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Funding flows for climate change research on Africa: where do they come from and where do they go?

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ABSTRACT

Africa has only contributed a small fraction of global greenhouse gas emissions yet faces disproportionate risks from climate change. This imbalance is one of many inequities associated with climate change and raises questions concerning the origin, distribution and thematic prioritization of funding for climate-change research on Africa. This article analyses a database comprising USD 1.51 trillion of research grants from 521 organizations around the world and covering all fields of research from 1990 to 2020. At most 3.8% of global funding for climate-change research is spent on African topics – a figure incommensurate with Africa's share of the world population and vulnerability to climate change. Moreover, institutions based in Europe and North America received 78% of funding for climate research on Africa, while African institutions received only 14.5%. Research on climate mitigation received only 17% of the funding while climate impacts and adaptation each received around 40%. Except for Egypt and Nigeria, funding supported research on former British colonies more than other African countries. The findings highlight the need to prioritise research on a broader set of climate-change issues in Africa and to increase funding for Africa-based researchers in order to strengthen African ownership of research informing African responses to climate change.

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Africa; climate change; mitigation; adaptation; research financing; decolonization of science

1. Introduction

Africa comprises over a fourth of the world's countries, almost a fifth of its population and is host to some of its most biodiverse ecosystems. African countries have contributed among the least to the causes of climate change yet Africa is warming faster than the global average and has many populations highly vulnerable to climate change impacts (Bond, 2019; Busby et al., 2014; IPCC, 2020). For example, total agricultural productivity growth in Africa has been reduced by 34% since 1961 due to climate change, more than any other world region (Ault et al., 2021). Between 2000–2019, floods and droughts affected 337 million people across the continent (CRED, 2019). Thus, in terms of scale and severity of observed climate change impacts and future climate risk, the continent merits a central place in global climate research.

Funding plays a key role in directing research priorities and thereby informing our responses to climate change. However, funding has often been overlooked by scholarship on climate change research (Overland & Sovacool, 2020). We know of no analysis published on the allocations of climate change research funding, its distribution across different themes or its relevance for climate policy pertaining to Africa.

This blind spot is mirrored in climate policy negotiations. For instance, the UNFCCC (2016) roadmap to transforming financial flows makes no mention of funding for climate change *research*. This contrasts with the more extensive scholarship on allocation of funding for direct adaptation and mitigation projects (Afful-Koomson, 2015; Boodoo et al., 2018; Kasdan et al., 2020). Discussions of climate finance disbursements concentrate on 'support for climate action' and the ratio of adaptation to mitigation funds, but do not explicitly cover climate change research funding (Fridahl & Linnér, 2016).

Under the Copenhagen Accord of the United Nations Framework Convention on Climate Change (UNFCCC), developed countries committed to allocating financial resources to support the climate change mitigation and adaptation efforts of developing countries (Boucher et al., 2016; Khan et al., 2019; Klöck et al., 2018). Developed countries were to take immediate action and mobilize USD 100 billion of 'new and additional' funding per year by 2020. Africa, least developed countries and small island developing states were to be prioritized (Fonta et al., 2018). Target 4 under Sustainable Development Goal (SDG) 13, 'Climate Action', reaffirms the financial commitment under the Copenhagen Accord (UN, 2017). As the deadline for this funding target passed in 2020 and given its implications for Africa's response to climate change and the realization of SDG 13 in particular, it is timely to update

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our knowledge about actual climate financing flows (Mitchell et al., 2021), including for climate research.

Here, we seek to fill this gap by analysing financing for Africa-related climate research between 1990 and 2020. We use the Dimensions database, which provides access to data that are unprecedented in their scale and richness. This makes it possible to take research to an empirical level that has previously been unattainable. We identify which countries and organizations are funding Africa-related climate-change research, where the research is being carried out, and what topics and fields of research are prioritized.

The article is divided into five sections. In the next section we briefly review the relevant literature. In the third section we present our methodology for scraping data from the Dimensions database and analysing them. In the fourth section we present the results and discuss them, and in the final section we conclude and suggest some avenues for further research.

2. Background

The scientific literature on climate change has increased near-exponentially and even sub-categories such as climate change adaptation have become too large to assess manually (Sietsma et al., 2021). Callaghan et al. (2020) find that nearly 50 000 research papers on climate change were published in 2018 alone. Nevertheless, large knowledge gaps exist in research for many of the most vulnerable African countries and sectors at risk from climate change (Sietsma et al., 2021). These knowledge gaps are particularly large because Africa is such a large continent with such diverse climate and ecosystems, and, consequently, agricultural systems. Differentiated research is therefore needed to properly understand the variegated impacts of climate change across the continent.

Previous work by Niang et al. (2014) and Hendrix (2017) has focused on research publications rather than funding for research (that is, on summarizing research output rather than input). Looking at actual research funding enables us to say something about the priorities, intentions and resources available for different topics and, as we show, taking a funding perspective is especially relevant from a climate justice and development perspective. In addition, the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) will be published in 2022, and our empirical data and analysis can help set the stage for assessment of climate research funding in AR6 and beyond. To the extent that the existing research does touch on funding, there is a consensus that almost all funding for climate research on Africa originates outside the continent and flows to institutions based in Europe and the United States (Bakare et al., 2014; Bendana, 2019; Blicharska et al., 2017; Siders, 2019).

This article is also relevant for several other branches of literature: on climate change as both a product and form of colonialism (Abimbola et al., 2021; Gram-Hanssen et al., 2021); on the role of developing country researchers in joint research, the power to set research agendas and the decolonization of science (Schipper et al., 2021; Trisos et al., 2021); on the importance of colonial legacies such as languages for current funding flows; on the allocations of climate change research funding on grounds of vulnerability, exposure or risk (Chen et al., 2015; Chen et al., 2018; Kling et al., 2021; Sarkodie & Strezov, 2018); and on biases such as the 'streetlight effect' in climate research involving developing countries (Hendrix, 2017). In the course of the article, we relate our analysis and findings to all these issue areas.

3. Methodology

This study uses data extracted from the world's largest research-funding database, Dimensions (2020a). For the period 1990–2020, the database comprises 4.5 million research grants with a total value of USD 1.51 trillion granted by 521 funding organizations from 39 countries. Based on these data we have sought to identify which grants were provided for climate research and which of those focused on Africa. For the purpose of this article, we define 'climate research' to include research projects in the natural sciences, technical sciences, social sciences or humanities that state that they deal with climate change. To ensure transparency, we have posted the full dataset for this article online (Dimensions, 2020b).

The data were analysed on two levels. First, funding amounts for research on Africa and the rest of the world were estimated by carrying out keyword searches. For this purpose, a modified version of a Boolean search string developed by Overland and Sovacool (2020) was used in combination with a search string representing all African countries and major ecoregions. The resulting aggregate search string used for this article was as follows:

> ("climate change" OR "climate crisis" OR "climate policy" OR "CO2 emissions" OR "Kyoto Protocol" OR "global warming" OR "GHG" OR "greenhouse effect" OR "greenhouse gas" OR "Paris Agreement")

AND

> ("Africa" OR "Algeria" OR "Angola" OR "Benin" OR "Botswana" OR "Burkina Faso" OR "Burundi" OR "Cabo Verde" OR "Cameroon" OR "Central African Republic" OR "Chad" OR "Comoros" OR "Congo" OR "Cote d'Ivoire" OR "Côte d'Ivoire" OR "Democratic Republic of the Congo" OR "Djibouti" OR "DRC" OR "Egypt" OR "Equatorial Guinea" OR "Eritrea" OR "Eswatini" OR "Swaziland" OR "Ethiopia" OR "Gabon" OR "Gambia" OR "Ghana" OR "Guinea" OR "Guinea-Bissau" OR "Kalahari" OR "Kenya" OR "Kilimanjaro" OR "Lesotho" OR "Liberia" OR "Libya" OR "Madagascar" OR "Maghreb" OR "Malawi" OR "Mali" OR "Mauritania" OR "Mauritius" OR "Morocco" OR "Mozambique" OR "Namibia" OR "Niger" OR "Nigeria" OR "Nile" OR "Okavango" OR "Rwanda" OR "Sahara" OR "Sahel" OR "Sahrawi" OR "Sao Tome and Principe" OR "São Tomé and Príncipe" OR "Senegal" OR "Seychelles" OR "Sierra Leone" OR "Somalia" OR "Somaliland" OR "South Africa" OR "South Sudan" OR "Sudan" OR "Tanzania" OR "Togo" OR "Tunisia" OR "Uganda" OR "Western Sahara" OR "Zambia" OR "Zimbabwe")

By applying our search string to the titles and abstracts of research grants, we were able to generate quantitative estimates of the size of funding for climate research on Africa relative to climate research on the rest of the world. Although the Dimensions database includes data from 521 funding agencies from around the world, all titles and abstracts are in English, making

it possible to use only English keywords without biasing the results.

Using the search string, we identified a tentative 2,319 climate-change research projects on African topics, representing a total of USD 1.23 billion of funding. However, recognizing the risk of false hits, we also carried out a second, more in-depth qualitative level of analysis of research projects on climate change in Africa. This analysis was carried out by a team of five people over a period of three weeks, with twice-weekly plenary meetings to discuss ambivalent cases and to agree on common guidelines. The guidelines are included in the appendices at the end of the article and summarized here. We read the titles and abstracts of all identified projects in detail, reclassified projects where the Boolean keywords occurred accidentally and categorized projects according to the following criteria: source of funding; countries in which the research was carried out; African countries covered by the research; and whether the research was about climate change impacts, mitigation of greenhouse gases or adaptation to climate change. We also identified which climate-risk categories each project targeted, using seven categories from IPCC work on Africa: ecosystems, food systems, freshwater resources, urban areas, security and conflict, poverty and livelihoods and health (Niang et al., 2014, p. 1237).

There are several ways of categorizing climate-related activities. We chose the tripartite system of impacts, mitigation and adaptation drawing on the work of the IPCC, the International Institute for Applied Systems Analysis (IIASA), the World Conservation Monitoring Centre of the UN Environmental Programme and a considerable body of research (Caldeira et al., 2003; Nakicenovic et al., 1994; Overland & Sovacool, 2020; Parry, 2009; Richels et al., 2004; Rojas-Downing et al., 2017; Wreford et al., 2010; Yohe et al., 2004; Zegeye, 2018). In the context of this article, the most important aspect of the typology is the distinction between adaptation and mitigation, as it connects with the concept of climate justice (Robinson and Shine, 2018). A disproportionate share of greenhouse gas emissions have been caused by wealthier, industrialized countries outside Africa (Ritchie, 2019). Also Africa contributes some emissions, mainly due to agricultural expansion and intensification through tropical deforestation and methane emissions from livestock cultivation (Foley et al., 2011; Tilman et al., 2011). Africa's major oil and gas producers also have substantial emissions. However, whereas the world's developed countries had emissions of 13.86 metric tons of CO equivalents (tCO2e) on average between 1990 and 2018, those of the African countries were less than a third of that, at 4.05 tCO2e (Climate Watch, 2021; World Bank, 2020).

However, the challenge of adapting to climate change falls most heavily on developing countries, including those in Africa, where there is also the need to lift people out of poverty and achieve development goals, without burning fossil fuels (Kartha & Baer, 2015). There is also much climate research that is neither about mitigation nor directly about adaptation, but simply about the impact on the natural world or human societies. In a climate justice perspective, it makes sense to make this a category that is distinct from actual adaptation, which is concerned with how societies and ecosystems adapt to those impacts.

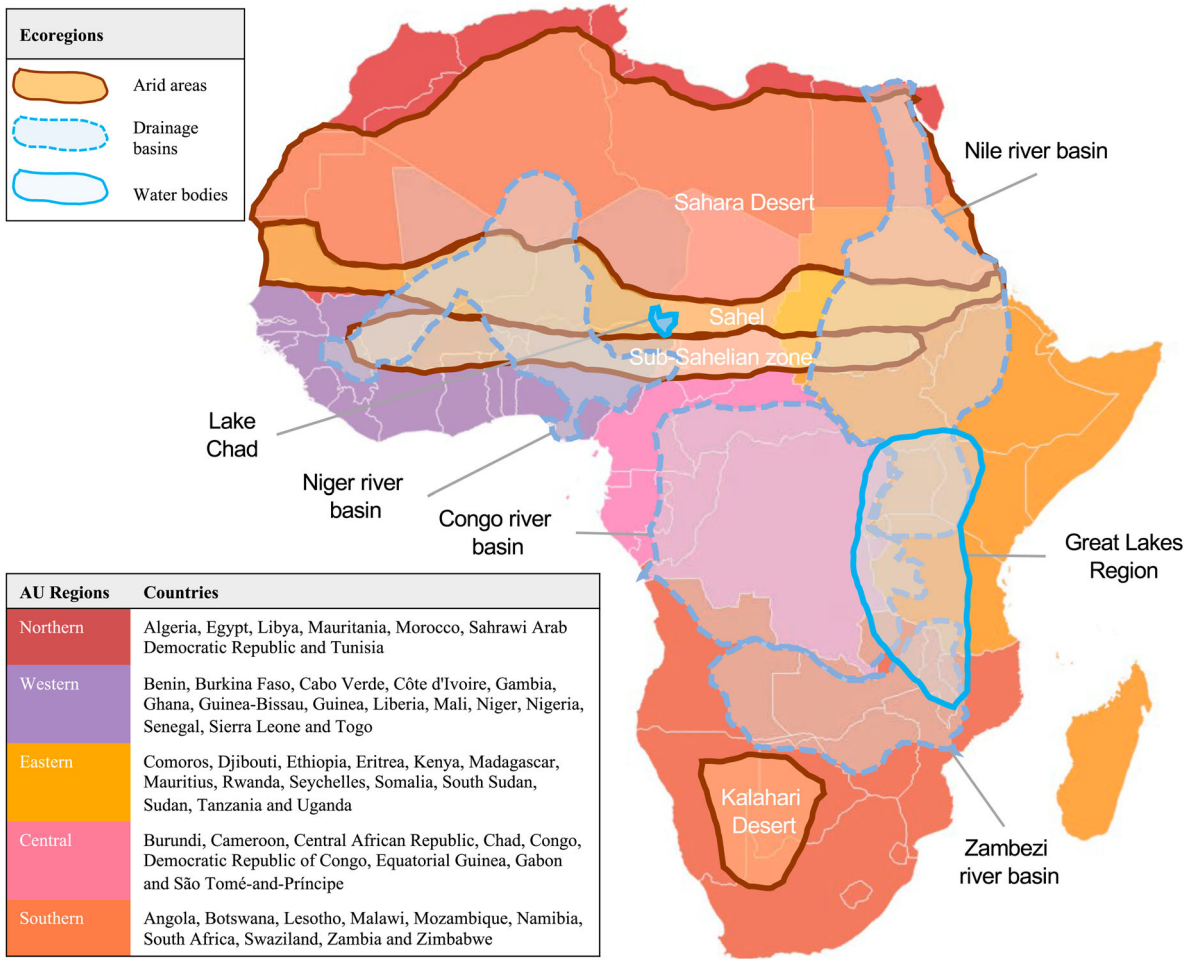
When a research project covered multiple countries, we divided the funding for the project evenly between those countries. In defining regions of Africa, we first took into account the UN definition of Africa. This includes the Arabic-speaking countries of North Africa, which in some other contexts are defined as part of the Middle East and North Africa (MENA). Second, we used the African Union (AU) definition of five African regions (see Figure 1). In cases where a project stated that it was about a particular region, we split the funding evenly between the countries in that region. This means that the division of regional funding flows between countries within a region is an approximation, and this is a limitation of the analysis. Further detailed definitions of regions, ecoregions and other geographical names is provided in the appendices.

Drawing on Overland and Sovacool (2020), we took the 22 main fields of research and 155 sub-fields recognized by the Dimensions database and distinguished between natural and technical sciences on the one hand and social sciences and humanities on the other. Much climate research is inherently interdisciplinary or multidisciplinary, and we classified such projects as both natural and social sciences and counted them once for each category. The full list of main and subsidiary fields and our classification of them into natural and social sciences is presented in the appendices.

To assess whether research funding flows for research on a given country correlated with country-level expected vulnerability to climate change we used the ND-GAIN (2017) index. A broad range of indicators of climate change vulnerability are available (Muccione et al. 2017). We selected the ND-GAIN Country Index because it is best suited for our purposes. It measures a country's exposure, sensitivity and capacity to adapt to the effects of climate change and is calibrated towards the potential impacts of climate change on key sectors of food, water, health, ecosystem service, human habitat, and infrastructure. It summarizes a country's vulnerability to climate change and other global challenges (we do not include the ND-GAIN 'readiness' dimension, as it is less relevant four our research) (e.g. Chen et al., 2015). ND-GAIN has been applied widely in climate research on Africa (Chen et al., 2015; Chen et al., 2018; Kling et al., 2021; Sarkodie & Strezov, 2018).

The Dimensions database is the world's largest with regard to research funding, and seeks to be as comprehensive as possible, incorporating all available data from research-funding organizations, private or public. However, it still has limitations. As no research funding organization is obliged to supply data to Dimensions, its coverage cannot be complete. A more specific weakness is that Dimensions does not distinguish between research funding from Belgian national sources and the European Union (EU) institutions based in Belgium. We got around this problem by manually checking each project that Dimensions categorized as Belgian-funded and determining whether the funding organization was indeed Belgian or in fact a body of the European Union based in Brussels.

Another limitation is that some research in and on Africa may be financed directly by aid agencies, non-governmental



AU Regions	Countries
Northern	Algeria, Egypt, Libya, Mauritania, Morocco, Sahrawi Arab Democratic Republic and Tunisia
Western	Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea-Bissau, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo
Eastern	Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania and Uganda
Central	Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon and São Tomé-and-Príncipe
Southern	Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe

Figure 1. African regions according to African Union (AU); ecoregions as identified in research funding titles and abstracts in Dimensions data. For illustrative purposes only, not to scale, boundaries approximate.

organisations or religious organisations. The Dimensions database only includes data from the world's 521 major research-funding organisations and thus does not cover such other organisations and any research they might fund directly. However, many of the 521 research funding organisations listed in Dimensions (e.g. UK Research and Innovation) obtain significant financial resources from their government aid and development agencies, so some development aid funding for research is included in our data. Given these significant limitations and strengths of the Dimensions database, our findings provide the best estimate of funding patterns for Africa-related climate-change research that is possible to put together with current data availability.

4. Results and discussion

4.1. Proportion of research funding spent on climate change

Based on the analysis using the Boolean search string, we estimate changes in funding flows for Africa-related climate research and relate these to global research funding trends. Figure 2 panel A shows that funding for climate-related research on Africa has always been small – between USD 31000 and USD 97.83 million per year – compared to global climate research funding. The total amount spent on Africa-related climate research from 1990 to 2020 was (USD 1.262 billion). Panel B shows that the share of global funding for climate-change research that focused on Africa-related topics fluctuated upwards from around 0–5% between 1990 and 2020 with high variation year on year. Although this means that Africa has been receiving an increasing share of global climate research funding, the global funding for climate research has been on a decreasing trend since 2010 and the share for Africa is still very small and remains incommensurate with Africa's share of the world population and vulnerability to climate change. This is problematic in a climate justice perspective, because – with the partial exception of South Africa, the emissions from the African agricultural sector and the African petroleum producing countries Algeria, Angola, Egypt, Libya and Nigeria (Anuga et al., 2020; Tongwane et al., 2016; Valentini et al., 2014) – climate change has been largely caused by the activities of non-African, industrialized countries.

In Panel C of Figure 2, we shift to a different perspective and compare the proportion of funding for research on Africa spent on climate-related topics to the share of global research funding that was spent on climate-related topics. This gives an indication of the prioritization of climate change within

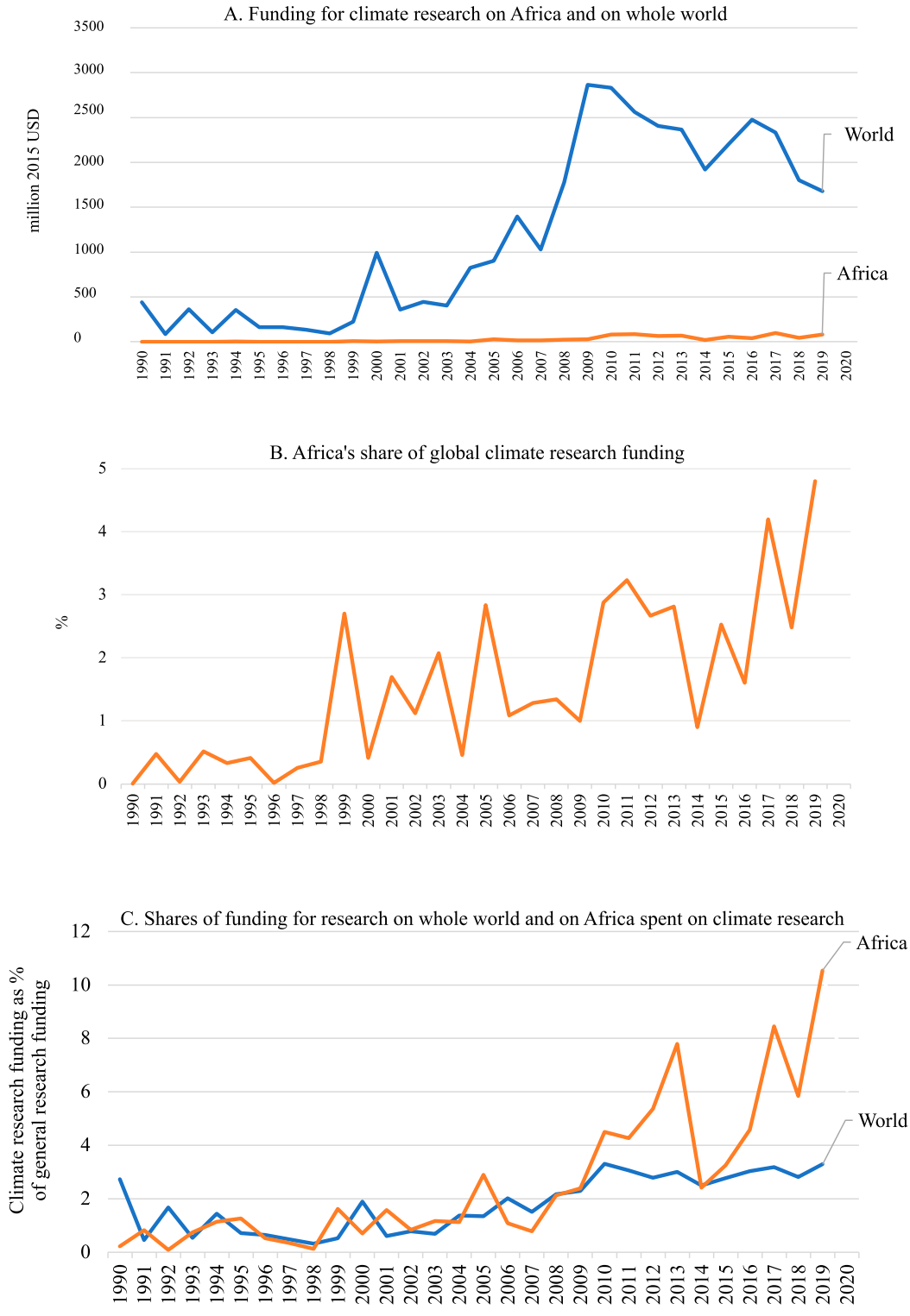


Figure 2. Climate research funding trends.

research on Africa compared to the prioritization of climate change within research globally. From 1990 to 2010, there was negligible difference between African and global trends. However, from 2010 onwards, while funding allocated for climate research globally has never exceeded 4% of global research funding, the percentage of funding allocated to climate-related research on Africa has typically exceeded 4% of Africa-related research funding with up to 10% of funding allocated to climate-related topics in a given year. This could be interpreted as a response to the identified severity of climate change risks and impacts on the African continent from the 4th IPCC assessment report (2007) onwards (Fields, 2005; Masson-Delmotte et al., 2018), and the high variability potentially explained by irregular funding disbursement windows.

All numbers in this section are based on analysis using the Boolean search string, as this is best suited for large-scale

global analysis covering millions of research grants – which would be prohibitively laborious for humans to categorize qualitatively. This analysis is useful for comparing the *relative* proportions of funding for Africa-related climate research to global research funding flows, but it gives a less accurate impression of the actual amounts of funding going into Africa-related climate research.

4.2. Sources of funding

In this and the subsequent sub-sections, we look more closely at various aspects of the internal patterns and structure of funding for climate research on Africa. The numbers in these sections are based on our second level of analysis, in which we qualitatively categorized grants based on titles and abstracts. Based on this deeper analysis, we adjust the estimated total sum of funding spent on Africa-related climate research between 1990 and 2020 to USD 620 million.

According to our data, the main sources of funding for Africa-related climate research are the UK, the USA and the EU. Germany and Sweden also play prominent roles (Figure 3, panel A). There has been a notable shift in the research-funding regime since 2016 when the UK became the largest nation-state research funder in this field. The same period saw a substantial reduction in US funding. Yet, the UK's position may drop substantially in the near future due to large cuts to research budgets for work on developing countries as part of reductions in Official Development Assistance implemented in 2021 (Smith, 2021).

The lack of research funding from African sources could in principle be due to bias in the Dimensions database. Of the 521 funding organisations covered by Dimensions, only one is based in Africa – the National Research Foundation of South Africa. However, it is not certain that this bias in the data distorts the overall estimates much. Most African countries have small economies and spend a very low proportion of GDP on research (Bakare et al., 2014; Bendana, 2019). For many of them, neither the World Bank nor UNESCO has any data on their research funding (UNESCO, 2020; World Bank, 2020). The small number of scientific publications produced by researchers based in Africa (except South Africa) also bears witness to the lack of research funding in most African countries (Blicharska et al., 2017). Thus, despite its limitations, the contents of the Dimensions database provide a reasonable reflection on the lack of research funding from African sources for research on African climate issues.

Our analysis found that government institutions supply around 98% of the funding for Africa-related climate research. The results indicate clear trends with implications both for the academic study of climate change and for the African states themselves: our analysis indicates that funding for climate change research on Africa is largely dictated by the priorities of government institutions in the EU, the UK and the USA. These donor organizations can then shape the agendas for climate-related research on Africa. For example, knowledge gaps are commonly defined by funding agencies as part of research grants, often from a Northern perspective (Vincent et al., 2020). European and North American funding agencies also often require capacity building as part of research projects. This combination of Northern-led identification of both knowledge and skills gaps can result in projects where African partners are positioned primarily as recipients engaged to support research and/or have their 'capacity built' rather than lead research projects on an equal basis. These relationships between researchers based in Africa and researchers based in non-African developed countries can result in extractive arrangements benefiting the developed-country researchers rather than mutually beneficial collaborations (Chu et al., 2014). To counter this, there is a need for African scientific and user priorities to more strongly define the knowledge and skills gaps being addressed by climate research projects funded by Northern funding agencies (Vogel et al., 2019), as well as for increased funding from African sources.

4.3. Recipients of Africa-related climate research funding

In addition to being the main sources of research funding, research institutions based in western Europe and the United States received most of the funding (78%, USD 480.25 mill.) for climate-change-related research on Africa from 1990 to 2020 compared to only 14.5% (USD 89.15) for institutions based in Africa (Figure 3B). This means that much of the funding for research on climate issues in Africa both originates outside Africa and goes to researchers outside the continent.

This is perhaps not surprising given that the UK, EU and North American funding agencies often mandate that a research institution from their country of origin is the lead on research projects. Similar inequities in research leadership, collaboration and authorship facing African researchers have been documented by Siders (2019), who noted that only half of the adaptation studies conducted in Africa had an African researcher as first author, and no study conducted on another continent had an African lead author. In a similar vein, Conway et al. (2019) and Crick et al. (2018) call for more bottom-up assessment of climate risks and adaptation in Africa.

According to the Dimensions data, Kenya (2.3% of total funding) and South Africa (2.2%) are the only African countries among the top 10 countries in the world in terms of institutions receiving funding for climate-related research on Africa (Figure 3B).

This unequal distribution of funding raises questions of unequal power dynamics in how climate change research agendas on Africa are shaped by research institutions in Europe and the USA. Controlling research funding is a key component of setting the research agenda (Vincent et al., 2020) and how funding is allocated within research collaborations can profoundly affect power relationships. Those empowered to shape research agendas can shape research answers, but this power dynamic is too rarely considered in climate change research. For example, faculty committees at lead institutions often value lead or corresponding author positions more highly which drives Northern research partners to seek prominent authorship positions and leadership roles on collaborations rather than more readily make these positions available to developing country researchers (Hedt-Gauthier et al., 2018). Researchers at Northern institutions may also select research questions and shape outputs for a Northern

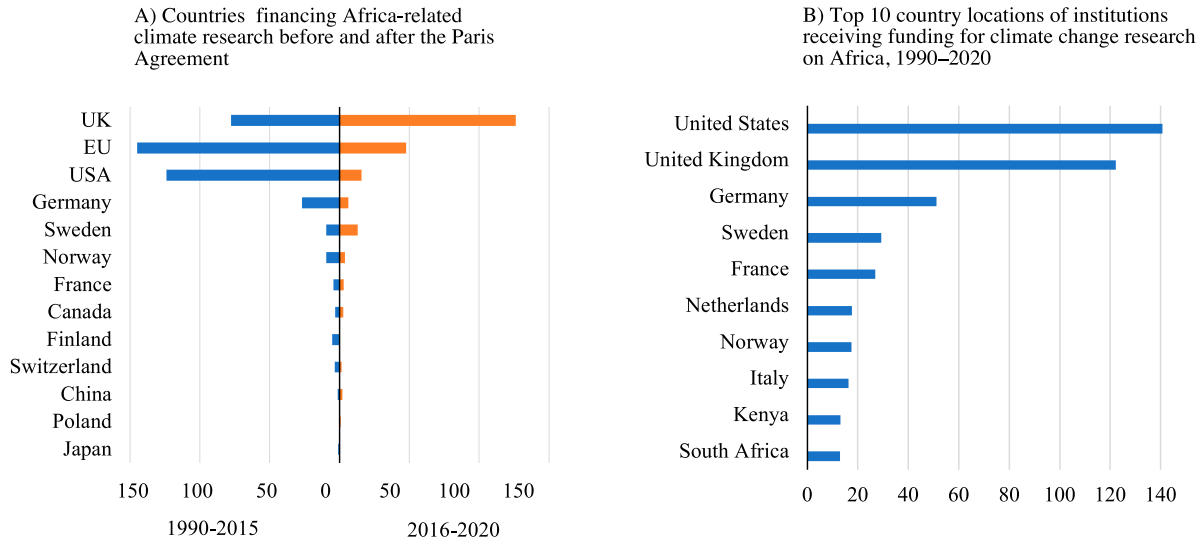


Figure 3. Funding for climate change research focused on Africa, ranked by: (A) countries that provided research funding, (B) the location of research institutions that received funding. (Collaborative projects were classified according to the country location of the lead institution. Data on funding flows for all countries is available in the appendices).

audience rather than providing actionable insights on climate change issues of concern to local partners (Nago & Krott, 2020), particularly if those local partners and institutions – unlike Northern institutions – are unable to commission subsequent research. Positioning African institutions as secondary to their Northern counterparts thus reinforces unequal relationships and obstructs co-production of the knowledge needed to address climate and environmental risks (Trisos et al., 2021; Vincent et al., 2020). In contrast, providing direct control of resources to all project partners confers a sense of equality that can better set the stage for an equitable research partnership (ESPA Directorate, 2018).

The six African countries with institutions that received the most funding for Africa-related climate-change research over the period 1990–2020 were Kenya (2.3% – USD 14.2 mill.), South Africa (2.2% – USD 13.7 mill.), Tanzania (0.92% – USD 5.68 mill.), Ghana (0.86% – USD 5.3 mill.), Ethiopia (0.86% – USD 5.26 mill.) and Zambia (0.88% – USD 5.2 mill.). Although these amounts are a small fraction of those received by institutions outside Africa, this pattern of funding within Africa conforms to the findings of Hendrix (2017) that British colonial heritage might be important in explaining the geographic distribution of research.[1] The notable exception is Ethiopia, which was never colonized. As the continent's second-most-populous state and host to the African Union headquarters as well as to large UN offices, Ethiopia's prominence is not surprising and constitutes an exception. A less significant exception is Tanzania, which was a German colony for around 35 years before becoming a British colony. These findings suggest that funding gravitates towards African countries with a British colonial legacy; however, the causal mechanism is not clear. It could be the fact that these countries are Anglophone (as a consequence of colonial histories) and therefore more accessible to the many researchers around the world who use English as their professional language; it could also be due to other aspects of colonial legacies or some other unknown factors.

4.4. The geography of Africa-related climate research

In the preceding paragraphs and Figure 3B, we examined the locations of the institutions that received most funding for climate research on Africa. We now assess the prioritization of different African countries as the objects of funded research and compare this with their vulnerability to climate change (see Figure 4).

The five African countries on which the most climate-research funding was spent between 1990 and 2020 were South Africa, Kenya, Tanzania, Ethiopia and Ghana (see Figure 4; see Appendix E for funding amounts for each country). The uneven allocation of funding for climate research highlights how more equitable distribution of research funding is not just a question of relations between developing and developed countries but also allocation among developing countries themselves. This finding confirms the argument of Hendrix (2017, p. 137), according to whom there is a 'streetlight effect' in climate research on Africa: a 'tendency for researchers to focus on particular questions, cases and variables for reasons of convenience or data availability rather than broader relevance, policy impact, or construct validity'.

It is notable that comparatively little funding was spent on the study of Nigeria, despite its being the continent's most populous state and English being its official language. This contrasts with the findings of Hendrix (2017), wherein Nigeria and other former British colonies are the most-favoured countries for Africa-related climate research. In another contrast to Hendrix (2017), Egypt, the most populous country in North Africa as well as being historically linked to the British Empire, has received limited attention despite its dependence on the Nile and its consequent vulnerability to climate change.

The difference between our findings and those of Hendrix (2017) may be due to the fact that his analysis is based on bibliometric data – mainly Google Scholar searchers and selected journals – while ours is based on research *funding* data. Both are useful. Bibliometric analysis says more about research

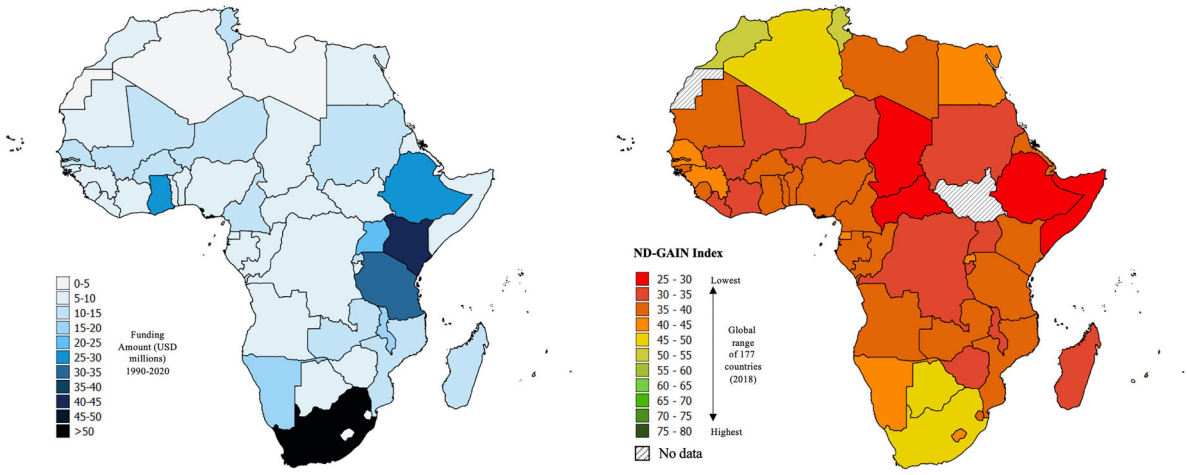


Figure 4. Climate-research funding and climate risk according to ND-GAIN by African country, 1990–2020. (For distribution of funding among institutions in all African countries, see the complete table in the appendices).

output, while research funding analysis is particularly relevant for questions of intended prioritization and distribution of research opportunities.

Funding has also been allocated for research on some countries with arid and semi-arid territories that have seen successive droughts and high climatic variability such as Mali (2.44% – USD 14.5 mill), Namibia (2.96% – USD 17.6 mill.), Niger (2.21% – USD 13,15 mill.), and Senegal (2.08% – USD 12.4 mill). Yet other countries with similar challenges, like Algeria (0.82% – USD 4.8 mill), have received less attention and research on North African countries is generally most underfunded compared to the climate vulnerability of those countries. The lack of funding for research on North African countries is reflected in a dearth of climate knowledge for the region (Niang et al., 2014; Vincent & Cundill, 2021). Among the North African countries, the largest amount of research funding has been focused on Tunisia (1.76% – USD 10.5 mill) despite it being the smallest of these states both in terms of population and surface area.

Also underrepresented are the Central African states, including the Democratic Republic of the Congo (1.19% – USD 7 mill.) with its large rainforest and peatland carbon sinks (Dargie et al., 2017). This is of note considering the limited capacity of stakeholders in the region to track rapidly evolving discourses on reduced emissions from avoided deforestation (Tiani et al., 2015).

One factor that may partly explain the uneven allocation of funding for research on African countries is the influence of development aid agendas in shaping the priorities of aid-donor

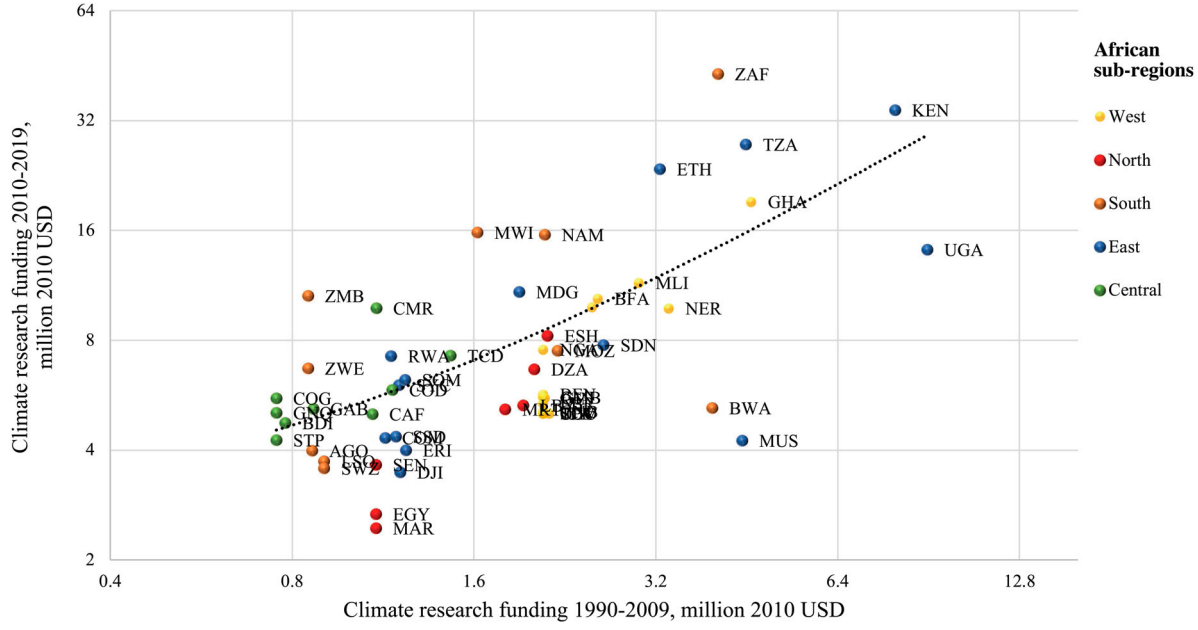


Figure 5. Comparison of climate change research funding on African countries before and after (UNFCCC) Copenhagen Accord (1 Jan. 2010), logarithmic scale, r=0.62. A smaller relative share of funding was spent studying countries below the red dotted line between 2010–2020, while those above the line received a greater relative share.

countries. Billions of dollars of development aid target Africa annually (Betzold & Weiler, 2017; Betzold & Weiler, 2018), and a small portion of this funding is spent on climate change research. It is therefore possible that development-aid priorities make it easier to obtain funding to study some African topics and countries more than others (Dieleman et al., 2016; Mason-D'Croz et al., 2019). Aid priorities may in turn change due to events such as natural disasters, armed conflicts and refugee crises. For example, disaster and development-related topics dominate adaptation research in many African countries (Sietsma et al., 2021). Other development aid priorities can include the strategic and business interests of donor countries, the status of aid-target countries as least-developed countries and, again, past colonial ties. Further research is needed to fully understand the relationship between development-aid policies and priorities in funding climate-change research on Africa.

Although Betzold and Weiler (2017) found countries that were assessed to be more exposed to climate change risks received more climate-related development finance for adaptation, other studies indicate climate change vulnerability is not a strong factor influencing the allocation of finance for climate change adaptation projects in developing countries (Donner et al., 2016; Doshi & Garschagen, 2020). Our analysis extends these results to research funding, finding no correlation between the ND-GAIN index of climate change vulnerability and climate change research funding (r=0.09). This lack of a relationship in funding of research on countries estimated to be more vulnerable to climate change is concerning although we also note that the national-level vulnerability index we used may mask substantial differences in vulnerability within countries, many of which are large and varied.

Figure 5 compares the research funding spent on studying African countries in the decade from 2010 to 2020 and the preceding 20 years (1990-2009). In absolute terms, more funding was spent between 2010 and 2020 than in the preceding two decades. Among the countries that saw the greatest increases for 2010–2020 compared to 1990–2009 were South Africa, Tanzania, Ethiopia, Malawi, Zambia and Ghana. Some of the countries with the largest declines were Botswana, Egypt, Morocco and Mauritius. At the regional level, North Africa saw the greatest decline whereas Southern Africa and the East African cluster of Kenya, Tanzania and Ethiopia experienced the greatest gains.

4.5. Funding allocated for research on climate mitigation versus impacts and adaptation

Climate-change-impact studies and adaptation studies each received almost 40% (USD 240 million) of the funding for research on climate-related issues in Africa while mitigation research received substantially less, at 17% (USD 105 million) (Figure 6). Although recent research points to important knowledge gaps on adaptation in specific sectors in Africa, such as cities (Vincent & Cundill, 2021), our results indicate that a high portion of research funds do go towards adaptation-focused research projects. One possible explanation for this pattern of greater funding for adaptation-related research in Africa is that many least developed countries express stronger demand for finance supporting adaptation rather than mitigation (Zhang & Pan, 2016). Research led by institutions based outside Africa may also lean towards impacts that can be investigated remotely, for example using climate models, rather than engaging in longer processes of co-production of research with local stakeholders (Tiani et al., 2015). This fits with previous work which found that the geographical distribution of author affiliations of climate change publications (in >15,000 articles) is skewed towards wealthy and institutionally well-developed countries (Pasgaard et al., 2015). Another explanation is that Africa has so far contributed less to greenhouse gas emissions compared to many other regions and thus has less of a mitigation responsibility in historical terms. However, there are some important exceptions. South Africa is a major coal producer and consumer; hence, it also requires a robust mitigation strategy (Chevallier, 2011; Favretto et al., 2018). Similarly, Algeria, Angola, Egypt, Libya and Nigeria have all produced significant amounts of oil and/or gas, and African countries face the challenge of ensuring access to energy for all (Sustainable Development Goal 7), lifting people out of poverty and achieving other development goals, without burning fossil fuels (Robinson and Shine, 2018). There is therefore a need for substantial increases in funding for mitigation research to accelerate African countries' transition to renewable energy in order to prevent them from becoming major greenhouse gas polluters of the future (Asongu & Odhiambo, 2018; Vorster et al., 2011; Winkler & Marquand, 2009). There has also been limited research on co-benefits or trade-offs between adaptation and mitigation solutions in Africa (Héloïse & Cherubini, 2020; UNEP, 2021) a priority area for increased funding given the importance of food, energy, water and biodiversity sectors for both adaptation and mitigation, as well as the interlinkages among the Sustainable Development Goals across these sectors (Liu et al., 2018).

Since at least 2005, funding for climate change impact, adaptation and mitigation studies have been highly variable on an annual basis (Figure 6). This suggests an inconsistency in flows of climate change research funding on Africa which would likely affect research planning and outcomes. Figure 6 also indicates that funding for impact and adaptation research and funding for adaptation and mitigation research appear to move together, while funding for impact and mitigation research are less connected with each other over time. One explanation for this might be that understanding how to adapt to climate change depends on having knowledge about its observed and projected impacts (UNEP, 2021).

Figure 7 shows how funding for research on climate impacts, adaptation and mitigation has been distributed to research projects focused on different African regions, as well as particular ecoregions. More funding supported research on climate impacts and adaptation than on mitigation for all regions of Africa, as well as for research focussed on every individual country. Of the ecoregions we assessed, more funding was focussed on the Sahel than on any other ecoregion. As defined in the appendices, the Sahel includes Burkina Faso, Chad, Mali, Mauritania, Niger, Senegal and Sudan.

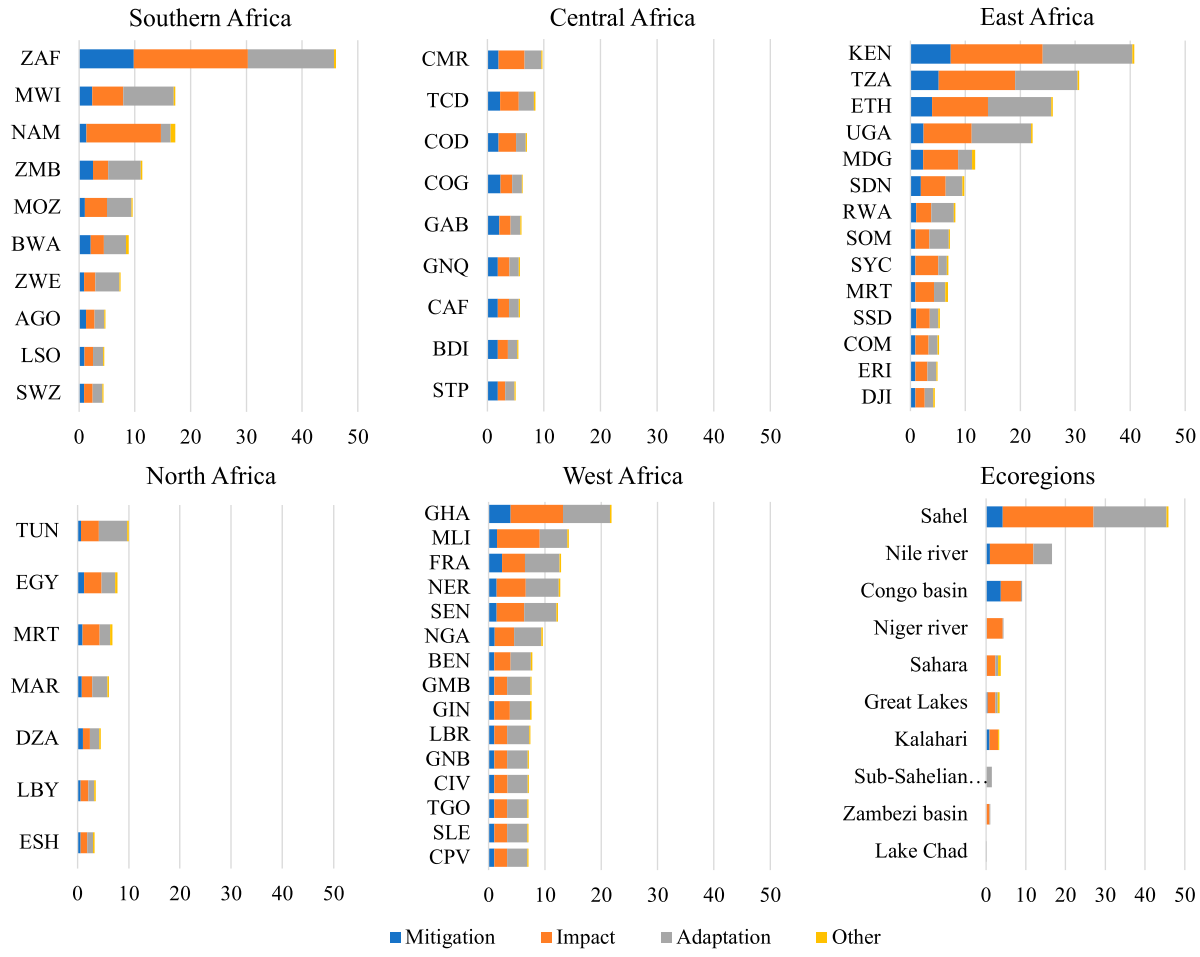


Figure 7. Funding flows by African country, region, ecoregion; in million 2010 USD; three-letter country codes in appendices.

4.6. Alignment of research funding with sectoral climate risks

Out of seven climate-risk areas for Africa identified in the IPCC's Fifth Assessment Report (AR5) (Niang et al., 2014), food systems is the most highly prioritised topic in funding for Africa-related climate research (Figure 8). Agriculture has always been a vital economic sector and source of employment across Africa (Webersik & Wilson, 2009), with food security remaining a concern in much of the continent and 57% of the population of Africa still living in rural areas (UNDESA, 2019). Yet over 90% of African food production is rainfed, rendering many regions and livelihoods vulnerable to food insecurity due to climate change (Bang et al., 2019; Evariste et al., 2018; Fuller et al., 2018). The agricultural sector has contributed the largest economic losses from climate change in Africa (Acevedo et al., 2017), with climate variables such as extreme heat negatively affecting outdoor labour productivity and agricultural supply chains (Fanzo et al., 2018; Graff Zivin & Neidell, 2014). Hence the emphasis on food systems is unsurprising and has been noted in Vincent and Cundill (2021). Within adaptation research specifically, there is a tendency for studies focused on Sub-Saharan Africa to concentrate on small-holder farmers (Abegunde et al., 2019; Shackleton et al., 2015), but there has also been some broader focus on crop yields (Muchuru & Nhamo, 2019). Similarly, freshwater systems have also been prioritised by funding and are intricately tied to food systems (Ogutu-Ohwayo & Balirwa, 2006).

Research on ecosystems received the second-highest funding amount. This emphasis reflects the richness of Africa's biodiversity and ecosystem services and their recognition as strategic assets for sustainable development, including ecosystem-based adaptations to climate change such as forest management (Ofoegbu et al., 2017). Central African forests make up some of the largest natural-carbon sinks on the planet with an average concentration of 425 Mg/h in their soil (Abernethy et al., 2016; Palm et al., 2004). Yet until recently, relatively little was known about the carbon storage services of these ecosystems such as the Congolese peatland carbon sink holding nearly 30 billion tonnes of carbon (Dargie et al., 2017; Lewis et al., 2009; Lewis et al., 2018). The significance of these ecosystems extends beyond their role as carbon sinks, as many people's livelihoods also depend on the biodiversity they support.

We find that climate-related research on health, cities and urban areas, poverty and livelihoods, and security and conflict (including human migration, in accordance with IPCC AR5 risk classification) has received substantially less funding than food, ecosystems and freshwater (Figure 8). The higher allocations to research on food systems as compared to cities/urban areas matches observations of trends in academic

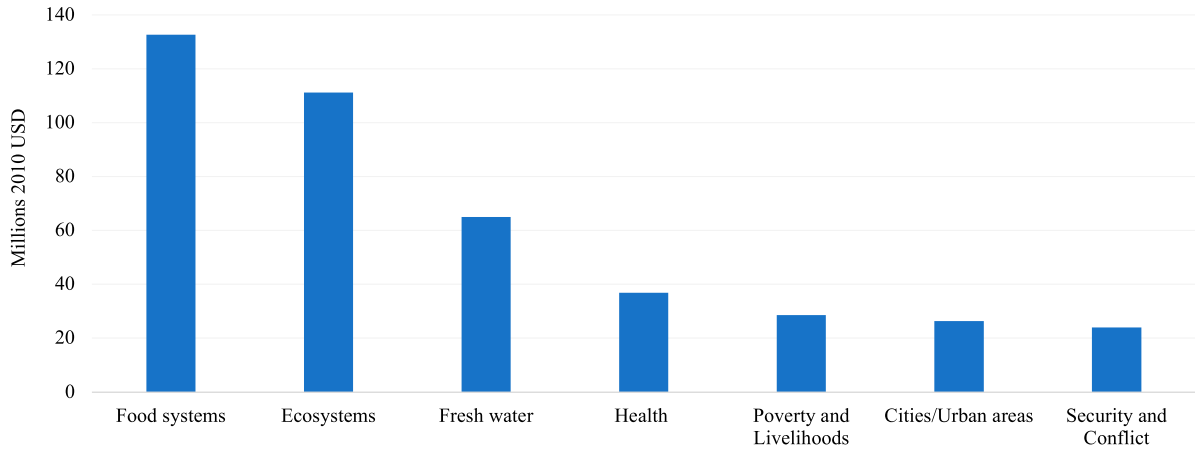


Figure 8. Distribution of funding across risk categories, 1990–2020. When projects covered multiple categories they were counted once for each category.

publications on climate-related risks which point to an emphasis on rural over urban issues, at least for security and conflict (Plänitz, 2019). However, Africa is the most rapidly urbanizing continent with a population expected to be more than 60% urban by 2050 (UN-Habitat, 2016). Understanding the direct and indirect relationship between urbanization, climate change risks and both adaptation and mitigation responses is an urgent priority with recent studies pointing to potential climate-change-mitigation and conservation co-benefits of well-planned urban areas (Colenbrander et al., 2018; Güneralp et al., 2017). There is also increasing recognition of the role of migration, including rural to urban migration, in adaptation (Wiederkehr et al., 2018), and of climate change as a risk factor for armed conflict (Busby et al., 2014; Mach et al., 2019). Growing evidence indicates that climate variability and change have already negatively impacted health, education attainment and economic growth across Africa and that future climate change poses severe risks to health, livelihoods, and poverty reduction efforts on the continent (Costello et al., 2009; Diffenbaugh & Burke, 2019; Hallegatte & Rozenberg, 2017; Hyunen et al., 2013; Randell & Gray, 2019; Tibesigwa et al., 2017; Tosam & Mbih, 2015). Research financing has not kept pace with these emerging concerns nor considered other emerging themes such as projected risk from climate change to African heritage (Brooks et al., 2020); a broadening of research-funding priorities is needed to match projected future climate-related risks for Africa.

With a share of 28%, the social sciences and humanities play a greater role in Africa-related climate research than in global climate research, where these disciplines have a share of only 12% – according to our level 1 analysis using the Boolean search string (cf. Overland & Sovacool, 2020). In this regard, climate-change research on Africa has a strength over comparable research on other parts of the world in that it does not downplay the importance of the social and broader developmental aspects of climate change. For the detailed definition of what was counted as social sciences and humanities, see the appendices.

5. Conclusions

Funding for research on climate change in Africa between 1990 and 2020, seen through the lens of the Dimensions database, exhibits notable trends. Among these trends are the increase in the percentage of Africa-related research funding that is allocated to climate research, and a stronger social sciences element in Africa-related climate research than in climate research on the world as a whole. Climate-change impacts and adaptation have been the major foci of funding for research on Africa to date. This makes sense in terms of past emissions, but increased mitigation research is critical to a low-carbon and climate resilient future for Africa as populations, economies and energy consumption grow. There has also been little funding for research on major states like Egypt and Nigeria relative to their large population sizes. Overall, relatively little funding targets North and Central Africa compared to Southern and East Africa and most former British colonies and Anglophone countries. After 2015, despite pledges of support for increased funding (such as the Accra Consensus on agricultural research) there was no substantial increase in funding for climate-related research in Africa from developed countries.

Our study also highlights important issues of justice and equity in funding for climate research. Most funding for climate-change research on Africa goes to researchers based outside the continent. Africans have contributed among the least to causing climate change yet face some of its most severe impacts. The industrialized countries that carry most of the responsibility for greenhouse gas emissions thus have a responsibility not only to share climate-change research on Africa conducted at institutions in developed countries but also to substantially increase funding for research on climate change in Africa by researchers based at African institutions.

Climate change is increasingly framed as both a form and a product of colonization. Schipper et al. (2021) have noted the persistence of inequitable partnerships and colonial models of scientific practice, where researchers from the Global North often claim senior authorship rights, and researchers from the Global South are relegated to the status of local research assistants and data collectors. Our findings extend this notion to climate change research funding in Africa which also follows geographies of colonial legacy and locates power unequally, privileging researchers at institutions in Europe and the USA.

Recognizing Euro-American centricity and ongoing power imbalances both in causing climate change, and in how climate research is produced and used is an important first step. The next step is committing to decoloniality, meaning actively undoing those systems and ways of thinking – as opposed to post-coloniality, which is our historical reality and does not require taking responsibility for ongoing inequitable systems. Our analysis highlights that this work must include the transformation of allocations of climate change research funding. Without a more equitable allocation of climate change research funding to institutions based in Africa, the ability of African researchers to set research agendas will remain diminished. We propose an approach where for every dollar spent on Africa-related climate change research at institutions based in wealthy nations, an equal amount is spent on research at institutions in an African country.

In addition, the direct beneficiaries of climate change research funding (mainly non-African research institutions) can commit to opening up their power to others by practicing climate change research in inclusive teams. A major step in this direction is enabling marginalized groups to lead and set research agendas, as well as faculty committees at Northern universities valuing highly articles where a Northern-based researcher is not a lead or corresponding author but has made a substantial contribution, enabling those in privileged research institutions to more readily give up prominent authorship positions.

It also makes sense for African countries to invest their own resources towards understanding and responding to climate-change risks. Increased funding for climate research in Africa by Africans will be of limited value if African research institutions do not have the capacity to turn funding into good research. This is to some extent a chicken-and-egg problem: without sufficient funding it is difficult for research institutions to develop; with lack of development it is difficult to know where to channel the funding. One approach that could be particularly effective is for African governments to include climate-research funding in their Nationally Determined Contributions (NDCs) under the Paris Agreement.

As the Dimensions database does not have perfect global coverage, our findings should not be interpreted as final conclusions but as a starting point for further investigation. This could, for example, be done through acquisition and in-depth analysis of research-funding data from individual African countries to correct for any gaps and biases in the Dimensions database. There are also specific topics that would benefit from further research, such as the climate- justice aspect of the research-funding patterns we have identified as well as the influence of development aid flows and priorities on the availability of funding for climate change research on specific African and other developing countries. Another avenue for further research could be to look more closely at how changing development aid priorities affect what Africa-related research on climate change is carried out. Yet another promising avenue for future research would be to compare funding for climate change research on different continents in order to get a more complete picture of inequalities in research funding globally. This would require developing search strings similar to the one we developed for Africa and applying them to the Dimensions database. The development of such search strings is not straightforward, but should be easier for other continents since we have already worked out an approach to Africa. Finally, as the Dimensions database is expanded and improved on a monthly basis, simply repeating our analysis in a few years might also yield new insights, especially concerning funding emanating from within Africa.

Note

1. Tanzania was a German colony for around 35 years before becoming a British colony.

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References

Abegunde, V. O., Sibanda, M., & Obi, A. (2019). The dynamics of climate change adaptation in Sub-Saharan Africa: A review of climate-smart agriculture among small-scale farmers. *Climate*, *7*(132), 1–23. https://doi.org/10.3390/cli7110132

Abernethy, K., Maisels, F., & White, L. J. T. (2016). Environmental issues in Central Africa. *Annual Review of Environment and Resources*, *41*(1), 1–33. https://doi.org/10.1146/annurev-environ-110615-085415

Abimbola, O., Aikins, J. K., Makhesi-Wilkinson, T., & Roberts, E. (2021). *Racism and climate (in)Justice: How Racism and colonialism shape the climate crisis and climate action*. Heinrich Böll-Stiftung. https://us.boell.org/en/2021/03/19/racism-and-climate-injustice-0

Acevedo, S., Mrkaic, M., Novta, N., Poplawski-Ribeiro, M., Pugacheva, E., & Topalova, P. (2017). The effects of weather shocks on economic activity: How can low-income countries cope? In IMF (Ed.), *World Economic outlook, October 2017: Seeking Sustainable growth: Short-term recovery, long-term challenges*. International Monetary Fund. Research Dept. 2017. https://doi.org/10.5089/9781484312490.081.

Afful-Koomson, T. (2015). The Green Climate Fund in Africa: What should be different? *Climate and Development*, *7*(4), 367–379. https://doi.org/10.1080/17565529.2014.951015

Anuga, S. W., Chirinda, N., Nukpezah, D., Ahenkan, A., Andrieu, N., & Gordon, C. (2020). Towards low carbon agriculture: Systematic-narratives of climate-smart agriculture mitigation potential in Africa. *Current Research in Environmental Sustainability*, *2*, 100015. https://doi.org/100015.10.1016/j.crsust.2020.100015

Asongu, A. S., & Odhiambo, N. (2018). Environmental degradation and inclusive human development in sub-Saharan Africa. *Sustainable Development*, *27*(1), 1–10. https://doi.org/10.1002/sd.1858

Ault, T., Carrillo, C. M., Chambers, R. G., & Lobell, D. B. (2021). Anthropogenic climate change has slowed global agricultural productivity growth. *Nature Climate Change*, *11*, 306–312. https://doi.org/10.1038/s41558-021-01000-1

Bakare, M. O., Munir, K. M., & Bello-Mojeed, M. A. (2014). Public health and research funding for childhood neurodevelopmental disorders in Sub-Saharan Africa: A time to balance priorities. *Healthcare in Low Resource Settings*, *2*(1), 1–3. https://doi.org/10.4081/hls.2014.1559

Bang, H., Miles, L., & Gordon, R. (2019). Evaluating local vulnerability and organisational resilience to frequent flooding in Africa: The case of Northern Cameroon. *Foresight (los Angeles, Calif)*, *21*(2), 266–284. https://doi.org/10.1108/FS-06-2018-0068

Bendana, C. (2019). African research projects are failing because funding agencies can't match donor money. *Science*, https://doi.org/10.1126/science.aax6796

Betzold, C., & Weiler, F. (2017). Allocation of Aid for adaptation to climate change: Do vulnerable countries receive more support? *International Environmental Agreements: Politics, Law and Economics*, *17*(1), 17–36. https://doi.org/10.1007/s10784-016-9343-8

Betzold, C., & Weiler, F. (2018). *Development aid and adaptation to climate change in developing countries*. Springer.

Blicharska, M., Smithers, R. J., Kuchler, M., Agrawal, G. K., Gutiérrez, J. M., Hassanali, A., Huq, S., Koller, S. H., Marjit, S., Mshinda, H. M., Masjuki, H. H., Solomons, N. W., Staden, J. V., & Mikusiński, G. (2017). Steps to overcome the north–South divide in research relevant to climate change policy and practice. *Nature Climate Change*, *7*(1), 21–27. https://doi.org/10.1038/nclimate3163

Bond, P. (2019). Climate justice in, by, and for Africa. In M. Dietz, & H. Garrelts (Eds.), *Routledge handbook of the climate change movement* (pp. 205–221). Routledge.

Boodoo, Z., Mersmann, F., & Olsen, K. H. (2018). The implications of how climate funds conceptualize transformational change in developing countries. *Climate and Development*, *10*(8), 1211–1224. https://doi.org/10.1080/17565529.2018.1442788

Boucher, O., Bellassen, V., Benveniste, H., Ciais, P., Criqui, P., Guivarch, C., Le Treut, H., Mathy, S., & Séférian, R. (2016). Opinion: In the wake of Paris Agreement, scientists must embrace new directions for climate change research. *PNAS*, *113*(27), 7287–7290. https://doi.org/10.1073/pnas.1607739113

Brooks, N., Clarke, J., Ngaruiya, G. W., & Wangui, E. E. (2020). African heritage in a Changing climate. *Azania: Archaeological Research in Africa*, *55*(3), 297–328. https://doi.org/10.1080/0067270X.2020.1792177

Busby, J. W., Cook, K. H., Vizy, E. K., Smith, T. G., & Bekalo, M. (2014). Identifying hot spots of security vulnerability associated with climate change in Africa. *Climatic Change*, *124*(4), 717–731. https://doi.org/10.1007/s10584-014-1142-z

Caldeira, K., Jain, A. K., & Hoffert, M. I. (2003). Climate sensitivity uncertainty and the need for energy without CO2 emission. *Science*, *299* (5615), 2052–2054. https://doi.org/10.1126/science.1078938

Callaghan, M. W., Minx, J. C., & Forster, P. M. (2020). A topography of climate change research. *Nature Climate Change*, *10*(2), 118–123. https://doi.org/10.1038/s41558-019-0684-5

Chen, C., Hellmann, J., Berrang-Ford, L., Noble, I., & Regan, P. (2018). A global assessment of adaptation Investment from the Perspectives of equity and efficiency. *Mitigation and Adaptation Strategies for Global Change*, *23*(1), 101–122. https://doi.org/10.1007/s11027-016-9731-y

Chen, C., Noble, I., Hellmann, J., Coffee, J., Murillo, M., & Chawla, N. (2015). University of Notre Dame Global Adaptation Index: Country Index Technical Report. Technical Report. University of Notre Dame, https://gain.nd.edu/assets/254377/nd_gain_technical_document_2015.pdf

Chevallier, R. (2011). Integrating adaptation into development strategies: The Southern African perspective. *Climate and Development*, *2*(2), 191–200. https://doi.org/10.3763/cdev.2010.0039

Chu, K. M., Jayaraman, S., Kyamanywa, P., & Ntakiyiruta, G. (2014). Building research capacity in Africa: Equity and global health collaborations. *PLOS Medicine*, *11*(3), e1001612. https://doi.org/10.1371/journal.pmed.1001612

Climate Watch. (2021). Historical GHG Emissions. https://www.climatewatchdata.org/ghg-emissions?

Colenbrander, S., Sudmant, A., Chilundika, N., & Gouldson, A. (2018). The scope for low-carbon development in Kigali, Rwanda: An economic appraisal. *Sustainable Development*, *27*(3), 349–365. https://doi.org/10.1002/sd.1906

Conway, D., Nicholls, R. J., Brown, S., Tebboth, M. G., Adger, W. N., Ahmad, B., Biemans, H., Crick, F., Lutz, A. F., De Campos, R. S., & Said, M. (2019). The need for bottom-up assessments of climate risks and adaptation in climate-sensitive regions. *Nature Climate Change*, *9*(7), 503–511. https://doi.org/10.1038/s41558-019-0502-0

Costello, A., Abbas, M., Allen, A., Ball, S., Bell, S., Bellamy, R., Friel, S., Groce, N., Johnson, A., Kett, M., & Lee, M. (2009). Managing the health effects of climate change: Lancet and University college London Institute for global health commission. *The Lancet*, *373* (9676), 1693–1733. https://doi.org/10.1289/EHP555

CRED. (2019). Disasters in Africa: 20 year review (2000–2019). https://www.emdat.be/cred-crunch-56-disasters-africa-20-year-review-2000-2019

Crick, F., Gannon, K. E., Diop, M., & Sow, M. (2018). Enabling private sector adaptation to climate change in sub-Saharan Africa. *WIRES Climate Change*, *9*(2), e505. https://doi.org/10.1002/wcc.505

Dargie, G. C., Lewis, S. L., Lawson, I. T., Mitchard, E. T. A., Page, S. E., Bocko, Y. E., & Ifo, S. A. (2017). Age, extent and carbon storage of the Central Congo Basin peatland complex. *Nature*, 1–18. https://doi.org/10.1038/nature21048

Dieleman, J. L., Schneider, M. T., Haakenstad, A., Singh, L., Sadat, N., Birger, M., Reynolds, A., Templin, T., Hamavid, H., Chapin, A., & Murray, C. J. (2016). Development Assistance for health: Past trends, associations, and the future of International financial flows for health. *The Lancet*, *387*(10037), 2536–2544. https://doi.org/10.1016/S0140-6736(16)30168-4

Diffenbaugh, N. S., & Burke, M. (2019). Global warming has increased global economic inequality. *Proceedings of the National Academy of Sciences*, *116*(20), 9808–9813. https://doi.org/10.1073/pnas.1816020116

Dimensions. (2020a). *The Dimensions Database*. http://dimensions.ai

Dimensions. (2020b). Dimensions data for article on funding flows for research on climate change issues in Africa, Researchgate. doi:10.13140/RG.2.2.25963.57126. https://www.researchgate.net/publication/347594066_Dimensions_data_for_article_on_funding_flows_for_research_on_climate_change_issues_in_Africa

Donner, S. D., Kandlikar, M., & Webber, S. (2016). Measuring and tracking the flow of climate change adaptation aid to the developing world. *Environmental Research Letters*, *11*(5), 054006. https://doi.org/10.1088/1748-9326/11/5/054006

Doshi, D., & Garschagen, M. (2020). Understanding adaptation finance allocation: Which factors enable or constrain vulnerable countries to access funding? *Sustainability*, *12*(10), 4308. https://doi.org/10.3390/su12104308

ESPA Directorate. (2018). Research into Results for the ESPA Directorate. Ecosystem Services for Poverty Alleviation Programme Highlights 2009–2018. https://www.espa.ac.uk/files/espa/ESPA%20Programme%20Highlights%20Report%202009_2018.pdf

Evariste, F. F., Jean, S. D., Victor, K., & Claudia, M. (2018). Assessing climate change vulnerability and local adaptation strategies in adjacent communities of the kribi-Campo coastal ecosystems, South Cameroon. *Urban Climate*, *24*, 1037–1051. https://doi.org/10.1016/j.uclim.2017.12.007

Fanzo, J., Davis, C., McLaren, R., & Choufani, J. (2018). The effect of climate change across food systems: Implications for nutrition outcomes. *Global Food Security*, *18*, 12–19. https://doi.org/10.1016/j.gfs.2018.06.001

Favretto, N., Dougill, A. J., Stringer, L. C., Afionis, S., & Quinn, C. H. (2018). Links between climate change mitigation, adaptation and Development in land Policy and ecosystem restoration projects: Lessons from South Africa. *Sustainability*, *10*(3), 779. https://www.mdpi.com/2071-1050/10/3/779 https://doi.org/10.3390/su10030779

Fields, S. (2005). Continental divide: Why Africa's climate change burden Is greater. *Environmental Health Perspectives*, *113*(8), 534–537. https://doi.org/10.1289/ehp.113-a534

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K., West, P. C., & Balzer, C. (2011). Solutions for a cultivated planet. *Nature*, *478*(7369), 337–342. https://doi.org/10.1038/nature10452

Fonta, W. M., Ayuk, E. T., & van Huysen, T. (2018). Africa and the Green Climate Fund: Current challenges and future opportunities. *Climate Policy*, https://doi.org/10.1080/14693062.2018.1459447

Fridahl, M., & Linnér, B.-O. (2016). Perspectives on the Green Climate Fund: Possible compromises on capitalization and balanced allocation. *Climate and Development*, *8*(2), 105–109. https://doi.org/10.1080/17565529.2015.1040368

Fuller, T. L., Clee, P. R. S., Njabo, K. Y., Tróchez, A., Morgan, K., Meñe, D. B., Anthony, N. M., Gonder, M. K., Allen, W. R., Hanna, R., & Smith, T. B. (2018). Climate warming causes declines in crop yields and lowers school attendance rates in Central Africa. *Science of the Total Environment*, *610*, 503–510. https://doi.org/10.1016/j.scitotenv.2017.08.041

Graff Zivin, J., & Neidell, M. (2014). Temperature and the allocation of time: Implications for climate change. *Journal of Labor Economics*, *32*(1), 1–26. https://doi.org/10.1086/671766

Gram-Hanssen, I., Schafenacker, N., & Bentz, J. (2021). Decolonizing transformations through 'right relations'. *Sustainability Science*, https://doi.org/10.1007/s11625-021-00960-9

Güneralp, B., Lwasa, S., Masundire, H., Parnell, S., & Seto, K. C. (2017). Urbanization in Africa: Challenges and opportunities for conservation. *Environmental Research Letters*, *13*(1), 015002. https://doi.org/10.1088/1748-9326/aa94fe

Hallegatte, S., & Rozenberg, J. (2017). Climate change through a poverty lens. *Nature Climate Change*, *7*(4), 250–256. https://doi.org/10.1038/nclimate3253

Hedt-Gauthier, B., Airhihenbuwa, C. O., Bawah, A. A., Cherian, T., Connelly, M. T., Hibberd, P. L., Ivers, L. C., Jerome, J. G., Kateera, F., Manabe, Y. C., & Maru, D. (2018). Academic promotion policies and equity in global health collaborations. *Lancet*, *392*(10158), 1607–1609. https://doi.org/10.1016/S0140-6736(18)32345-6

Hendrix, C. S. (2017). The streetlight effect in climate change research on Africa. *Global Environmental Change*, *43*, 137–147. https://doi.org/10.1016/j.gloenvcha.2017.01.009

Héloïse, T., & Cherubini, F. (2020). Co-Benefits and trade-offs of agroforestry for climate change mitigation and other Sustainability goals in West Africa. *Global Ecology and Conservation*, *22*, e00919. https://doi.org/10.1016/j.gecco.2020.e00919

Hyunen, M. T. E. M., Martens, P., & Akin, S.-M. (2013). Climate change: An amplifier of existing health risks in developing countries. *Environment, Development and Sustainability*, *15*(6), 1425–1442. https://doi.org/10.1007/s10668-013-9450-4

IPCC. (2020). Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Edited by J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H. O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, P. R. Shukla. 2019. https://www.ipcc.ch/srccl-report-download-page/

Kartha, S., & Baer, P. (2015). Zero carbon zero poverty: The climate justice way: Achieving an equitable phase-out of carbon emissions by 2050 while protecting human rights. *Mary Robinson Foundation – Climate Justice Report*, *1*(1), 1–69. https://www.mrfcj.org/pdf/2015-02-05-Zero-Carbon-Zero-Poverty-the-Climate-Justice-Way.pdf

Kasdan, L., Kuhl, L., & Kurukulasuriya, P. (2020). The evolution of transformational change in multilateral funds dedicated to financing adaptation to climate change. *Climate and Development*, https://doi.org/10.1080/17565529.2020.1790333

Khan, M., Robinson, S., Weikmans, R., Ciplet, D., & Roberts, J. T. (2019). Twenty-five years of adaptation finance through a climate justice lens. *Climatic Change*, https://doi.org/10.1007/s10584-019-02563-x

Kling, G., Volz, U., Murinde, V., & Ayas, S. (2021). The impact of Climate Vulnerability on firms' Cost of capital and access to finance. *World Development*, *137*, 105131. https://doi.org/10.1016/j.worlddev.2020.105131

Klöck, C., Molenaers, N., & Weiler, F. (2018). Responsibility, capacity, greenness or vulnerability? What explains the levels of climate aid provided by bilateral donors? *Environmental Politics*, https://doi.org/10.1080/09644016.2018.1480273

Lewis, S. L., Lopez-Gonzalez, G., Sonké, B., Affum-Baffoe, K., Baker, T. R., Ojo, L. O., Phillips, O. L., Reitsma, J. M., White, L., Comiskey, J. A., & Ewango, C. E. (2009). Increasing carbon storage in intact African tropical forests. *Nature*, *457*(7232), 1003–1006. https://doi.org/10.1038/nature07771

Lewis, S. L., Page, S. E., Lawson, I. T., Boom, A., Mitchard, E. T., Sjogersten, S., … Morris, P. J. (2018). *CongoPeat: Past, Present and*

Future of the Peatlands of the Central Congo Basin (grant number NE/R016860/1). Dimensions. https://app.dimensions.ai/details/grant/grant.7746042

Liu, J., Hull, V., Godfray, H. C. J., Tilman, D., Gleick, P., Hoff, H., Pahl-Wostl, C., Xu, Z., Chung, M. G., Sun, J., & Li, S. (2018). Nexus approaches to global sustainable development. *Nature Sustainability*, *1*(9), 466–476. https://doi.org/10.1038/s41893-018-0135-8

Mach, K. J., Kraan, C. M., Adger, W. N., Buhaug, H., Burke, M., Fearon, J. D., Field, C. B., Hendrix, C. S., Maystadt, J. F., O'Loughlin, J., & Roessler, P. (2019). Climate as a risk factor for armed conflict. *Nature*, *571*(7764), 193–197. https://doi.org/10.1038/s41586-019-1300-6

Mason-D'Croz, D., Sulser, T. B., Wiebe, K., Rosegrant, M. W., Lowder, S. K., Nin-Pratt, A., Willenbockel, D., Robinson, S., Zhu, T., Cenacchi, N., & Dunston, S. (2019). Agricultural investments and Hunger in Africa modeling potential Contributions to Sdg2 – Zero Hunger. *World Development*, *116*, 38–53. https://doi.org/10.1016/j.worlddev.2018.12.006

Masson-Delmotte, V., Zhai, P., Pörtner, H. O., Roberts, D., Skea, J., Shukla, P. R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., & Connors, S. (2018). *Global warming of 1.5 C. An IPCC Special Report on the impacts of global warming*. https://www.ipcc.ch/sr15/

Mitchell, I., Ritchie, E., & Tahmasebi, A. (2021). Is climate finance towards $100 billion "New and additional"? *GCD Policy Paper*, *205*, 1–14.

Muccione, V., Allen, S. K., Huggel, C. & Birkmann, J. (2017). Differentiating regions for adaptation financing: The role of global vulnerability and risk distributions. *Wiley Interdisciplinary Reviews: Climate Change*, *8*(2), 1–8. https://doi.org/10.1002/wcc.447

Muchuru, S., & Nhamo, G. (2019). A review of climate change adaptation measures in the African crop sector. *Climate and Development*, *11*(10), 10. https://doi.org/10.1080/17565529.2019.1585319

Nago, M., & Krott, M. (2020). Systemic failures in north–south climate change knowledge transfer: A case study of the Congo basin. *Climate Policy*, https://doi.org/10.1080/14693062.2020.1820850

Nakicenovic, N., Nordhaus, W. D., Richels, R., & Toth, F. L. (1994). Integrative assessment of mitigation, impacts, and adaptation to climate change.

ND-GAIN. (2017). Climate Vulnerability Index: Climate Vulnerability Score of ND-GAIN Index 2017. https://gain.nd.edu/our-work/country-index/rankings/

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). Africa. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, & L. White (Eds.), *Eds.), climate change 2014: Impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on climate change* (pp. 1199–1265). Cambridge University Press.

Ofoegbu, C., Chirwa, P. W., Francis, J., & Babalola, F. D. (2017). Assessing local-level forest use and management capacity as a climate-change adaptation strategy in vhembe district of South Africa. *Climate and Development*, *11*, 6. https://doi.org/10.1080/17565529.2018.1447904

Ogutu-Ohwayo, R., & Balirwa, J. S. (2006). Management Challenges of freshwater Fisheries in Africa. *Lakes & Reservoirs: Science, Policy and Management for Sustainable Use*, *11*(4), 215–226. https://doi.org/10.1111/j.1440-1770.2006.00312.x

Overland, I., & Sovacool, B. K. (2020). The misallocation of climate research funding. *Energy Research & Social Science*, *62*, https://doi.org/10.1016/j.erss.2019.101349

Palm, C., Tomich, T., Van Nordwijk, M., Vosti, S., Gockowski, J., Alegre, J., & Verchot, L. (2004). Mitigating GHG emissions in the humid tropics: Case Studies from the alternatives to slash-and-burn Program (ASB). *Environment, Development and Sustainability*, *6*(1/2), 146–162. https://doi.org/10.1023/B:ENVI.0000003634.50442.ca

Parry, M. (2009). Closing the loop between mitigation, impacts and adaptation. *Climatic Change*, *96*(1-2), 23–37. https://doi.org/10.1007/s10584-009-9646-7

Pasgaard, M., Dalsgaard, B., Maruyama, P. K., Sandel, B., & Strange, N. (2015). Geographical imbalances and divides in the scientific production of climate change knowledge. *Global Environmental Change*, *35*, 279–288. https://doi.org/10.1016/j.gloenvcha.2015.09.018

Plänitz, E. (2019). Neglecting the urban? Exploring rural-urban disparities in the climate change–conflict literature on Sub-Sahara Africa. *Urban Climate*, *30*, 1–11. https://doi.org/10.1016/j.uclim.2019.100533

Randell, H., & Gray, C. (2019). Climate change and educational attainment in the global tropics. *Proceedings of the National Academy of Sciences*, *116*(18), 8840–8845. https://doi.org/10.1073/pnas.1817480116

Richels, R. G., Manne, A. S., & Wigley, T. M. L. (2004). Moving beyond concentrations: the challenge of limiting temperature change. AEI-Brookings Joint Center for Regulatory Studies, Working Paper No. 04-11. http://ssrn.com/abstract=545742

Ritchie, H. (2019). Who has contributed most to global CO2 emissions? *Our World in Data*. https://ourworldindata.org/contributed-most-global-co2

Robinson, M. & Shine, T. (2018). Achieving a climate justice pathway to 1.5 °C. *Nature Climate Change*, *8*, 564–569. https://doi.org/10.1038/s41558-018-0189-7

Rojas-Downing, M. M., Nejadhashemi, A. P., Harrigan, T., & Woznicki, S. A. (2017). Climate change and livestock: Impacts, adaptation, and mitigation. *Climate Risk Management*, *16*, 145–163. https://doi.org/10.1016/j.crm.2017.02.001

Sarkodie, S. A., & Strezov, V. (2018). Economic, social and governance adaptation readiness for mitigation of climate change vulnerability: Evidence from 192 countries. *Science of The Total Environment*, *656*(2019), 150–164. https://doi.org/10.1016/j.scitotenv.2018.11.349

Schipper, E. L. F., Ensor, J., Mukherji, A., Mirzabaev, A., Fraser, A., Harvey, B., Totin, E., Garschagen, M., Pathak, M., Antwi-Agyei, P., & Tanner, T. (2021). Equity in climate scholarship: A manifesto for action. *Climate and Development*, 1–4. https://doi.org/10.1080/17565529.2021.1923308

Shackleton, S., Ziervogel, G., Sallu, S., Gill, T., & Tschakert, P. (2015). Why is socially-just climate change adaptation in sub-Saharan Africa so challenging? A review of barriers identified from empirical cases. *WIRES Climate Change*, *6*(3), 321–344. https://doi.org/10.1002/wcc.335

Siders, A. R. (2019). Adaptive capacity to climate change: A synthesis of concepts, methods, and findings in a fragmented field. *WIRES Climate Change*, *10*(3), e573. https://doi.org/10.1002/wcc.573

Sietsma, A. J., Ford, J. D., Callaghan, M. W., & Minx, J. C. (2021). Progress in climate change adaptation research. *Environmental Research Letters*, *16*(5), 2–14. https://doi.org/10.1088/1748-9326/abf7f3

Smith, C. (2021). UKRI Official Development Assistance letter 11 March 2021. *UK Research and Innovation*. https://www.ukri.org/our-work/ukri-oda-letter-11-march-2021/

Tiani, A. M., Bele, M. Y., & Sonwa, D. J. (2015). What are we talking about? The state of perceptions and knowledge on REDD+ and adaptation to climate change in Central Africa. *Climate and Development*, *7*(4), 310–321. https://doi.org/10.1080/17565529.2014.953901

Tibesigwa, B., Visser, M., & Turpie, J. (2017). Climate change and South Africa's commercial farms: An assessment of impacts on specialised horticulture, crop, livestock and mixed farming systems. *Environment, Development and Sustainability*, *19*(2), 607–636. https://doi.org/10.1007/s10668-015-9755-6

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proceedings of the National Academy of Sciences*, *108*(50), 20260–20264. https://doi.org/10.1073/pnas.1116437108

Tongwane, M., Mdlambuzi, T., Moeletsi, M., Tsubo, M., Mliswa, V., & Grootboom, L. (2016). Greenhouse gas emissions from different crop production and management practices in South Africa. *Environmental Development*, *19*, 23–35. https://doi.org/10.1016/j.envdev.2016.06.004

Tosam, M. J., & Mbih, R. A. (2015). Climate change, health, and sustainable development in Africa. *Environment, Development and Sustainability*, *17*(4), 787–800. https://doi.org/10.1007/s10668-014-9575-0

Trisos, C. H., Auerbach, J. A., & Katti, M. (2021). Decoloniality and anti-oppressive practices for a more ethical ecology. *Nature Ecology & Evolution*, https://doi.org/10.1038/s41559-021-01460-w

UN. (2017). Resolution adopted by the General Assembly on 6 July 2017, Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development (A/RES/71/313).
UN-Habitat. (2016). *World Cities Report 2016 – Urbanization and Development: Emerging Futures*. United Nations Human Settlements Programme (UN-Habitat). http://wcr.unhabitat.org/wp-content/uploads/2017/02/WCR-2016_-Abridged-version-1.pdf
UNDESA. (2019). *World Urbanization Prospects: The 2018 Revision*. United Nations, Department of Economic and Social Affairs, Population Division, New York https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf
UNEP. (2021). *Adaptation Gap Report 2020*. United Nations Environment Programme (UNEP).
UNESCO. (2020). *Science, technology and innovation: Total R&D personnel (FTE) –Total*. http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en
UNFCCC. (2016). Roadmap to US$100 Billion. https://unfccc.int/sites/default/files/resource/climate-finance-roadmap-to-us100-billion.pdf
Valentini, R., Arneth, A., Bombelli, A., Castaldi, S., Cazzolla Gatti, R., Chevallier, F., Ciais, P., Grieco, E., Hartmann, J., Henry, M., & Houghton, R. A. (2014). A full greenhouse gases budget of Africa: Synthesis, uncertainties, and vulnerabilities. *Biogeosciences (online)*, *11*(2), 381–407. https://doi.org/10.5194/bg-11-381-2014
Vincent, K., Carter, S., Steynor, A., Visman, E., & Wågsæther, K. L. (2020). Addressing power imbalances in co-production. *Nature Climate Change*, *10*(10), 877–878. https://doi.org/10.1038/s41558-020-00910-w
Vincent, K., & Cundill, G. (2021). The Evolution of empirical adaptation research in the Global South from 2010 to 2020. *Climate and Development*, 1–14. https://doi.org/10.1080/17565529.2021.1877104
Vogel, C., Steynor, A., & Manyuchia, A. (2019). Climate services in Africa: Re-imagining an inclusive, robust and sustainable service. *Climate Services*, *15*, 100107. https://doi.org/10.1016/j.cliser.2019.100107
Vorster, S., Winkler, H., & Jooste, M. (2011). Mitigating climate change through carbon pricing: An emerging policy debate in South Africa. *Climate and Development*, *3*(3), https://doi.org/10.1080/17565529.2011.598367
Webersik, C., & Wilson, C. (2009). Achieving environmental sustainability and growth in Africa: The role of science, technology and innovation. *Sustainable Development*, *17*(6), https://doi.org/10.1002/sd.411
Wiederkehr, C., Beckmann, M., & Hermans, K. (2018). Environmental change, adaptation strategies and the relevance of migration in Sub-Saharan drylands. *Environmental Research Letters*, *13*(11), https://doi.org/10.1088/1748-9326/aae6de
Winkler, H., & Marquand, A. (2009). Changing development paths: From an energy-intensive to low-carbon economy in South Africa. *Climate Change and Development*, *1*(1), https://doi.org/10.3763/cdev.2009.0003
World Bank. (2020). *Research and development expenditure (% of GDP)*. https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS
Wreford, A., Dominic, M., & Adger, N. (2010). *Climate change and agriculture: Impacts, adaptation and mitigation*. OECD publishing.
Yohe, G., Andronova, N., & Schlesinger, M. (2004). To hedge or not against an uncertain climate future? *Science*, *306*(5695), 416–417. https://doi.org/10.1126/science.1101170
Zegeye, H. (2018). Climate change in Ethiopia: Impacts, mitigation and adaptation. *International Journal of Research in Environmental Studies*, *5*(1), 18–35.
Zhang, W., & Pan, X. (2016). Study on the demand of climate finance for developing countries based on submitted INDC. *Advances in Climate Change Research*, *7*(1-2), 99–104. https://doi.org/10.1016/j.accre.2016.05.002

Appendices

Appendix A. Interpretation of geographical terms

When research funding in the Dimensions database was dedicated to a geographical unit that was not a country, we needed to define which country(ies) that geographical term covers in order to be able to generate statistics on funding for the study of different countries. This was done according to the definitions in this table. Funding flows were divided evenly between the countries covered by a geographical term. For example, if funding was dedicated to a region consisting of three countries, the funding would be divided equally between those three countries in our dataset.

Term	Countries that this region includes	Countries
AFRICA	Benin, Burkina Faso, Cabo Verde, Cote d'Ivore, Gambia, Ghana, Guinea-Bissau, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome-and-Principe, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania, Uganda, Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe, Algeria, Egypt, Libya, Mauritania, Morocco, Saharawi Arab Democratic Republic, Tunisia	55
ATLANTIC REGION OF AFRICA	Angola, Benin, Cameroon, Cabo Verde, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Cote d'Ivoire, Liberia, Mauritania, Morocco, Namibia, Nigeria, Republic of the Congo, Sao Tome-and-Principe, Senegal, Sierra Leone, South Africa, Togo, Western Sahara.	24
CONGO BASIN	Democratic Republic of the Congo, Cameroon, Central Africa Republic, Gabon, Equatorial Guinea, Congo	6
EAST CENTRAL AFRICA	Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania, Uganda, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome-and-Principe	23
EQUATORIAL AFRICA	Angola, Cameroon, CAR, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sudan, Zambia, Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, Tanzania, Uganda, Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome-and-Principe, Senegal, Sierra Leone, Togo, Botswana, Zimbabwe, Namibia, Cabo Verde	45
GREAT LAKES REGION	Burundi, Democratic Republic of the Congo, Kenya, Malawi, Rwanda, Tanzania, Uganda	7
HORN OF AFRICA	Ethiopia, Uganda, Kenya, Tanzania, South Sudan, Sudan, Somalia, Eritrea, Djibouti	9
KALAHARI DESERT	Botswana, Namibia, South Africa	3
KILIMANJARO	Tanzania	1
LAKE CHAD	Chad, Niger, Nigeria, Cameroon	4
LAKE TANGANYIKA	Tanzania, Democratic Republic of the Congo, Burundi, Zambia	4
LAKE VICTORIA	Kenya, Tanzania, Uganda	3
MOUNT KENYA	Kenya	1
NIGER RIVER	Benin, Guinea, Mali, Niger, Nigeria	5
NILE	Burundi, Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, Uganda	11
NUBIA	Sudan	1
SAHARA	Chad, Mali, Algeria, Niger, Egypt, Tunisia, Libya, Mauritania, Sudan, Western Sahara	10
SAHEL		7

(*Continued*)

Continued.

Term	Countries that this region includes	Countries
	Burkina Faso, Chad, Mali, Mauritania, Niger, Senegal, Sudan	
SOMALILAND	Somalia	1
SOUTH-CENTRAL AFRICA	Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome-and-Principe	19
SUB-EQUATORIAL AFRICA	Western Sahara, Morocco, Tunisia, Algeria, Libya, Egypt, Namibia, Botswana, South Africa, Lesotho, Swaziland, Mozambique, Madagascar	13
SUB-SAHARAN AFRICA	Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania, Uganda, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome-and-Principe, Benin, Burkina Faso, Cabo Verde, Cote d`Ivore, Gambia, Ghana, Guinea-Bissau, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo	48
SUB-SAHELIAN AFRICA	Mali, Burkina Faso, Niger, Chad, Senegal, Cameroon, Mauritania	7
TANA LAKE	Ethiopia	1
TROPICAL AFRICA	Angola, Cameroon, CAR, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sudan, Zambia, Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, Tanzania, Uganda, Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome-and-Principe, Senegal, Sierra Leone, Togo, Botswana, Zimbabwe, Namibia, Cabo Verde	45
WEST-CENTRAL AFRICA	Benin, Burkina Faso, Cabo Verde, Cote d'Ivore, Gambia, Ghana, Guinea-Bissau, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome-and-Principe	24
ZAIRE	Democratic Republic of the Congo	1
ZAMBEZI BASIN	Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zimbabwe, Zambia	8

Appendix B. Guidelines for qualitative classification of project titles and abstracts

The purpose of the qualitative classification was to check whether projects were correctly identified by Boolean search strings as being about Africa, to determine whether they were about mitigation, impact, or adaptation and which of seven types of climate risk they concerned.

- Definitions:
  a) "Mitigation – actions that reduce net carbon emissions and limit long-term climate change."
  b) "Adaptation – actions that help human and natural systems to adjust to climate change."
  c) "Research on new technologies, on institutional designs and on climate and impacts science, which should reduce uncertainties and facilitate future decisions" (Caldeira et al., 2003; Richels et al., 2004; Yohe et al., 2004).
- Projects were allowed to have multiple/overlapping classifications; for example, they could be about both climate change mitigation and adaptation to climate change at the same time. When a project had such multiple categorisations, its funding was divided between those categories.
- The category "ambivalent" was applied to projects that were difficult to classify. This created more options for handling the ambivalence of projects and made it easier to double-check projects that were difficult to classify. For example, when counting funds for mitigation, we included both the projects that were clearly about mitigation and those that were probably about mitigation although not with certainty.
- Projects on the following topics were classified as concerning climate mitigation:
  climate justice or a just energy transition
  the consequences of mitigation
  resilience to climate change
  the financial consequences of mitigation
  co-benefits of mitigation
  carbon trading
  studies of emissions (without necessarily doing anything to reduce them) > Maybe mitigation
- Projects were not counted as concerning climate mitigation if:
  they aimed at general enlightenment/education on climate change issues.
- Projects on the following topics were classified as adaptation projects:
  Risk management
- Rules about what was counted and what was not counted as a climate change project:
  If a project seemed to be less than 0.33% about climate change according to our subjective assessment, we did not count it as a climate project.
  If in doubt, and a project did not say much about climate change, did not focus on it and did not include it in the title, we did not count it as being about climate change.
  If a project was about a general topic, such as biodiversity or vector-borne diseases, and climate change was one of many factors mentioned as playing a contextual role for biodiversity or vector-borne diseases but not in focus and not highlighted, then we did not count the project as being about climate change.

Appendix C. Countries financing Africa-related climate research before and after the Paris agreement 1990-2020, in 2010 USD

Funder country	Funding 1990–2015	Funding 2016–2020	Sum of funding 1990–2020
United Kingdom	77667534	110673319	188340853
European Union	144952400	41551705	186504104
United States	123802697	14493330	138296026
Germany	26953569	5684966	32638535
Sweden	9598347	11500847	21099194
Norway	9319752	3418124	12737877
France	4269654	3160988	7430642
Canada	2940291	2571212	5511502
Finland	5214792	0	5214792
Switzerland	3231838	1449798	4681636
China	1131816	2111828	3243645
Poland	461868	864101	1325970
Japan	1051253	63573	1114825
Australia	732165	0	732165
Italy	591821	0	591821
Denmark	284120	0	284120
New Zealand	231973	0	231973
Estonia	100853	0	100853
Portugal	57956	0	57956

(*Continued*)

Continued.

Funder country	Funding 1990–2015	Funding 2016–2020	Sum of funding 1990–2020
Austria	0	49263	49263

* USD sums in this table are based on data generated after qualitative categorization of project abstracts.

Appendix D. Locations of institutions receiving funding for climate change research on Africa, 1990–2020, in 2010 USD

Country of research institution	Sum*	Country of research institution	Sum
USA	147710940	C. African Rep.	807126
UK	122119599	Morocco	719813
Germany	51252661	Latvia	716014
Sweden	29237915	Hungary	685188
France	26950255	Botswana	665216
Netherlands	17591473	Sri Lanka	582192
Norway	17533682	D.R. of the Congo	573337
Italy	16298589	R. of the Congo	571262
Kenya	13152474	Philippines	565432
South Africa	12897557	South Korea	565432
Finland	12022798	Jordan	507118
Switzerland	10672297	Portugal	505780
Austria	7927310	Greece	488945
Belgium	7753940	Bolivia	465234
Denmark	7670210	Togo	423525
Spain	6940062	Bulgaria	375400
Canada	6066496	Palestinian Territory	362675
Ghana	5885087	Algeria	345263
Senegal	5817337	Kazakhstan	338550
Tanzania	5246281	Mozambique	254619
Niger	5177209	Cabo Verde	254449
Ethiopia	4998693	Iran	245847
China	4967015	Brunei	236560
Zambia	4750765	Rwanda	212981
Burkina Faso	4439492	Russia	207362
Cyprus	3931350	Sierra Leone	183794
Malawi	3892839	Estonia	100853
Seychelles	3500058	Mongolia	54626
Colombia	3430305	Thailand	48329
Tunisia	3291363	Nigeria	47733
Benin	2833494	Reunion	42030
Australia	2793043	Mauritius	18274
Uganda	2522907	Jamaica	18274
India	2216528	Malta	18274
Japan	2073629	Guinea-Bissau	14489
Mali	2002235		
Brazil	1861770		
Poland	1724727		
Israel	1624024		
Bangladesh	1576154		
New Zealand	1516865		
Argentina	1486297		
Madagascar	1462861		
Malaysia	1324899		
Cameroon	1206064		
Indonesia	1187824		
Czechia	1041389		
Ireland	1014916		
Egypt	1005115		
Mexico	942048		
Chile	903982		
Sudan	829942		

*USD sums in this table are based on data generated after qualitative categorization of project abstracts.

Appendix E. Climate-related research on African countries, 1990–2020

Country	Funding in 2010 USD*	% of total
South Africa	46949797	7.906
Kenya	42150430	7.098
Tanzania	32048804	5.397
Ethiopia	26765498	4.507
Ghana	23772553	4.003
Uganda	23152779	3.899
Namibia	17605108	2.965
Malawi	17387137	2.928
Mali	14488656	2.440
Niger	13145827	2.214
Burkina Faso	12956467	2.182
Madagascar	12735093	2.145
Senegal	12356427	2.081
Zambia	11409470	1.921
Cameroon	10919109	1.839
Tunisia	10446197	1.759
Sudan	10394787	1.750
Mozambique	9687698	1.631
Nigeria	9643419	1.624
Botswana	9136409	1.539
Egypt	8774549	1.478
Chad	8769295	1.477
Mauritius	8691858	1.464
Rwanda	8410488	1.416
Benin	7779006	1.310
Gambia	7673338	1.292
Guinea	7657696	1.290
Zimbabwe	7545109	1.271
Liberia	7472960	1.258
Somalia	7455047	1.255
Mauritania	7284658	1.227
Seychelles	7228353	1.217
Guinea-Bissau	7193789	1.211
Cote d`Ivore	7185980	1.210
Cabo Verde	7135833	1.202
Sierra Leone	7135833	1.202
Togo	7135833	1.202
Morocco	7066225	1.190
Dem. Rep. of Congo	7055155	1.188
Congo	6330616	1.066
Gabon	6090010	1.026
Equatorial Guinea	5843075	0.984
Central African Republic	5811742	0.979
South Sudan	5592158	0.942
Burundi	5563089	0.937
Comoros	5458549	0.919
Eritrea	5230981	0.881
Sao Tome-and-Principe	5044550	0.850
Angola	4849604	0.817
Algeria	4839929	0.815
Djibouti	4681109	0.788
Lesotho	4675843	0.787
Swaziland	4512150	0.760
Libya	3859925	0.650
Sahrawi Arab Dem. Rep.	3633064	0.612

*USD sums in this table are based on data generated after qualitative categorization of project abstracts.

Appendix F. Fields of research classified as natural and social sciences

Numbers are the codes used in the Dimensions database for the fields of research.

Classified as natural and technical sciences	Classified as social sciences and humanities
01 Mathematical Sciences	13 Education
0101 Pure Mathematics	1301 Education Systems
0102 Applied Mathematics	1302 Curriculum and Pedagogy
	1303 Specialist Studies in Education

(*Continued*)

Continued.

Classified as natural and technical sciences	Classified as social sciences and humanities
0103 Numerical and Computational Mathematics	
0104 Statistics	1399 Other Education
0105 Mathematical Physics	14 Economics
02 Physical Sciences	1401 Economic Theory
0201 Astronomical and Space Sciences	1402 Applied Economics
0202 Atomic, Molecular, Nuclear, Particle and Plasma Physics	1403 Econometrics
0203 Classical Physics	1499 Other Economics
0204 Condensed Matter Physics	15 Commerce, Management, Tourism and Services
0205 Optical Physics	1501 Accounting, Auditing and Accountability
0206 Quantum Physics	1502 Banking, Finance and Investment
0299 Other Physical Sciences	1503 Business and Management
03 Chemical Sciences	1504 Commercial Services
0301 Analytical Chemistry	1505 Marketing
0302 Inorganic Chemistry	1506 Tourism
0303 Macromolecular and Materials Chemistry	1507 Transportation and Freight Services
0304 Medicinal and Biomolecular Chemistry	16 Studies in Human Society
0305 Organic Chemistry	1601 Anthropology
0306 Physical Chemistry (incl. Structural)	1602 Criminology
0307 Theoretical and Computational Chemistry	1603 Demography
0399 Other Chemical Sciences	1604 Human Geography
04 Earth Sciences	1605 Policy and Administration
0401 Atmospheric Sciences	1606 Political Science
0402 Geochemistry	1607 Social Work
0403 Geology	1608 Sociology
0404 Geophysics	1699 Other Studies in Human Society
0405 Oceanography	17 Psychology and Cognitive Sciences
0406 Physical Geography and Environmental Geoscience	1701 Psychology
0499 Other Earth Sciences	1702 Cognitive Sciences
05 Environmental Sciences	1799 Other Psychology and Cognitive Sciences
0501 Ecological Applications	18 Law and Legal Studies
0502 Environmental Science and Management	1801 Law
0503 Soil Sciences	1899 Other Law and Legal Studies
0599 Other Environmental Sciences	19 Studies in Creative Arts and Writing
06 Biological Sciences	1901 Art Theory and Criticism
0601 Biochemistry and Cell Biology	1902 Film, Television and Digital Media
0602 Ecology	1903 Journalism and Professional Writing
0603 Evolutionary Biology	1904 Performing Arts and Creative Writing
0604 Genetics	1905 Visual Arts and Crafts
0605 Microbiology	1999 Other Studies in Creative Arts and Writing
0606 Physiology	20 Language, Communication and Culture
0607 Plant Biology	2001 Communication and Media Studies
0608 Zoology	2002 Cultural Studies
0699 Other Biological Sciences	2003 Language Studies
07 Agricultural and Veterinary Sciences	2004 Linguistics
0701 Agriculture, Land and Farm Management	2005 Literary Studies
0702 Animal Production	2099 Other Language, Communication and Culture
0703 Crop and Pasture Production	21 History and Archaeology
0704 Fisheries Sciences	2101 Archaeology
0705 Forestry Sciences	2102 Curatorial and Related Studies
0706 Horticultural Production	2103 Historical Studies
0707 Veterinary Sciences	2199 Other History and Archaeology
0799 Other Agricultural and Veterinary Sciences	22 Philosophy and Religious Studies
08 Information and Computing Sciences	2201 Applied Ethics
0801 Artificial Intelligence and Image Processing	2202 History and Philosophy of Specific Fields
0802 Computation Theory and Mathematics	2203 Philosophy
0803 Computer Software	2204 Religion and Religious Studies
0804 Data Format	2299 Other Philosophy and Religious Studies
0805 Distributed Computing	12 Built Environment and Design
0806 Information Systems	1201 Architecture
0807 Library and Information Studies	
0899 Other Information and Computing Sciences	
09 Engineering	
0901 Aerospace Engineering	
0902 Automotive Engineering	
0903 Biomedical Engineering	
0904 Chemical Engineering	
0905 Civil Engineering	
0906 Electrical and Electronic Engineering	
0907 Environmental Engineering	
0908 Food Sciences	
0909 Geomatic Engineering	
0910 Manufacturing Engineering	
0911 Maritime Engineering	
0912 Materials Engineering	
0913 Mechanical Engineering	
0914 Resources Engineering and Extractive Metallurgy	
0915 Interdisciplinary Engineering	
0999 Other Engineering	
10 Technology	
1001 Agricultural Biotechnology	
1002 Environmental Biotechnology	
1003 Industrial Biotechnology	
1004 Medical Biotechnology	
1005 Communications Technologies	
1006 Computer Hardware	
1007 Nanotechnology	
1099 Other Technology	
11 Medical and Health Sciences	
1101 Medical Biochemistry and Metabolomics	
1102 Cardiorespiratory Medicine and Haematology	
1103 Clinical Sciences	
1104 Complementary and Alternative Medicine	
1105 Dentistry	
1106 Human Movement and Sports Science	
1107 Immunology	
1108 Medical Microbiology	
1109 Neurosciences	
1110 Nursing	
1111 Nutrition and Dietetics	
1112 Oncology and Carcinogenesis	
1113 Ophthalmology and Optometry	
1114 Paediatrics and Reproductive Medicine	
1115 Pharmacology and Pharmaceutical Sciences	
1116 Medical Physiology	
1117 Public Health and Health Services	
1199 Other Medical and Health Sciences	
12 Built Environment and Design	
1202 Building	
1203 Design Practice and Management	

(*Continued*)

(*Continued*)

Continued.

Classified as natural and technical sciences	Classified as social sciences and humanities
1204 Engineering Design	
1205 Urban and Regional Planning	
1299 Other Built Environment and Design	

Appendix G. ISO 3166–1 ALPHA-3 Country codes

DZA	Algeria	MDG	Madagascar
AGO	Angola	MWI	Malawi
BEN	Benin	MLI	Mali
BWA	Botswana	MRT	Mauritania
BFA	Burkina Faso	MUS	Mauritius
BDI	Burundi	MAR	Morocco
CPV	Cape Verde	MOZ	Mozambique
CMR	Cameroon	NAM	Namibia
CAF	Central African Republic	NER	Niger
TCD	Chad	NGA	Nigeria
COM	Comoros	RWA	Rwanda
COG	Congo	ESH	Sahrawi Arab Dem. Rep.
CIV	Cote d`Ivoire	STP	São Tomé & Príncipe
COD	Dem. Rep. of the Congo	SEN	Senegal
DJI	Djibouti	SYC	Seychelles
EGY	Egypt	SLE	Sierra Leone
GNQ	Equatorial Guinea	SOM	Somalia
ERI	Eritrea	ZAF	South Africa
ETH	Ethiopia	SSD	South Sudan
GAB	Gabon	SDN	Sudan
GMB	Gambia	SWZ	Swaziland
GHA	Ghana	TZA	Tanzania
GIN	Guinea	TGO	Togo
GNB	Guinea-Bissau	TUN	Tunisia
KEN	Kenya	UGA	Uganda
LSO	Lesotho	ZMB	Zambia
LBR	Liberia	ZWE	Zimbabwe
LBY	Libya		