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PERSPECTIVE

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Steps to overcome the North–South divide in research relevant to climate change policy and practice

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A global North–South divide in research, and its negative consequences, has been highlighted in various scientific disciplines. Northern domination of science relevant to climate change policy and practice, and limited research led by Southern researchers in Southern countries, may hinder further development and implementation of global climate change agreements and nationally appropriate actions. Despite efforts to address the North–South divide, progress has been slow. In this Perspective, we illustrate the extent of the divide, review underlying issues and analyse their consequences for climate change policy development and implementation. We propose a set of practical steps in both Northern and Southern countries that a wide range of actors should take at global, regional and national scales to span the North–South divide, with examples of some actions already being implemented.

The North–South divide (see Box 1) has significant implications for how science is designed, produced, implemented, interpreted, and communicated. As such, the steps required to span the divide, seen in disciplines such as medicine[1], education[2], and environmental science[3,4], should be of considerable interest not only to the scientific community but also to all those working at the science-policy interface. Understanding of local contexts is facilitated when research is led by researchers from a country relevant to the investigation. This may be essential if scientific outputs are to be viewed as inclusively generated and as reflective of socio-political and cultural circumstances, thereby encouraging decision-makers to translate results into locally sensitive policy and practice. Similarly, the key features of knowledge that are effective in influencing policies — credibility, salience and legitimacy[5] — will be bolstered in relation to global issues in both the South and North by the equitable involvement of Southern as well as Northern researchers. Knowledge produced in a more equal manner will be seen as more impartial (not biased by a Northern-dominated perspective) and relevant (sensitive to local contexts in both Northern and Southern countries). In relation to climate change research, the North–South divide has been outlined through analysis of the distribution of peer-reviewed publications together with its underlying causes[6], authorship of reports by the IPCC[7], and the IPCC's geographical expertise[8].

Currently, most of the science underpinning agreements and policy instruments developed under the UN Framework Convention on Climate Change (UNFCCC) is generated in the North[7,8] and it is Northern countries that have set the global climate change policy agenda since the beginning[9]. The Paris Agreement heralds a new bottom-up approach with countries providing their own Nationally Determined Contributions (NDCs). However, Northern domination of science globally relevant to climate change policy and practice and lack of research led by Southern researchers in Southern countries may hinder development and implementation of bottom-up global agreements and nationally appropriate actions in Southern countries. The divide may impact most on least developed countries (LDC) and small island developing states (SIDS), which are the most vulnerable to climate change[10] but contribute least to relevant research[6].

Despite efforts to address the problem of the North–South divide in science — by intergovernmental organizations (including the IPCC), international donor organizations, national government bodies, national research councils, scientific journals, and others[11,12] — improvement in the situation has progressed in slow motion[13]. In recognition of the importance of spanning the divide, the United Nations' 2030 Agenda for Sustainable Development includes a number of relevant goals and targets in science and

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Box 1 | North–South definitions.

For the sake of simplicity, we use the terms 'North' and 'Northern' to refer to countries that are members of the OECD (Organisation for Economic Co-operation and Development) or are classified as high-income economies by the World Bank, based on estimates of gross national income per capita. These are largely, but not exclusively, countries in Europe, North America, East Asia and Australasia. The terms 'South' and Southern' are, therefore, used here by default to refer to countries classified as upper-middle income, lower-middle income or low-income economies, which are mostly, but not wholly, located in the rest of Asia, Africa and Latin America[34].

technology[14]. Building upon this backdrop, we would advocate that the practical steps identified in this Perspective should be comprehensively implemented in order to catalyse a paradigm shift from a Northern-dominated research culture that underlies the divide to one that supports the equitable involvement of Southern researchers in scientific development.

The extent of the divide

Past analyses of publications have sought to explore the depth of the North–South divide in research[2,4,6]. Given the very wide range of scientific disciplines that inform climate change policy and practice, for the purposes of this Perspective, the North–South divide can be simply and swiftly illustrated by the World Bank's development indicators, compiled from officially recognized international sources, which include various statistics by country for science and technology[15], and by relatively simple analyses of the authorship of scientific journal papers.

The World Bank's data shows that the national average: number of scientific and technical journal articles produced in 2011 by researchers from Northern countries was 10,442, compared to 1,323 from Southern countries; full time equivalent researchers per million people was 3,220 in the North and 393 in the South for the period 2005–2014; expenditure on research and development was 1.44% and 0.38% of gross domestic product (GDP) in Northern and Southern countries respectively for the period 2005–2014.

Figure 1 presents analysis of almost half a million scientific papers covering all fields of research for the years 2000–2014 (see Supplementary Methods for further information). We have found that the average percentages of first authors affiliated to institutions in the focal country of the particular studies for each World Bank country income category shows a very steep declining gradient from high-income to low-income economies (Fig. 1b). Moreover, the average percentages for first authors affiliated to Northern institutions is greater than 50% in all country income categories except upper-middle income economies. We have found that authors affiliated to Northern institutions, specifically those from the OECD, also dominate the authorship of scientific papers that explicitly address climate change issues (Fig. 2; see Supplementary Methods for further information about the analysis). During the period 2000–2014, more than 85% of the author affiliations of relevant scientific papers published (93,584 publications) were from OECD countries, while less than 10% were from other high-income economies or each Southern country income category (only 1.1% in the case of low-income economies). This mirrors a previous finding that around 80% of authors and reviewers of successive assessment reports produced by the IPCC were from OECD countries[7].

Underlying issues

The North–South divide is a consequence of Southern countries' lesser capacities to pursue research[3,16]. Although there is little quantitative research to illuminate the reasons for these differences in capacity, some indications have been provided. For example, it has been suggested that Northern countries are the main suppliers of knowledge relevant to climate change policy and practice because they are more stable and richer, ensuring a higher level of secondary school enrolment and more resources for research and development[6]. Other studies have also underlined the relationships between GDP and spending on research and development and publication rates[4]. In general, investment in research and development is concentrated in the North. For example, only 10% of funding for health research is spent in the South, where 90% of the world's burden of disease resides[17]. However, it has been suggested that a nation's wealth may not guarantee scientific productivity, and that governance factors may also play a role[4]. Other limitations may be linked to lack of scientific traditions and adequate academic education and resources[16,18] which may hinder Southern researchers in their engagement with internationally recognized science.

Apart from the impact of a country's wealth, Northern researchers may be more successful in securing funding for a range of practical reasons. They usually lead many more international proposals than Southern researchers, as they tend to be more conversant with the rigours of grant procurement, have better internet access for completion of online applications, greater command of English[19] and better *curricula vitae*, fuelled by previous successes. Similarly, Northern researchers may not only be more successful at publishing because of their greater capacity to pursue research and because relevant investment is concentrated in the North, but also because Southern researchers may face practical challenges that vary in their severity from country to country. Southern researchers may be: (i) less familiar with journal requirements; (ii) unable to reference relevant/recent literature, as access to publishing houses' outputs and databases is often prohibitively expensive[20]; (iii) hampered in completing online submission of manuscripts due to poor internet access; and (iv) less fluent in English[19].

Practical issues may encourage prejudice (from Northern funders, research institutions, and researchers) regarding the capacity of Southern institutions to lead North–South partnerships and of Southern researchers as lead authors, which may compound barriers to funding and publishing[17]. Hence, North–South research programmes may often demonstrate tokenistic engagement of Southern researchers by Northern researchers in order to secure funding[21]: "…it is common for research funding to be sourced from an agency in the North so that the Northern research partners are closer to the funders. Leadership is usually held by a Northern partner and a small minority of Research Program Consortia are led by Southern institutions." Institutional funding arrangements may also seek to promote Northern researchers at the expense of Southern researchers due to national interests, for example, national research councils' promotion of research by their own nationals rather than more generally. They may not explicitly advantage Northern researchers but may do so indirectly by addressing research priorities and methodological standards that comply with the cultural and scientific traditions and perspectives of the North[17,22].

Barrett *et al.*[21] noted that successful collaboration requires Northern and Southern researchers to understand each other's working environments, with clear lines of responsibility for the implementation of action plans. Northern researchers may have limited appreciation of the infrastructural, cultural and contextual challenges faced by Southern researchers or Southern beneficiaries of North–South research programmes. Thus, Southern researchers need to be able to adequately inform Northern researchers' development of research frameworks and models of Southern issues, which also need to make use of locally developed evidence bases. Hence, knowledge exchange needs to happen North–South, South–North and South–South within a frame of mutual respect[12]. However, it seems that hierarchical attitudes mean that North–South

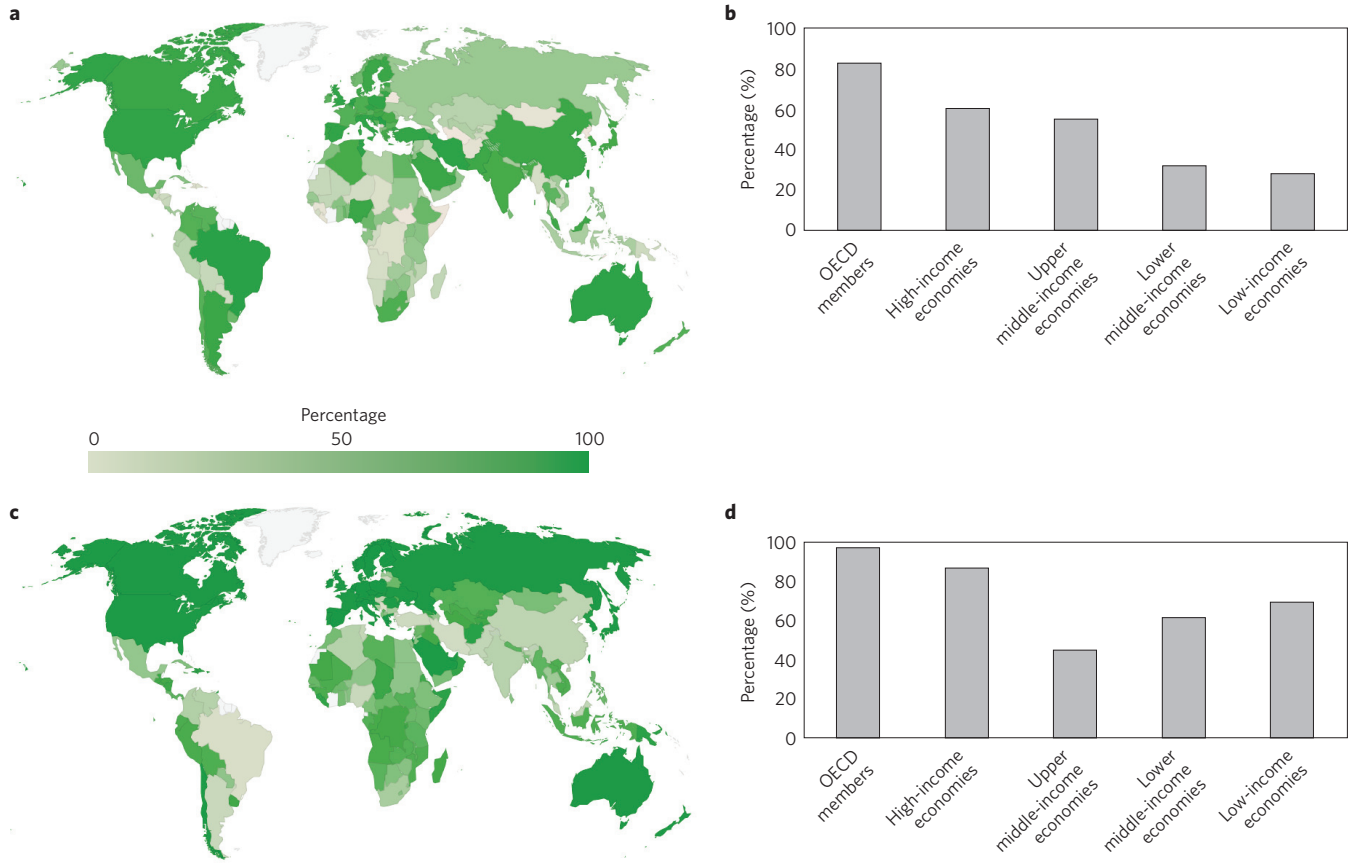

Figure 1 | Affiliations of first authors of scientific papers published in 2000–2014 in relation to countries' economic status and by country. **a**–**d**, Average percentages for each country-income category are presented in relation to: first authors affiliated to institutions in the focal country of the particular studies, (**a**) and (**b**); first authors affiliated to Northern institutions, (**c**) and (**d**). The number of countries and papers in each income category included in the analyses: OECD members (28 countries; 170,535 publications), high-income economies (16 countries; 31,189 publications), upper middle-income economies (42 countries; 171,136 publications), lower middle-income economies (38 countries; 60,886 publications), low-income economies (33 countries; 35,002 publications).

communications tend to dominate leading to a lack of common understanding with impacts on the efficacy of research. This situation may be compounded when Northern researchers rarely visit Southern countries, are poorly acquainted with the characteristics of Southern academic environments, or arrive in the South with inadequate qualifications to pursue research[17].

Insufficient opportunities for academic education at home and the lure of a more supportive research environment abroad may seduce many young Southern researchers to stay in Northern countries after undertaking postgraduate studies at Northern universities. This may encourage a brain drain[16,23,24], as they may neither return to the South nor sustain academic links with their countries of origin[25]. Lack of long-term funding commitments may also lead to an 'internal' brain drain, as it may prevent Southern research institutions from retaining qualified people or keeping postgraduate students long enough to secure their qualifications[26]. This may, for example, make research projects more difficult to complete, undermining the collective efforts required to define outputs and to deliver them[2]. In addition, Southern researchers may become isolated from other experts due to neglect of regional and national research networks[27].

Consequences of the divide for climate change policy

There is a paucity of empirical research on the implications for climate change policy development and implementation of the North–South divide in science. However, it seems reasonable to assume that Northern domination of science globally and lack of research led by researchers from Southern institutions may hinder further development and implementation of global climate change agreements and nationally appropriate actions in a range of ways.

Karlsson *et al.*[4] have suggested that the North–South divide in environmental research deprives the scientific community of considerable intellectual capital, influences research priorities and "most likely confines approaches to narrow paradigms from a few cultural settings and perspectives". Similarly, the divide in research relevant to climate change policy and practice may limit Southern countries' understanding of the scientific background and use of evidence-based arguments within the work of the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation of the UNFCCC. As a result, the views of Northern researchers may dominate the way in which these bodies provide scientific advice and assessments of implementation to support the work of: the Conferences of the Parties; and the Conferences of the Parties serving as the Meeting of the Parties to the Kyoto Protocol[7]. This situation may be compounded by Southern policymakers not trusting their own scientists, if they lack international credibility[28], and instead relying more on experts, data, and knowledge from the North[29]. Southern scientists have argued that most studies feeding into global assessments focus directly or indirectly on issues more relevant to the North and are often based on assumptions not transferable to the South[30].

The North–South divide in research relevant to climate change policy and practice favours richer countries, which emit more carbon and are less vulnerable to climate change[6], and puts LDC and

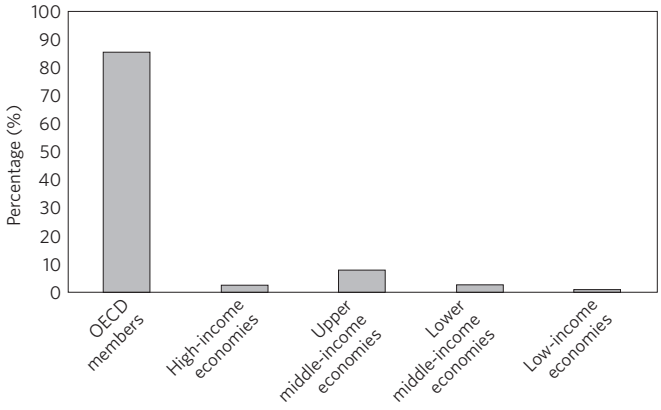

Figure 2 | Affiliations of authors of scientific articles about climate change in relation to countries' economic status. Percentage of author-affiliations of scientific articles published in 2000–2014 (93,584 publications) concerning climate change (that is, with "climate change" or "climatic change" in the title, abstract or keywords) from each country income category.

SIDS at a severe disadvantage[6,10]. Therefore, the divide may help fuel many of the long-standing divisive issues in global negotiations between Northern and Southern policies[9]. To take a current example, as a consequence of the divide, Southern countries may have limited abilities, on the one hand, to pose evidence-based questions as to whether Northern countries' NDCs to global mitigation goals/targets are equitable and, on the other hand, to accept positions put forward by Northern countries and justified by Northern research that Southern countries may perceive as biased towards Northern countries' vested interests. Both asymmetrical phenomena may inevitably lead to further questioning of the adequacy of Northern countries' contributions to the Paris Agreement's main aim to keep global temperature rise this century well below 2 °C and to drive efforts to limit the temperature increase even further to 1.5 °C above pre-industrial levels.

As specific local factors may not be considered or sufficiently accounted for in generating and implementing scientific knowledge[4,31], the divide may hinder Southern countries' presentation of robust Nationally Appropriate Mitigation Actions (NAMAs), Low Emission Development Strategies (LEDSs), NDCs and National Adaptation Plans (NAPs). A lack of relevant science about these countries may threaten the global legitimacy of NAMAs, LEDs, NDCs and NAPs and thereby have a negative impact on implementation of the Paris Agreement's outcomes on funding, in general (for both mitigation and adaptation), or on countries' individual abilities to secure international funding (for example, through the Green Climate Fund or Reduced Emissions from Deforestation and Forest Degradation; REDD+). A lack of involvement of researchers from institutions within countries in science underpinning their NAMAs, LEDs, NDCs and NAPs may also threaten the local legitimacy of these documents and, thus, impede their implementation on a global basis. Furthermore, Southern countries' capacity to implement NAMAs, LEDs, NDCs and NAPs may be dependent on research and technology transfer from the North, which is unlikely to be adapted to the specificities of Southern countries[6]. More specifically, limited research about Southern countries, especially research led by academics from local institutions, limits the efficacy and legitimacy of: assessments of climate change vulnerabilities, impacts and risks (for example, in relation to harmonized presentation of Country-Level Impacts of Climate Change; http://go.nature.com/2fInh6k); disaster risk reduction; monitoring, reporting and verification; monitoring and evaluation of adaptation actions; and National Communications to the UNFCCC.

The potential consequences of the North–South divide in research for climate change policy development and implementation, globally and locally, are difficult to evidence systematically, as they have received limited attention from the research community to date. Future empirical studies are urgently needed to investigate the implications of the North–South divide for climate change policies and action at global and local scales for Southern and Northern countries. It will be vital that such research is pursued with appropriate involvement of researchers from the North and the South. Similarly, there is a need for more studies quantifying the issues that underlie the divide and linking these issues to their consequences.

A practical way forward

A number of the United Nations' Sustainable Development Goals (SDGs) and targets directly address the need to span the North–South divide in science (for example Targets 4b, 9.5, 9b, 12a, 17.6–17.9, 17.18)[14]. They underline the necessity of: strengthening Southern countries' scientific and technological capacities; ensuring a conducive policy environment to support their development, research and innovation; building a stronger educational base; and enhancing North–South, South–South and triangular regional and international cooperation in science, technology and innovation.

In order to advance the SDGs and span the North–South research divide, a comprehensive approach that addresses both the underlying issues and their consequences for science is needed. In 2007, Karlsson *et al.*[4] outlined two key general strategies for tackling the divide in relation to environmental sciences. They provided a set of actions that focused on either changing the patterns of knowledge production or the process of decision making in order to soften the consequences of the divide at the science/policy interface. However, almost ten years later, the divide remains as deep as ever. Hence, building on their approach, we recommend a set of practical steps in both Northern and Southern countries (Box 2), identified specifically in relation to a wide range of actors at global, regional and national scales, including: intergovernmental and international donor and governmental organizations; research programmes and institutions; and publishers of international journals. As mentioned in relation to the extent of the divide, research across a very wide range of scientific disciplines is relevant to climate change policy and practice. Hence, the recommended steps are intended to address the overall capacity of Southern researchers to contribute to the development of knowledge.

Some of the practical steps are already being implemented to bridge the North–South divide in research in ways that can be built upon. We provide examples in relation to each of the groups of actors in Box 2.

Intergovernmental organizations, international donor organizations and Northern governmental institutions are already making efforts to promote postgraduate education in Southern countries. For example, some provide opportunities for PhD internships, or PhD scholarships for Southern researchers to study in Northern countries, including the British Council's Newton Bhabha Fund (http://go.nature.com/2gpfPhA) and the United Nations' University's World Institute for Development Economics Research (https://www.wider.unu.edu). The IPCC Scholarship Programme (http://go.nature.com/2fuvDAD) is a prime example of an initiative that aims to build the research capacities of young Southern scientists in relation to climate change. The Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) Fellowship Programme of the United Nations Environment Programme (http://www.unep.org/provia), which seeks to build the capacity of young scientists particularly from Southern countries, with a focus on South–South collaboration, was launched in 2015. Even more recently, in March 2016, the Wellcome Trust, in partnership with others, launched a new programme for early-career scientists from non-G7 countries (that is, not Canada, France, Germany, Italy, Japan, the UK or the US) who have

Box 2 | Recommended practical steps to span the North–South divide in research.

Intergovernmental organizations, international donor organizations and Northern governmental institutions should promote postgraduate education in Southern countries through:

- Provision of long-term funding to improve working conditions and stability in Southern institutions
- Financial support for students to conduct studies in their country of origin — for example, providing scholarships and funding for research
- Funding of necessary equipment, laboratory facilities and salaries for assistants
- Mentorship programmes that encourage Northern researchers to support young Southern researchers
- Development of 'sandwich' graduate programmes where students spend time in both Northern and Southern countries
- Organizational and financial support for online courses

Intergovernmental organizations, international donor organizations and Northern governmental organizations should:

- Establish North–South research programmes and research networks and ensure that both Northern and Southern researchers have a substantive input to their design
- Encourage Southern researchers to return to academic institutions in the South to continue their research after completing postgraduate studies or research projects in the North
- Support Southern researchers in Northern countries to contribute to research in their countries of origin
- Encourage researchers affiliated to institutions in the vicinity to lead identification of regional, national and local research needs and engagement with policymakers and practitioners
- Encourage researchers affiliated to institutions in the vicinity to coordinate review and synthesis papers that summarize findings and apply those findings to regional, national or local contexts
- Financially support international journals to help span the divide

North–South research programmes should:

- Use simple online application procedures, for example, document download/upload options as an alternative option to online forms
- Encourage experienced Northern and Southern scientists to mentor Southern researchers through the application process to act as principal investigators and to be lead authors
- Preferentially fund projects with researchers in lead or key roles from the country that is the focus of the research
- Encourage Southern researchers to lead data gathering, stakeholder consultation, and all possible aspects of research, with the support of experienced Northern and Southern researchers
- Ensure that Northern researchers are mentored by Southern researchers to increase their cultural sensitivity and understanding of local contexts
- Require Northern researchers to undertake visits to the county being researched frequently for as long as possible, to interact with Southern researchers and seek guidance and support from them

Southern governments should:

- Lobby intergovernmental organizations and international donor organizations to fund Southern research priorities by Southern research institutions
- Support local research programmes by providing research funding
- Promote development of graduate and post-graduate programmes in Southern academic institutions

Southern research institutions should:

- Build alliances with both Northern and Southern scientific communities to share common research infrastructure and to strengthen local capacity to perform high-quality research
- Build networks of South–South collaborations to strengthen researchers' capacities to cooperate with Northern researchers and with other Southern colleagues, and make use of existing experiences, knowledge and expertise within the South
- Work together to address common research priorities that span several Southern countries in order to approach regional problems and maximize use of the existing research base
- Consolidate and create local graduate programmes in order to develop new generations of scientists
- Support young researchers to return from studies in the North so that they may continue to contribute to the generation of Southern knowledge
- Promote interdisciplinary and multinational projects incorporating Southern researchers
- Provide conditions for testing innovative and creative methodologies that match the local context rather than reproduce Northern approaches

Publishers of international journals should:

- Have policies that welcome research from Southern countries, for example, enabling iterative submissions and revisions in order to secure scientific advice to improve quality, and provide free editorial language services and reduced fees for publications by Southern researchers
- Provide open access or reduced fees for Southern researchers
- Increase representation of Southern researchers on editorial boards

trained in the UK or US but want to continue their research in their home country (http://go.nature.com/2fuoMYc).

Intergovernmental organizations, international donor organizations and Northern governmental institutions have established a range of North–South research programmes and research networks. Some, such as Wealth Accounting and the Valuation of Ecosystem Services (https://www.wavespartnership.org), Ecosystem Services for Poverty Alleviation (http://www.espa.ac.uk), Implementing Education Quality in Low-Income Countries (http://www.edqual.org)[21] and NeTropica[32] (a scientific network in the field of tropical diseases; http://go.nature.com/2frFpjM) have been active in seeking to address some of the other actions in Box 2. For example, they have deliberately distributed programme and project leadership among both Northern and Southern partners, and introduced publishing and authorship guidelines. The West African Science Service Center on Climate Change and Adapted Land Use (http://www.wascal.org), funded by the German Federal Ministry of Education and Research, was initiated to develop effective adaptation and mitigation measures for climate change and has sought to strengthen local research capacities in collaboration with German universities.

Box 3 | Examples of consequences of implementing steps to span the North–South divide.

Southern researchers would equitably:

- Contribute to development of global research frameworks and global models of climate change issues
- Be involved in the global review and synthesis of relevant science, for example, IPCC assessment reports
- Inform downscaling of global climate models to Southern regions or countries
- Contribute to science underpinning development of Southern countries' greenhouse gas inventories

Southern researchers would:

- Lead research that may be used to inform Southern countries' national assessments of mitigation, vulnerabilities, impacts, risks, and adaptation so that infrastructural, cultural and contextual challenges, data, policymakers, and practitioners are taken into account adequately
- Encourage citizen science in monitoring, reporting and verification, and monitoring and evaluation of adaptation actions

Some Southern governments are already making greater investments in research, as indicated by the World Bank's statistics[15] on both the number of full time researchers per million people and expenditure on research and development as a proportion of GDP, particularly by some upper-middle income countries (for example, China, Brazil, or Malaysia). However, the scale of investment is still extremely limited compared to Northern countries.

There is a range of existing South–South initiatives by Southern research institutions. For example, these include the Consortium of Global South Youth Scholars[33], and the South Asian University (http://www.sau.int), an international university established by the eight member nations of the South Asian Association for Regional Co-operation: Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka.

With regard to improving Southern researchers' access to high quality scientific literature, the Research4Life initiative (www.research4life.org) has already made substantial headway in providing Southern countries with online access to — and training for — academic and professional peer-reviewed journals. Formed from three programmes sponsored by the United Nations, Research4Life is a public–private partnership involving more than 130 science publishers.

While the examples above provide some optimism, nevertheless more extensive and concerted actions are required to implement all of the steps in Box 2 if the North–South divide in research is to be overcome. Examples of consequences for science relevant to climate change policy and practice that would result from their implementation are described in Box 3. Given the continuing extent of the North–South divide, it is axiomatic that none of the consequences in Box 3 are generally evident, as yet, but some examples are provided below.

Southern researchers have already made a substantive contribution to PROVIA, which acknowledges lessons learnt from past programmes and promises to deliver improved coordination of international research. Notable involvement of Southern researchers in IPCC assessment reports includes researchers from Bangladesh, Brazil, China, India, and South Africa[7,30]. The Coordinated Regional Climate Downscaling Experiment (http://www.cordex.org/), sponsored by the World Climate Research Programme, has recognized that flagship pilot studies should be driven by regional scientific communities and are contributing to capacity building in many Southern countries. Support from Northern institutions is enabling Southern countries (recently including Kenya and Turkey) to develop their own systems for compiling national greenhouse gas inventories. Studies led by Southern researchers from local institutions, which have been used to inform assessments of mitigation, vulnerabilities, impacts, risks or adaptation, are particularly prevalent in Bangladesh and Nepal, as a result of substantial investment by international donor organizations. However, these various exceptions merely serve to reaffirm the extent of the divide, as generally, the outcomes in Box 3 are far from the norm.

Ultimately, it should be borne in mind that Southern countries may have wider needs for socioeconomic support and development, as described by the SDGs as a whole, that present more fundamental limitations to countries' abilities to engage meaningfully in scientific endeavours. As such, only the development of "national capacity will eventually put the South on an equal footing with its Northern partners"[27].

Our Perspective provides a broad overview of the North–South divide in research relevant to addressing challenges posed by climate change: underlying issues, potential consequences for policy and practice, and a comprehensive set of recommended actions intended to bridge the divide. The views expressed are based on existing publications, as well as our personal experiences. However, we acknowledge that empirical evidence on the underlying causes of the divide (such as the study by Pasgaard and Strange[6]) is scarce. Evidence on the potential consequences of the divide for climate change policy and practice is almost non-existent. In-depth investigations of the many issues highlighted in this Perspective could increase understanding and awareness of the importance of finding ways to span the North–South research divide for the future of our planet, and facilitate better design of concrete measures to address the divide, tailored to regional and local contexts.

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M.B., R.J.S., G.M. initiated the study; G.M. conducted the analysis with help of M.B. and R.J.S.; M.B. and R.J.S. wrote the paper and contributed equally to this work. All other authors contributed to the text, and provided practical examples for inclusion in the article.

Additional information

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Competing financial interests

The authors declare no competing financial interests.