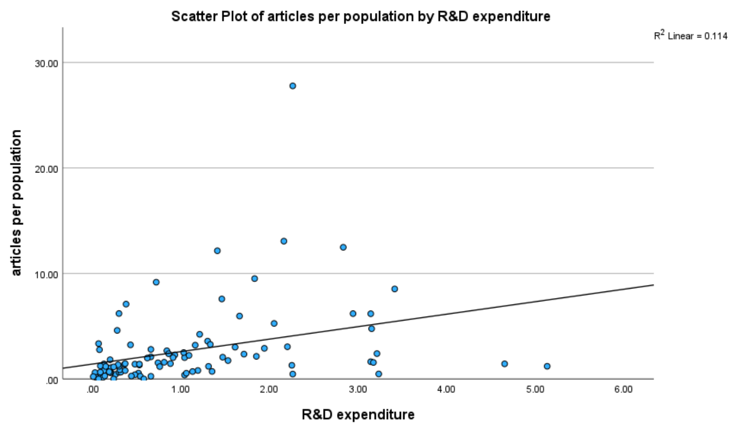




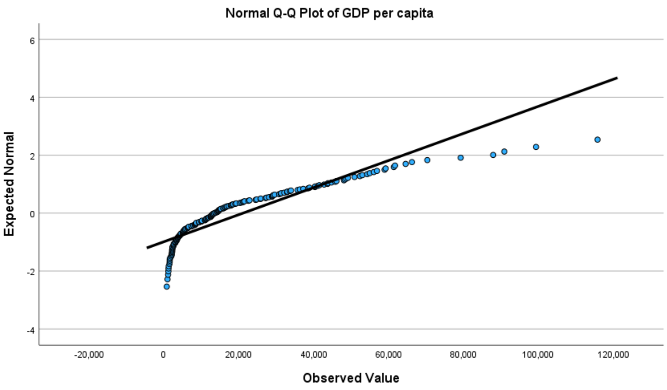
Much like the distribution of the previous varible, the distribution of R&D expenditure data sample is still non-normal, even if outliers are eliminated. Skewness value is only slightly smaller, 1.102.

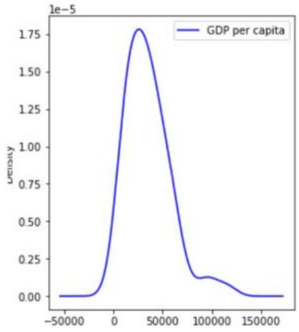


Moving from the QQ-plot to the scatterplot, the general trend of the data points shows that there is some clear variation in the data values: the data points are spread out, especially when the values grow higher (moving up and to the right in the plot). There are data points that somewhat follow an upward trend, and that are set closely to the linear fit line in the graph, which might indicate a weak linear relationship between the article variable and the R&D variable. However, the data is distributed quite unevenly, all in all, and discontinuities (gaps in this trend) and outliers are clearly present. Possible weak linearity should, therefore, be viewed with caution.

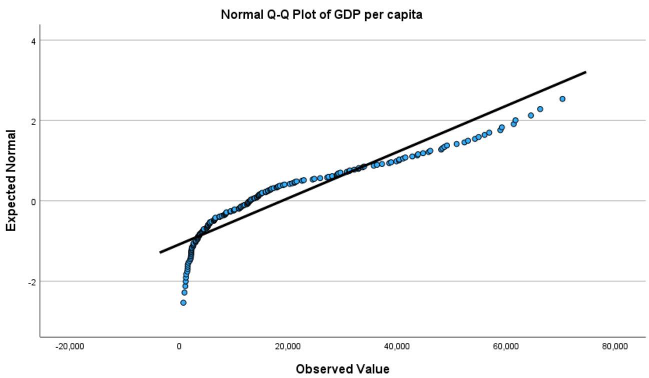


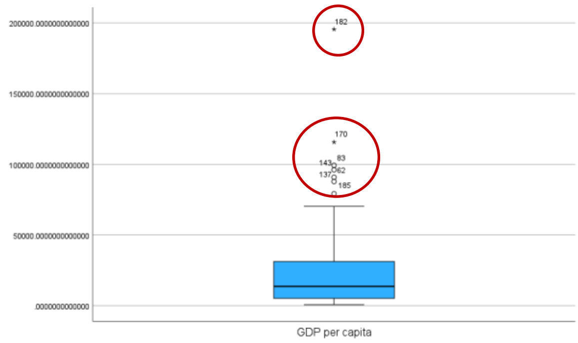
The **GDP per capita** -variable shows, as demonstrated below, a somewhat similar trend to the R&D expenditure varible, where the data points fall more or less along the normal distibution line in the middle of the graph but diverge at the ends. The skeweness value for GDP per capita is 2.750, which means that the distribution is skewed to the right and does not follow a normal distirbution.



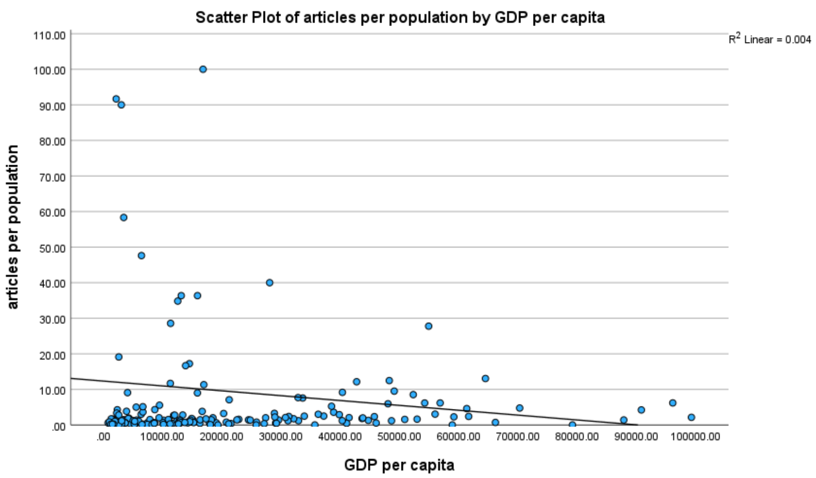


As is shown by the plots below, eliminating outliers decreases the skewness slightly, to 1.092, but the distribution still does not fit normal distribution, indicating a positive right-skew.

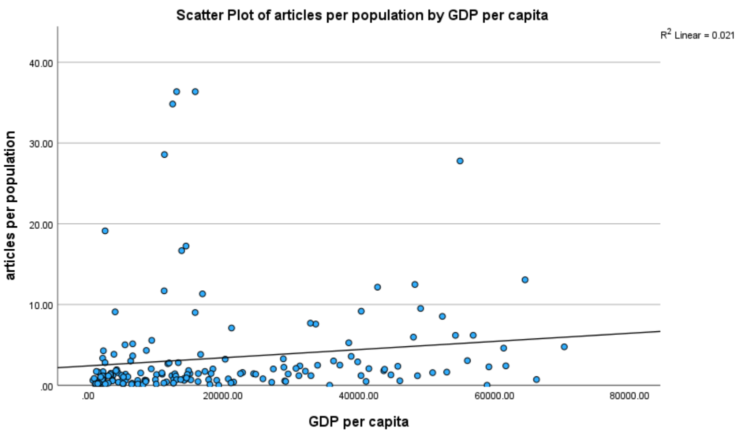




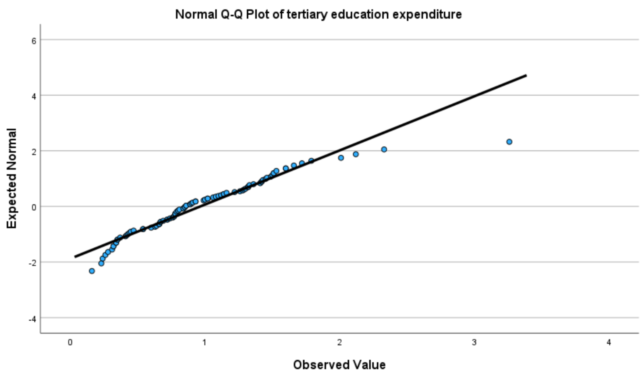
The scatterplot demonstrates that the data points, especially those with higher values, are quite widespread. While there are some data points that follow the linear fit line, there are obvious gaps in this pattern. There could be a possible weak linear relationship between the variables, although, a negative one in this case, interestingly. However, due to the uneven distribution of data and clear discontinuities, this is rather ambiguous. Moreover, obvious outliers are present, showing extreme values that skew the plot.

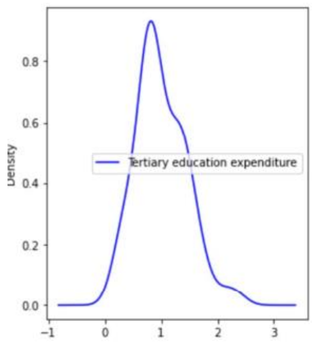


Therefore, a scatterplot with the outliers removed may offer a different picture of the spatial distribution of data. There is still clear variation in the data values, as well as gaps and discontinuities in the pattern of data points, but the movement indicates a positive relationship rather than a negative one.

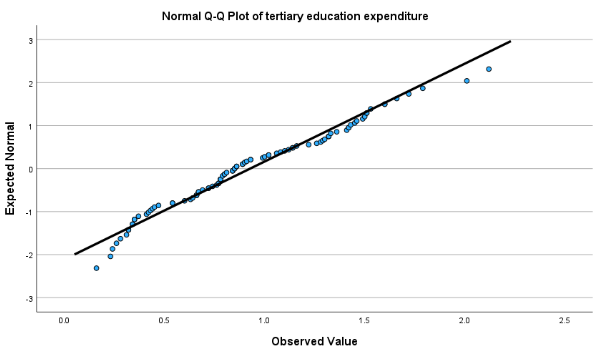


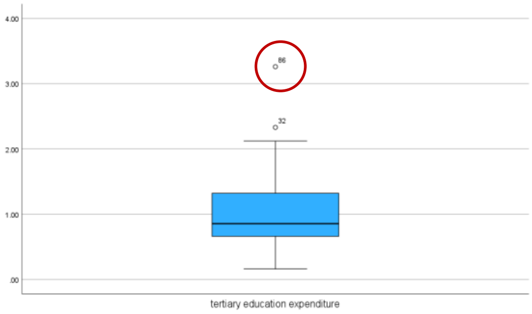
The **government expenditure on tertiary education -**variable seems to have a distribution that follows the normal distribution more closely than the previous variables, although on a closer look it, too, is skewed. The skeweness value is 1.206 which indicates a positive skew to the right. Perhaps related to this, one notable outlier can be seen on the far right of the chart.



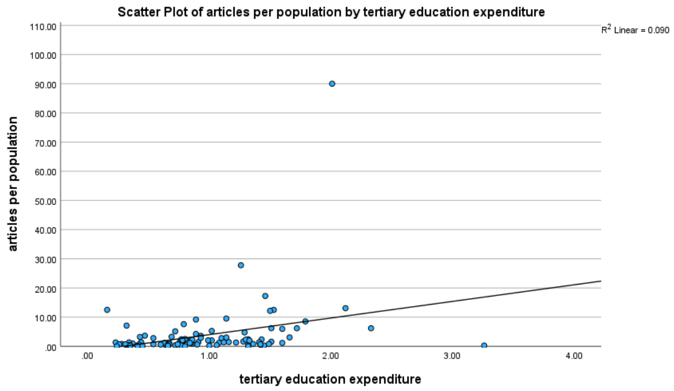


If the outlier is eliminated, the skeweness value decreses to 0.383 which can be considered small enough a skew for the distribution to follow a normal distribution. In this case, an outlier does make a difference.

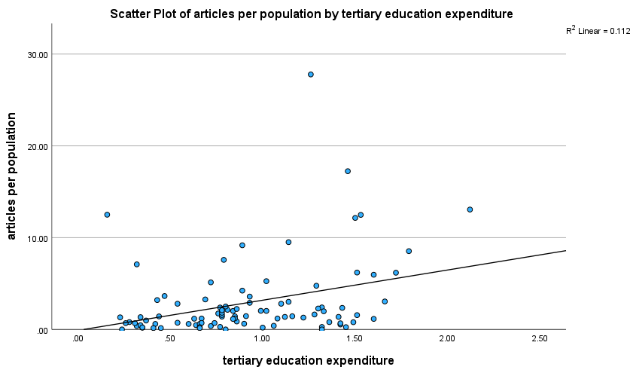




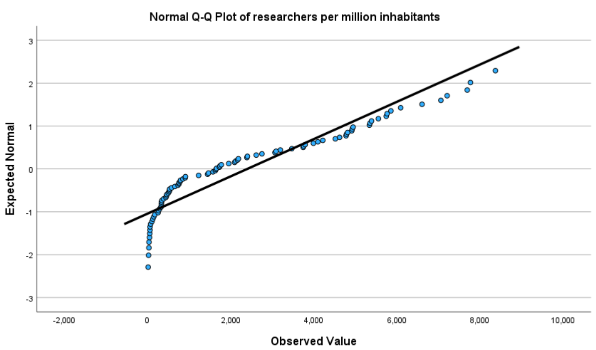
The scatterplot below shows at least one clear outlier in the upper middle section of the plot. Said extreme value alone is enough to affect the range of the data points to an extent that the distribution of the rest of the data (the main cloud of data at the bottom of the plot) is hard to distinguish because the points are packed together so tightly. Therefore, creating another scatterplot with the extreme value eliminated is justified so that the spatial distribution of data can be better assessed.

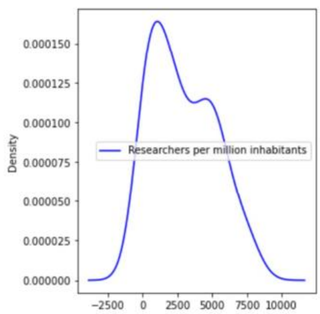


The new scatterplot shows that, as is the case with the previous scatterplots, there is some variation in the spatial distribution of the data, and even the parts that could indicate a weak linear relationship have some gaps and irregularities in them. There seems to be some indication of values rising together in a manner fitting for a positive relationship, but the relationship would be only weak by strength.

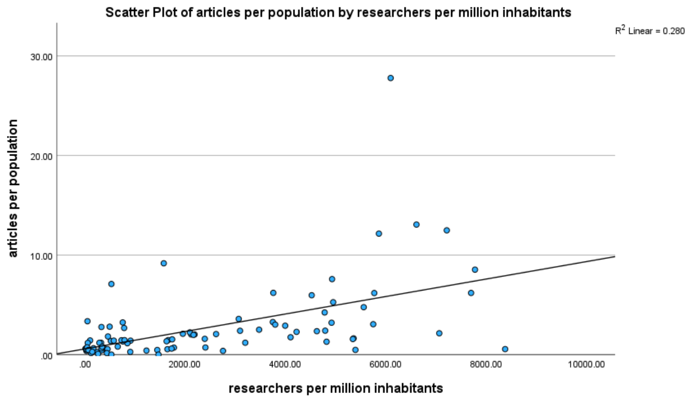


The **number of researchers per million people -**variable mostly follows the trend seen in the other plots.



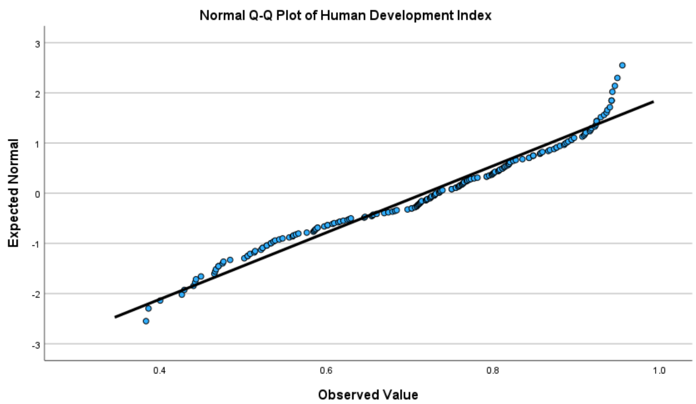


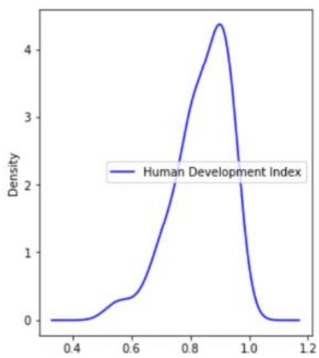
This QQ plot presents a positive, right-skew that takes the value of 0.820. The left end of the distribution displayed above is more "data-heavy", deviating from the normal distribution, than the centre of the distribution, whereas the right end seems be more "data-light", as the data is less concentrated there. This seems to be a common feature for nearly all of the distributions so far, which can be explained by a greater proportion of smaller values in data compared to larger ones.



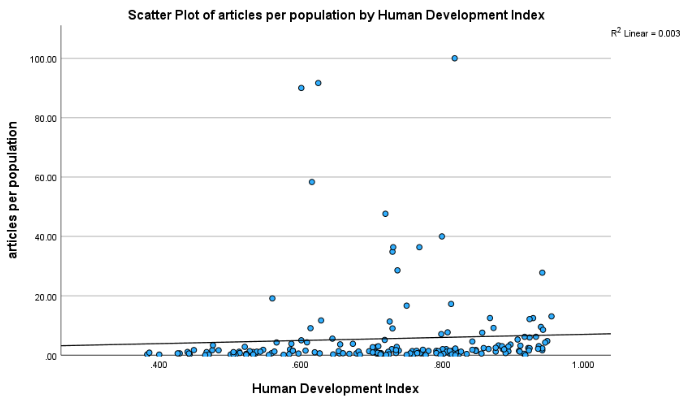
Regarding the scatterplot above, there are a few clear outliers that differ from the rest of the data points. Moreover, there is clear variation in the spatial distribution of the data. There is a decent amount of data points that somewhat follow the linear fit line, indicating a possible positive relationship, although there are some irregularities and variations too, rendering any possible linearity rather weak.

Unlike the previous variables, the **Human Development Index** can be viewed as having an approximate normal distribution. Its skeweness value is - 0.331 — having thus a slight negative, left-skew — but this skew can be considered small enough for the distributions to be more or less symmetric. It is worth pointing out that the values of each data point are much closer to each other due to the scale in which Human Development Index is measured; from zero to one. Thus, no outliers seem to be present in this plot.

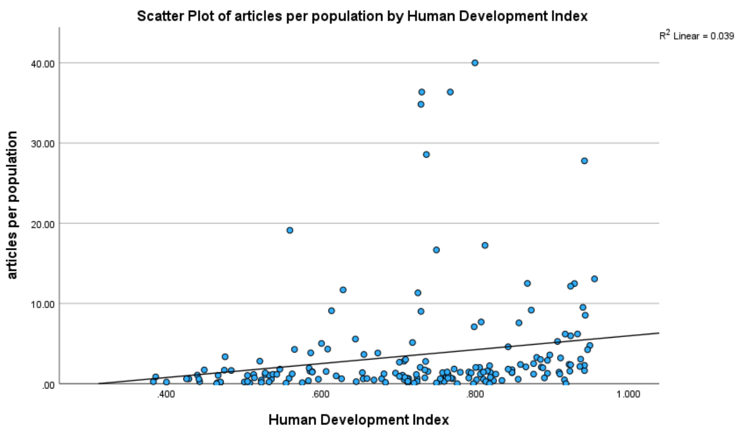




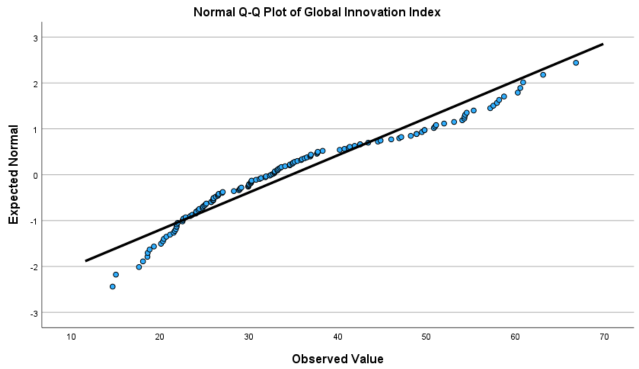
The scatterplot, however, shows clear outliers with disproportionately high values. Due to this, the rest of the data is packed together at the bottom of the plot, making it hard to see any clear trend in the spatial distribution of data. Hence, a scatterplot with the most notable outliers removed may give a better view of the data.

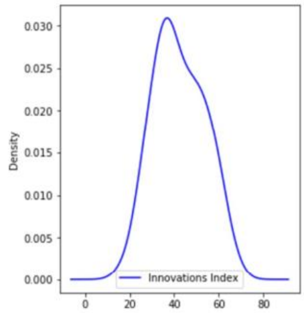


Once the most notable outliers are eliminated, there are still several extreme values present, but the trend in the rest of the data becomes more visible. Some data values seem to be rising together, indicating a positive relationship, but there are obvious discontinuities and irregularities in this movement. Any possible linearity seems rather dubious in this graph, and weak at best.

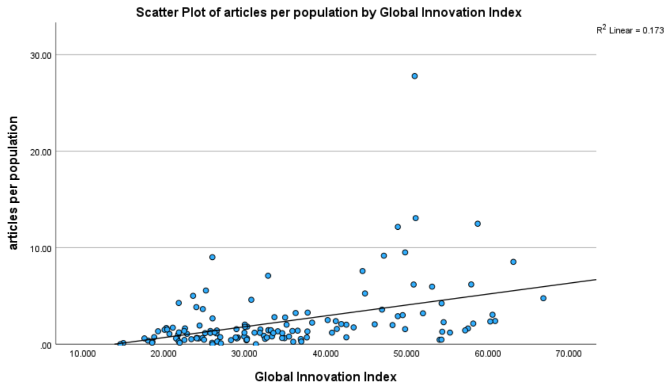


Finally, the **Global Innovation Index** -variable shares similar features with most of the other plots. The distribution seems to somewhat follow the normal distribution line in the middle of the graph, but the tail-ends are lighter with data and differ more by distribution. The Global Innovation Index has the least skewed distribution so far, with outliers on. Its skewness value is 0.668, indicating thus a moderate positive skew, or a right-skew.





Much like the previous scatterplots, the scatterplot below displays both outliers and variation in the spatial distribution of the data. The seems to be some movement of values rising together, indicating a possible linear relationship, albeit a weak one. Nonetheless, there are irregularities and discontinuities in this trend, and any notion of linearity must be approached with appropriate cautiousness.



In conclusion, the variables presented above, with one exception, do not follow a normal distribution. Their Gaussian curves imitate a general bell shape, and their QQ-plots demonstrate some of the distribution of data points to have parallels to the normal distribution line. However, as their skeweness values indicate, all of the distributions are skewed to some extent. Moreover, the linearity of any variable is questionable, and the existing variation in spatial distribution in the scatterplots as well as the irregularities in the data closest to the linear fit line do not give a sufficiently consistent indication of linearity. Perhaps most notably, outliers are clearly present in almost all the variables. This is a noteworthy challenge to Pearson's correlation analysis, since Pearson's correlation value may be significantly affected by even one outlier, whereas Spearman's and Kendall's measures of correlation are much more robust to outliers (Croux & Dehon 2010: 498; Xu *et al.* 2013: 265). This makes sense, of course, considering that the two parametric measures rely on ranks rather than on the actual observed scores.

All these points lead to the conclusion that the variables used in my analysis do not fulfil the criteria for Pearson's correlation coefficient. Should I opt for Pearson's correlation, the results would most likely be skewed and would not, therefore, give an accurate image of the relationship between the variables in my analysis. Considering the nature of the data, as observed above, Spearman's or Kendall's correlation coefficient will be better suited for my study. When comparing Kendall's and Spearman's correlation with each other, Kendall's correlation has been characterised as slightly more efficient and resistant to outliers (see for example Croux & Dehon 2010: 505; 509). I will look into both correlation coefficients and compare their results to build the overall understanding of the association between the number of case studies and the research and economy related factors. However, I may put more weight on Kendall's correlation measure due to its aforementioned characteristics.

6. Analysis

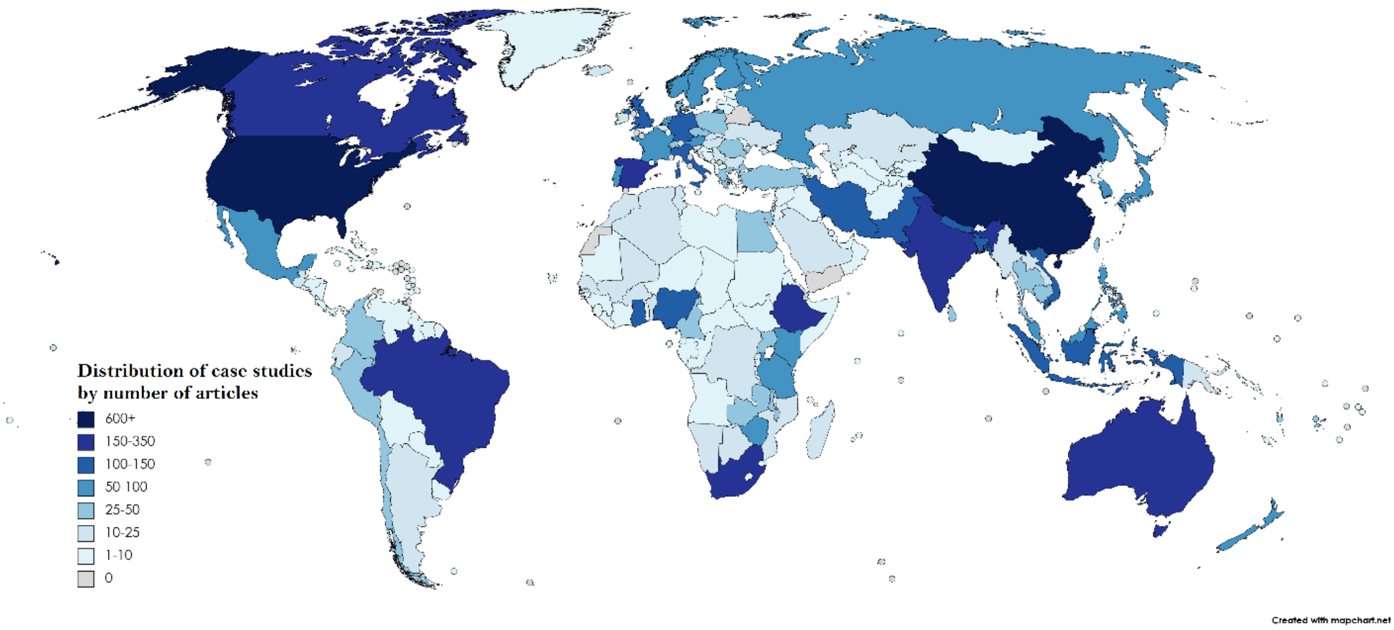
This chapter presents the analysis of the thesis, divided into two sections. The first one presents and examines the regional distribution of representation by mapping the case study locations in my sample of articles, examining thus the first research question. I will start by building an overview of the case study distribution on a global scale and then continue by taking a more in depth look one continental region at a time. The aim of the first part of the analysis is to map how the distribution of research locations is situated proportionally in different continents and sub-continents, in different countries, as well as in one economic category (World Bank Income Groups) and in one developmental category (UNCTAD Development Groups). This may help to reveal something about possible geographical asymmetries in research activities in, and interests towards, different regions in the context of "internationally" oriented research.

The second section maps, in turn, the global distribution of the different indicators mentioned in the previous section — Research and Development expenditure (as a percentage of GDP), GDP per capita (PPP), government expenditure on tertiary education (as a percentage of GDP), the number of researchers per million people, Human Development Index, and Global Innovation Index — comparing them to the distribution of the case studies. My aim is to examine their relationship to the research output of my data sample by determining whether they correlate with each other. My hypothesis, at this point, is that there might be positive correlations between them, although the strength of such correlations remains to be seen. It is worth pointing out that despite this hypothesis, no strong conclusion can be made with my relatively small sample and small number of indicators. Moreover, the correlation analysis has very limited capacity to help explain why certain areas are researched more and others less, as I cannot make conclusions about causation based on possible correlation. On more theoretical grounds, there is likely a whole myriad of explaining factors, many of them intertwined.

The third question about the importance of case study distribution and differing research interests and activity in the "international" sphere of research will be discussed in the chapter following the analysis (see chapter 7). This section is not part of the analysis, nor will it be "analytical" by description. Rather, it is a brief contemplative discussion about the importance of the regional representation in scientific research.

6.1 Regional representation through the spatial distribution of case studies

This first section of the analysis answers the first research question by examining which countries and regions have been studied and to what extent in my dataset. Following the process of categorising and analysing the data of this thesis, it is possible to map — both literally and figuratively — the regional distribution of case studies in my sample of articles. As the map below shows, giving a brief overview of the overall number of articles per country, there are certain countries and regions that stand out from others. Moreover, there seems to be certain patterns of choice regarding case study locations.



Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

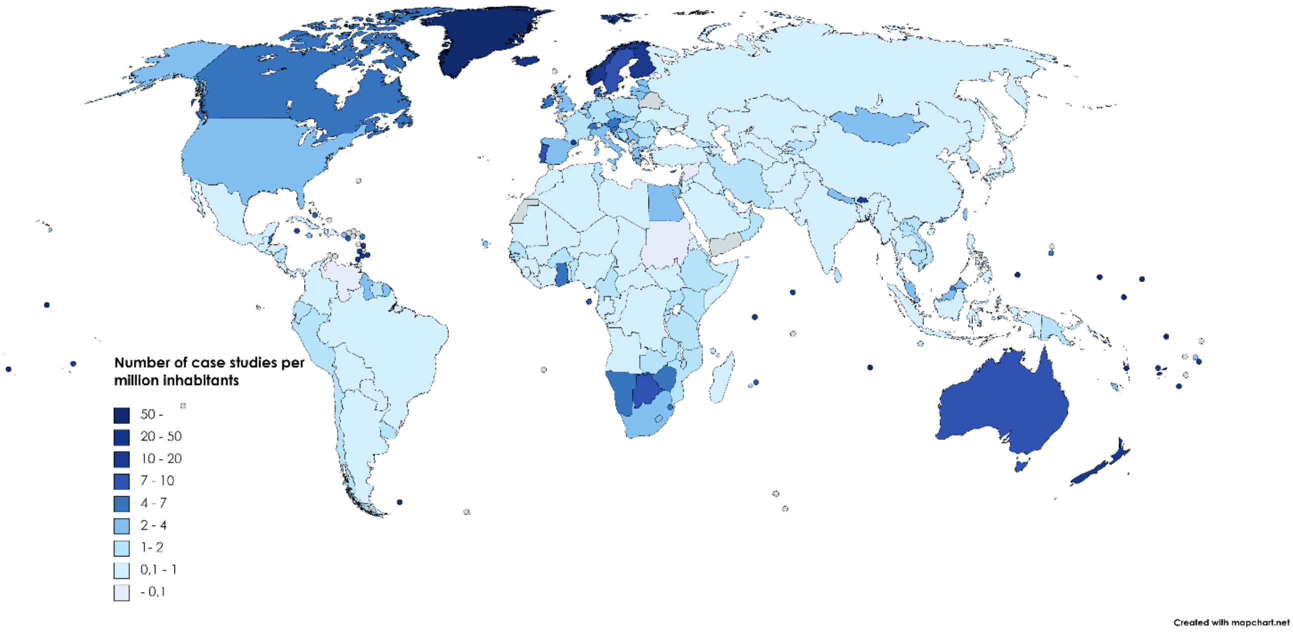
First of all, there are certain countries that stand out as case studies due to the sheer number of articles they are represented in. USA (790) and China (643) are by far the most common case study locations in my sample, which comes as no surprise considering just the volume of research conducted in said countries. Other countries that are recurrent case study locations are, for example, India (346), Australia (242), Canada (225), Ethiopia (191), Brazil (169), Spain (169) and South Africa (165). Moreover, some other countries stand out as exceptional compared to their surrounding geographical context: for example, Iran (121) differs by visibility from the rest of the Middle East that is not much represented in the dataset of this study. Similarly, Brazil is among the most popular case study locations despite the fact that the rest of South America is much less present in my sample of articles. Ethiopia, South-Africa, Ghana (154), and Nigeria (113), in turn, stand out from the rest of the African countries.

Secondly, there are also broader regions — clusters of countries — that stand out. Some of them are researched very little, or at least considerably less compared to other regions, in the sample of my dataset.

Such areas are Central America, the Middle East, Eastern Europe, Central Asia, Francophone Africa, as well as the vast majority of small islands and small island developing states. The Arctic and the Antarctic (not shown on the map above!) are also among the least represented areas in the data. Higher concentrations of representation, on the other hand, can be found from North America, from Southern and Western Europe, and from South Asia. While these observations are far from irrelevant, it is worth pointing out, however, that focusing on broad regions that comprise many different countries and regions within countries may actually give an imprecise, and even misleading, image of the levels of representation different regions truly can be associated with. A more comprehensive examination is needed.

Indeed, examining the dataset of this thesis has demonstrated that looking at too broad regional categories, such as continental regions or subregions, does not necessarily provide accurate enough information. If one would ask, for example, whether the African continent (that is to a great extent considered a highly vulnerable area to climate change) is proportionally as represented in research as other continental areas, the answer would be yes. In the data sample of this thesis, Africa does not, *as a whole*, stand out as an area that is under-represented. However, if one is to look at the situation again on a country level or on a sub-country level, the answer would be different because there are considerable differences in representation between different countries (and, presumably, between regions within countries). It seems that case studies tend to form clusters, and thus the distribution of representation is more heavily concentrated in certain areas than in others. For this reason, my study aims to "zoom in" a little, that is, to pay attention specifically to countries to gain a deeper understanding of the varying distribution of case study locations without reducing the analysed areas to too homogenous entities.

Before taking a more detailed look at the distribution of case studies continent by continent and country by country, a new perspective on the spatial distribution of case studies is needed: one that is adjusted to the population size of each country. Some of the indicators in the second part of the analysis are adjusted as “per capita” or “per million inhabitants”, and it may be wise to so with the number of articles as well to be able to better compare countries with considerable differences between population sizes. Adjusting scientific output to population has also been suggested by researchers on the field (see for example Demeter 2020: 94), as was mentioned at end of the theory chapter. The importance of population size becomes quite apparent when looking at the map presented above. Many of the countries that are the most common case study locations in my data sample are, in fact, some of the most populous countries out there: China, India, the United States, Indonesia, Pakistan, Brazil, Bangladesh, Ethiopia, Nigeria, and so on. The large number of articles in such countries may be partially explained by their large population sizes. When the amount of case studies is adjusted to population, the representational proportions of case studies in my data sample look quite different, as the following map reveals:

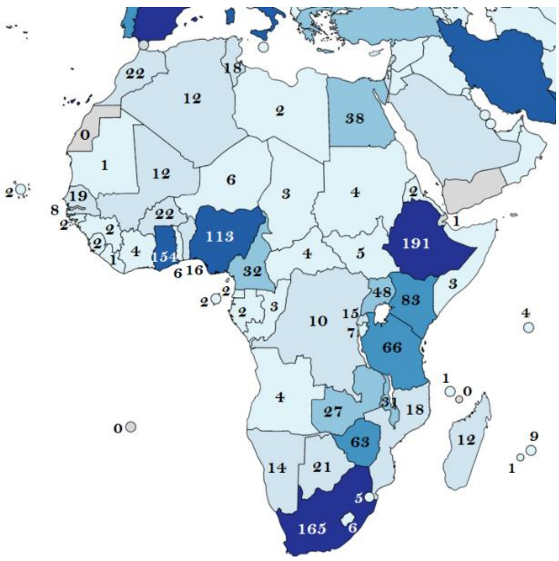


Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

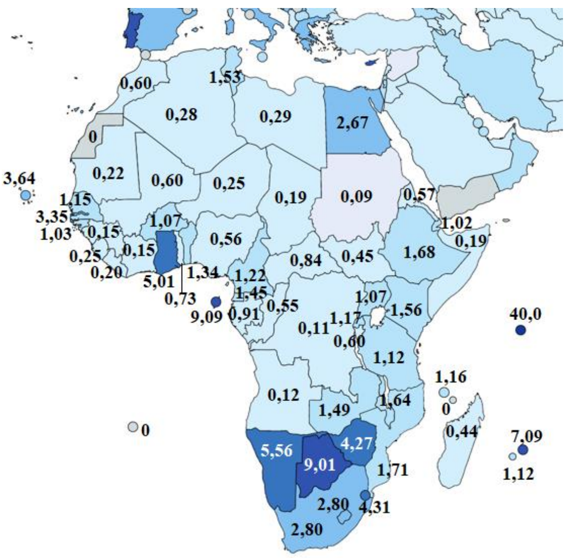
This new view on the case study distribution indicates quite different proportions of regional representation. Australia and New Zealand are still among the more studied countries, but other than that, the case study distribution is much more concentrated in Northern Europe (comprising nearly all Nordic countries), in Northern America (with the focus more on Canada than on the United States), as well as in Southern Africa, (although not quite as much in South Africa). It is worth pointing out, however, that although adjusting the number of articles to the population sizes, minimising thus possible size-effects, makes the countries more comparable to each other and to some of the indicators used in the next section, there is one slightly problematic aspect of this adjustment that is worth acknowledging: some of the numbers are, for the lack of a better term, skewed. This is seen through the countries with very small populations, as they can have very high case studies per population - numbers even with just one article. For example, as is shown by the map above, low-population countries such as the small island developing states are quite overproportionate due to their significantly smaller populations. This does not give a fully accurate image of the overall levels of representation because, in this case, most small islands are among the least studied countries all in all. Moreover, I find it important to acknowledge that no truly generalisable conclusions about representation, or research interest and activity, can be made for those countries that only have a couple of articles at most in the whole dataset.

In the following pages I will take a more detailed look at the distribution of case studies one (continental) region at a time. The maps presented above give an overview of the whole world at once, but to truly grasp the differences in representation, a more in-depth view is needed. I will do this by going through country-level numbers one section at a time, all the while presenting some observations about the proportions of case study locations. Before doing that, four brief remarks are in order. First, the maps and numbers below are presented in a way that would be convenient to the reader, and thus only include the overall number of case studies from all five years. As the number of case studies has little significant variance between the five years during which the articles of the data sample are published, my analysis does not separate the data year by year. However, more detailed lists sectioned country by country and year per year can, of course, be found attached at the end of this thesis. In the same vein, the population sizes to which the numbers of case studies have been adjusted are averages from the five-year period. Second, when comparing the numbers of case studies between countries, conclusions about possible differences between said countries should be viewed critically when the numbers of articles are small and/or there are only small differences between those numbers. Third, I find it important to point out that the maps used to illustrate regional representation in my data have certain shortcomings, such as not showing the Antarctic and some small islands, as well as being slightly hard to read due to the small sizes of certain countries and microstates. Moreover, the projection of these maps is dictated by the MapChart -map making tool used to create them, and is not, by any means, the most accurate projection (geographically or politically) in existence. However, I have deemed this map sufficient for illustration purposes, and it is the only modifiable map I have found that shows microstates and small island developing states. Fourth, when discussing regional categories, there are understandably notable variations in definitions and in their political implications. To have some kind of guiding classification system in place, the geographical divisions in my work mostly follow the regional classifications presented by United Nations Conference on Trade and Development statistics, UNCTADstat[4].

The first regional section I will look into more in detail is the African continent, and within it different sub-sections: Western, Central, Eastern, Northern, and Southern Africa. As the maps below show, the majority of African countries are among the less studied regions in my dataset. There are, however, some much more popular case study locations, especially in Eastern, Southern, and Western Africa.



overall number of case studies per country



case studies adjusted to the average population size of the five-year timeframe

[4] See: https://unctadstat.unctad.org/EN/

In **Western Africa**, Ghana (154) and Nigeria (113) — rather heavily populated, anglophone countries — stand out as more studied regions in the original sample. Ghana stands out also in the population-adjusted version, although the same cannot be said for Nigeria. The rest of the region, in turn, is represented to a much smaller extent in both versions of the map. For example, the coastal West Africa, including Togo (6), Côte d'Ivoire (4), Liberia (1), Sierra Leone (2), Guinea (2), and Guinea-Bissau (2), have some of the smallest numbers of case studies in the whole data sample, as do Niger (6), The Gambia (8), and Mauritania (1). The Gambia and Cape Verde (2) show bigger levels of visibility when the articles are adjusted to population, due to their comparatively small populations. Saint Helena (0), like many island states across the world, is among the countries not studied at all in my data. Mali (12), Benin (16), and Senegal (19) come up as case studies slightly more often in the original sample, but even then, their numbers are rather humble on a global scale. It seems that while the differences in case study proportions are more nuanced when adjusted to population, Ghana stands out from the rest of Western Africa in both versions of the map. This can perhaps be related, at least partially, to the wide usage of the English language as well as to the fact that according to the Global Peace Index, Ghana is among the most "peaceful" countries in the African continent as per the global average[5]. The latter factor may contribute to an environment in which adaptation and mitigation related research can be prioritised, and the academic infrastructure is not disturbed by instability or conflict.

Central Africa seems to be, all in all, the least represented area in Africa. Cameroon (32) is the most represented country in this region in the original article sample, although it stands out much less when the case studies are adjusted to population. Central African Republic (4), Chad (3), Equatorial Guinea (2), Gabon (2), Congo (3), Democratic Republic of the Congo (10), and Angola (4) are, like many countries in the African continent, among some of the least common case study locations in my data. São Tomé and Príncipe (2) has exceptionally high number of articles in the population-adjusted version, but this should be viewed critically, as the proportion is based on only two articles in total.

Eastern Africa stands out as the most represented area in Africa in the original dataset. Much of this is due to Ethiopia (191), one of the most studied regions of all. This effect, however, is diminished when the population sizes are taken into consideration. Nonetheless, many Eastern African countries, such as Kenya (83), Tanzania (66), and Uganda (48), are also among the more studied countries in both maps. The countries in the Horn of Africa, Eritrea (2), Djibouti (1), and Somalia (3), as well as South Sudan (5), show some of the smallest numbers of case studies in both versions of the map. Burundi (7) and Madagascar (12), as well, are presented on a more modest scale. Malawi (31), Mozambique (18), Rwanda (15), and Zambia (27), on the other hand, are more represented as case studies in both the original dataset and the population-adjusted one. The island states Comoros (1), Mayotte (0), and Réunion (0) are hardly included as case studies, but Seychelles (4) and Mauritius (9) stand out as more studied in comparison. This is undeniably related to their

[5] Institute for Economics & Peace. Global Peace Index 2022: Measuring Peace in a Complex World, Sydney, June 2022. Available from: http://visionofhumanity.org/resources (accessed 20/01/2023).

smaller population sizes, although other factors related to “stability” or research infrastructures may also play a role.

Northern Africa, while not the least common case study area, is still represented in a rather moderate number of articles. Libya (2) and Sudan (4) are among the least studied countries both in the original article sample and in the population-adjusted one. Algeria (12), Tunisia (18), and Morocco (22) show slightly higher numbers when the population sizes are not accounted for, but the two countries that truly stand out in Northern Africa, in both versions of the map, are Egypt (38) and Western Sahara (0): the former being the most common case study location in this region, and the latter not being studied at all. Lack of studies situated in Western Sahara in my data may be explained, at least to some extent, by the territory being both sparsely populated and disputed. The higher visibility of Egypt, on the other hand, can perhaps be associated to the Nile Delta that is highly important to agriculture but, at the same time, one of the mega-deltas that is the most vulnerable to climate change[6].

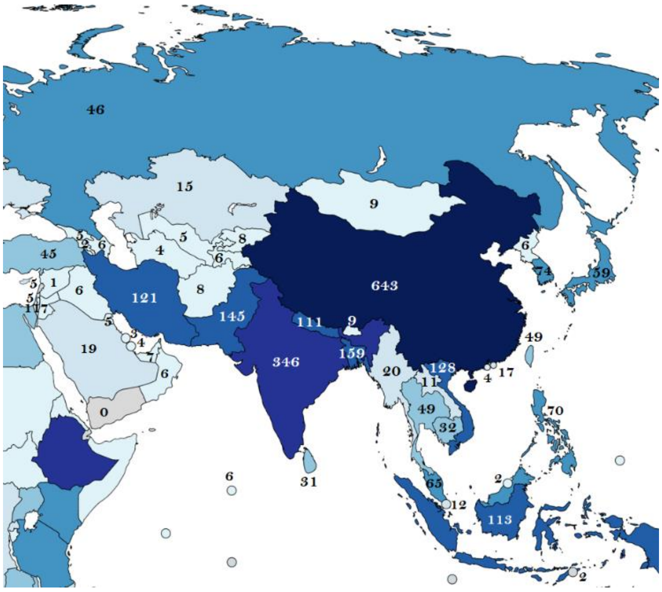
Southern Africa, finally, stands out as one of the most researched areas in Africa. In the original sample of articles, this is due to the high number of case studies in South Africa (165), but if the case studies are adjusted to population, Namibia (14), Botswana (21), and Zimbabwe (63) have higher proportions in comparison. The small-sized Lesotho (6) and Eswatini (5) do not particularly stand out in the original sample, given their relatively small levels of representation, but due to their small populations, they have a higher proportion of case studies when population sizes are taken into consideration. In any case, Southern Africa is the most represented area in Africa in the population-adjusted case study sample. This may be partially explained by the smaller population sizes of the countries (aside from South Africa), but climatic factors, such as the high rate in which much of Southern Africa is warming compared to the global average, increasing risk of draughts, and decrease in agricultural productivity (Scholes & Engelbrecht 2021:1; IPCC 2021: 644) are likely relevant as well. Moreover, certain institutional factors are notable too: for example, out of the sixteen member universities of the *African Research Universities Alliance* (ARUA), six are South-African universities[7], and about half of the African universities in *Times Higher Education* World University Rankings[8] -list are South-African. Although such rankings are always somewhat subjective, often following the hegemonic, “centre”-led understanding of academic performance, it seems that South Africa (and Southern Africa by extension) is the most recognized region of Africa in the “global” academic system.

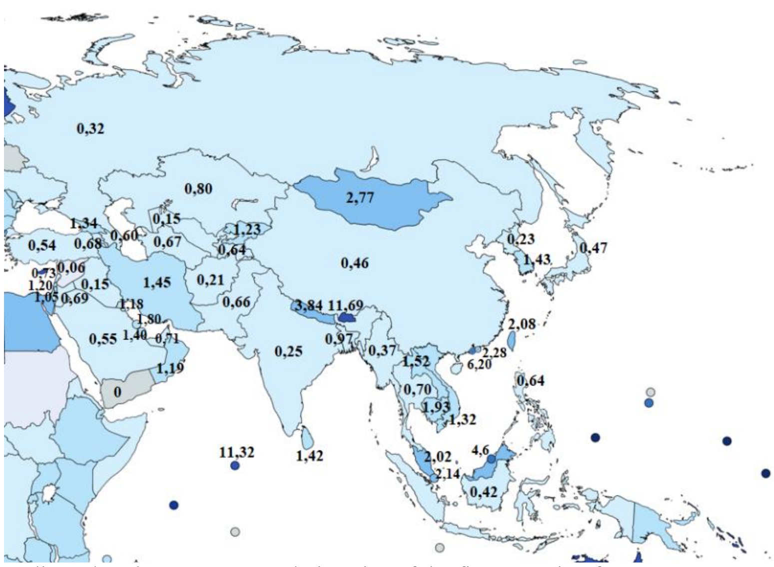
All in all, it is clear that the number of times each country and region are represented as case studies vary clearly. Generally speaking, it seems that certain more heavily populated and anglophone countries in Eastern, Southern, and Western Africa come up in the original data set considerably more often than others.

[6] See UNDRR: https://www.preventionweb.net/news/egypt-scales-climate-adaptation-actions-its-agriculture-water-and-agrifood-sectors
[7] See ARUA: https://arua.org.za/member-universities/
[8] Times Higher Education: https://www.timeshighereducation.com/world-university-rankings

At the same time, many francophone countries and countries considered to be some of the least developed in Africa are amongst the least represented case study locations in my sample of articles. Similarly, most of the island nations have little, if any, representation. If population sizes are taken into consideration, the picture changes slightly. The overall proportions still remain, and Eastern, Southern, and Western Africa show higher case study numbers in both versions of the map. Granted, the extent to which these numbers vary between countries changes, as do some of the countries that stand out particularly.

The second regional section under examination is the Asian continent, and its sub-sections: Southern, Central, Eastern, South-eastern, and Western Asia. As the map below demonstrates, regarding the original sample of articles, the variation of representation seems to be particularly high in the Asian continent — in fact, the highest out of all continental regions. When adjusted to population, the proportions of case studies are much more even.





overall number of case studies per country case studies adjusted to the average population size of the five-year timeframe

Southern Asia is among the most studied regions, and many of its countries are some of the most common case study locations in the original data sample. India (346), Bangladesh (159), Pakistan (145), and Nepal (111), are at the very top of the list. It is noteworthy, however, that they all have very high population sizes, especially the three first mentioned countries. When adjusted to population, the number of articles per country is actually at the lower end of the scale, with the exception of Nepal. Sri Lanka (31) shows a more modest proportion of articles in the original dataset, although the number rises when adjusted to population. Afghanistan (8) is the least common case study location in South Asia in both versions of the map, which is likely related to the political instability and the challenging humanitarian situation in the country, having a direct effect on matters such as data availability. In contrast, Bhutan (9) and Maldives (6) have very high levels of representation due to their small population sizes, although their numbers are the lowest in the original data.

In comparison to South Asia, **Central Asia**, as a whole, is one the least common case study areas, regardless of whether the numbers of case studies are population-adjusted or not. Kyrgyzstan (8) stands out from the rest as the most studied when population sizes are accounted for, while Uzbekistan (5) shows the opposite situation with the lowest case study proportion. The rest of the countries — Kazakhstan (15), Uzbekistan (5), Turkmenistan (4), and Tajikistan (6) — have rather low levels of representation in the article sample. Considering that all the countries in Central Asia have a relatively small number of articles and, more importantly, there aren't all that significant differences between them in the original and the adjusted data sample (apart from some possible size-effects), too strong conclusions should not be drawn about their differences based on my limited data.

Regarding the overall number of case studies, **Eastern Asia** is dominated by China (643), the second most studied country in my data sample after the US. The special administrative regions of China — Hong Kong (17) and Macao (4) — only correspond to a small fraction of all the case studies. Considering China's massive population, the case study proportions look significantly different when the article sample is adjusted to population. What is more, all of Eastern Asia, aside from Mongolia (9), Taiwan (49), and South Korea (74), are among the least represented countries in this version of the map, although the two latter are on the higher side of case studies in the original data. Japan (59) is among the more studied countries when the data is not population-adjusted, but less so when the large population is taken into consideration. North Korea (6), finally, is the least studied country in Eastern Asia. Moreover, it only comes up in the articles as a part of the Korean Peninsula, together with South Korea. This comes hardly as surprise considering that North Korea is one of the most repressive countries[9] and struggles with poverty and underdevelopment.

South-eastern Asia, like Southern Asia, has a relatively high variation of representation between countries in the original sample of articles. The smaller island states Singapore (12) and Timor-Leste (2), as well as the sultanate Brunei Darussalam (2), come up as case studies in small numbers but, as usual, when population-adjusted, their numbers of case studies are proportionately higher due to their smaller populations. Viet Nam (128) and Indonesia (113), on the other hand, stand out as some of the most popular case study areas, both in South-eastern Asia and on a global scale, but when their large population sizes are accounted for, their proportion decreases. Myanmar (20), Thailand (49), Laos (11), and Cambodia (32) are on the middle range of South-eastern Asia case study wise, and the two latter ones with smaller populations show slightly higher numbers when the data is population-adjusted. Malaysia (65) and Philippines (70) are on the higher middle ground in the Asian context, and their numbers of case studies are very similar to each other, but Philippines displays a clearly smaller proportion compared to Malaysia. Such differences, considering that the original numbers of articles are on par, may be explained with the differences in population sizes. Indeed, adjusting the number of case studies to population does not necessarily fully remove the effects of differing

[9] Human Rights Watch World Report 2022: https://www.hrw.org/world-report/2022/country-chapters/north-korea

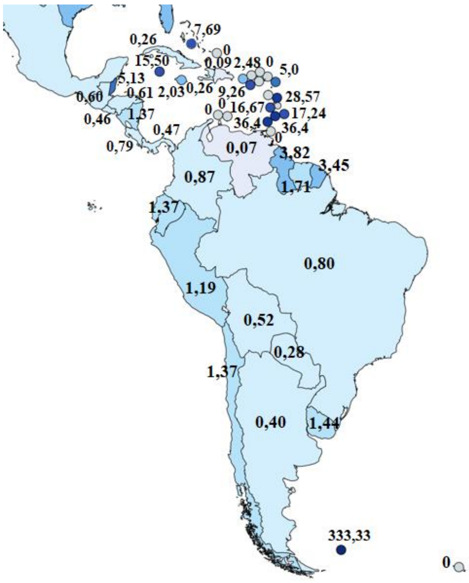
populations: when there are no significant differences in the amounts of articles between countries, the difference that remains is often times related to the population size the data has been divided with.

Western Asia, much like Central Asia, is among the least represented areas globally. Countries in the Caucasus region of this area, Armenia (2), Azerbaijan (6), and Georgia (5), are among some of the least common case study locations. Said countries do not show high numbers in the population-adjusted illustration either, with Georgia being slightly more researched in this version. Comparably, most countries in the Arabian Peninsula, namely Bahrain (3), Kuwait (5), Oman (6), Qatar (4), and the United Arab Emirates (7), have similar numbers in the original data sample, and their proportions remain rather constant in the population-adjusted version, although the United Arab Emirates is slightly smaller, most likely due to its slightly bigger population. Saudi Arabia (19) has slightly higher representation originally, but considering the population size, it has one of the lowest numbers of case studies. Aside from larger population, the significant oil reserves in the country may or may not play a role in its interest in adaptation and mitigation related research. Yemen (0), suffering from one of the largest humanitarian crises in the world, is among the countries not represented at all in the sample of articles.

The rest of the Middle East region — comprising Israel (11), Palestine (5), Jordan (7), Lebanon (5), Iraq (6), and Syria (1) — has mostly similar levels of representation to the others presented above, both in the original and in the population-adjusted versions. Syria, however, stands out as having the smallest number of case studies (aside from Yemen, of course) regardless of population, which is likely related to the many forms of instability the country faces: for example, the Global Peace Index lists Syria among the least "peaceful" countries out there. This has undeniably an effect on academic endeavours through many factors such as data availability. Turkey (45), in turn, seems to be a slightly more common case study location in the original data, but is less so with the large population considered. Finally, the country that stands out perhaps the most is Iran (121): it forms a stark contrast to the rest of the countries in the original article sample, and although its proportion of case studies is much smaller when adjusted to population, it is still larger than average in the Middle Eastern or Western Asian context. As one of the indicators in the second section of the analysis reveals, Iran has a rather large number of researchers for its population, which may be a contributing factor to its ability to publish research. Moreover, the country's vulnerability to water scarcity may be significant, as is revealed by the fact that many of the case studies situated in Iran in my data set involve water.

On the whole, as mentioned before, the variation of representation in the original article sample is generally very high in the Asian continent, most significantly in South Asia. Like in the African continent examined previously, there seems to a pattern of bigger and more heavily populated countries being more represented. However, when population size is taken into consideration, the differences are admittedly downplayed.

The third regional section I will explore consists of Central and Southern America.



overall number of case studies per country

case studies adjusted to the average population size of the five-year timeframe

Central America, as can be seen from the map above, is among the least represented areas in the whole data sample. The nearby Caribbean island-nations, also shown on the map, are even less common case study locations in my data and many of them are completely outside of representation. However, the Caribbean region, comprising many small island developing states, will be looked into more in detail in a separate section about Small Island Developing States (SIDS). Therefore, the following paragraphs only examine Central and South America.

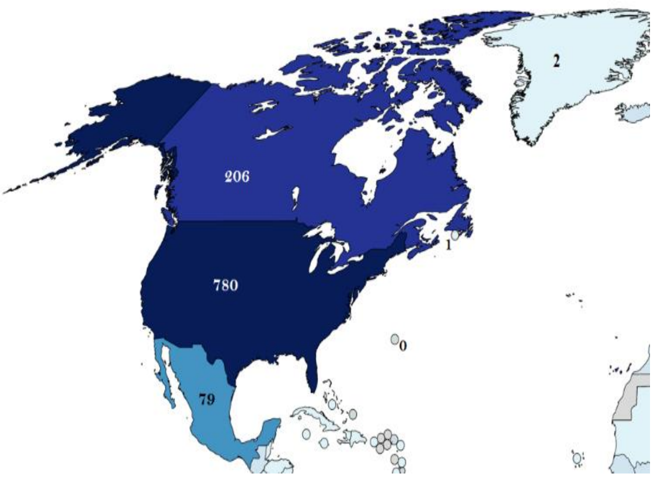
The countries of **Central America**, as mentioned above, are represented in small numbers of case studies in the original dataset. The bigger and more populated countries, Guatemala (10), Nicaragua (9), and Honduras (6), have slightly more case studies in my article sample, but this difference is mitigated by population sizes. Moreover, their numbers of case studies are similar enough so that any differences notable on the population-adjusted map are likely reflections of the differences in the population sizes said case studies are divided with. Costa Rica (4), El Salvador (3), and Panama (2), showing slightly smaller numbers, do not particularly stand out from the population-adjusted map. In the second map, Belize (2) has by far the highest coverage of articles from Central America, but this is likely explained by its significantly smaller population size.

South America, in comparison, has much more variation of representation in the original data. Brazil (169) stands out as the most popular case study location in the region, and one of the most represented areas globally. This may be related not only to the size of the country and its population, but also to the Amazon rainforest covering a significant portion of Brazil. Many of the other countries in the region have a rather middle-range level of representation: they are not among the least common case study areas but are much less present compared to the likes of Brazil. Colombia (44), Argentina (18), Chile (26), Ecuador (24), and

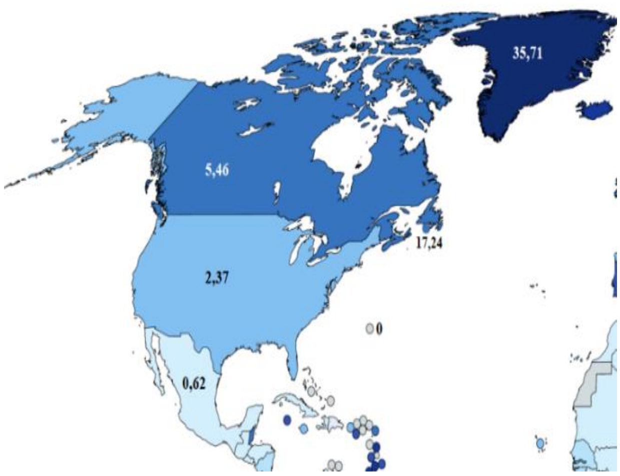
Peru (39) belong in this list. The three latter countries demonstrate proportionately higher numbers on the map on the right, which is hardly solely due to population sizes. Perhaps some of this can be explained by the complex ecological and climatic conditions in this part of South America, related for example to the Amazon rainforest, the Atacama Desert, and the Andes Mountains. Some of their neighbouring countries, namely Venezuela (2) and Bolivia (6), are much less visible in comparison, both in the original and in the population-adjusted one. Paraguay (2) and Uruguay (5) demonstrate similar numbers, and although Uruguay has a higher number on the map on the right, the difference in the original numbers of articles is too small to make a conclusion about a significant difference between them. Finally, some of the smaller and less populated countries in the northern part of the continent, Guyana (3), Suriname (1), and French Guiana (1), as well as the islands Falkland Islands (1) and South Georgia and South Sandwich Islands (0), are among the least represented areas in the original data but show the highest numbers when the number of case studies is adjusted to population. These differences are likely related to the changes in population sizes, above all.

In conclusion, Central and South America are among the less popular case study regions in my sample of articles, with the exception of Brazil. On the opposite spectrum of representation, Central American countries as well as the small islands in the regional category of this list are some of the least represented in my data. However, the size of the country and its population plays a role in these differences. Moreover, as I have discussed earlier, the question of language bears relevance here. English may not the be the primary publishing language in Central and South America, or at least English likely competes with Spanish and Portuguese as important academic languages. As is the case with francophone Africa, it would come as no surprise if different language choices for the data would alter the representation of some of the less represented countries within this regional category.

The fourth regional section under scrutiny corresponds to **Northern America**, one of the most studied areas in the whole dataset. Despite the region consisting only of a handful of countries in the classification used in this study, some differences in representation are noticeable, as the maps below demonstrate.



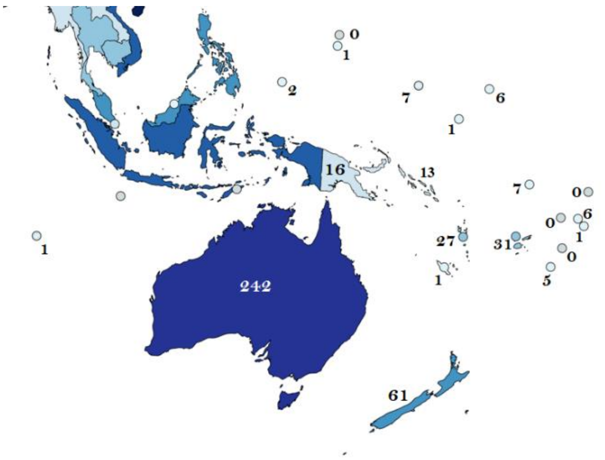
overall number of case studies per country



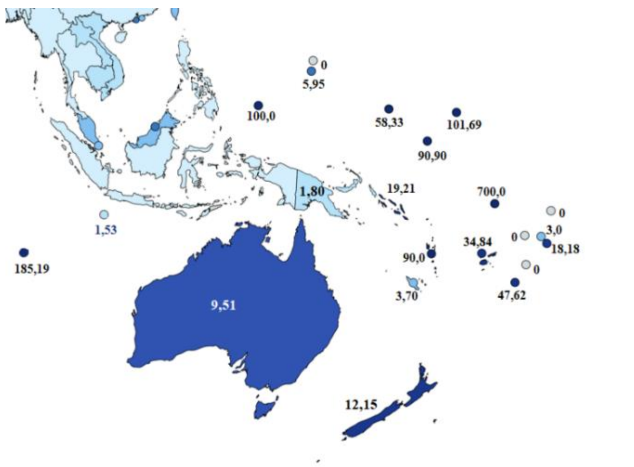
case studies adjusted to the average population size of the five-year timeframe

Within the Northern American region, the United States (780) is, as is probably clear by this point, the single most studied country in my original sample of articles. Canada (206), although nowhere close to the US, is also among the most represented case study locations. In comparison, the number of Mexico (79) case studies is much more moderate in both versions of the map. Here again language may be a contributing factor, since the role of Spanish as a publishing language may well override that of English. When adjusting to population, the proportion of case studies is much bigger in Canada than in the US, which can likely be attributed to the effects of vastly different population sizes. Greenland (8) — geographically part of the North American continent but politically speaking an autonomous part of Denmark — is measured in this case according to the one-third of the country that is not part of the Arctic Circle. Polar regions, including the Arctic, have their own category further down. As can perhaps be expected by measuring the population size alone, Greenland is present very little in the original data sample but much more visible in the population-adjusted version. Similarly, Saint Pierre and Miquelon (1) has barely any representation, as is the case with many islands, but due to the small population size, it has a much larger proportion on the map on the right. Bermuda (0), on the other hand, is not included into the case studies in my data sample.

The fifth regional section I will look into is the **Australasian** part of Oceania. Like the Caribbean region from the Central and South America -category, Oceania will be in the SIDS-section further below. Australasia forms the smallest — and perhaps an unnecessarily small — regional section of categorization in my analysis, but as small islands like the ones found in Melanesia, Micronesia, and Polynesia regions of Oceania are both considered highly vulnerable *and* seem to be the least visible group of countries, I will look into them separately to give them the attention they deserve.



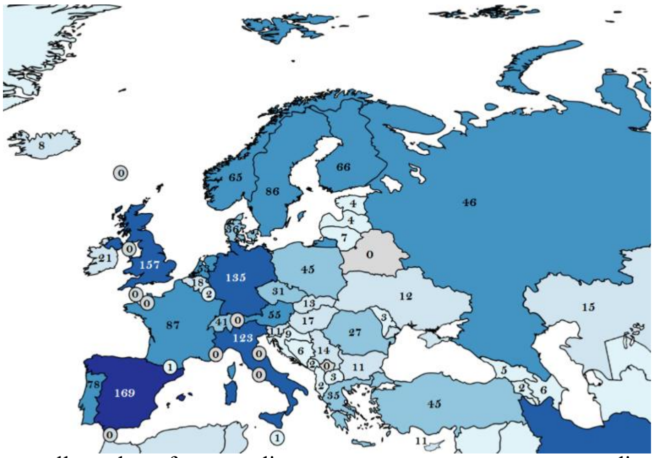
overall number of case studies per country

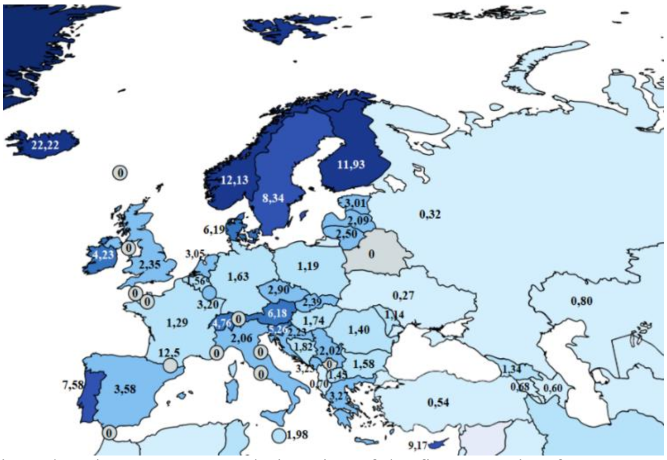


case studies adjusted to the average population size of the five-year timeframe

All in all, Australia (242) is the fourth most common case study location in the whole sample of articles in my thesis. New Zealand/Aotearoa (61), on the other hand, is much less researched in comparison, despite their relative proximity and shared dominant status of the English language. As is the case with other areas, the size of the country and the population is likely one explaining factor. When adjusted to population, the numbers of case studies still remain very high for both Australia and New Zealand. In fact, they are among the handful of countries that show proportionately high representation in both the original dataset and in the population-adjusted one. Thus, they are some of the most common case study locations in the whole data set.

The sixth regional section being examined is the European continent. Due to the variance of representation, as the map below demonstrates, I will include the sub-categories of Northern, Southern, Eastern and Western Europe in this overview. The arctic region case studies within Europe can be found from another section.





overall number of case studies per country

case studies adjusted to the average population size of the five-year timeframe

Northern Europe seems to have some variance in representation by sub-region. The Baltic countries stand out as the least researched: compared to most of the Nordic countries, for example, Estonia (4), Latvia (4), and Lithuania (7) come up as case studies in small numbers. Said countries show higher numbers when the data is population-adjusted, but this is likely due to their population being smaller compared to most countries in the region. Iceland (8) is also among the lesser studied countries, although it shows a completely different proportion when the small population is taken into consideration, and Faroe Islands (0) are completely outside of the dataset. The rest of the Nordic countries — Denmark (36), Norway (65), Sweden (86), and Finland (66) — are much more popular case study locations and, interestingly, some of the most higly represented countries in all of the population-adjusted data. It may not be a coincidence that the Nordic countries score highly in all of the indicators in the second section of the analysis, which may indicate that the academic infrastructure to participate in "international" research is thriving in these countries. Regarding the rest of North Europe, Ireland (21) has a somewhat moderate number of case studies in the original data, but shows quite a bit higher levels of representation in the population-adjusted data. The neighboring United Kingdom (157) is the most popular research location in Northern Europe in the origininal article sample, which might be associated both to the position of English language and the bigger population compared to the rest of the countries in this area. On the other end of the scale, Isle of Man (0) is not represented at all.

Southern Europe has rather large variance of representation between different countries. The biggest and most populated Spain (169) and Italy (123) stand out as the most popular case study locations in the original data sample, and they are among the most represented countries both in Europe and on the global scale. When adjusted to population, said countries are still on the higher end of representation. The same goes for

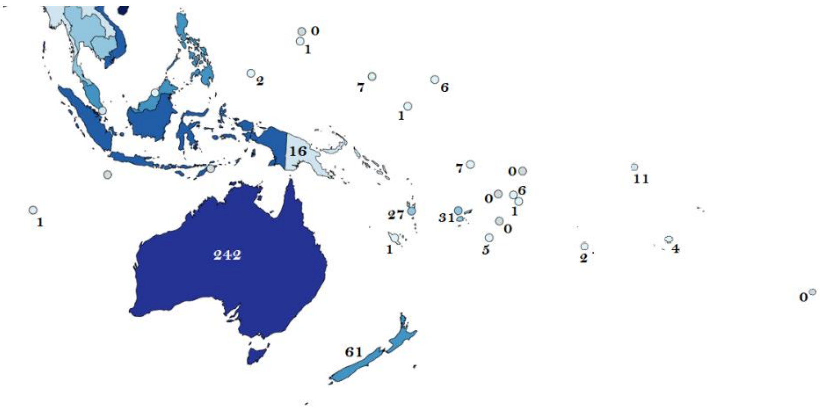
Portugal (78) and Greece (35) that are the next most researched countries in the original data. Portugal stands out as the most common case study location in Southern Europe when population is accounted for. The relatively high proportion of researchers in the country, as one of the indicators in the next section shows, may be relevant. The rest of the Southern Europe is much less studied in the original dataset, and many of the countries in this region are among the least represented in my sample of articles. Serbia (14), Slovenia (11), Cyprus (11), Croatia (9), and Bosnia and Herzegovina (6) come up less often as case studies, and North Macedonia (3), Montenegro (2), Albania (2), Malta (1), and Kosovo (0) even less so. However, many of these countries have a higher proportion of case studies when adjusted to population. Slovenia and Cyprus, especially, stand out has showing higher numbers, which can be at least partially attributed to their smaller population sizes, considering that their case study numbers are otherwise similar to the other mentioned countries. As can perhaps be expected, the microstates Andorra (1), San Marino (0), Vatican (0), Monaco (0), and Gibraltar (0) are nearly fully outside of representation. Andorra, having a very small population, rises significantly in proportion on the population-adjusted map, even though it only has one case study in the original data sample.

Eastern Europe has a little bit less variation in comparison: there are some bigger, a little bit more represented countries, such as Poland (45), the Czech Republic (31), Romania (27), as well as Hungary (17), Slovakia (13), Ukraine (12), and Bulgaria (11). These countries do not, however, stand out as much in the population-adjusted data. Russia (46), classified as part of Eastern Europe after UNCTAD statistics but also considered to be part of Northern Asia, is the most represented country in the region in the original dataset. However, when its very large population is taken into consideration, it is among the least represented areas. Moldova (3) and Belarus (0) are at the very bottom of the list when it comes to representation. All in all, out of the categories mentioned here, Eastern Europe is the least common European case study location regardless of whether the data has been adjusted to population sizes or not.

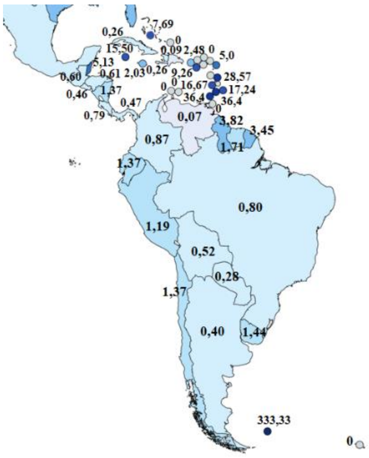
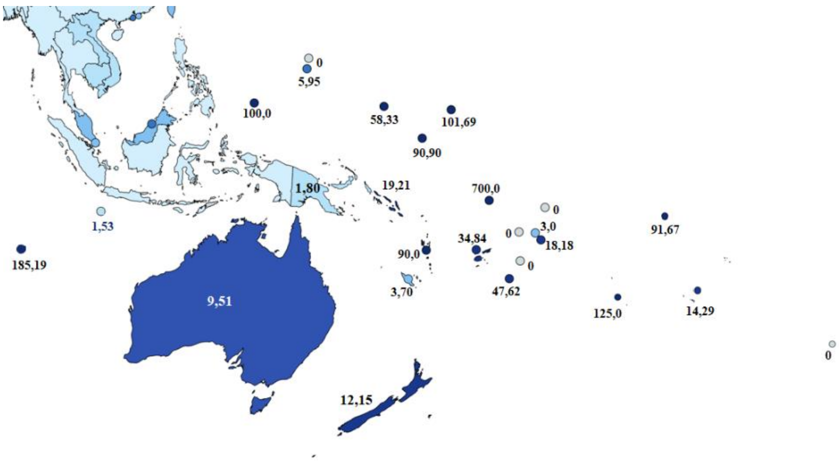
Western Europe, finally, is on the higher end of representation in the European context. In the original data, Germany (135) stands out as the most popular case study location in this category, but France (87), Austria (55), Netherlands (53), and Switzerland (41) come up in the data fairly often as well. The three latter countries stand out in the population-adjusted data, which may be reflective of their research related infrastructures: much like the Nordic countries mentioned previously, the three countries score highly in all of the indicators examined in the second section of my analysis. This may indeed be significant. The two remaining countries in Western Europe, Belgium (18) and Luxembourg (2), have less visibility compared to the other countries in this category, although Luxembourg is on the higher side case study wise on the map on the right, due to its small population size.

All in all, as can be expected due to the great number of countries, there is a lot of variety in the volume of representation between different case study locations in Europe. Southern and Western Europe cover the majority of the most common European case study locations in the original data, but when the numbers of case studies are population-adjusted, the representational focus shifts to the Northern Europe instead. Eastern Europe, on the other hand, remains as the least common European region for case studies, regardless of whether the population sizes are accounted for or not.

The seventh regional section I look into comprises the **Small Island Developing States (SIDS)** — one of the groups of countries that is often characterised as highly vulnerable and, due to rising sea levels, faces one of the earliest existential threats associated to climate change. The list of countries I have included in this category corresponds to a list of SIDS provided by the United Nations[10]. Interestingly enough, compared to the other regional categories presented above, the small island developing states have by far the highest number of countries and areas not covered at all by the research in my data. In fact, about two thirds (68%) of the countries outside of representation in my sample of articles are island states or SIDS. Moreover, the vast majority of the SIDS, when represented, are amongst the least common case study locations in the sample, showing some of the lowest numbers of the whole dataset. Of course, when adjusted to population, this trend is reversed: small islands and small island developing states show by far the highest numbers. This should, however, be viewed critically, considering just how small both the population sizes and most of the case study numbers are. The proportions are somewhat skewed for making credible interpretations.

overall numbers and adjusted numbers of case studies per country in the Caribbean (left) and in Oceania (right)

[10] See for example: https://www.un.org/ohrlls/content/list-sids

Regarding the overall low levels of representation of SIDS, I want to acknowledge that small islands outside of SIDS have the least representation of all. Small island -related research seems to mostly be about Small Island Developing States specifically. This may be related to the "status" of SIDS as a separate category of island states in United Nations programmes and elsewhere, having thus one the highest profiles of islands.

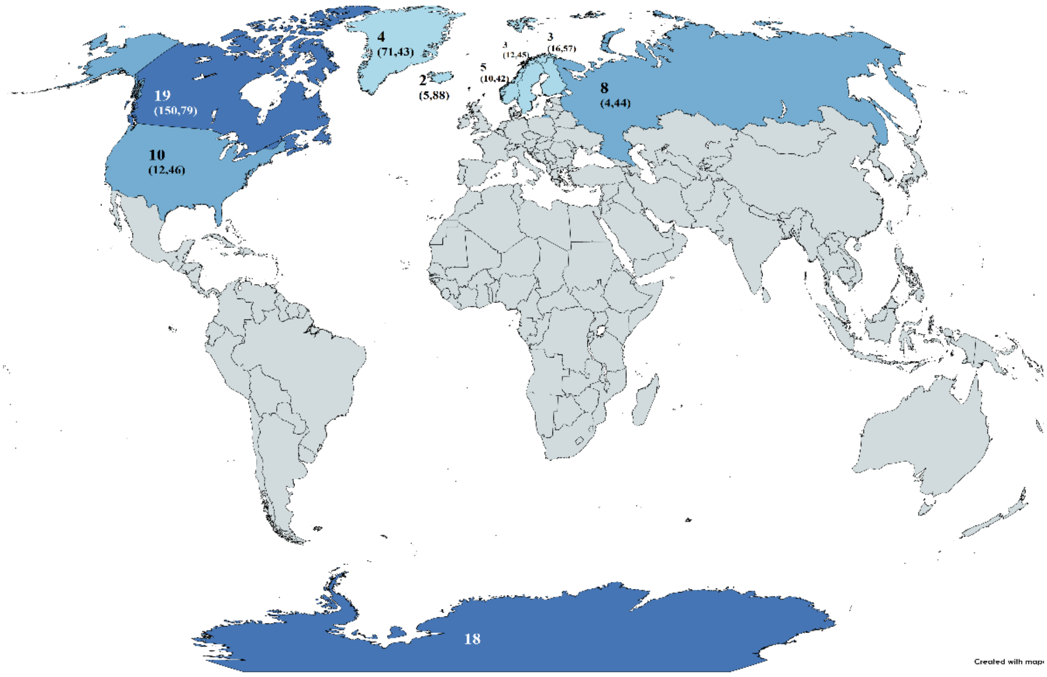
The **Caribbean** region is, all in all, slightly less studied than the Pacific islands in Oceania. There are some islands that come up a handful of times in the original data, such as Puerto Rico (8), Jamaica (6), Barbados (5), Grenada (4), Saint Vincent and the Grenadines (4), Bahamas (3), Cuba (3), Haiti (3), Saint Lucia (3), Dominica (2), Guadeloupe (2), Dominican Republic (1), Cayman Islands (1), and Sint Maarten (1). However, almost as many are fully outside of representation: Anguilla (0), Antigua and Barbuda (0), Aruba (0), British Virgin Islands (0), Curaçao (0), Montserrat (0), Saint Kitts and Nevis (0), Trinidad and Tobago (0), Turks and Caicos Islands (0), and Martinique (0) do not come up once in my data sample.

Oceania (excluding Australasia) comprises Melanesia, Polynesia, and Micronesia or, as often expressed in the articles of my data, Pacific islands. The island states in this region demonstrate the same pattern of very little representation that seems to be the case for most small islands. The Pacific small islands are more visible in the sampled research compared to the Caribbean because the most popular SIDS -case study locations, Fiji (31) and Vanuatu (27), are in the region. There are some other islands that come up to a slightly higher extent, although less than the two aforementioned: Papua New Guinea (16), Solomon Islands (13), Kiribati (11), Federated States of Micronesia (7), Tuvalu (7), Marshall Islands (6), Samoa (6), Tonga (5), and French Polynesia (4). These rest of the islands come up rarely — Palau (2), Cook Islands (2), American Samoa (1), Guam (1), Nauru (1), and New Caledonia (1) — if at all; Christmas Island (0), Cocos (Keeling) Islands (0), Niue (0), Northern Mariana Islands (0), Heard Island and McDonald Islands (0), Tokelau (0), Wallis and Futuna Islands (0), Pitcairn Islands (0). The differences in proportion in population-adjusted data, both in the Caribbean and in Oceania, is likely solely related to differences in population sizes. However, the reason why the neighbouring Fiji and Vanuatu stand out from the rest of the islands (in the original data sample) may be related to a myriad of factors. For example, the University of the South Pacific -research university[11] encompasses both islands, and many others in Oceania, having the main campus in Fiji. Moreover, both countries are some of the closest islands to Australia that, in turn, is one of the primary "outsider" affiliations in the Oceania case studies in my dataset. Research collaboration with Australia and New Zealand may play a role in why Fiji and Vanuatu stand out from the rest of the islands.

The seventh and final regional section examined consists of the **Polar regions**, that is, the **Arctic** and the **Antarctic**. While the polar regions might be more visible in other kind of climate change research, in the adaptation and mitigation related research of the dataset of this thesis, they are, as a whole, the least represented regional category. Inhabited Polar regions form a relatively small area to study compared to

[11] See USP: https://www.usp.ac.fj/

many other regions in the world, which might partially explain why they are studied relatively little in my data sample. There is no exceptional variation in the volume of articles between the different Arctic countries but, as perhaps can be expected, the Arctic region as a whole is much more visible compared the Antarctic.



Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

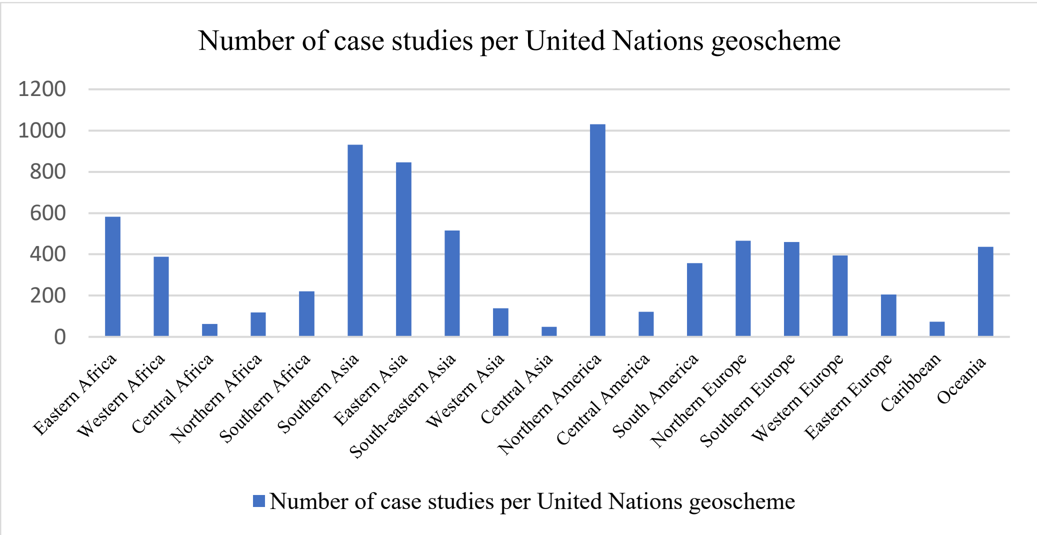
n.b. Due to some technical limitations of the map-making tool used, the Arctic region is marked by whole countries on the map above. In reality, of course, the Arctic only covers parts of these countries.

As mentioned above, the **Arctic** is not much represented in the articles of my data sample but there are still some differences to be seen between different countries. In the original data sample, Arctic Canada (19) is the most common Arctic case study location, followed by Arctic Alaska (10) and Arctic Russia (8). The Arctic regions in the Nordic countries as well as Arctic Greenland are less visible in comparison. This may, of course, be related to the overall population differences between these countries. Arctic Norway (5) is slightly more studied than Arctic Finland (3), Sweden (2) or Iceland (2). Arctic Greenland (4) is close to Norway in this scale of representation. Adjusting the original case study numbers to population only leads to approximations, since establishing precise population sizes for the Arctic turned out to be somewhat difficult. Moreover, drawing lines between "arctic" and "non-arctic" parts of a given country or region is not quite straightforward. It would seem that many of the differences seen in the population-adjusted figures are likely related to size effects when the original case study numbers have no great variation.

The **Antarctic region** (18), in turn, is less studied compared to the Arctic. This is hardly surprising considering that there are no native or permanent human residents in the region, which likely decreases the interest to study climate adaptation and mitigation over other climate change related topics. Still, the

Antarctic is not by any means among the least studied areas in the dataset. Considering that there are plenty of science stations in Antarctica[12], it is probable that the region is important for climate research in general.

Although much of my analysis focuses on states, it is worth "zooming out" occasionally to acknowledge the different layers of regional representation in research. Therefore, I will briefly summarise the proportions of representation between the different "clusters" of countries, corresponding to the geographical divisions examined above. Here, I have illustrated said proportions by using regional categories according to the United Nations geoscheme (that is on par with the UNCTADstat regional categories). As is the case with the UNCTADstat regional categories, the United Nations geoscheme classification is only one regional classification out of many and it is used for statistical convenience only. All regional classifications are socially constructed and have unavoidable political undertones — the categories this study uses are no exception to that. For the limited scope of my thesis, I have deemed these classifications sufficient for structuring the analysis according to an existing model.

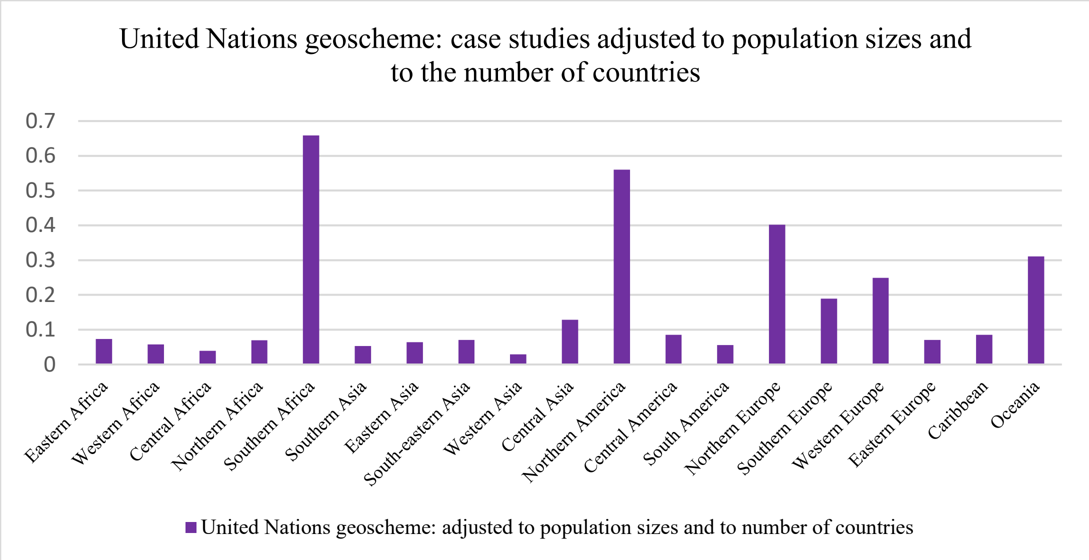


As the world map on page 40 demonstrates as well, the case study locations are not equally proportioned, and certain regional categories stand out due to larger or smaller visibility. In the graph above, Southern and Eastern Asia, as well as Northern America comprise the highest numbers of case studies in my data sample. Eastern Africa, South-eastern Asia, Europe (outside of Eastern Europe), and Oceania (above all due to Australia) stand out as well due to being relatively high on the list.

However, as previously established in this section, large population sizes play a role in this division. Moreover, as always when comparing geographical regions that include a number of different countries, it is worth pointing out that these different geoscheme regions have very different population sizes as well as different numbers of countries within them — the population sizes range from around 40 000 to over a billion, while the countries range from only five to twenty-seven. Therefore, it is plausible that some of the

[12] See for example: https://www.coolantarctica.com/Community/antarctic_bases.php

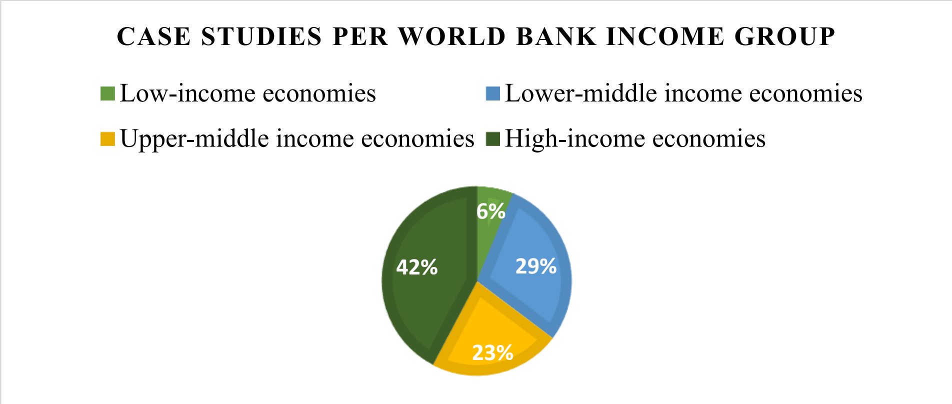
differences in proportions seen above can be explained by the differences in population sizes and in the number of countries. When adjusted to the population sizes and the number of countries in each geoscheme area, the proportions look quite different, as shown below.



The chart above demonstrates similar case study proportions as the map on page 42. Admittedly, the proportions in this graph are not fully outside of the influence of the population sizes and the number of countries. The regions that stand out, namely Southern Africa, Northern America, Northern Europe (as well as Southern and Western Europe), and Oceania, all share two or more of the following qualities: a large number of articles, a relatively small population size, and a small number of countries in the region. The effects of population and country sizes and numbers cannot be fully erased. Nevertheless, certain patterns are shared between these different visualisations, regardless of population sizes: Northern America, Oceania, and Europe, excluding Eastern Europe, seem to comprise some of the most common case study locations regardless of population size.

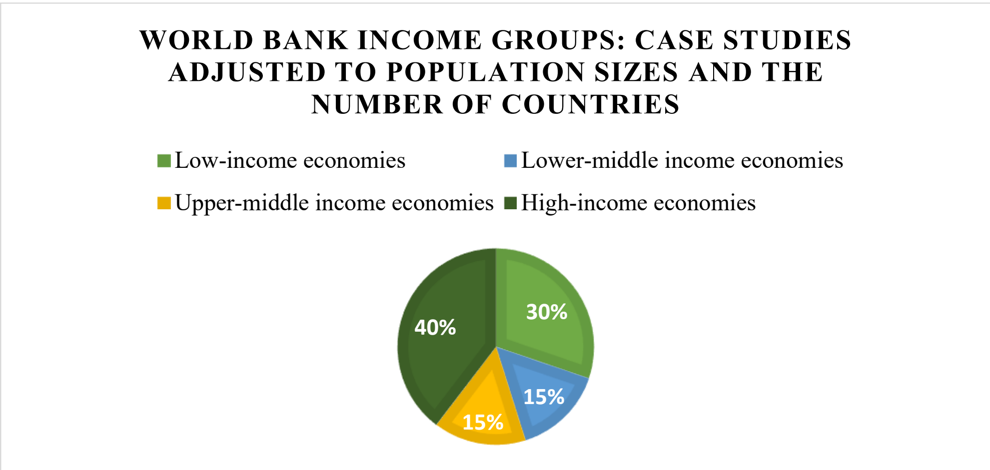
Moreover, as economic (and developmental) factors are central in my analysis, I have allowed myself to digress slightly from the analysis conducted so far by taking into consideration two more ways to group countries that give a glimpse into those elements. First, World Bank Income Groups help to illustrate the distribution of case studies by income group and to show possible differences in representation that might reflect economic factors. These income groups — low-income, lower-middle income, upper-middle income, and high-income economies — are listed by the World Bank[13] and measured using gross national income (GNI) per capita, in US dollars, and converted from local currencies.

[13] See: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups



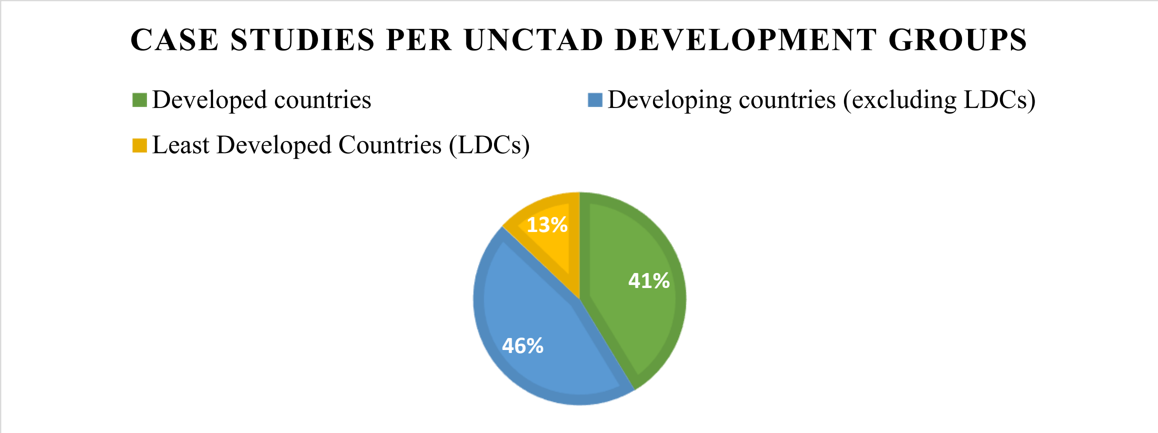
In the graph above, the high-income economies (81 countries) have the highest level of representation in case studies compared to the other groups. There is not a big difference between lower-middle (54 countries) and upper-middle (54 countries) income economies, and the differences that exist are related to certain individual countries that have a particularly high number of case studies. What is the most significant observation, however, is the striking contrast between the low-income economies (28) compared to the rest. There are considerably less countries in that category, of course, but whether that alone is enough to explain the difference requires a further look into the matter. Differing abilities to finance research, and required infrastructures to conduct it, between these income groups may play a role as well.

As is the case with the graphs presented previously, adjusting the case study numbers to the population sizes and to the number of countries per Income Group region changes the proportions: high-income economies still dominate the chart but low-income economies rise strikingly in visibility as the second biggest category.



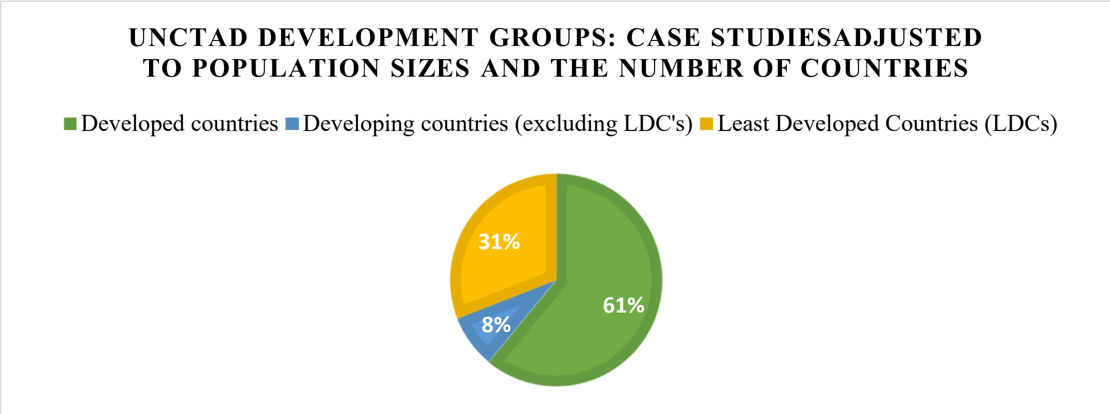
This may be partially explained by the fact that, although the amount of case studies is lowest in this category, both the population size and the number of countries are much smaller than those of the rest of the categories. Further, considering that a lot of the low-income economies are also considered to have "high human vulnerability" regarding climate change, prioritising adaptation and mitigation related research in these regions specifically would not be surprising. The thematic focus in climate change research, hence, may indeed be relevant when assessing the levels of regional representation.

Secondly, UNCTAD Development Groups[14] may help to approach possible development related factors behind different levels of spatial representation. These categories of developing countries, developed countries, and least developed countries, are listed by United Nations Conference on Trade and Development (UNCTAD). I acknowledge that classifying countries or economies by development status is far from straightforward, and these categories are rough indicators only. As is pointed out by UNCTAD, these developmental categories are intended for statistical convenience and bear no judgement about any development processes of any country or region[15]. In this study, too, they complement the overview of the distribution of case studies my analysis aims to build, and are used for statistical purposes only.



The developed countries -category (61 countries) is the most represented in the case studies in my sample of articles, but the developing countries -group (126) is relatively close — although there are twice as many countries in this category, which is significant when assessing the proportions. Much like is the case with the income groups above, the most prominent observation that might have the most bearing in my analysis is the share of the least developed countries in the case study distribution. There are highly represented countries in all the categories in both groupings, but there seems to be some correlation between the level of case study representation and economy and development related factors especially when it comes to the least developed countries that have the lowest incomes. This observation, of course, is influenced by the number of countries and the population sizes of each category, so a population-adjusted graph is worth looking at as well.

[14] See the full list: https://unctadstat.unctad.org/en/Classifications/DimCountries_All_Hierarchy.pdf
[15] See UNCTAD classifications: https://unctadstat.unctad.org/en/classifications.html



Much like is the case with the previous charts, adjusting the numbers to population sizes and to the number of countries per Development Group changes the proportions quite notably: developed and the least developed countries are much more present in this case. Developing countries seem almost non-existent in comparison — however, there is by far the biggest number of countries and the largest overall population size in this classification which affects the population adjustment calculations significantly. Therefore, the exact numbers are likely always somewhat affected by size-effects. A conclusion that can be drawn, however, is that when population sizes and the number of countries in each category is taken into consideration, the differences between "high-income" and "low-income" as well as "developed" and "least developed" countries is not quite as large as may seem at first glance. Whether developmental and economic statuses, or factors related to them, are sufficient for explaining the variation in spatial distribution of case studies in my data sample requires further analysis.

6.2 Degrees of association between the recurrence of case study locations and chosen factors

In this section of the analysis, I will look into the relationship between the number of case studies and certain research, education, economy, and development related factors. More specifically, I will examine whether the number of case studies per country correlates with any of the variable factors. This correlation analysis gives a basis for further discussion about the relationship between different aspects of knowledge output and factors such as those mentioned above. As mentioned in the methodology chapter, correlation does not, however, imply causation, and therefore I will not be advocating a cause-and-effect relationship between the studied variables, although some degree of causality may well exist between them in real life. Instead of looking for a direct explanation to the distribution of case studies examined in the previous chapter, I will simply look into the relationships between my chosen variables to find out whether the analysis reveals any correlation between them. Naturally, this does not reveal the depth of admittedly complex relationships, but it may open a discussion about the possible interrelatedness of scientific input related factors and scientific output related factors (such as the choice of case study location).

As mentioned before, the factors that I will look into in relation to case study locations — and scientific output by extension, considering how interrelated the institutional affiliations seem to be with the case study locations — are Research and Development expenditure (as a percentage of GDP), GDP per capita (PPP), government expenditure on tertiary education (as a percentage of GDP), the number of researchers per million people, Human Development Index, and Global Innovation Index. The bulk of the data concerning these variables has been collected from two databases: UNESCO Institute for Statistics -database and TheGlobalEconomy.com -database. The latter compiles data from sources such as the World Bank, the International Monetary Fund, the United Nations, and the World Economic Forum. When possible, I have compared the data from these databases with snippets of available data from several other sources, mainly from OECD, World Bank and other UNESCO databases to maximise the reliability of the statistics presented. As is the case with the numbers of case studies in my data, the proportions between different areas are of primary interests rather than any individual numbers themselves.

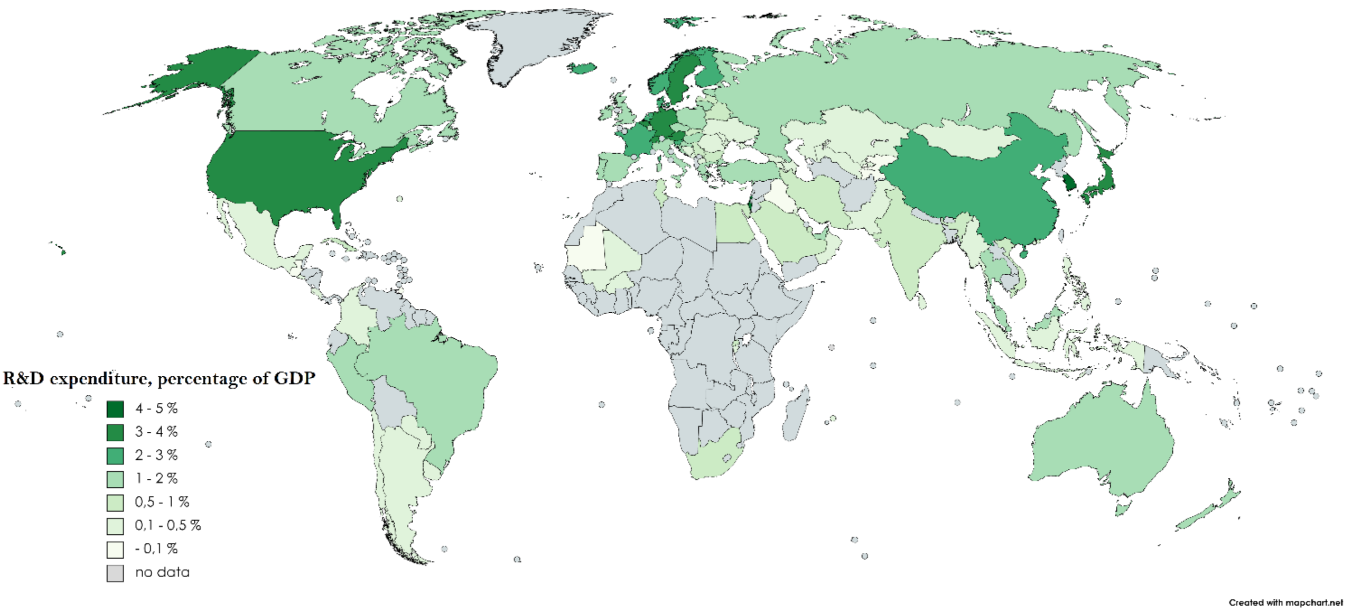
Before looking into the different variables in the following analysis, a brief remark about my choice of factors is in order. First of all, the variables chosen for the analysis of this study are, naturally, only a handful of possible variables to choose for a correlation analysis; they cannot, and are not expected to, be all-encompassing. There are many other factors that are relevant to scientific research and that I could have chosen for the analysis. The ones that will be part of my correlation analysis have been chosen because of their presumed direct relevance to research, knowledge production, and economy that fuels knowledge production. It is still worth acknowledging, however, that much knowledge is left outside of them, and they by no means represent a comprehensive list of possible factors associated to scientific research. The relationships between scientific knowledge production and research, education, and economy related factors are inherently complex, and these factors are often intertwined. Moreover, there are many contributing factors unrelated to knowledge production that may well influence these relationships as well. My analysis is not, therefore, enough on its own to build a sufficient understanding of the complexity of factors related to, and possibly influencing, scientific knowledge production.

Second, the explanatory capacity of my chosen factors is admittedly limited. Indicators such as GDP, Global Innovation Index, or Human Development Index are hardly equipped to build a comprehensive image of the economic, innovative, or developmental capacities of different countries. Measuring as complex phenomena as prosperity, capacity, development etc. is far from straightforward, and there may be much that these indicators are not taking into consideration — least of all international variation and variation between the different factors measured within said indicators. How useful these kinds of indicators truly are to understand complex phenomena, without simplifying them, can and should be questioned. While I use these indicators to have concrete, numeric values to analyse, I acknowledge their limits: in my study, they are *indicators*, giving thus a superficial idea of the factors they aim to measure despite not being able to encompass their complexity as a whole.

6.2.1 Research and development (R&D) expenditure as a percentage of GDP

The first indicator I will look into in relation to scientific output is Research and Development (R&D) expenditure. This expenditure covers the expenditure on research and development carried out by research and higher education institutions, business enterprises, university and government laboratories, as well as government and private non-profit organisations in a given country. The R&D indicator is measured in USD constant prices, as a percentage of GDP, and taking into consideration Purchasing Power Parities.[16] Despite the fact that general R&D expenditures do not reveal the exact funding rates or sources of the studies included in my data, I have included R&D as a variable in my analysis due to its direct economic relevance to research on a broader scale. The extent to which a country invests in research and development may be reflected on research output related aspects in relation to the "international" academia.

To examine this possibility, I have collected available data concerning countries' R&D expenditures from the timeframe of the article sample, that is, between the years 2018 and 2022. Data from the year 2022 has not been available for almost any country, and thus the R&D expenditure data presented by the map below covers the years 2018 – 2021. The R&D expenditure numbers used in my analysis are measured averages from this timeframe. Many countries have a slight rise in their research and development expenditure in the year 2020, which can perhaps be attributed to the COVID-19 pandemic and following need for research, but all in all, the numbers are rather stable across the years with no remarkable variation other than that.



Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

Unfortunately, there is a number of countries that do not have data available from this timeframe or, in some cases, not at all from any year. Hence, a noteworthy problem with mapping the R&D expenditures is the

[16] See for example: https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm

availability of data: despite my extensive search, there are many countries — especially African countries and small islands — that are left outside of my analysis due to the lack of data. Based on the data that can be found, however, there are some observations that can be made. As is demonstrated by the map above, there is some clear variance in the R&D expenditures on a global scale. The majority of the highest R&D expenditures are located in North America, in Northern and Western Europe, and in Eastern Asia: countries that stand out are Israel, South Korea, Japan, Sweden, US, Germany, and Austria. On the other hand, some of the lowest R&D expenditures can be found from Western and Central Asia, the Balkan region, and Central and Southern America. Iraq, Guatemala, Mongolia, The Gambia, Kyrgyzstan, and Tajikistan have particularly low numbers. It is worth pointing out that some of the observed differences are very large: certain countries may use up to five percent of their GDP to research and development, whereas others use less than zero point one percent. A correlation analysis may give an indication of whether there is any notable association between these expenditures and the number of case studies per country in my dataset.

Generating two correlation coefficients with the help of the SPSS software points that on a scale between 0 (no correlation) and 1 (strong correlation), there seems to be a moderate positive correlation between these variables. Based on (n) 97 observations, Kendall's tau coefficient (τ) takes the value of 0,366 and Spearman's rho coefficient (r_s) the value of 0,514. Both correlations are statistically significant ($p < 0.01$), as is shown by the table below. The results of the SPSS-calculation are shown in full in the table below.

Correlations

			articles per population	R&D expenditure
Kendall's tau_b	articles per population	Correlation Coefficient	1.000	.366**
		Sig. (1-tailed)	.	<,001
		N	97	97
	R&D expenditure	Correlation Coefficient	.366**	1.000
		Sig. (1-tailed)	<,001	.
		N	97	97
Spearman's rho	articles per population	Correlation Coefficient	1.000	.514**
		Sig. (1-tailed)	.	<,001
		N	97	97
	R&D expenditure	Correlation Coefficient	.514**	1.000
		Sig. (1-tailed)	<,001	.
		N	97	97

**. Correlation is significant at the 0.01 level (1-tailed).

There are some differences in the results from these two correlations, as the Kendall's correlation coefficient is slightly smaller than the Spearman's rho. However, the strength and direction of the measured correlations are still sufficiently similar to conclude that there is a positive correlation of a moderate strength.

Before moving on to the next variable, a brief remark about the statistical significance as well as about the interpretation of correlation coefficients is in order. First of all, the p-value, indicating statistical significance, addresses the probability of the observed results occurring in the sample due to randomness or by change: if the p-value is less than 0.01, as is the case in my analysis, the probability of observing said correlation when there is actually none is less than 0,1 %, and the result of the correlation analysis can be viewed as statistically significant (Schober *et al.* 2018: 1069). It is worth pointing out, however, that reporting statistical significance through p-values has been criticised due to large datasets nearly almost leading to statistically significant p-values and, therefore, extending the idea of significance by explaining practical real-life relevance is often a useful complementary step to measuring statistical significance (see for example Mohajeri *et al.* 2020: 526). I will proceed by reporting the p-values for each correlation coefficient, but I will also aim to address some of the further, real-world significance of the observed correlations.

Secondly, related to the significance of results, correlation coefficients have sometimes been criticised due to the lack of clear interpretation for them. Indeed, presenting correlation coefficients offers a relatively abstract numerical value that can be somewhat challenging to interpret. One suggested way to help with interpretation is to square the correlation coefficient to create a "coefficient of determination" (R^2) that can be conceptualised as the proportion of variance in one variable that is accounted for by the variance in the other variable (Lee Rodgers & Nicewander 1988: 62). Therefore, if the correlation coefficient is 0,366, the coefficient of determination is $R^2 = 0{,}366^2 = 0{,}134 = 13{,}4\%$ where around 13 % of the variability of scientific output in my data sample could be associated to the variance in R&D expenditure. However, while squaring a correlation coefficient offers perhaps a more clearly explainable interpretation for the proportion of shared variance between two variables, the coefficient of determination indicates the proportion of variance explained by a *linear* model (see for example Nakagawa *et al.* 2017: 1) and, hence, calculating a coefficient of determination when non-linear data is ranked in a non-parametric test, such as Spearman's or Kendall's, may be futile. Because of this, I will report the calculated correlations through their direction (positive or negative) and their strength (weak, moderate, strong) only.

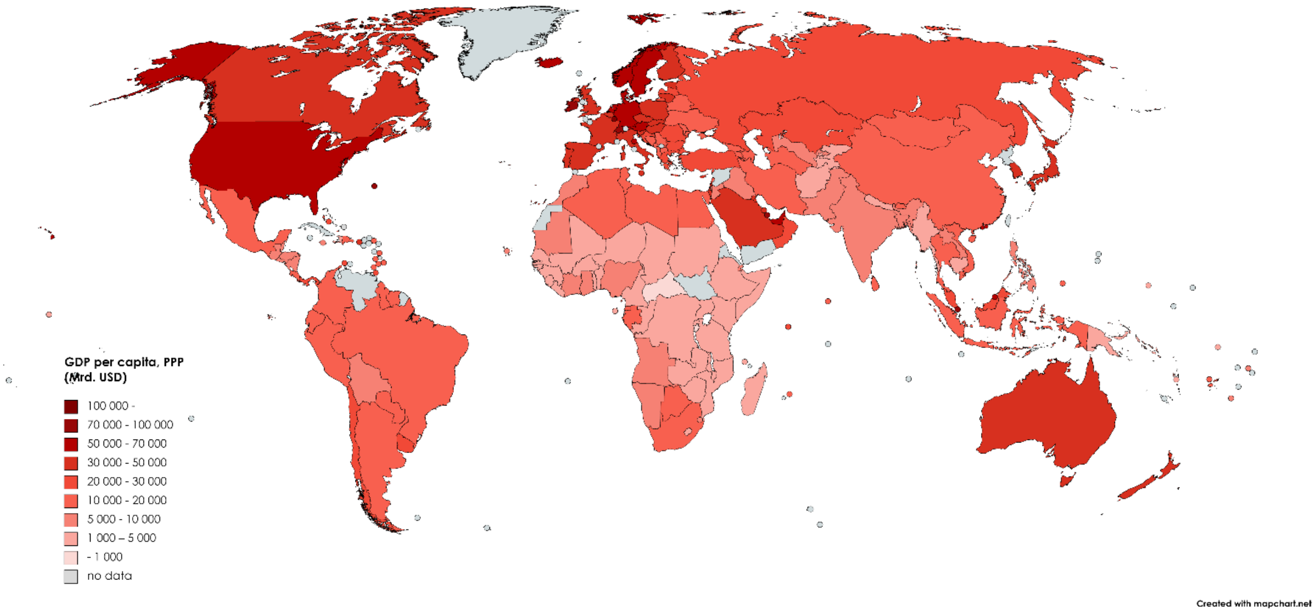
6.2.2 GDP per capita at purchasing power parity (PPP, Mrd. USD)

The second variable to be examined is Gross Domestic Product (GDP) per capita, based on purchasing power parity (PPP). I have chosen to include PPP as it takes into consideration the price level differences across countries.[17] Although GDP is by no means a comprehensive economic indicator, I have chosen it as one of the variables because it can give some general indication of the health of a country's economy. Naturally, it does not encompass the complexity of "wealth", and its capacity to give information about the economic situation of a given country should, consequently, be treated as limited only. If one assumes that a higher GDP may be a sign of a stronger economy, what follows is that it might translate into a bigger capacity to take part in "global" scientific output. According to Demeter (2020: 94), GDP per capita is the

[17] See for example: https://ec.europa.eu/eurostat/web/purchasing-power-parities

economic indicator that correlates the most with scientific output. Whether this is the case in my data sample will be shown below.

To put this to test, I collected available data about the GDP (PPP) levels of different countries from the years 2018 – 2021 and, as is the case with all chosen variables, the proportions presented by the map below are the averages from this timeframe. There is a handful of countries that have no data of GDP based on purchasing power parity from the 2018 – 2021 timeframe, but all in all the available data makes this the largest sample amongst all my variables.



Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

As the map above demonstrates, the highest GDP per capita levels can be found from Northern and Western Europe, Northern America, Middle East, and from some small countries in Southwestern Asia. Countries such as Luxembourg, Singapore, Ireland, Qatar, and Switzerland stand out with their high GDPs. The lowest GDP levels, on the other hand, are located nearly exclusively in Africa and in the small island developing states. Burundi, Central African Republic, Somalia, and Niger show some of the lowest numbers. As is the case with R&D expenditures, there are notable differences in GDP levels across the globe: the highest GDPs reach 100 000 mrd. USD, while the smallest are under 1 000 mrd. USD. Therefore, the differences that may potentially influence different countries' economic capacity to invest in scientific research are not by any means insignificant.

Despite these observations, the relationship between the number of case studies and the GDP per country only shows a weak positive correlation in my data sample: based on (n) 185 observations, Kendall's tau coefficient (τ) is 0,180 and Spearman's rho coefficient (r_s) is 0,255. Both correlations are statistically significant ($p < 0.01$).

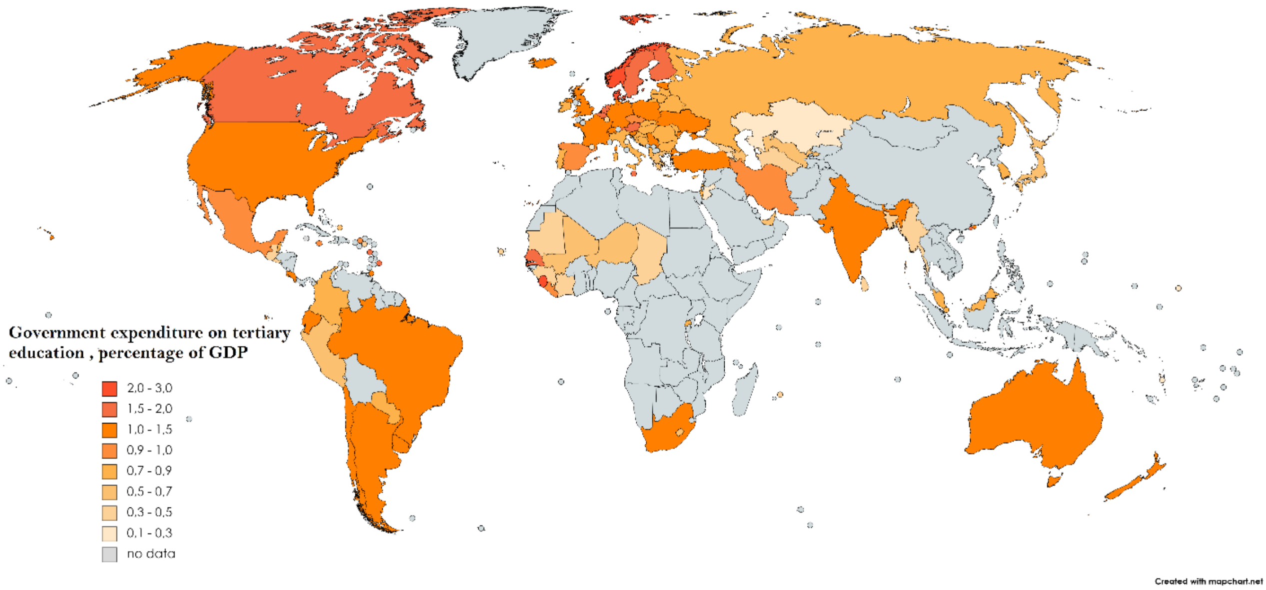
Correlations

			articles per population	GDP per capita
Kendall's tau_b	articles per population	Correlation Coefficient	1.000	.180**
		Sig. (1-tailed)	.	<,001
		N	185	185
	GDP per capita	Correlation Coefficient	.180**	1.000
		Sig. (1-tailed)	<,001	.
		N	185	185
Spearman's rho	articles per population	Correlation Coefficient	1.000	.255**
		Sig. (1-tailed)	.	<,001
		N	185	185
	GDP per capita	Correlation Coefficient	.255**	1.000
		Sig. (1-tailed)	<,001	.
		N	185	185

**. Correlation is significant at the 0.01 level (1-tailed).

6.2.3 Government expenditure on tertiary education as a percentage of GDP

The third chosen variable is the government expenditure on tertiary education, measured as a percentage of GDP. The reason why I look into tertiary education specifically is that the tertiary level is most closely linked to research in many countries, either because tertiary institutions are committed to research and partake in conducting it, or because they prepare students to conduct research in the future. This is not to say, of course, that scientific research conducted by higher education institutions would be limited to the tertiary level of education, only that tertiary education expenditure may be the most relevant educational expenditure in the context of my thesis.



Map created with MapChart.net, licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License]

To look into this relationship, available data about tertiary education expenditure has been collected from the timeframe 2018 – 2021. As is the case with R&D expenditure, much data is lacking from Africa and small islands, but also from Asia and Central (and South) America. The results of the correlation analysis might be more telling with more comprehensive data, and therefore the lack of data from many parts of the world is a clear limit to my analysis. There are, however, certain observations that can be made with the limited data available. Some of the highest tertiary education expenditure levels can be found, as is shown by the map above, from Northern and Western Europe, Northern America, but also from South America as well as from Southern and Western Africa. Countries such as Sierra Leone, Denmark, Norway, Austria, Belgium, and Canada stand out has having particularly high tertiary education expenditures in relation to their GDP. The lowest levels, in turn, are located in the Balkans, Central Asia, and small island developing states: for example in Andorra, Armenia, Kazakhstan, Marshall Islands, and Vanuatu. By looking at the three examined variables so far, it seems that the highest and lowest levels of R&D expenditures, tertiary expenditures, and GDPs are rather consistently located in the same areas: Northern America as well as Northern and Western Europe seem to have the highest numbers, while most parts of Africa and small island developing states have some of the lowest numbers in the available data (as well as the largest numbers of missing data).

The similarity between the variables can be extended to the correlations as well. As has been the case with the other variables, correlation analysis shows that the relationship between the number of case studies and governments' tertiary education expenditures shows a weak positive correlation. Kendall's tau coefficient (τ) takes the value of 0,262 and Spearman's rho coefficient (r_s) the value of 0,369, based on (n) 98 observations and with statistical significance ($p < 0.01$).

Correlations

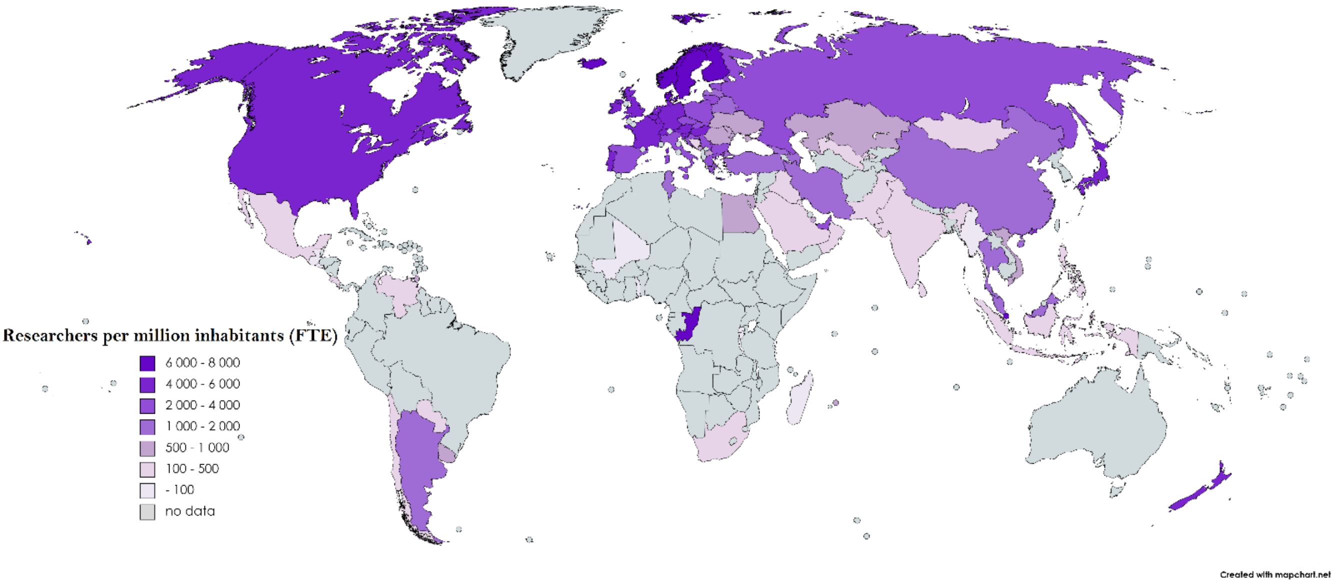
			articles per population	tertiary education expenditure
Kendall's tau_b	articles per population	Correlation Coefficient	1.000	.262**
		Sig. (1-tailed)	.	<,001
		N	98	98
	tertiary education expenditure	Correlation Coefficient	.262**	1.000
		Sig. (1-tailed)	<,001	.
		N	98	98
Spearman's rho	articles per population	Correlation Coefficient	1.000	.369**
		Sig. (1-tailed)	.	<,001
		N	98	98
	tertiary education expenditure	Correlation Coefficient	.369**	1.000
		Sig. (1-tailed)	<,001	.
		N	98	98

**. Correlation is significant at the 0.01 level (1-tailed).

6.2.4 Number of researchers per million inhabitants (FTE)

The fourth variable in my analysis is the number of researchers per million inhabitants (in full-time equivalent). The data for this variable has been collected from the years 2018 to 2020 due to the lack of data for the years 2021 and 2022. The lack of data is not only temporal, as there is a considerable lack of data also when it comes to the regions from which said data is collected. Data has been unavailable especially from

South America, Africa and the small islands and small island developing states, as the map below demonstrates. This variable has the least data available out of all variables.



Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

Still, as is the case with the other examined factors, certain observations can be drawn. Northern and Western Europe, Northern America, and some of Eastern Asia are among the most "researcher rich" areas. Countries such as Denmark, Finland, Singapore, Sweden, Iceland, Norway and, perhaps exceptionally, Republic of the Congo, stand out. On the other hand, the lowest numbers of researchers can be found from Central and South America, some of Africa, as well as from Southern and Western Asia: El Salvador, the Gambia, Guatemala, Madagascar, Mali, Rwanda, and Togo have the least researchers per million inhabitants.

While correlation from such a limited data sample needs to be looked at with certain cautiousness, the correlation between the number of case studies and the number of researchers per million inhabitants is the highest out of all measured correlations. A correlation analysis reveals a moderate, or even a relatively strong, positive correlation: based on (n) 90 observations, Kendall's tau coefficient (τ) is 0,455 and Spearman's rho coefficient (r_s) is 0,611. Both correlations are statistically significant ($p < 0.01$).

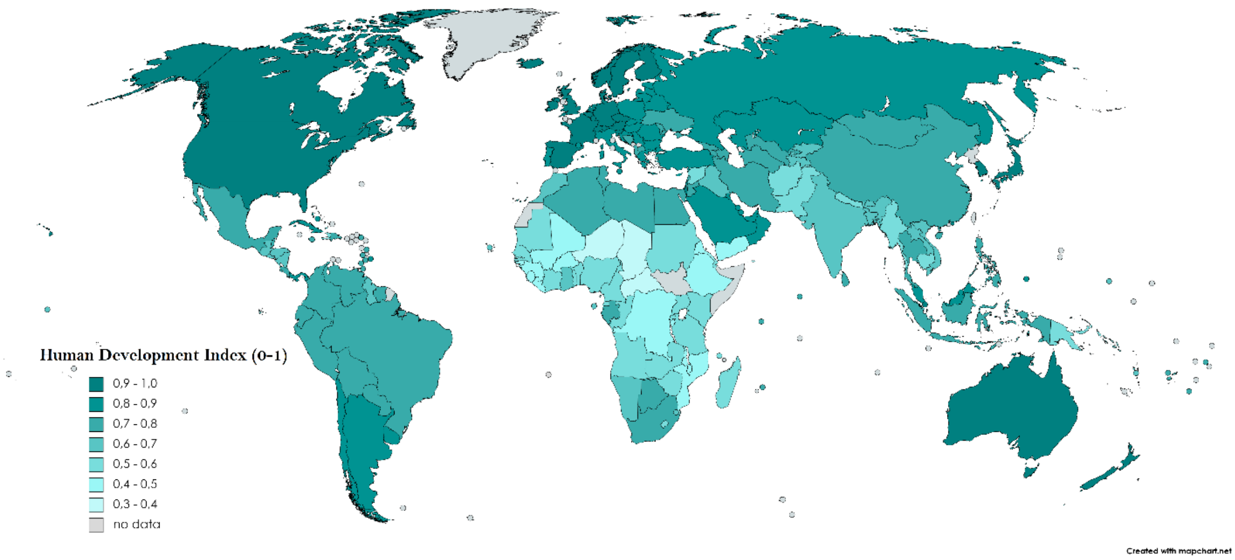
Correlations

			articles per population	researchers per million inhabitants
Kendall's tau_b	articles per population	Correlation Coefficient	1.000	.455**
		Sig. (1-tailed)	.	<,001
		N	90	90
	researchers per million inhabitants	Correlation Coefficient	.455**	1.000
		Sig. (1-tailed)	<,001	.
		N	90	90
Spearman's rho	articles per population	Correlation Coefficient	1.000	.611**
		Sig. (1-tailed)	.	<,001
		N	90	90
	researchers per million inhabitants	Correlation Coefficient	.611**	1.000
		Sig. (1-tailed)	<,001	.
		N	90	90

**. Correlation is significant at the 0.01 level (1-tailed).

6.2.5 Human Development Index

The fifth variable used in my correlation analysis is the Human Development Index, taking a value between 0 and 1. This index has been chosen to add an indicator that is not as economy oriented as most of the other indicators are. Human Development Index summarises the average achievement in three dimensions considered central for human development: health (measured by life expectancy at birth), education (measured by mean of years of schooling for adults and expected years of schooling for children), as well as standard of living (measured by gross national income per capita).[18] Much like is the case with GDP per capita, I do not expect this indicator to be an all-encompassing measure of human development, but it offers a superficial, overall glimpse into some developmental factors and suffices, therefore, for my analysis.



Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

The available Human Development Index -data of different countries has been collected from the years 2018 – 2020, and the proportions presented by the map above are visualised by the averages from this timeframe. Although there is a lack of data from the years 2021 and 2022, geographically speaking this variable has one of the highest coverages of data among my variables. Regarding the proportional distribution of data values, the Human Development Index -variable reinforces the pattern visible in the other variables: the biggest Human Development Index -values can be found from Northern, Western and Southern Europe, Northern America, Australia and New Zealand, as well as from some of Eastern Asia. Countries that demonstrate the highest numbers are Norway, Ireland, Switzerland, Hong Kong, Iceland, and Germany. At the same time, the lowest values are located nearly exclusively in Africa: Chad, Central African Republic, and Niger stand out as having the lowest Human Development Index- levels of all.

[18] See for example: https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

Moreover, the found correlation is similar by direction and by strength to other measured correlations: the relationship between the number of case studies and the Human Development Index values indicates a weak positive correlation between the two variables. Based on (n) 184 observations, Kendall's tau coefficient (τ) is 0,250 and Spearman's rho coefficient (r_s) is 0,362. Both correlations are statistically significant ($p < 0.01$).

Correlations

			articles per population	Human Development Index
Kendall's tau_b	articles per population	Correlation Coefficient	1.000	.250**
		Sig. (1-tailed)	.	<,001
		N	184	184
	Human Development Index	Correlation Coefficient	.250**	1.000
		Sig. (1-tailed)	<,001	.
		N	184	184
Spearman's rho	articles per population	Correlation Coefficient	1.000	.362**
		Sig. (1-tailed)	.	<,001
		N	184	184
	Human Development Index	Correlation Coefficient	.362**	1.000
		Sig. (1-tailed)	<,001	.
		N	184	184

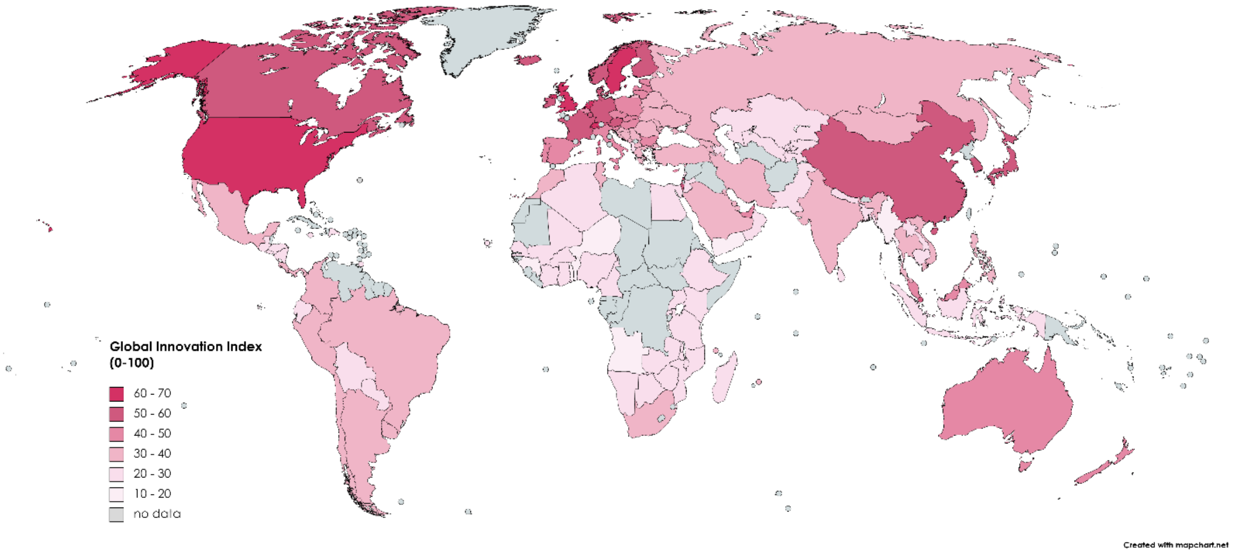
**. Correlation is significant at the 0.01 level (1-tailed).

6.2.6 Global Innovation Index

The sixth and final variable in my analysis is the Global Innovation Index, measured with a value between 1 and 100. This index aims to measure and rank economies' innovation by taking into consideration institutions, human capital and research, infrastructure, market sophistication, and business sophistication as a part of "Innovation Input Sub-Index", as well as knowledge and technology outputs and creative outputs as a part of "Innovation Output Sub-Index".[19] As is the case with other indexes, Global Innovation Index hardly covers, or brings out, all aspects of innovation, but it works in my study as a brief glimpse into differing innovation performances, by some measures, of different countries.

To look into the relationship between innovation and the number of articles in my dataset, I collected the available data about Global Innovation Index levels of different countries from the years 2018-2022, presented as averages from this timeframe on the map below. As is the case with most other variables, there is data missing form some countries, especially from Africa and from small islands. Nonetheless, I will present certain observations from the data I have.

[19] See for example: https://www.globalinnovationindex.org/about-gii#framework



Map created with MapChart.net, licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

Some of the highest Global Innovation Index -values are located in Northern America, Northern and Western Europe, and Eastern Asia. Netherlands, Sweden, Switzerland, the United Kingdom, and the US show the highest numbers in this regard. Some of the lowest values, in turn, can be found from Africa, the Middle East, and South-eastern Asia. Countries that stand out are, for example, Angola, Benin, Myanmar, Guinea, Niger, and Yemen. It seems that all the variables show a similar pattern of distribution in which Northern America, Northern and Western Europe, and Eastern Asia tend to show the highest values, whereas the lowest values are often located in Africa, in Western and Central Asia, as well as in the small island developing states. Moreover, the regions that are usually missing data are many African countries and most small islands. Somewhat similar trend can be seen in the distribution of case studies in my data sample, although there is variation when examining country-level numbers.

On par with the correlation between R&D expenditure and the number of articles, there is a moderate positive correlation between the number of case studies and the Global Innovation Index. Based on (n) 135 observations, Kendall's tau coefficient (τ) takes the value of 0,346 and Spearman's rho coefficient (r_s) the value of 0,490. Both of these correlation values are statistically significant ($p < 0.01$).

Correlations

			articles per population	Global Innovation Index
Kendall's tau_b	articles per population	Correlation Coefficient	1.000	.346**
		Sig. (1-tailed)	.	<,001
		N	135	135
	Global Innovation Index	Correlation Coefficient	.346**	1.000
		Sig. (1-tailed)	<,001	.
		N	135	135
Spearman's rho	articles per population	Correlation Coefficient	1.000	.490**
		Sig. (1-tailed)	.	<,001
		N	135	135
	Global Innovation Index	Correlation Coefficient	.490**	1.000
		Sig. (1-tailed)	<,001	.
		N	135	135

**. Correlation is significant at the 0.01 level (1-tailed).

It seems that all of the variables presented above show a positive, weak to moderate correlation with the number of case studies per country. What, then, can be concluded from this? Firstly, I want to acknowledge that my analysis is based on limited data, and too strong interpretations should be avoided. However, it seems clear that there is an association of some kind between the recurrence of case studies and certain economy, research, education, and development indicators. This association is positive by nature, and a positive correlation means that when the value of one variable increases or decreases, the value of another variable moves in the same direction. For example, if the R&D expenditure of a given country increases, an increase in case studies is likely to be observed as well. As pointed out before, this does not give information about causation, so the reason why case studies would increase in such a scenario are not necessarily *caused* by increased R&D spending. Of course, correlation does not mean that causation is ruled out, only that correlation coefficients are not the measure that can, or seeks to, prove cause-and-effect relationships.

The direction of a correlation is easier to interpret than its strength. None of the correlation coefficients in my study, considering both Kendall's tau and Spearman's rho, are particularly strong. What this tells is that while there seems to be a general trend of the values of two variables moving together in my dataset — often times the countries that have either a very small or a very high number of case studies show corresponding high or low values in the different indicators — there are always exceptions to this in the form of values that do not fall into such a pattern, undermining thus the observed trend. The strongest, and a relatively strong overall, observed correlation is between the number of case studies per country and the number of researchers, which makes sense considering that researchers — or if one wants to put it differently, the intellectual "labour force" of knowledge economy — are the most directly related factor to scientific research amongst my variables. People conducting research are an integral part of the academic infrastructure, and it is no surprise if their number would translate, to some extent, to the numbers of conducted research. Aside from researchers, R&D expenditures and the Global Innovation Index also show moderate correlations to the recurrence of case study locations. GDP per capita, tertiary education expenditures, and the Human Development Index, on the other hand, only demonstrate weak correlations.

When pondering on these differences in correlation coefficients, I want to point out, however, that the size of a correlation coefficient in my analysis is not an entirely fool-proof indicator of the actual relationships between the variables in real life. A small correlation coefficient generated from my limited data sample does not make the other variables any less important *per se*; they just demonstrate weaker correlations in my data. In the context of scientific knowledge production and research, factors such as GDP and higher education expenditure may well bear relevance for scientific research output or contextual choices in general, even if there is only a weak correlation between the variables in my dataset. Moreover, the differences in correlation strengths between the variables in my analysis are admittedly small, so no substantial interpretative differences can be presented about them.

Finally, a brief word about the significance of the conducted correlation analysis and the obtained correlation coefficients is in order. It is worth noticing that the strength of correlation describes the strength of association between two variables in a given dataset, but this strength is not automatically descriptive of the real-world relevance of analysed factors. It is plausible that the weaker correlations are indicative of a rather unsubstantial relationship between the variables. However, the analysis conducted in this thesis is not by any means enough to claim that the factors showing a weak association to the number of case studies would not be relevant for knowledge production as a whole. Moreover, results obtained in a different study with different data may show different correlations to my own: Demeter (2020: 94), for example, argues that GDP per capita is the economic indicator that correlates the most with scientific output (that in my data sample goes mostly hand in hand with case study locations). My analysis leads to a different result, which may be related to taking into consideration purchasing power parities or adjusting the variables to population, or simply down to my data. The chosen short temporal context may be relevant as well, and a longitudinal study might be better suited for this kind of analysis (see for example Vinkler 2008: 248-249). In any case, I want to acknowledge the need to be cautious not to draw too strong conclusions when addressing the broader phenomenon a given dataset is supposed to be descriptive of, such as scientific knowledge production.

Scientific research is a very complex phenomenon to explain, and there is a whole myriad of factors involved that are associated to each other to differing extents. There are likely many factors that are equally relevant to the variables chosen for my analysis, and a look into a broad range of factors certainly offers fruitful ground for further research. The overall conclusion that I can make based on my own data sample is that factors directly related to research, such as the number of researchers and research expenditures, likely have the strongest association to research locations (and, by extension, research output). A more general economic or developmental status of a country may bear less significance, especially outside of the extremes of the scale. However, as discussed in the theory chapter, economic resources likely have a role in knowledge production as a whole but they interact with other relevant factors.

7. Why do differences in the distribution of case studies matter?

In this final chapter, I aim to contemplate on the importance of distribution of regional focuses in climate change research. The starting point for this discussion is that varying levels of research interest towards, and activity in, different regions is not inconsequential: from visibility in the “international” academia to the very academic infrastructures that make scientific research possible, there is power in knowledge production that cannot, and should not, be ignored. It matters who conducts research, where, and on what terms. As mentioned in the beginning of this thesis, I view knowledge production as something that is socially oriented and intertwined with the society it stems from. Because of this, scientific research, like any form of knowledge production, not only reflects and maintains power but is also a form of power in itself.

This way of thinking about knowledge and power goes well together with Susan Strange's framework of structural power, which is why I have chosen said framework as a theoretical basis for my study. Assuming knowledge and knowledge-systems to be social by nature, and subject to political contestation, highlights the importance of agency: scientific research and the global knowledge system are not "natural" or "fixed", rather, they are partially rooted at shared expectations and paradigms, on the one hand, but constantly shaped by processes of negotiation and re-negotiation, on the other. It matters who can make legitimate knowledge claims, who defines what we seek to generate knowledge about — or how and where that happens — and who participates in conceptualizing possible futures. Therefore, the existing representation of, and research interest in, different spatial contexts are bound to human choices that, in turn, are influenced by varying social conditions. Knowledge production is thus inherently linked to social realities — shaping them and being shaped by them. From this point of view, knowledge always has some social significance.

As is clear by now, some of the significance of adaptation and mitigation related knowledge production, specifically, stems from their importance in responding to the effects of climate change. What we know about adaptation and mitigation, and what regions are being researched or involved in research, is hardly irrelevant. Because climate change affects all of humanity and all regions, adaptation and mitigation are an unavoidable part of coping with the future with climate change. Moreover, as both the vulnerability to climate change and the capacity to respond to it differ significantly between and within different regions, the extent to which these different regions are being studied becomes all the more important. Research conducted in one area is not necessarily perfectly applicable, if at all, to another area. Indeed, as Felt *et al.* (2017: 1078) point out, scientific knowledge about global environmental issues is inherently tied to the places and histories — as well as to the social and political meanings — from which said knowledge stems from. Climate change related challenges and solutions have different focuses in different spatial contexts and, ideally, adaptation and mitigation related research would cover as much of them as possible. This would help to prevent the homogenisation of those adaptation and mitigation needs and solutions that have relevant geography-bound differences.

In addition, inclusive knowledge production that encompasses many different kinds of actors and contexts — including but not limited to states — is important in itself; symbolically, politically, and socially. As is argued by Felt *et al.* (2017: 1077-1078), knowledge about environmental issues is inherently political by nature: contestations over the different framings of climate change reveal underlying social influences on our knowledge, and understanding these influences improves both our understanding of complex, global environmental issues as well as the likelihood of creating successful responses to them. Considering the importance of adaptation and mitigation, and considering that climate change is a phenomenon that is truly "global" in every sense of the word, significant asymmetries in knowledge production, in creation and in implementation of policies, and in generating collective actions, create a basis for inequality, as well as strengthen existing inequalities, in the international system. Therefore, contestations over different framings of climate change knowledge and action always reflect, at least to some extent, political and social realities within which actors are not automatically on an equal footing: agencies differ, and are contested.

Further, the significance of adaptation and mitigation knowledge is related to the importance of knowledge as a social and economic “resource”. In the theoretical section it was pointed out, after Strange, that power can be seen as passing increasingly from the “capital-rich” to the “information-rich”, and perhaps one can say that legitimated information, or knowledge, is an important resource that allows a society to thrive socially and economically. From this point of view, knowledge is an asset in the face of climate change: it may influence governance and policies, investments, innovations and technology, research and education, and so on. Beyond *being* a “resource”, scientific knowledge also *requires* resources, which is one of the aspects contributing to asymmetries and inequalities in the global knowledge system. Establishing a functioning academic infrastructure that makes it possible to conduct research, educate students and mobilise researchers, as well as to build and fund research institutes, requires not only credit and other resources, but also “labour force” and its own kind of governance. Moreover, it is worth pointing out that due to the fact that such an infrastructure needs resources to exist, let alone flourish, it may be prone to influences through such resources. For example, expectations conveyed through the funding system and the access it gives to different social groups can be a noteworthy influence (Jasanoff 2001: 534). It is thus feasible that funding, as well as other resource-related aspects of scientific knowledge production, can have an effect on what research is conducted and where.

What is more, on the topic of influence, if one aims to take part in the competitive “global” academia, let alone gain foothold and visibility in it, there is often all the more demand for the infrastructure and needed resources. Those that do not have the means to establish such infrastructures or meet the demands of the competitive global knowledge system, miss agency in the “knowledge based economy” that power is so closely intertwined with. It would seem, therefore, that knowledge requiring economic resources and knowledge being a resource linked to economy are interrelated: knowledge production, especially a “global” kind, requires resources — being “capital-rich”, in other words, as Strange puts it — but on the other hand, economic success and competitiveness is increasingly seen as requiring knowledge power. Although the correlation analysis in this thesis did not demonstrate particularly strong correlations between the measured economic factors and the distribution of case studies, it is still feasible that economic power and knowledge power are interrelated in the very structures of the social reality in which they evolve. Because of this, the extent to which actors and contexts alike are presented can be a direct reflection of structural power tied to knowledge and economy, and the interplay between the two.

Another reason why regional representation matters, is related to the relationship between scientific research and public policy. Voß & Freeman (2015:25), among others, point out that “knowing governance” — “simplified and partial version of political reality” — takes shape as collectively established knowledge and influences, therefore, the political reality as well as the possibilities of (political) action. Presumably, scientific knowledge reflects and is reflected by political reality and, by extension, is linked to agency. Adaptation and mitigation research, specifically, often has a practical orientation which creates a link between such research and governance and policies. How effective scientific knowledge truly is in compelling public policy is, of course, to be debated. Despite its importance, adaptation and mitigation research does not necessarily offer concrete solutions that can be implemented as is through policies: they certainly raise the importance of action in a given context, but that does not always lead to answers as to what exactly the action should be. Therefore, a certain ambiguity can be a hindrance to policymaking in the context of climate change.

Moreover, scientific research is not the only driving force behind policy and governance. Hart & Victor (1993: 667-668; in Grundmann & Stehr 2012: 123) highlight the importance of "elite entrepreneurship" and the "windows opened by the environmental movement" in shaping both policy and science. It may well be that scientific evidence in itself is not always enough, but an interplay of a whole myriad of actors and influences is needed. However, although scientific research and academic discussions do not automatically reach key decision makers and wider public in a way that would make a difference, the possibility for knowledge to translate into action should not be discarded. A pact between scientific research and policymaking in the context of climate change is not unusual: organisations and bodies like Intergovernmental Panel on Climate Change (IPCC) are a good example of bringing science and policymaking together. IPCC, for example, aims to offer policymakers regular and up to date scientific assessments related climate change. In this way, scientific research may take part in international climate change negotiations and decision-making regarding adaptation and mitigation policies.

Aside from direct impact on policymaking that scientific research may have, there is a more subtle, yet profound, impact knowledge production can have. Related to the point of knowledge production and the social reality being mutually constitutive, paradigms, or paradigmatic ways of thinking, are powerful in shaping the very foundations of what we think we can know, how, and by whom. The social patterns influenced by paradigms, and influencing them, determine what is considered to be legitimate knowledge and what are legitimate standards for scientific research, as well as who can determine legitimacy in this context. This has a direct influence on who can produce such legitimate knowledge — let alone "international" scientific knowledge applicable to the "whole world" — and, by extension, where such research takes place. These patterns and paradigms may influence the efforts to be inclusive and even the extent to which inclusivity matters to different actors in the first place: if certain kinds of knowledge, or certain actors and contexts, are seen as less legitimate, there may be much less interest to include them into "international" science. The problem is, then, that a hierarchy of knowledge that legitimises or delegitimises actors, contexts, or ways of knowing always leads to differing levels of inclusion and visibility: such a hierarchy dictates a continuum of "more" or "less" legitimacy, and this has practical consequences. As mentioned before, having less visibility in the "international" academia, and not being among those who establish the international scientific agenda, may have a direct effect on whose issues from which contexts gain prevalence (see San Martín 2021: 425). A central position in a knowledge network, therefore, is directly related to power and visibility, both of which have social consequences.

This is related to one of the core messages of this study: it can be easy to get used to an abundance of research from or about certain places and a lack of research from or about others. However, not questioning such an asymmetry is problematic, and, consequently, this thesis aims to highlight the importance of paying attention to matters of representation in scientific research (and knowledge production in general). Making a conscious effort to ask questions about representation, agency, and contexts breaks the habit of accepting existing paradigms and power-positions as "natural" without further consideration to the structural conditions from which they arise — and which they reinforce, in turn. In the context of scientific research, paying attention to different spatio-social framings, and not taking them as a given, helps to unravel underlying patterns in research: which problems and solutions are made accessible, and through which locations. As mentioned earlier, these patterns and framings have social and political consequences, being inherently tied to structures and structural power. Although visibility in research would not automatically lead to equal visibility in governance, there is a wider trend of legitimacy that is worth considering. What and who we are used to seeing in scientific research both shapes and is shaped by the social reality in which said research takes place, including attitudes and patterns of choice that actors form. From the point of view of structural power, after Strange's framework, the matter of legitimacy can be viewed as a reflection of structural power: it leads not only to the power to "set the agenda of discussion or to design - - the international regimes of rules and customs", but also to the power to shape the very frameworks in which actors work and relate to each other (Strange 2015: 27).

For this reason, representation cannot be separated from power in the structures of global knowledge systems. As was mentioned in the theory chapter, power disparities in international scientific research, as well as the knowledge divide created by said disparities, cannot be changed with just more research (San Martín 2021: 425-426). Instead, one must go deeper into the processes of knowledge production and address the legitimisation and integration of different actors, contexts, and paradigms. This applies to environmental research as well: as Harding (2011: 200) points out, combining specialist knowledge from many languages and from many socio-spatial locations, as well as reversing the "one-way flow of knowledge dominating the world's education system", may very well be key to finding solutions to the many environmental challenges the world as a whole is facing and will face in the future. It is, therefore, worth paying attention to regional representations in climate change research, as well as to their potential deeper socio-political connections and paradigmatic patterns reflecting and contributing to structural power in the global knowledge system.

8. Conclusion

This thesis has taken a look at scientific knowledge production about adaptation and mitigation in the context of climate change. The aim of my study has been to map the geographical distribution of such research, as well as to determine whether certain economy, education, research, and development related factors can be associated to differing research activity in, and interest towards, different regions of the world. As a starting point for this endeavour, there have been two central underlying assumptions behind my study. First, any form of knowledge production, such as scientific research, is inherently social by nature; it is created, negotiated, and circulated through social processes. In my approach, knowledge production is intertwined in societal structures and, by extension, reflects and maintains power and social realities. Therefore, knowledge production cannot be fully understood or analysed without consideration to agency and power. As mentioned in the beginning of this thesis, regional representation in research is not coincidental, but is born out of conscious choices that reflect the social conditions they stem from. Different spatio-social framings in research about global phenomena shapes, and is shaped by, the social reality in which knowledge production takes place. One of the ways in which this manifests itself is through the patters of research that determine the legitimacy of inquiry, including which problems and solutions are prioritised or made accessible, and through which contexts and locations. Second, social relations and human agency— both central to knowledge production — are always spatially constituted and organised. In the same vein, resources needed for, or obtained by, them are also inherently tied to geographical contexts. Spatiality, thus, is to a great extent linked to social reality, and spatial contexts should not be excluded when studying social phenomena.

Based on these considerations, three elements can be highlighted: the social organisation of knowledge, spatial or geographical contexts, and resources. Said elements form the cornerstones of the theoretical discussion, as well as the wider analytical approach, of this study. Indeed, due to the importance, and presumed interrelatedness, of social nature of knowledge production, spatiality, and resources, the theoretical section leans on an IPE approach to knowledge and power, discussing Susan Strange's structural power framework. As an addition to this, my thesis deepens the aforementioned approach with a critical discussion about knowledge power and the global knowledge economy, all the while paying special attention to the matter of inequalities and asymmetries of "global" knowledge production. Some of the main ideas presented in the theory section highlight that structural power — that is, the power to shape the very structures within which actors operate — is key to knowledge production and other similar processes in the global political economy: regarding scientific research, structural power may manifest itself through how, where, and by whom legitimate research is conducted, and what is considered to be legitimate research in the first place. Moreover, the importance of structural power in the context of "global" knowledge production becomes all the more clear as the competition between states takes place more and more in the knowledge structure. At the same time, the knowledge structure has a clear economic dimension: knowledge creation can be seen as key in economic success and as a form of national investment that has strategic importance.

However, such knowledge production implies both structural advantages and disadvantages. Regarding the latter, it is notable that production and circulation of organised "global" knowledge is marked by inequalities and asymmetries. Part of these asymmetries is related to the pressure of academic and economic requirements of modern science: there is a need for infrastructures to participate in the global knowledge structure, as well as for funding, investments, and trained people. There are disparities in access to these factors, which brings forth questions about legitimacy, research priorities, and agency. Importantly, structural advantages and disadvantages, as well as factors contributing to asymmetries and disparities in "global" knowledge production are spatially organised; or at the very least, they have spatial manifestations. Therefore, examining regional representations in the form of spatial distribution of case studies is relevant in the context of scientific knowledge production, especially when knowledge is produced about a phenomenon that is considered to be truly global by nature.

Such an examination of regional representations in adaptation and mitigation related climate change research was organised through two sections of analysis: one looking into the geographical distribution of case studies, and the other examining the existence and strength of possible correlations between the recurrence of case study locations and certain economy, research, education, and development related indicators — Research and Development expenditure (as a percentage of GDP), GDP per capita (PPP), government expenditure on tertiary education (as a percentage of GDP), the number of researchers per million people, Human Development Index, and Global Innovation Index. These were chosen as variables for the correlation analysis due to their presumed relevance to scientific knowledge production and to the economy that fuels it. The data that was analysed in my study comprised 10 000 scientific articles about climate adaptation and mitigation, published between the years 2018 and 2022 and collected from *Scopus* -database. Out of this sample, 6 844 articles could be classified as case studies and they formed, therefore, the final dataset. All in all, these articles included 7 826 regional cases.

Moving on to the analysis, the first research question aimed to investigate which regions have been studied, and to what extent, in my sample of articles. This question was approached in the first section of the analysis that maps the proportions and distribution of case studies by continental or other geographical regions, by countries, and by two economy and development categories. The second research question inquired whether the observed distribution of case studies (or, more specifically, the prevalence of case study locations) correlates with the chosen indicators. This question was examined in the second section of the analysis by conducting Kendall's tau and Spearman's rho correlation analysis. A third and final question — not a research question but a brief contemplation following the analysis — reflected on the importance of differences in the distribution of case studies in climate change research. By addressing why differing levels of research activity in, and interest towards, different geographical regions matter, I also offered some further justification for choosing to examine this topic in my own study.

Regarding the observations drawn from my analysis, based on the questions presented above, certain patterns are clearly visible. First of all, there is clear variation in the spatial distribution of case study locations; some countries and regions are much more studied than others. There are “clusters” that stand out either due to the large number or the small (or even non-existent) number of case studies conducted in them. In the original dataset, some of the most populous countries from all continents dominate the map that I have used to illustrate the proportions of case study locations. Therefore, when looking at raw data, that is, the original numbers of case studies, population sizes clearly affect the image one can build of regional representation. When the number of case studies per country has been population-adjusted, the “clusters” shift: in this version of the data, the highest proportions of case studies can be found from Oceania, Northern Europe (especially from the Nordic countries), Northern America, as well as from Southern Africa. Using a population-adjusted perspective does not, however, fully erase size-effects when comparing countries that have a very similar number of case studies. Moreover, it is worth pointing out that many of the countries with significantly small populations stand out even with a single article due to their low population sizes. Nonetheless, the important overall conclusion that can be made — and, I believe, generalised to other datasets — is that case study locations are not evenly distributed. There is some major variance in the recurrence of country-level research contexts, and the first section of the analysis demonstrates very differing proportions of regional representation across the globe.

Secondly, the correlation analysis shows a positive association between the recurrence of case studies and all of the chosen economy, research, education, and development related indicators. However, as these correlations are only weak to moderate by strength, conclusions about substantial relationships between the variables should be approached with caution. It is justified, nonetheless, to deduce that the recurrence of case studies can be associated to the examined variables, in at least some cases even to a point where their relationship likely has real-world significance. The strongest correlation could be found between the number of case studies and the number of researchers, but R&D expenditures and the Global Innovation Index demonstrated moderate correlations to the recurrence of case study locations as well. GDP per capita (PPP), tertiary education expenditures, and the Human Development Index only showed weak correlations. Based on my correlation analysis, the aforementioned factors seem to have rather unsubstantial relationships with the number of case studies. It is worth pointing out, however, that a small correlation coefficient does not necessarily imply a relationship between two factors that is non-significant by scale or by nature in real life. As pointed out before, the size of correlation coefficient is not an all-encompassing indicator of the practical relevance of relationships between variables, nor is it inherently descriptive of the importance of factors; certainly not in my analysis that only demonstrates modest correlations with relatively small differences between each variable pair. The information that the size of a correlation coefficient gives, simply, is the strength of association between two variables in a given dataset. The real-world significance of association always requires further, context-specific thought.

In any case, when it comes to explaining the observed differences in the distribution of case study locations, there are certainly many possible factors, many of them intertwined. Based on both the theoretical and the analytical considerations in this study, economic factors most likely have some bearing in knowledge production and in building required infrastructures to take part in a global scientific knowledge system, despite the rather modest correlations in my analysis. Moreover, in addition to my chosen indicators, factors that are not directly related to research, education, or resources are worth contemplating when examining scientific knowledge production. A whole myriad of societal and social factors may be important as well in explaining some of the differences in my data sample. For example, lack of security due to an armed conflict or high levels of violence, political and social instability, lack of freedom of speech and expression, or a poor state of democracy may influence, directly or indirectly, the capacity to produce knowledge, let alone scientific knowledge that is able to reach the competitive global arena. Indeed, there are likely many other factors that are associated to the spatial distribution of case study locations not covered by my analysis. Although I cannot make conclusions about causality based on a correlation analysis, I believe that the interplay of many different factors, such as some of those mentioned above, would offer the most comprehensive explanation to the observed variance in the recurrence of case study locations.

Another element that might be relevant in explaining observed differences in regional representations is related to the differing levels of prioritisation of adaptation and mitigation, or of climate change more broadly. While climate change is a topic that bears relevance to the whole globe, and knowledge of it will be produced in one way or another likely everywhere, there may be more urgent or topical subjects of research for given times and contexts. Despite its importance, climate change adaptation and mitigation may not be the most pressing research topic in every country, society, or academic community, and this may perhaps explain, to a small extent, some of the differences in the distribution of case studies shown in my analysis. This is not to say that not prioritising climate change research would automatically mean not acknowledging the threat posed by climate change, but that there are other pressing issues and phenomena to study with the resources that are available. Being able to produce and to publish a large volume of research in the first place, as well as being able to prioritise research topics that are not necessarily immediate or exclusive to one’s own society, may rise from a certain place of privilege.

Moreover, regarding “global” knowledge production more in general, a further remark on the assumed target audience of the research I have examined is in order. Related to the language and format of knowledge, as discussed before, it is worth pointing out that producing scientific knowledge that is considered “international” by nature — especially when research is published in a language other than one’s first language, or in a language that is not a widely used language in one’s own society — the primary intended audience is hardly the local authorities, policy makers, and actors; rather, it is more likely that this kind of scientific knowledge is for the “international” academia. The aim, then, would be to participate in the “global” knowledge production, perhaps to gain international visibility and legitimacy. If the aim is, on the other hand, to partake in or to initiate a local discussion about adaptation and mitigation, said discussion may well take place in a language different than English. It may also happen on a different format or platform to academia and typical peer-reviewed articles. Therefore, a look into scientific articles published in English is not going to be enough on its own to build a truly comprehensive image of regional distribution of research.

Finally, a few words about possible future research. This study is unavoidably limited by scope and, consequently, only intended to give a brief glimpse into regional representation in adaptation and mitigation related research. If one would want to deepen the analysis of this thesis, there are several elements to consider. First of all, for reasons explained earlier, adding data in different languages would build a more comprehensive image of conducted research and would allow a comparison between different publication languages. It would certainly be interesting to see how the distribution of case studies changes when the focus is no longer solely on English. Secondly, the format of data could be broadened or changed. Instead of relying on scientific articles published in an international database, other kinds of documents, such as working and policy papers, could be included into the analysis. In the same vein, the data could come for example from grassroots organisations and people instead of academia. Third, research about scientific knowledge production does not have to be limited to climate change or "hard sciences"; other topics and fields, such as the field of social sciences, would surely benefit from studies about existing research. Fourth, the relationship between research locations and institutional affiliations could be investigated more thoroughly and across different fields. This gives rise to interesting discussions about possible influencing factors, such as funding. Lastly, if correlations are examined, choosing different variables could give new insight into knowledge production. All in all, there is much fruitful ground for further research, and such research can be recommended considering that studying existing research is important in creating and maintaining awareness about patterns in scientific knowledge production, as well as their possible socio-political consequences and power-dimensions.

Bibliography

Aggarwal, R. & Ranganathan, P. (2016). "Common pitfalls in statistical analysis: The use of correlation techniques". *Perspectives in clinical research*. 7 (4), 187–190.

Agnew, J. A. (2015). *The Wiley Blackwell companion to political geography*. Second edition. John A. Agnew (ed.). Chichester, England: Wiley Blackwell.

Allen, M.R., O.P. Dube, W. Solecki, F. Aragón-Durand, W. Cramer, S. Humphreys, M. Kainuma, J. Kala, N. Mahowald, Y. Mulugetta, R. Perez, M. Wairiu, and K. Zickfeld. (2018). "Framing and Context". In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M.

Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 49-92.

Altbach, P. G. (2013). "Advancing the national and global knowledge economy: the role of research universities in developing countries". *Studies in higher education (Dorchester-on-Thames)*. 38 (3), 316–330.

Altbach, Philip G. (1987). *The knowledge context: Comparative perspectives on the distribution of knowledge*. Albany: State University of New York Press.

Amelina, A. & Nergiz, D. D. & Faist, T. & Glick Schiller, N. (2012). *Beyond Methodological Nationalism: Research Methodologies for Cross-Border Studies*. Vol. 24. London: Routledge.

Ataie-Ashtiani, B. (2017). "Chinese and Iranian Scientific Publications: Fast Growth and Poor Ethics". *Science and Engineering Ethics*. 23, 317–319.

Beck, U. (2007). "The Cosmopolitan Condition: Why Methodological Nationalism Fails". *Theory, culture & society*. 24 (7-8), 286–290.

Below, K. C. & Herweg, S. & Knoblich, R. & Unverzagt, K. (2014). "Hidden in Plain View: Exploring the Knowledge Power of States", in *The Global Politics of Science and Technology - Vol. 2*. Berlin, Heidelberg: Springer Berlin Heidelberg. pp. 117–141.

"Climate Change 'Biggest Threat Modern Humans Have Ever Faced', World-Renowned Naturalist Tells Security Council, Calls for Greater Global Cooperation". *Security Council Press Release*. UN document, SC/14445. (2021).

Cox, K.R. (1991). "Redefining 'territory'". *Political Geography Quarterly*. 10(1): 5– 7.

Connell, R. & Pearse, R. & Collyer, F. & Maia, J. & Morrell, R. (2018a). "Re-making the global economy of knowledge: do new fields of research change the structure of North–South relations?". *The British journal of sociology*. 69 (3), 738–757.

Connell, R. & Pearse, R. & Collyer, F. & Maia, J. & Morrell, R. (2018b). "Negotiating with the North: How Southern-tier intellectual workers deal with the global economy of knowledge". *The Sociological review (Keele)*. 66 (1), 41–57.

Croux, C. & Dehon, C. (2010). "Influence functions of the Spearman and Kendall correlation measures". *Statistical methods & applications*. 19 (4), 497–515.

David, M. & Meersohn Schmidt, C. (2019). "Power and Counter-Power: Knowledge Structure and the Limits of Control". *Sociological research online*. 24 (1), 21–37.

Demeter, M. (2020). *Academic Knowledge Production and the Global South*. Palgrave Macmillan.

Durand, C. & Milberg, W. (2019). "Intellectual Monopoly in Global Value Chains." *Review of International Political Economy*. 27 (2): 404–429.

El-Hashash, E. F. & Shiekh, R. H. A. (2022). "A Comparison of the Pearson, Spearman Rank and Kendall Tau Correlation Coefficients Using Quantitative Variables". *Asian Journal of Probability and Statistics*. 36–48.

Fasenfest, D. (2010). “A Political Economy of Knowledge Production”. *Critical sociology*. 36 (4), 483–487.

Felt, U. *et al.* (2017). *The handbook of science and technology studies*. Fourth edition. Cambridge, Massachusetts: The MIT Press.

Grundmann, R. & Stehr, N. (2012). *The power of scientific knowledge: from research to public policy*. Cambridge: Cambridge University Press.

Guzzini, S. (1993). “Structural power: The limits of neorealist analysis”. *International Organization*, 47 (3), 443– 478.

Haggart, B. (2019). “Taking Knowledge Seriously: Towards an International Political Economy Theory of Knowledge Governance”, in *Information, Technology and Control in a Changing World*. Cham: Springer International Publishing. pp. 25–51.

Harding, S. G. (2011). *The postcolonial science and technology studies reader*. Durham [N.C: Duke University Press].

Hart, D. M. & Victor, D. G. (1993). “Scientific Elites and the Making of US Policy for Climate Change Research, 1957-74”. *Social Studies of Science,* 23(4): 643-680.

Hauke, J. & Kossowski, T. (2011). “Comparison of Values of Pearson’s and Spearman’s Correlation Coefficients on the Same Sets of Data”. *Quaestiones geographicae*. 30 (2), 87–93.

Hveem, H. & Iapadre, L. (2011). *The global governance of knowledge creation and diffusion*. Abingdon, Oxon: Routledge.

IPCC, 2022: *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA.

IPCC, 2021: *Climate Change 2021: The Physical Science Basis*. *Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jasanoff, S. (2001). *Handbook of science and technology studies*. Rev. ed. Thousand Oaks, Calif.; SAGE.

Jones Parry, E. (n.d.). “The Greatest Threat To Global Security: Climate Change Is Not Merely An Environmental Problem”. *UN Chronicle*. https://www.un.org/en/chronicle/article/greatest-threat-global-security-climate-change-not-merely-environmental-problem (read 13/6/2022)

Karlsson, S. & Srebotnjak, T. & Gonzales, P. (2007). “Understanding the North–South knowledge divide and its implications for policy: a quantitative analysis of the generation of scientific knowledge in the environmental sciences”. *Environmental science & policy*. 10 (7), 668–684.

Kendall, M.G. (1948). *Rank correlation methods*. 4th ed. Griffin, London.

Knapp, H. (2017). *Introductory statistics using SPSS*. 2nd edition. Los Angeles, CA: SAGE Publications, Inc.

Lee Rodgers, J. & Nicewander, W. A. (1988). "Thirteen Ways to Look at the Correlation Coefficient". *The American statistician*. 42 (1), 59–66.

Marden, J. I. (2004). "Positions and QQ Plots". *Statistical science*. 19 (4), 606–614.

May, C. (1996). "Strange fruit: Susan Strange's theory of structural power in international political economy". *Global Studies*. 10(2): 167–189.

McKeever, A. (2021, September 9). "Why climate change is still the greatest threat to human health". *National Geographic*. https://www.nationalgeographic.com/science/article/why-climate-change-is-still-the-greatest-threat-to-human-health (read 13/6/2022)

Mohajeri, K. & Mesgari, M. & Lee, A. S. (2020). "When Statistical Significance Is Not Enough: Investigating Relevance, Practical Significance, and Statistical Significance". *MIS Quarterly*, 44(2), 525–559.

Nakagawa S. & Johnson, P.C.D. & Schielzeth, H. (2017). "The coefficient of determination R^2 and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded". *J. R. Soc. Interface* 14: 20170213.

Nathan, D. (2021). "Knowledge and Inequality: An Exploration". *Institute for Human Development*; IHD Working paper series.

Paasi, A. (2003). "Territory". In Agnew, J., Mitchell, K., & Toal, G. (eds). *A Companion to Political Geography*. Oxford: Blackwell, 109– 122.

Painter, J. & Jeffrey, A. S. (2009). *Political geography: an introduction to space and power*. Los Angeles: SAGE.

Piketty, T. (2013). *Capital in the Twenty-First Century*. Cambridge, MA: Harvard University Press.

Pustovitovskij, A. & Kremer, J.-F. (2012). "Towards a New Understanding of Structural Power: 'Structure Is What States Make of It'", in *Power in the 21st Century*. Berlin, Heidelberg: Springer Berlin Heidelberg. pp. 59–78.

Reid, H. M. (2014). *Introduction to statistics: fundamental concepts and procedures of data analysis*. Los Angeles, CA: SAGE Publications, Inc.

Renn, J. (2020). *The Evolution of Knowledge: Rethinking Science for the Anthropocene*. New Haven, CT: Princeton University Press.

San Martín, W. (2021). "Unequal Knowledge: Justice, Colonialism, and Expertise in Global Environmental Research". *Global environment*. 14 (2), 423–430.

Sarikaya, A. & Gleicher, M. (2018). "Scatterplots: Tasks, Data, and Designs". *IEEE transactions on visualization and computer graphics*. 24 (1), 402–412.

Schober, P. & Bossers, S. M. & Schwarte, L. A. (2018). "Statistical Significance Versus Clinical Importance of Observed Effect Sizes: What Do P Values and Confidence Intervals Really Represent?" *Anesthesia and analgesia*. 126 (3), 1068–1072.

Scholes, R. & Engelbrecht, F. (2021). "Climate impacts in southern Africa during the 21st Century". Report for the *Centre for Environmental Rights*. https://cer.org.za/wp-content/uploads/2021/09/Climate-impacts-in-South-Africa_Final_September_2021.FINAL_.pdf

Smith, L.T. (2012). *Decolonizing Methodologies: Research and Indigenous Peoples*. London: Zed Books.

Soldatenko, G. (2015). "A contribution toward the decolonization of philosophy: Asserting the coloniality of power in the study of non-western philosophical traditions". *Comparative and Continental Philosophy*, 7(2), 138–156.

Strange, S. (2015) [1988]. *States and Markets*. London: Bloomsbury Publishing Plc.

Strange, S. (1989). "Towards a theory of transnational empire". In E.-O. Czempiel & J. N. Rosenau (Eds.). *Global changes and theoretical challenge*. Lexington: Lexington Books.

Strange, S. (1996). *The retreat of the state: The diffusion of power in the world economy*. Cambridge: Cambridge University Press.

Tyson, L. & Spence, M. (2017). "Exploring the Effects of Technology on Income and Wealth Inequality." In *After Piketty: The Agenda for Economics and Inequality*, edited by Heather Boushey, J. Bradford Delong, and Marshall Steinbaum. Cambridge, MA: Harvard University Press.

Vinkler, P. (2008). "Correlation between the structure of scientific research, scientometric indicators and GDP in EU and non-EU countries". *Scientometrics*. 74 (2), 237–254.

Voß, J.-P. & Freeman, R. (2015). *Knowing Governance: The Epistemic Construction of Political Order*. London: Palgrave Macmillan UK.

Walker, M. & Martinez-Vargas, C. (2022). "Epistemic governance and the colonial epistemic structure: towards epistemic humility and transformed South-North relations". *Critical studies in education*. 63 (5), 556–571.

Weber, M. (1947). *The theory of social and economic organization*. New York: The Free Press.

Wilsford, D. (1994). "Path dependency, or why history makes it difficult but not impossible to reform health care systems in a big way". *Journal of Public Policy*, 14 (3), 251– 283.

Xu, W., Hou, Y., Hung, Y. S., & Zou, Y. (2013). "A comparative analysis of Spearman's rho and Kendall's tau in normal and contaminated normal models". *Signal Processing*, *93*(1), 261–276.

Yarrow, D. (2022). "Valuing knowledge: The political economy of human capital accounting". *Review of international political economy*: *RIPE*. 29 (1), 227–254.

Attachments

The number of case studies in the dataset by year, by country, and by continental/geographical region

Africa						
	2022	2021	2020	2019	2018	All
Benin	3	1	2	5	5	16
Burkina Fas	5	5	3	2	7	22
Cabo Verde	0	1	1	0	0	2
Côte d'Ivoi	1	0	0	2	1	4
The Gambia	4	1	0	2	1	8
Ghana	30	32	30	32	30	154
Guinea	1	1	0	0	0	2
Guinea-Bis	1	0	0	1	0	2
Liberia	0	0	0	0	1	1
Mali	2	1	2	2	5	12
Mauritania	0	0	1	0	0	1
Niger	2	0	1	3	0	6
Nigeria	24	26	25	19	19	113
Saint Helen	0	0	0	0	0	0
Ascension a	0	0	0	0	0	0
Senegal	2	3	3	6	5	19
Sierra Leon	1	0	1	0	0	2
Togo	3	1	1	1	0	6
Angola	0	1	0	2	1	4
Cameroon	7	8	3	7	7	32
Central Afr	1	0	1	2	0	4
Chad	0	1	0	2	0	3
Democratic	4	1	1	3	1	10
Republic of	1	0	0	2	0	3
Equatorial (	1	0	0	1	0	2
Gabon	1	0	0	1	0	2
São Tomé a	0	1	0	1	0	2
Rwanda	4	2	5	3	1	15
Burundi	2	3	2	0	0	7
Tanzania	12	19	10	6	19	66
Kenya	13	22	17	17	14	83
Uganda	9	11	7	10	11	48
South Suda	3	2	0	0	0	5
Djibouti	1	0	0	0	0	1
Eritrea	0	2	0	0	0	2
Ethiopia	42	50	35	30	34	191
Somalia	2	0	1	0	0	3
Comoros*	1	0	0	0	0	1
Mauritius*	5	0	2	1	1	9

Seychelles*	2	1	1	0	0	4
Réunion	0	0	0	1	0	1
Mayotte	0	0	0	0	0	0
Botswana	3	4	4	5	5	21
Guinea-Bis:	1	0	0	1	0	2
Lesotho	1	2	1	1	1	6
South Afric	32	34	28	37	34	165
Madagascai	7	3	0	0	2	12
Swaziland/I	0	1	0	3	1	5
Malawi	6	4	6	7	8	31
Zambia	3	6	5	5	8	27
Mozambiqu	3	5	1	4	5	18
Zimbabwe	11	15	8	14	15	63
Namibia	2	3	3	2	4	14
Algeria	1	2	2	3	4	12
Egypt	8	11	5	3	11	38
Libya	0	0	1	1	0	2
Morocco	3	5	5	4	5	22
Sudan	0	2	2	0	0	4
Tunisia	2	2	4	6	4	18
Western Sal	0	0	0	0	0	0
General	17	20	16	21	24	98
All	290	314	246	281	294	1425

Asia						
	2022	**2021**	**2020**	**2019**	**2018**	**All**
Afghanistan	1	1	2	3	1	8
Bangladesh	35	30	26	40	28	159
Bhutan	1	2	2	1	3	9
India	65	74	63	67	77	346
Maldives*	2	2	1	1	0	6
Nepal	26	22	19	23	21	111
Pakistan	36	36	29	23	21	145
Sri Lanka	5	7	4	9	6	31
Russia*	10	8	8	13	7	46
China	131	118	141	122	131	643
Kazakhstan'	2	3	5	1	4	15
Saudi Arab:	4	4	2	4	5	19
Iran	31	22	32	25	11	121
Mongolia	0	4	2	2	1	9
Indonesia*	25	20	19	31	18	113
Turkey*	14	9	7	7	8	45
Myanmar	3	6	4	3	4	20
Yemen	0	0	0	0	0	0
Thailand	10	11	6	6	16	49

Turkmenista	1	0	1	0	2	4
Uzbekistan	1	1	0	0	3	5
Iraq	2	0	0	1	3	6
Japan	10	11	17	14	7	59
Vietnam	29	31	26	19	23	128
Malaysia	10	11	15	17	12	65
Oman	2	0	0	2	2	6
Philippines	19	10	13	9	19	70
Laos	1	5	0	0	5	11
Kyrgystan	3	2	0	0	3	8
Syria	0	0	1	0	0	1
Cambodia	3	10	8	3	8	32
Tajikistan	2	1	0	0	3	6
South Kore	13	13	14	14	20	74
North Kore	0	1	0	2	3	6
Jordan	1	3	0	2	1	7
UAE	2	2	0	1	2	7
Azerbaijan*	2	1	1	1	1	6
Georgia*	2	2	0	0	1	5
Egypt*	8	11	5	3	11	38
Taiwan	11	14	7	9	8	49
Armenia*	0	1	0	0	1	2
Israel	2	2	3	2	2	11
Kuwait	2	0	0	1	2	5
Timor-Leste	0	0	0	1	1	2
Qatar	1	0	1	1	1	4
Lebanon	0	4	0	0	1	5
Cyprus*	0	3	6	0	2	11
Palestine	0	0	1	1	3	5
Brunei	0	1	0	0	1	2
Bahrain*	0	0	0	2	1	3
Singapore*	4	2	2	2	2	12
Maldives*	2	2	1	1	0	6
General	15	30	19	25	27	116
All	549	550	512	514	543	2668

Central and South America						
	2022	**2021**	**2020**	**2019**	**2018**	**All**
Belize*	1	0	0	1	0	2
Costa Rica	0	1	0	2	1	4
El Salvador	0	0	0	2	1	3
Guatemala	2	1	1	4	2	10
Honduras	1	1	0	1	3	6
Nicaragua	0	1	2	4	2	9
Panama	0	0	0	2	0	2
Argentina	2	4	1	2	9	18
Bolivia	1	2	1	0	2	6

Brazil	35	31	40	36	27	169
Chile	3	9	3	6	5	26
Colombia	7	10	4	15	8	44
Ecuador	2	5	5	10	2	24
Bouvet Isla	0	0	0	0	0	0
Falkland Isl	0	0	0	0	1	1
French Gui	0	1	0	0	0	1
Guyana*	0	1	0	2	0	3
Paraguay	0	0	0	1	1	2
Peru	12	11	5	3	8	39
Suriname*	1	0	0	0	0	1
Uruguay	0	2	2	0	1	5
Venezuela	0	0	0	2	0	2
General	9	13	8	9	12	51
All	76	93	72	102	85	428

North America						
	2022	**2021**	**2020**	**2019**	**2018**	**All**
USA	142	139	163	162	174	780
Canada	34	43	37	41	51	206
Mexico	10	16	15	17	21	79
Greenland	0	1	1	0	0	2
General	4	5	10	9	9	37
All	190	204	226	229	255	1104

Europe						
	2022	**2021**	**2020**	**2019**	**2018**	**All**
Russia*	10	8	8	13	7	46
Ukraine	1	4	0	4	3	12
France (*)	13	14	23	19	18	87
Spain (*)	29	25	42	34	39	169
Sweden	20	14	18	14	20	86
Norway	16	5	12	12	20	65
Finland	12	9	19	11	15	66
Denmark	3	6	10	6	11	36
Iceland	2	2	1	0	3	8
Germany	28	23	28	28	28	135
Poland	11	10	9	8	7	45
Italy	22	23	24	29	25	123
UK (*)	22	32	32	31	40	157
Romania	6	4	5	6	6	27
Belarus	0	0	0	0	0	0
Kazakstan*	2	3	5	1	4	15
Greece	6	10	8	6	5	35
Bulgaria	1	0	4	5	1	11
Hungary	4	4	3	3	3	17

Portugal	14	7	30	14	13	78
Serbia	1	1	6	3	3	14
Austria	7	12	13	12	11	55
Czech Repu	8	7	2	8	6	31
Ireland	5	2	6	4	4	21
Lithuania	0	1	2	1	3	7
Latvia	0	1	1	1	1	4
Croatia	1	1	1	6	0	9
Bosnia and	2	0	1	3	0	6
Slovakia	0	3	5	3	2	13
Estonia	0	0	1	0	3	4
Switzerland	3	9	7	10	12	41
Netherlands	7	7	16	12	11	53
Moldova	1	1	0	0	1	3
Belgium	2	2	5	5	4	18
Albania	1	0	0	1	0	2
North Mace	0	0	0	2	1	3
Turkey*	14	9	7	7	8	45
Slovenia	1	1	2	5	2	11
Montenegro	0	0	1	1	0	2
Kosovo	0	0	0	0	0	0
Azerbaijan*	2	1	1	1	1	6
Georgia*	2	2	0	0	1	5
Luxembourg	0	1	0	1	0	2
Andorra	0	0	0	1	0	1
Malta	0	1	0	0	0	1
Liechtenstei	0	0	0	0	0	0
San Marino	0	0	0	0	0	0
Monaco	0	0	0	0	0	0
Vatican city	0	0	0	0	0	0
Cyprus*	0	3	6	0	2	11
Armenia*	0	1	0	0	1	2
General	31	39	40	50	44	204
All	310	308	404	381	389	1792

Australasia (excluding Small Islands)						
	2022	**2021**	**2020**	**2019**	**2018**	**All**
Australia	44	33	56	59	50	242
New Zealar	10	12	19	6	14	61
General	0	~8	2	0	1	11
All	54	53	77	65	65	314

Small Islands						
	2022	**2021**	**2020**	**2019**	**2018**	**All**
Bahrain*	0	0	0	0	1	1
Cabo Verde	0	1	1	0	0	2
Comoros*	1	0	0	0	0	1

Guinea-Bis	0	0	0	1	0	1
Maldives*	2	2	1	1	0	6
Mauritius*	5	0	2	1	1	9
São Tomé a	0	1	0	1	0	2
Seychelles*	2	1	1	0	0	4
Singapore*	4	2	2	2	2	12
Antigua and	0	0	0	0	0	0
Bahamas	0	2	0	0	1	3
Barbados	0	1	2	1	1	5
Belize*	1	0	0	1	0	2
Cuba	1	0	0	2	0	3
Dominica	1	0	0	1	0	2
Dominican	1	0	0	0	0	1
Grenada	0	1	0	2	1	4
Guyana*	0	1	0	2	0	3
Haiti	0	1	1	1	0	3
Jamaica	0	1	2	0	3	6
Saint Kitts a	0	0	0	0	0	0
Saint Lucia	0	2	0	1	0	3
Saint Vince	0	1	1	1	1	4
Suriname*	1	0	0	0	0	1
Trinidad an	0	0	0	0	0	0
Fiji	4	4	10	6	7	31
Kiribati	2	2	2	2	3	11
Marshall Is	1	2	1	1	1	6
Micronesia	0	2	0	2	3	7
Nauru	0	0	0	1	0	1
Palau	0	1	0	0	1	2
Papua New	3	2	4	3	4	16
Samoa	1	1	1	0	3	6
Solomon Isl	2	1	4	4	2	13
Timor-Leste	0	0	0	1	1	2
Tonga	0	1	2	1	1	5
Tuvalu	1	1	1	2	2	7
Vanuatu	4	5	10	4	4	27
American S	0	0	0	0	1	1
Anguilla	0	0	0	0	0	0
Aruba	0	0	0	0	0	0
Bermuda	0	0	0	0	0	0
British Virg	0	0	0	0	0	0
Cayman Isla	1	0	0	0	0	1
Commonwe	0	0	0	0	0	0
Cook Island	1	1	0	0	0	2
Curacao	0	0	0	0	0	0

French Poly	2	0	1	1	0	4
Guadeloupe	1	0	1	0	0	2
Guam	0	1	0	0	0	1
Martinique	0	0	0	0	0	0
Montserrat	0	0	0	0	0	0
New Caled	0	0	1	0	0	1
Niue	0	0	0	0	0	0
Puerto Rico	0	5	1	1	1	8
Sint Maarte	0	0	0	1	0	1
Turks and C	0	0	0	0	0	0
U.S. Virgin	0	1	0	0	0	1
General	10	4	9	10	23	56
All	52	51	61	58	68	290

Polar regions (Arctic and Antarctica)						
	2022	**2021**	**2020**	**2019**	**2018**	**All**
Canada	3	5	4	4	3	19
Alaska	0	2	1	3	4	10
Russia	3	1	2	0	2	8
Greenland	0	0	2	0	4	6
Finland	1	0	0	0	2	3
Sweden	2	0	0	0	1	3
Norway	2	0	1	1	1	5
Iceland	1	0	0	0	1	2
Antarctica	1	5	3	4	5	18
General	1	7	4	8	5	25
All	14	20	17	20	28	99