Global Environmental Change 43 (2017) 137–147

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

The streetlight effect in climate change research on Africa

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ARTICLE INFO

Article history:
Received 19 September 2016
Accepted 16 January 2017
Available online xxx

Keywords:
Climate change
Africa
Great Britain
Civil liberties
Scientific inquiry

ABSTRACT

The streetlight effect is the tendency for researchers to focus on particular questions, cases and variables for reasons of convenience or data availability rather than broader relevance, policy import, or construct validity. To what extent does the streetlight effect condition the state of knowledge about climate change in Africa? Analysis of Google Scholar search results, both general and within leading climate change-related journals, reveals that two proxies for objective need, population and land mass, are associated with a higher volume of scholarly attention. Countries with greater exposure to the negative effects of climate change and countries with less adaptive capacity do not receive more scholarly attention. Rather, I find evidence that factors like British colonial history, strong civil liberties, and to a lesser extent political stability – factors not directly related to risks from climate change – affect scholarly attention. The streetlight effect is evident in climate change research on Africa.

1. Introduction

The streetlight effect is the tendency for researchers to focus on particular questions, cases and variables for reasons of convenience or data availability rather than broader relevance, policy import, or construct validity (Kaplan, 1964). The streetlight effect is known also as the "Drunkard's Search," stemming from a story used to illustrate the issue: "A policeman sees a drunk man searching for something under a streetlight and asks what the drunk has lost. He says he lost his keys and they both look under the streetlight together. After a few minutes the policeman asks if he is sure he lost them here, and the drunk replies, no, and that he lost them in the park. The policeman asks why he is searching here, and the drunk replies, 'this is where the light is'" (Freedman, 2010). To what extent does the streetlight effect condition the state of scientific knowledge about climate change in Africa?

We might expect scholarly attention to particular cases would correspond to the numbers of people potentially affected by climate change (population), the extent of physical territory over which impacts might occur (territorial size), or physical exposure and the capacity to adapt to the effects of climate change (Niang et al., 2014). Yet scholarly attention is likely affected by a host of other factors – both cultural and practical – that may skew the nature of our understanding of climate impacts and responses thereto. Scientists may select cases and topics for reasons such as cultural affinity and personal networks or for practical considerations such as common languages, data availability, and the perceived permissibility and safety of conducting research in a particular country. These biases may not affect the validity of any particular study, but they may lead to an imbalanced state of scientific knowledge, with some cases receiving far more attention than others.

This issue is especially relevant for African countries for two main reasons. First, across the continent climate change is likely to have large physical, economic, and social impacts due to the primacy of agricultural livelihoods and limited resources for investment in adaptation (Collier et al., 2008; Conway and Mustelin, 2014). Second, due to lower levels of economic development and under-resourced educational systems, African countries are particularly reliant on both funding and researchers from developed countries for understanding climate impacts on their ecosystems and societies. For example, none of the 65 Atmosphere–Ocean General Circulation Models (AOGCMs) and Earth System Models (ESMs) evaluated by the Intergovernmental Panel on Climate Change (IPCC) for assessment in the Assessment Report 5 (AR5) was developed by research teams based in Africa. Further, Africa accounts for 16.4% of world population but only 0.8% of global research and development expenditures (National

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http://dx.doi.org/10.1016/j.gloenvcha.2017.01.009
0959-3780/

Science Foundation, 2014). Thus, a sizable proportion of climate change research on Africa is conducted and funded by non-Africans. Biases held by these researchers and funding agencies – and their manifest effects for research output – are potentially very important.

I develop two sets of hypotheses regarding the correlates of climate change-related scholarly attention paid to particular African countries. The first set revolves around objective "need" for climate change research, and hypothesizes that more scholarly attention will be paid to countries that are a) more populous, b) have larger land masses, c) are more physically exposed to potential negative effects from climate change, and d) have less adaptive capacity. The second set revolves around factors that affect the convenience of doing research and/or prospects for publication of research on a particular country, and hypothesizes that countries that are a) former British colonies, b) stronger in civil liberties, and c) more politically stable will receive increased scholarly attention.

Based on an analysis of Google Scholar search results, both general and within leading climate change-related journals, I find two proxies for objective need, population and land mass, consistently exert positive effects on the volume of scholarly attention. However, two other need proxies, exposure to climate change and adaptive capacity, do not relate to more scholarly attention. Furthermore, I find considerable evidence that factors like British colonial history, strong civil liberties, and to a lesser extent political stability affect scholarly attention. The streetlight effect is powerful in climate change research on Africa.

These results suggest two important implications for the state of knowledge and future inquiry around climate change impacts and adaptation in Africa. First, generalizations about Africa *as a region* derived from the extant literature, like the IPCC Working Group II (Impacts, Adaptation, and Vulnerability) AR5's chapter on Africa (Niang et al., 2014), are biased or potentially subject to scope conditions that are not present across the continent. More research needs to be conducted in and on non-Anglophone Africa and in countries with less permissive political environments. Second, funding agencies should prioritize research on non-Anglophone, less politically-open African countries in advance of the next IPCC report. This may be achieved through targeted funding or investment in high-quality translation services to help non-Anglophone scientists – both in Africa and elsewhere – contribute to the state of knowledge in English, the *lingua franca* of scientific discourse.

The next section elaborates the arguments regarding the need-based and convenience/capacity-based hypotheses. The following section discusses the data, estimation and results. The final section concludes with a discussion of the practical implications of these findings for climate change researchers, funders and policymakers.

2. Competing theories of scholarly attention

I investigate two competing perspectives of the drivers of climate change-related scholarly attention to African countries. The first, the need-based perspective, focuses on more objective indicators of the need for research: population, land area, physical exposure, and adaptive capacity. The second, the convenience/capacity-based perspective, focuses on factors not related to climate change risk but that affect the ease or feasibility of conducting inquiry.

2.1. Need-based

The need-based perspective is rooted in a utilitarian understanding of the normative concerns that should drive scientific attention: to achieve the greatest good for the greatest number (Bentham 1789; Grasso, 2007). It presumes scholarly case selection should proceed from a consideration of that study's potential to illuminate and address the needs of the greatest number in order to maximize aggregate welfare. This perspective is inherently humanist in the sense that the "number" to which Benthamite logic refers is conceived of in human terms. Thus understood, scholarly attention should be focused on those cases pertaining to the largest potential number of affected individuals – more populous countries should receive more scholarly interest, *ceteris paribus*. A study on climate change impacts in Nigeria, a country of ~190 million people, has the potential to illuminate the condition of and inform policy regarding a much larger proportion of the world's inhabitants than a similar study of nearby Equatorial Guinea (population less than one million). However, climate change will have all-encompassing effects on the world's various biomes and ecosystems, which can and should be valued apart from their contribution to human welfare through ecosystem goods and services (De Groot et al., 2002). Independent of population, physically larger countries should receive more attention.

The third and fourth components of need are physical exposure and adaptive capacity. Physical exposure refers to the degree to which biophysical processes related to climate change – such as changing temperatures and precipitation patterns, storms, and sea level rise – will affect the ecosystems and ecosystem services provided by a given country's physical environment. In contrast to the human-centric relevance implied by population size, physical exposure speaks not just to human impacts but to impacts on the ecosystem more broadly, and thus implies relevance for physical scientists interested in ecosystems or particular organisms *eio ipso.*

Adaptive capacity refers to the availability of resources and institutions of collective policymaking and implementation that can help human communities and ecosystems remain resilient in the face of environmental change. These issues speak to the "greatest good" component of utilitarian logic. *Ceteris paribus*, scholarly attention should be focused on those cases where the physical effects of climate change will be most dire and where local adaptive capacity is lowest. These cases constitute those for which climate change has the potential to do the most harm.

Alternately, cost-benefit analysis – an approach consistent with utilitarian logic but that incorporates the concepts of marginal cost and benefits (Paavola and Adger, 2006) – might suggest that more scholarly attention be paid to those cases in which marginal investments in adaptation/mitigation are likely to produce the largest benefits: that is, those cases where adaptive capacity is comparatively higher. Focusing on "worst-case" cases may result in investment of resources where they can do little good, as institutional capacity to implement policies and remedies is completely lacking. This type of logic is particularly relevant for African cases, where even comparatively well-off African countries like Botswana and Gabon are still below the global mean in terms of per capita income.

Thus five hypotheses emerge, all of which are *ceteris paribus* in their arguments. Hypotheses four and five reflect the theoretically ambiguous effects of adaptive capacity.

H_1: More populous countries will receive more scholarly attention related to climate change.

H_2: Countries with larger land masses will receive more scholarly attention related to climate change.

H_3: Countries with greater physical exposure to negative impacts from climate change will receive more scholarly attention related to climate change.

H_4: Countries with less adaptive capacity to climate change will receive more scholarly attention related to climate change.

H_5: Countries with more adaptive capacity to climate change will receive more scholarly attention related to climate change.

2.2. Convenience/capacity-based

While need-based factors are likely to affect case selection, the streetlight effect suggests researchers will be drawn disproportionately to cases where the barriers to entry are low, the permissibility of free inquiry is high, and the potential for the researcher or the study to be endangered or complicated by instability or violence is low. These convenience/capacity-based factors are unrelated to objective need for climate change research but nevertheless are likely to shape scholarly attention.

Barriers to entry include practical considerations like language, ease of travel, data availability, and access to professional and social networks that may facilitate successful research projects. In this respect, former British colonies have large advantages over similarly populous, large, and climate change-exposed counterparts for several reasons. First, former British colonies benefit from speaking English or having English as an official language, even if some or most informal communication takes place in African languages. Climate change emerged as an interdisciplinary subject at a time – the latter half of the 20th century – by which English had become a global language and the *lingua franca* of scientific discourse (Crystal, 1997; van Weijen, 2012). This affects both publication prospects for local African scientists – who are educated in the language of global scientific discourse – and the convenience of these countries for foreign scientists. For African scientists, these educational advantages result in higher overall volumes of scholarship (Komlagan and Okey, 2014). Because the vast majority of scientific communication takes place in English, even scientists from non-English speaking, non-European countries are more likely to be conversant in English than either French, Portuguese, or African languages and therefore more likely to conduct research in English.

In a related vein, former British colonies speak the language of – and in the case of Great Britain, have developed economic, scientific and historical ties with – the two major Western economic and scientific powers of the 20th century. To the extent that researchers have Africans in their social and professional networks, they are likely to be drawn from English-speaking countries, whose residents have significant advantages in terms of accessing educational and professional opportunities in the United States and Great Britain.

Second, former British colonies have been the subject of sustained scholarly inquiry in the English language since the colonial era. This has both direct and indirect effects. The direct effect on current scholarship is significant infrastructure for scholarly inquiry: former British colonies typically have the best time-series data on land use – including formal land titling – and hydro-meteorological phenomenon, like rainfall and temperature, which are central to climate change research (Herbst, 2000; Bellemare, 2013). The indirect effect is to incentivize further study of those cases already prevalent in the literature. Even if initial case selection was done for highly idiosyncratic or biased reasons, once those early studies have been published, researchers seeking to improve upon or extend those analyses face strong incentives to conduct their work around the same cases (Ebbinghaus, 2005).

Next, researchers are likely to gravitate toward countries with more open political systems that protect civil liberties like freedom of association and speech. Scientific research presupposes freedom of inquiry and communication – the ability to report freely the results of analysis and to conduct analysis in a context of transparency. In less permissive contexts, researchers may face significant barriers to obtaining permission to conduct field work. It is also more difficult to obtain valid responses to surveys when respondents know their participation may be monitored and sanctioned by government agents. Similarly, more closed regimes may be less willing to provide official data in re-analyzable form for fear that re-analysis may uncover "juking" or manipulation of the statistics for political purposes (Hollyer et al., 2011; Jerven, 2016).

Finally, researchers will likely be drawn to cases that are more politically stable. Changes in political regimes – the rules governing the selection of the government – often occasion broader periods of unrest, including street demonstrations, strikes, and violent rioting (Simon, 1984). These circumstances increase both the personal risk to researchers and significantly impede their ability to conduct inquiry. The effects may be even larger during armed conflict, which significantly complicates the collection and archiving of reliable data and entails personal risk. This is true both for data-driven and fieldwork-based research: field stations may be destroyed or inaccessible, records may be lost or not kept in the first place, and human survey responses are likely to be colored by fears that divulging truthful answers might imperil the respondent (Kalyvas, 2008; Burke et al., 2016). Moreover, travel to conflict-affected areas often entails significant personal safety risks for the researchers themselves, particularly if those researchers are from fields – like earth sciences – that are more focused on ecological processes and who may be less attuned to local political and social dynamics (Williams et al., 1992).

Three additional hypotheses emerge, all of which are *ceteris paribus* in their arguments:

H_6: Former British colonies will receive more scholarly attention related to climate change.

H_7: Countries with stronger civil liberties will receive more attention related to climate change.

H_8: Countries with greater levels of political instability will receive less attention related to climate change.

3. Data and estimation

The analysis is cross-national in nature, with countries being the unit of analysis. The sample includes both Sub-Saharan and North African cases, totaling all 54 sovereign countries on the continent, though availability of some independent variables restricts the analysis to fifty countries, with Eritrea, São Tomé and Príncipe, South Sudan, and Seychelles the excluded cases. Replication data for all analyses conducted in this article can be accessed at http://www.cullenhendrix.com.

3.1. Dependent variables

The measures of country-specific scholarly attention used as the dependent variables are derived from Google Scholar (http://scholar.google.com), accessed and searched August 23/24, 2016. Searches were conducted in English, and over a two-day period that did not include an update to Google's database. General searches (the first measure) were conducted during revisions on December 1, 2016. For a detailed discussion of search methodology, see the appendix. The search results are proxies for actual scholarly attention.

The reasons for focusing on English language sources are several. First, as noted earlier, English is now – and has been for the time period under which climate change research has flourished – the standard language of scientific communication (van Weijen, 2012). Second, English language sources form almost the entire evidentiary basis for consensus statements regarding the state of scientific knowledge around climate change. The IPCC AR5 chapter on Africa cites over 900 references, all but four of which were published either in English exclusively or co-published in English and a second language (Niang et al., 2014). The four non-English references were all in French, including one reference to the UNDP *Human Development Report 2009* (UNDP, 2009) which is also available in English. While there is a body of climate change research on Africa in other languages, it is not to date informing

IPCC assessments. Finally, this body is likely very small. A preliminary Google Scholar search of Portuguese sources, for instance, recovered only 411 references for "mudança climática and Angola" and 453 for "and Mozambique", both of which are Lusophone countries; a similar search in English recovered 26,500 and 35,800 results, respectively (Search conducted December 2, 2016. Searches in Portuguese and French restricted to Portuguese and French language sites). Searches in French ("*changement climatique*") recovered roughly 15% as many references for Francophone Côte d'Ivoire as searches in English and less than 3 percent as many for a non-Francophone country like Kenya.

The first measure of scholarly attention is the estimated number of Google Scholar-indexed studies returned by searching the terms "climate change" and "COUNTRYNAME", allowing the terms to appear anywhere in the study. Allowing the term to appear anywhere in the study captures both passing references and more sustained engagement with particular cases, as well as manuscripts that address the continent or region more broadly while making passing references to country names. Many of these studies likely focus on transboundary ecosystems, river basins or watersheds and/or sub-national administrative units, rather than the country as a whole, as climate impacts and/or adaptive capacity can vary widely within a country (Busby et al., 2014). The vast majority of climate change studies regarding Africa indexed by Google Scholar (>80% of 1,020,000, per searches conducted 12/6/16) mention at least one of the top ten countries in terms of scholarly attention (see Table 2); >85% mention at least one of the top 20. Studies that do not mention specific countries by name are in the distinct minority, though future research may extend this analysis to look at particular transboundary ecosystems, watersheds, and the like. I return to this point in the discussion.

The second is the estimated number of Google Scholar-indexed studies returned by searching the titles of scholarly works and containing the terms "climate change" and "COUNTRYNAME". Requiring the country name to appear in the title of the work is a strong signal that the work addresses the country in significant detail.

The next three are the estimated number of mentions of COUNTRYNAME anywhere in the study in three climate change-specific, peer-reviewed journals: *Climatic Change*, *Global Environmental Change*, and *Nature Climate Change*. These journals are characterized by high impact factors and interdisciplinary scholarship. All counts are natural log transformed prior to analysis.

The sixth measure, latent interest, treats all of these estimated counts as indirect, imperfect indicators of a latent concept – scholarly attention – and is based on factor analysis of the five manifest variables (for details, see appendix). The variable has a mean of zero and a standard deviation of one. Correlations between the various measures are uniformly high, ranging from r = 0.76 to r = 0.99 (Table 1). In a seventh specification, I use the (natural log) counts of references in Google Scholar *not* related to climate change, as a check on whether any revealed biases in climate change research are present in the broader scholarly literature.

Table 2 presents the top ten countries in terms of scholarly attention related to climate change according to the six different measures. Comparatively populous former British colonies (Nigeria, South Africa, Kenya and Egypt) appear at or near the top of each list.

3.2. Independent variables

The models include four proxies for "need", or the objective relevance of the countries in question for research on the physical and human impacts of climate change. The first two measures, population and total area, proxy the human and physical extent of the country. All else equal, larger populations and larger total areas should both provide more opportunities for conducting research and the resultant research should be more desirable on utilitarian grounds. Data are from the *World Development Indicators (2016)* for the year 2014.

The third measure, the Notre Dame Global Adaptation Index's (ND-GAIN) exposure variable, captures physical exposure to the negative effects of climate change. The measure was constructed to proxy the extent to which a country is exposed to significant biophysical impacts from climate change, independent of that country's sensitivity to climate change or adaptive capacity (Chen et al., 2015). The ND-GAIN exposure measure is a composite, time-invariant index incorporating information about projected changes in population, agricultural productivity, water availability and quality, disease environment, the local biome and biodiversity, human habitat, and sea level. The variable ranges from 0.39 (Libya) to 0.64 (Seychelles), with higher values corresponding to greater physical exposure to climate change risk. Some might be concerned the ND-GAIN measure may be biased because it implicitly accounts for population (both future change and future deaths from climate-borne diseases). As a robustness check, models were estimated using an alternate measure of climate vulnerability from Wheeler (2011). The results are presented in Table A2 and are similar to those presented here.

The fourth, GDP per capita, proxies adaptive capacity. Societies at higher levels of economic development typically have both more resources and more developed institutions of collective decision-making and policy implementation with which to confront challenges stemming from climate change (Adger et al., 2003). Data are from the *World Development Indicators* for the year 2014. The Appendix contains additional models (Tables A3 and A4) that control for potential confounds between the relationship between GDP per capita and adaptive capacity: natural resource rents as a share of GDP and total taxes as a share of GDP, the latter a widely used indicator of administrative capacity (Hendrix, 2010). Results are again similar to those presented here.

The model includes also four cultural-political variables that proxy salience to the scientific community, the openness of the research environment, and political stability – factors that might

Table 1
Correlations between Measures of Scholarly Attention.

	ln Refs., Google Scholar	ln Refs. in Title, Google Scholar	ln Refs. in *Climatic Change*	ln Refs. in *GEC*	ln Refs. in *Nature CC*	Latent Interest
ln Refs., Google Scholar	1.00					
ln Refs. in Title, Google Scholar	0.80	1.00				
ln Refs. in *Climatic Change*	0.89	0.84	1.00			
ln Refs. in *GEC*	0.87	0.86	0.95	1.00		
ln Refs. in *Nature CC*	0.79	0.76	0.84	0.86	1.00	
Latent Interest	0.92	0.88	0.98	0.99	0.88	1.00

Table 2
Top Ten African Countries ranked by Scholarly Attention.

Google Scholar, Anywhere		Google Scholar, Title		Climatic Change		Glob. Env. Change		Nature Clim. Change		Latent Interest	
South Africa	370,000	Nigeria	991	South Africa	474	South Africa	491	Egypt	142	South Africa	2.38
Kenya	117,000	Ethiopia	557	Kenya	239	Kenya	394	South Africa	102	Kenya	1.84
Nigeria	79,500	Kenya	547	Ethiopia	191	Tanzania	270	Namibia	51	Ethiopia	1.43
Egypt	72,800	South Africa	508	Egypt	177	Ethiopia	254	Kenya	47	Nigeria	1.43
Ethiopia	63,400	Ghana	313	Nigeria	161	Nigeria	244	Tanzania	37	Egypt	1.42
Tanzania	63,000	Tanzania	311	Niger	130	Egypt	225	Nigeria	33	Tanzania	1.32
Ghana	50,300	Uganda	186	Tanzania	128	Mozambique	188	Ethiopia	27	Zimbabwe	0.97
Uganda	47,600	Egypt	179	Sudan	122	Zimbabwe	187	Niger	22	Ghana	0.96
Sudan	43,300	Zimbabwe	170	Senegal	121	Uganda	180	Uganda	20	Uganda	0.92
Morocco/ Zimbabwe (tie)	42,300	Niger	151	Zimbabwe	115	Ghana	173	Mozambique	20	Niger	0.90

affect scholarly interest in and the feasibility of conducting research in particular countries independent of the objective "need" for climate change research therein. The first variable captures language and cultural linkage dynamics. The other three variables capture political openness and political stability.

The first variable is former British colony status, which is simply an indicator variable that takes a value of one for former British colonies and zero otherwise. Former British colonies include Botswana, Egypt, the Gambia, Ghana, Kenya, Lesotho, Malawi, Mauritius, Nigeria, Seychelles, Sierra Leone, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. The second, the Freedom House civil liberties score averaged over 1972–2015, proxies the level of openness and freedom of association, communication, and expression in a country. The variable has a theoretical range of one (wide ranging civil liberties) to seven (no freedom of expression or association). In this sample, the mean value is 4.85 and ranges from 2.11 (Mauritius, a consolidated electoral democracy) to 6.91 (Somalia). For the political variables for which time series are available, I calculate means and standard deviations beginning in 1970 (1972 in the case of Freedom House, due to data availability) as that time corresponds to the first Earth Day and the creation of the US National Oceanic and Atmospheric Association (NOAA), the world's largest funder of climate change research.

The third variable, the standard deviation of the Polity index score from 1970 to 2015, captures the stability and predictability of the political system (Marshall and Jaggers, 2002). Low values indicate infrequent changes in political institutions and regime type, while high values indicate large shifts in the political system between openness and more closed, authoritarian institutions. The mean value is 4.24 and ranges from 0 (Namibia, which has experienced no changes in the processes and rules governing executive selection since independence in 1990) to 7.45 (Malawi, which transitioned from closed autocracy to partial democracy during that time). The Polity scale is a 21-point ordinal scale ranging from −10 (full autocracy) to +10 (full democracy). The scale is derived from analysis of the rules that govern selection of the executive and the degree of consolidation in the party system. The Polity scale is among the most widely used measure of regime type in political science.

The fourth variable, armed conflict prevalence, is the proportion of the period from 1970 to 2014 during which the country was experiencing armed conflict, either domestic or external. The data are from the Uppsala Conflict Data Project (UCDP), which uses a relatively low battle-death threshold for coding armed conflict incidence (25 deaths in a given country-year) (Pettersson and Wallensteen, 2015). The variable has a mean of 0.2 and ranges from zero (several countries) to 0.98 (Ethiopia). As a continent, Africa has been the one of the most conflict-prone region of the world since the 1970s, following Asia.

3.3. Estimation

All models were run using ordinary least-squares regression with Huber-White robust standard errors. Models estimated using robust regression and weighted average least squares regression returned similar results.

3.4. Results

Table 3 presents the results of the regression analysis. Models 1–5 are run on natural log-transformed counts of scholarly references in Google Scholar, and title references in Google Scholar, *Climatic Change*, *Global Environmental Change*, and *Nature Climate Change*, respectively. Model 6 reports results for the latent interest variable, while model 7 reports results for scholarly references in Google Scholar *excluding* references to climate change. The latter investigates whether revealed patterns are replicated in inquiries outside climate change research. The model coefficients of determination (R^2) range from 0.646 (model 1, Google Scholar references with terms appearing anywhere in the study) to 0.850 (model 6, the latent interest), indicating a high degree of explanatory power. Across all specifications, the mean variance inflation factor was 1.89, indicating multicollinearity is not a significant issue.

Four findings emerge:

1. Population is the single most significant determinant of scholarly attention: more research is conducted on more populous countries. Across all six specifications, the coefficient on ln population is positive and highly statistically significant ($p < 0.01$). Analysis of partial R^2 values – the proportion of overall variance in the model explained by each independent variable – indicates population alone explains between 29% and 51% of variation in scholarly attention.
2. Countries with physically larger territories receive more scholarly attention, though the effect is not robust across all specifications. The coefficients on ln total land area are significant and positive for all the climate change-specific journals and the latent measure of interest.
3. Neither physical exposure to negative impacts from climate change nor adaptive capacity are consistently correlated with scholarly attention. The coefficients on climate change exposure are mostly insignificant and comparatively small in four of five climate change-related specifications. Moreover, the sign in four of those five specifications (models 1, 2, 3 and 5) is negative,

Table 3
Correlates of Scholarly References related to Climate Change, by Country. ~Indicates "Climate Change" excluded from the search term.

Variables	(1) ln References in Google Scholar	(2) ln References in Title in Google Scholar	(3) ln References in *Climatic Change*	(4) ln References in *Global Enviro. Change*	(5) ln References in *Nature Climate Change*	(6) Latent Interest	(7) ln ~Climate Change Studies
ln Population, 2014	0.387***	0.914***	0.446***	0.324***	0.412***	0.432***	0.755***
	(0.064)	(0.122)	(0.074)	(0.056)	(0.099)	(0.063)	(0.115)
ln Total Land Area	0.033	−0.020	0.156***	0.090**	0.228***	0.115**	0.077
	(0.047)	(0.083)	(0.051)	(0.040)	(0.065)	(0.045)	(0.092)
Climate Change Exposure	−0.708	−0.803	−0.632	−0.339	2.903*	−0.301	1.133
	(1.325)	(2.351)	(1.189)	(0.941)	(1.444)	(1.049)	(2.112)
ln GDP per capita, 2014	0.013	−0.135	−0.045	−0.052	−0.000	−0.045	0.044
	(0.093)	(0.155)	(0.102)	(0.071)	(0.093)	(0.080)	(0.158)
Former British Colony	0.397***	0.953***	0.365**	0.443***	0.321	0.464***	0.629***
	(0.134)	(0.279)	(0.143)	(0.098)	(0.199)	(0.115)	(0.173)
Avg. Civil Liberties Score, 1972–2015	−0.206***	−0.565***	−0.290***	−0.177***	−0.372***	−0.264***	−0.260***
	(0.070)	(0.121)	(0.060)	(0.050)	(0.099)	(0.053)	(0.092)
Std. Dev. Polity Score, 1970–2015	−0.046	−0.119*	−0.037	−0.037	−0.098*	−0.050*	−0.059
	(0.028)	(0.060)	(0.033)	(0.024)	(0.049)	(0.027)	(0.049)
Armed Conflict Prevalence, 1970–2015	0.264	−0.266	0.031	0.019	−0.432	0.012	−0.485
	(0.266)	(0.628)	(0.287)	(0.228)	(0.349)	(0.252)	(0.447)
Constant	4.764***	−6.429**	−3.101*	−0.388	−6.456***	−6.401***	−2.806
	(1.481)	(2.945)	(1.813)	(1.339)	(1.824)	(1.475)	(2.531)
Observations	50	50	50	50	50	50	50
R-squared	0.646	0.796	0.827	0.828	0.779	0.850	0.765

Robust standard errors in parentheses.
*** $p < 0.01$
** $p < 0.05$
* $p < 0.1$.

indicating that greater physical exposure is negatively correlated with scholarly attention. The largest positive coefficient for climate change exposure ($\beta = 2.903^*$, *Nature Climate Change*) still implies only a modest increase in scholarly references of seven – slightly more than one quarter of the observed standard deviation (24.3) – when moving from the minimum (least exposed, Libya) to the maximum (most exposed, Seychelles) values in the sample. Exposure to negative impacts from climate change is therefore not a consistent or particularly strong predictor of scholarly attention. Adaptive capacity – proxied as GDP per capita – does not correlate with scholarly attention either. The signs on GDP per capita are uniformly negative in sign but close to zero and do not attain statistical significance in any specification. The results are inconsistent with both hypothesized effects of adaptive capacity ("worst-case" vs. marginal cost/benefit). Thus, only two of the four quasi-objective measures of "need" for scholarly attention – population and land area – correlate consistently and strongly with scholarly attention. Neither exposure to physical threats from climate change nor adaptive capacity appear to drive scholarly attention.

4. Cultural and political factors emerge as more important determinants of scholarly attention than physical exposure or adaptive capacity. Former British colonies receive significantly more scholarly attention. The estimated coefficients are positive and significant ($p < 0.01$) across five of six specifications, with the coefficient on the fifth (*Nature Climate Change*) positive but not statistically significant ($p = 0.11$). Table 4 reports the estimated average number of scholarly references for the four count measures for former British colonies and non-former British colonies holding all else equal. Estimates are calculated from coefficients presented in Table 3. The differences are dramatic, with former British colonies receiving 38% to 159% more scholarly attention, depending on the measure. Analysis of partial R^2 values indicate former British colony status explains up to one quarter of the variation in scholarly attention (model 4, *Global Environmental Change*).

Evidence regarding the effects of political factors was more mixed. As expected, countries with stronger civil liberties receive significantly more attention. The coefficients on average civil liberties score are negative and highly significant ($p < 0.01$) in all

Table 4
Effect of former British Colony status on Scholarly attention related to Climate Change. Point estimates and 95% confidence intervals presented. ~Indicates not a former British Colony.

	~Fmr. British Colony	Fmr. British Colony	% Change
Refs. in Google Scholar	22,246 (18,044, 27,432)	33,097 (27,368, 40,026)	+49 (+52, +46)***
Title Refs. in Google Scholar	26.2 (19.2, 35.7)	68.0 (44.5, 103.8)	+159 (+132, +190)***
Refs. in *Climatic Change*	43.0 (36.4, 50.8)	62.0 (49.7, 77.3)	+44 (+37, +52)**
Refs. in *GEC*	76.0 (67.7, 85.4)	118.4 (101.1, 138.6)	+56 (+49, +62)***
Refs. in *Nature CC*	8.5 (6.9, 10.7)	11.8 (8.9, 15.6)	+38 (+29, +47)†

† Effect is not statistically significant ($p = 0.11$).
*** $p < 0.01$; refer to Table 3 for actual coefficient estimates.
** $p < 0.05$; refer to Table 3 for actual coefficient estimates.

specifications, indicating that countries with weaker civil liberties receive less scholarly attention. Based on model 2, all else equal an electoral democracy with significant civil liberties like Mauritius (average civil liberties = 2.11) would be the subject of more than ten times (172 vs. 13) as many studies as a country like Equatorial Guinea, where there are virtually no freedoms of speech or association (average civil liberties = 6.6).

Political instability, operationalized both as regime variability (standard deviation of Polity) and the prevalence of armed conflict, is less uniformly correlated with scholarly attention (see again Table 3). The standard deviation of the Polity score – the measure that proxies the frequency and magnitude of shifts from authoritarianism to democracy – is negative but only weakly correlated ($p < 0.1$) with scholarly attention in three of the five specifications. Again, based on model 2, a country governed by stable political institutions (Namibia) would be the subject of 35 more studies than comparatively unstable Malawi. Surprisingly, armed conflict does not appear to affect scholarly attention: the coefficients switch signs from model to model and do not attain statistical significance in any specification. While this finding is somewhat surprising, it may be due to the effects of conflict operating through negative impacts on civil liberties and changes in regime type, which are known to follow armed conflict (Chen et al., 2008).

The results support two main conclusions. First, beyond population and land area, measures that proxy objective "need" for scholarly attention regarding the effects of climate change – physical exposure and adaptive capacity – are not correlated with increased scholarly attention.

Second, cultural and political factors that affect the convenience or capacity to conduct research but which are not directly related to the extent of climate-related impacts – particularly former British colony status and civil liberties – are significant determinants of scholarly attention. Table 5 reports the sums of partial R^2 values for the need-based and convenience/capacity-based variables across the five measures of scholarly attention. While the need-based components consistently explain more variation than convenience/capacity-based measures, the gap is not large. Only for *Climatic Change* do the need-based measures outperform the convenience/capacity-based measures by a wide margin. For Google Scholar references in the title, the convenience/capacity based variables actually outperform the need-based variables.

Model 7 (see again Table 3), which analyzes Google Scholar references not related to climate change, suggests these biases are not unique to climate change scholarship – scholarly attention on African cases flows disproportionately toward former British colonies and countries with stronger civil liberties more generally. This finding is consistent with the theoretical conjectures regarding convenience and capacity, which are not unique to climate change. Whether this issue is more endemic in the physical and/or social sciences is a question left for future research.

4. Changing attention over time?

Has the streetlight effect changed over time? Thus far, the analysis has focused on differences between countries rather than differences between countries and over time. This temporal aggregation may obscure more nuanced relationships between the hypothesized factors affecting scholarly attention, as these may be time-variant in their effects. For example, political instability and civil liberties might matter less for scholarly attention in the latter period, as advances in remote sensing have significantly reduced barriers to data collection from afar for certain physical phenomena like land use, soil moisture, or sea level rise, obviating the need for researchers to operate in the field (see, for example, Zhuravleva et al., 2013).

To investigate this possibility, I present models that assess the extent of the streetlight effect across two time periods. The dependent variable is the natural log of references in *Global Environmental Change* for the periods 1990–1999 and 2000–2016. *Global Environmental Change* was chosen because of high correlations (all $r > 0.86$, with $r = 0.99$ for the latent interest variable) with the other indicators of scholarly interest, it began publishing in 1990 (so coverage is consistent across the two periods), and it was the most highly cited journal (with 36 references, versus 22 for *Climatic Change* and three for *Nature Climate Change*) in the Africa chapter in the WGII AR5.

Fig. 1 plots the raw counts of references across the two time periods for the 54 cases in the sample. The values are highly correlated ($r = 0.89$) across the two time periods, though the order-of-magnitude difference in the scales across the two time periods suggests significant growth, in absolute terms, in attention paid to African cases in general in the latter period. The dashed, roughly 45° line corresponds to predicted values. Values above the line indicate a case received relatively more attention in the earlier period, while values below the line indicate a case received more attention in the later period. The scatterplot suggests that of the most studied Anglophone African countries, Kenya dominated scholarship in the 1990s but South Africa received the most attention in the 2000s. This may have been related to South Africa's history of *apartheid*, which did not end until 1991, and white minority rule, which did not end until 1994. South Africa had been under a UN General Assembly-endorsed academic boycott since 1980, though some researchers did not recognize the boycott.

In these models, population, land area, GDP per capita, and the variables that proxy political openness and stability are calculated as means or standard deviations for corresponding time period. Climate change exposure and former British colony status are time-invariant. As with the core specifications, all models are run using ordinary least-squares with robust standard errors.

Table 6 presents the results of these models. Model 8 includes results for the period 1990–1999; models 9 and 10 include results for the period 2000–2016, with model 10 including a lagged

Table 5
Partial R^2 Analysis: Need-Based vs. Convenience/Capacity-Based Correlates of Scholarly Attention related to Climate Change.

	Need-Based	Convenience/Capacity Based	Difference
Refs. in Google Scholar	0.29	0.22	0.07
Title Refs. in Google Scholar	0.52	0.56	−0.04
Refs. in *Climatic Change*	0.62	0.39	0.23
Refs. in *GEC*	0.57	0.49	0.08
Refs. in *Nature CC*[†]	0.60	0.48	0.12
Latent Interest	0.67	0.57	0.10

Note: Partial R^2 can sum to greater than 1.0.

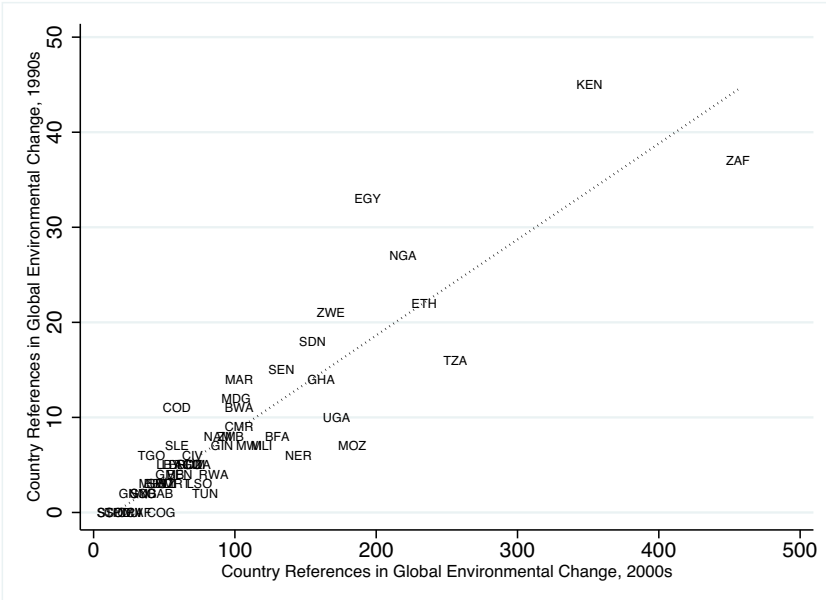

Fig. 1. Scholarly Attention to African Cases in *Global Environmental Change*, 1990s vs. 2000s. Values are counts of Google Scholar-indexed studies that mention the country in the journal *Global Environmental Change*. The roughly 45° line is predicted values, given scholarly interest in the 1990s. The correlation between values at the two time periods is high (r = 0.89), though the overall volume of scholarly attention increased significantly in the 2000s.

Table 6
Correlates of Scholarly References in Global Environmental Change over Time.

Variables	(8) ln References in Global Enviro Change, 1990s	(9) ln References in Global Enviro Change, 2000s	(10) ln References in Global Enviro Change, 2000s
Lagged DV			0.322***
			(0.082)
ln Population, 90 s Average	0.385***		
	(0.073)		
ln Population, 00 s Average		0.328***	0.170***
		(0.055)	(0.058)
ln Land Area, 90 s Average	0.119**		
	(0.058)		
ln Land Area, 00 s Average		0.088**	0.063*
		(0.036)	(0.034)
Climate Change Exposure	−0.952	0.122	0.188
	(1.481)	(1.209)	(1.039)
ln GDP per capita, 90 s Average	−0.218***		
	(0.078)		
ln GDP per capita, 00 s Average		−0.006	−0.010
		(0.056)	(0.053)
Former British Colony	0.838***	0.418***	0.215**
	(0.146)	(0.107)	(0.103)
Civil Liberties, 90 s Average	−0.076		
	(0.061)		
Civil Liberties, 00 s Average		−0.108***	−0.094***
		(0.033)	(0.026)
Std. Dev. Polity, 90s	−0.139***		
	(0.034)		
Std. Dev. Polity, 00s		−0.014	0.001
		(0.035)	(0.035)
Armed Conflict Prev., 90s	−0.285		
	(0.226)		
Armed Conflict Prev., 00s		−0.236	−0.089
		(0.215)	(0.169)
Constant	−3.084**	−1.529	0.685
	(1.356)	(1.283)	(1.231)
Observations	50	50	50
R-squared	0.829	0.823	0.867

Robust standard errors in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

dependent variable. The coefficient on the lagged dependent variable is positive and highly significant ($p < 0.01$). Consistent with the earlier discussion of path dependency in case selection, scholarly attention in the 1990s is a strong predictor of scholarly attention in the later period (Ebbinghaus, 2005).

In both periods, population ($p < 0.01$) and total land area ($p < 0.05$ in models 8 and 9, $p < 0.1$ in model 10) were positively correlated with scholarly references in *Global Environmental Change*, while the measure of physical exposure was not: the sign switches from model 8 to models 9 and 10 and standard errors are quite large. Adaptive capacity, proxied as GDP per capita, was negatively correlated with scholarly interest in the 1990s, with more research targeting relatively poorer countries, but uncorrelated with scholarly interest in the latter period.

Confirming the earlier cross-sectional findings, former British colonies receive significantly more scholarly attention ($p < 0.01$ in models 8 and 9, $p < 0.05$ in model 10), a finding that is recovered even when the lagged dependent variable is included and through which some of the effect of former British colonial status presumably operates.

Finally, the effects of the political variables were largely consistent with the cross-sectional analysis. While civil liberties were not associated with scholarly interest in the 1990s, countries with greater civil liberties received significantly more scholarly attention in the 2000s than their more closed counterparts ($p < 0.001$ in models 9 and 10). Finally, while political instability (Std. Dev. Polity) depressed scholarly attention in the 1990s, it does not appear to affect targeting in the latter period.

As a whole, these findings are largely consistent with the broader cross-sectional analysis presented in Table 3 and indicate the streetlight effect is largely consistent across time periods, though political instability mattered more in the 1990s and political openness more in the 2000s.

5. Discussion

Scholars studying the impacts of climate change in Africa have devoted roughly the same amount of attention to Kenya and South Africa – two countries with a combined population of 99 million and which account for six percent of the continent's land mass – as to 29 other African countries whose combined population numbers 280 million and which comprise nearly half (44%) of the continent's land mass. The present analysis suggests this imbalance has less to do with differences in physical exposure or adaptive capacity and more to do with their status as former British colonies and their more open political systems. And while this finding might be attributed in part to latter-period democratization and increasing respect for civil liberties in several prominent Anglophone cases that were targeted for research in the 1990s and which subsequently became significantly more open (Kenya, Nigeria, and South Africa), the exclusion of these cases did not materially alter the results.

These results have empirical, normative, and practical implications. First, efforts like those of the IPCC should be careful to note the potential scope conditions implied by the biased nature of research on climate change in Africa. The literature acknowledges the physical effects of climate change are contingent on and interact with contextual factors like the quality of governance, levels of development, and societal resilience that affect adaptive capacity (Adger et al., 2005). To the extent our case selection leads to bias in the cases on which climate change research is conducted, it introduces uncertainty about potential scope conditions and limits external validity for applying the findings to different contexts.

Take the example of community-based approaches to assessing and developing adaptive capacity, which is considered a crucial component of adaptation policy in areas of comparatively weak governance (Van Aalst et al., 2008; Reid et al., 2009). The IPCC AR5 WGII chapter on Africa discusses at length both physical vulnerability and adaptive capacity, and notes with "high" confidence that since the AR4 (2007), "there has been progress in Africa in implementing and researching community-based adaptation . . . with broad agreement that support to local-level adaptation is best achieved by starting with existing local adaptive capacity, and incorporating and building upon present coping strategies and norms, including indigenous practices" (Niang et al., 2014; 1229). "High" is the second-highest category of confidence in the validity of the author teams' judgments about the findings as determined through "evaluation and agreement" (Mastrandrea et al., 2010).

The evidence for this claim is based on 16 projects implemented at the local level, twelve of which were implemented in former British colonies: Ethiopia, *Ghana*, *Kenya* (×3), *Malawi*, Mozambique, Niger, Senegal, *South Africa* (×2), *Sudan*, *Tanzania*, *Uganda*, *Zambia*, and *Zimbabwe* (former British colonies italicized). That is, 75% of the evidence for a claim made about Africa *as a region* is derived from nine former British colonies representing 26% of Africa's population and 23% of its land mass. To the extent that the success of these community-based adaptation projects is contingent on demographic, economic, linguistic, political or social factors disproportionately present in former British colonies, the inference about Africa as a whole suffers from bias – or at the very least, has implicit and unacknowledged scope conditions.

This example is not unique. Country mentions by name in the IPCC AR5 Working Group II chapter on Africa (log normalized) are strongly correlated with the latent measure of scholarly interest ($r = 0.87$), which the present analysis demonstrates is biased toward former British colonies and countries with stronger civil liberties. Given the substantial literature on colonial legacies in Africa, which demonstrates lasting institutional, economic, and political effects of colonial rule, there is ample reason to believe this bias is important for understanding climate change impacts and prospects for adaptation (Young, 1994; Joireman, 2001; Glaeser and Shleifer, 2002; Djankov and Reynal-Querol, 2010).

These biases are likely to be largest for those issues and questions that cannot be addressed straightforwardly with remote-sensed or widely reported data like the World Bank's *World Development Indicators*. Analyses based on such data can be undertaken without the need for researchers to conduct extensive field work in-country and/or obtain official permission to conduct research. However, adaptive capacity may be determined by a host of highly local institutional and social factors that can only be observed crudely from afar, so studies relying on remote-sensed or widely reported, macro-level data cannot be expected to fully fill this gap in knowledge. Linguistic/cultural barriers and concerns about political context are likely to be more paramount for "ground-level" studies that require researchers to be physically present in the area under study. This is true for micro-level studies that are both qualitative and quantitative in nature, such as those that make use of structured surveys. Similar arguments can be made for the study of particular organisms and ecosystems that range across primarily non-Anglophone West and Central Africa. Tagging birds or taking tree ring samples may not require the use of English, but researchers may nevertheless be disproportionately drawn to field studies in more linguistically familiar, politically permissive environments.

The normative implications are almost self-evident: if climate change research is motivated in part by a desire to illuminate the impacts of climate change for those people and ecosystems most vulnerable to its consequences, there is no ethical reason why we would more highly value people or ecosystems simply because they exist in a territory that happened to be colonized by the

British in the 18th and 19th centuries or have stronger civil liberties in more recent decades. Yet this analysis implies our scholarship does just this.

This article adopts a country level of analysis, despite the fact that the effects of climate change often do not follow political boundaries. This implies two limitations that create avenues for future research. First, scholars may investigate the extent of the streetlight effect in the study of both subnational units and transboundary watersheds, animal and plant ranges, and river basins. For example, the present analysis suggests that particular river basins may benefit from much more scholarly attention based on their traversing Anglophone, more politically open countries. The Limpopo river basin has received more climate change-related scholarly attention than the Niger river basin (828 Google Scholar-indexed studies vs. 759, search methodology as above), even though the Niger river basin population is at least six or seven times greater. This may be due to the Limpopo flowing through three Anglophone countries (Botswana, South Africa and Zimbabwe, plus Lusophone Mozambique), whereas the Niger basin is composed mostly of former French colonies (Algeria, Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali and Niger, plus Anglophone Nigeria). Second, the analysis does not capture region-wide studies that do not mention particular country cases by name. Though these studies are fewer in number than studies mentioning particular cases, they may nevertheless contain important information for informing local knowledge and planning around the physical and social impacts of climate change.

This article suggests two concrete policy recommendations. First, both climate change research funders and researchers should place greater emphasis on grant proposals and projects addressing non-Anglophone and – where practical – less politically open cases. The 2014 IPCC chapter on Africa identifies several overarching data and research gaps, but biased coverage of particular country cases is not one of them (Niang et al., 2014; 1243). This is not to suggest climate researchers book tickets immediately for a highly authoritarian country in which they do not speak the language, but simply that preference should be given to proposals that address less well-covered cases. Doing so will be important in advance of the AR6, to be released in 2020/2021, so that volume can hopefully incorporate insights from a more diverse set of cases.

Second, the Anglophone bias might be partially addressed by funders providing resources for high-quality English translation of scholarly manuscripts and supporting materials. This would likely lead to greater coverage of Francophone, Lusophone and Arabic-speaking African countries, as well as Ethiopia and Eritrea. While the IPCC disseminates research in the six official United Nations languages (Arabic, Chinese, English, French, Russian and Spanish) and some IPCC synthesis reports and technical papers have been translated into non-UN languages, similar effort could be expended on translating primary research to inform IPCC assessments.

As a scholarly community, we have invested far more time, energy and resources in understanding the impacts of and adaptation to climate change in some African cases than in others. These discrepancies are only partially explained by proxies for objective need. This study indicates former British colonies and countries with stronger civil liberties are systematically overrepresented in the research on climate change impacts and adaptation in Africa. In researching these phenomena, we have been looking disproportionately where the light is most plentiful, rather than where the manifest need or opportunities for affecting outcomes are greatest. Addressing these systematic biases in the state of our knowledge is crucial for both scientific and ethical reasons.

Acknowledgements

The author would like to thank Marc Bellemare, Sarah Glaser, Dale Rothman, Idean Salehyan, and Johannes Urpelainen for comments and suggestions on earlier drafts of the manuscript. Any errors are the author's alone.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.gloenvcha.2017.01.009.

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