

<https://doi.org/10.1038/s43247-024-01964-w>

Balancing Earth science careers in an unequal world

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Unequal research experiences among Earth scientists from around the world are an obstacle to achieving sustainability. We assess challenges and propose ways to balance the careers of early- and mid-career researchers in the Global South with those in the Global North.

Historical and ongoing forms of imperialism and colonialism have influenced the development of Earth System science¹, resulting in significant disparities in scientific and technological progress between the Global South and the Global North. Global South researchers face greater challenges in conducting their investigations. Although scientific collaborations between the Global South and the Global North could potentially reduce these inequalities, they often perpetuate colonial dynamics. Researchers in the Global North usually have the resources and therefore typically propose, finance, and carry out the studies, whereas the participation of researchers in the Global South is often limited to applying the results or receiving recommendations in the form of reports^{2–5}. However, developing equitable collaborations is crucial for a just, sustainable future, which can only be achieved when incorporating local and regional knowledge from local scientists and agencies especially in Earth sciences.

>The Global South-North imbalance especially affects early- and mid-career researchers in building successful careers^{6,7}. To explore perceptions among affected researchers from around the world, the Young Earth System Scientists (YESS) community⁸ organized a side event at the 2nd Open Science Conference of the World Climate Research Programme held in Kigali, Rwanda in October 2023, entitled “Early-mid career perspectives on South-North inequalities: Fair collaborative research as a way to reduce them”. Participants anonymously shared their experiences working or studying in the Global South, Global North, or a combination of both, focusing on five main themes: scientific publications; participation in international organizations; participation in conferences, workshops, and training courses; access to quality jobs; and access to resources and data (see Supplementary Information for more details).

Here we depict the shared experiences, color coded by geography, as a seesaw (Fig. 1): unfavorable experiences weigh down the left-hand side of the seesaw; favorable ones lighten the load on the right hand side. Based on the insights from the activity, we suggest concrete actions to balance this seesaw, spanning from the individual to the international level.

Publishing odyssey for the Global South

Participants from the Global North reported mostly positive experiences in relation to the publication of their scientific work. Global South participants, by contrast, had encountered various hurdles (Figs. 1 and S1).

Financial resources, for example for covering Article Processing Charges, are a well-known barrier for the Global South researchers who participated but not for those from the Global North. However, it is not only funding that constitutes a problem: a bias against research from the Global South was brought up as one of the greatest challenges for the Global South participants to publish in international peer-reviewed journals. For example, one Global South participant stated: “*We often get our papers rejected because they are ‘too regional’ or ‘not novel enough.’*” In addition, Global South participants suggested that their limited access to resources and data, compared to their colleagues in the Global North, is not taken into account in evaluations. Finally, some Global South participants shared experiences of personal discrimination against them by Global North colleagues, such as: “*Global North colleague made me [...] doubt about my expertise or skills.*” Language was identified as a barrier for both the Global South and the Global North participants who were not proficient English speakers.

Global South researchers should have equitable opportunities to publish in scientific journals as their peers from the Global North. To balance the seesaw, publishers can offer fee waivers for low- or lower-middle-income economies, and ensure journals include early- and mid-career researchers from the Global South in their Editorial Boards to contextualize the review process. Considering opening editorial offices in the Global South would help further.

Additionally, requirements on the novelty and data robustness of studies should consider double-anonymized peer reviews to reduce bias against the Global South, while accounting for research resources and data availability in the study region. Journals could also display regional submission and acceptance statistics for transparency. Finally, language barriers should not affect the acceptance of publications: journals could follow examples like *Communications Earth & Environment*, where the quality of the English language is not considered for acceptance⁹. The rapid evolution of large language models could offer a helpful tool to overcome language barriers, if used responsibly.

Equity in international organizations

The process of engagement and leadership in international organizations seemed easier to participants from the Global North (Figs. 1 and S2), mainly because they benefit from the well-established connections of their institutions and supervisors, funding opportunities, and financial mechanisms adapted to their contextual needs. On the contrary, the Global South participants reported limited access to international organizations as a result of



Fig. 1 | Experiences of participants as scientists working in the Global South versus the Global North. The right-hand side, high seat of the seesaw lists favorable experiences; the left-hand side, low seat is weighed down by hindrances. Pie charts show the numbers of Global South, Global North, and mixed experiences of each category, in green, violet, and orange, respectively. One favorable and one

unfavorable experience for each topic are quoted in the figure with the same colour code. The bar plot on the bottom represents the total number of favorable and unfavorable reports from Global South, Global North, and mixed experiences, with the same color code. *The name of the country has been changed to "In my country" to protect anonymity.

a lack of such pre-existing connections, a phenomenon that one Global South participant compared with a “private club”.

In addition, the participants from the Global South highlighted challenges such as sub-optimal facilities, insufficient financial support to join certain organizations compared to their Global North counterparts, and limited time availability for active participation. The latter is often attributed to the extra time and effort needed to navigate the challenges of publishing. Most Global South and Global North participants affirmed the potential benefits associated with active engagement in international organizations, with early- and mid-career researcher networks like the YESS community playing a key role.

To reduce inequalities in this area, it would be important for the Global South institutions to host project offices, lead international projects, or organize relevant scientific events. Both Global South and Global North institutions could provide incentives to collaborate with Global South colleagues. Furthermore, institutions should encourage Global North colleagues to recognize their privileges to avoid reproducing a colonial bias when working with Global South colleagues.

Barriers around scientific events: funding, visas, discrimination

Global South and Global North participants face different challenges in attending conferences, workshops, and training courses (Figs. 1 and S3). The Global South participants often encountered financial constraints and depended on financial support from the organizers or international projects. In contrast, the Global North participants usually had enough funding from their institutions to attend at least one international conference per year.

Visa access was identified as a major barrier for the Global South participants, whereas their Global North counterparts reported no problems with obtaining or paying for visas to attend international events.

Although some Global South participants highlighted existing efforts to promote equity, such as initiatives by The Abdus Salam International Centre for Theoretical Physics that encourage South-North and South-South collaborations, more efforts are needed. Global North scientists can acknowledge their financial and visa privileges and use them to help bridge the gap with Global South researchers. For instance, conference organizers can promote balance and highlight hidden disparities by selecting keynote speakers and panel chairs from different cultures. Holding conferences in countries with fewer visa requirements for Global South participants can reduce visa barriers. Also, event organizers could work with host countries’ foreign ministries to support visa applications for Global South early- and mid-career researchers.

In order to reduce potential language barriers at conferences, researchers should be able to present in languages other than English, such as the official languages of the United Nations, with the provision of simultaneous translation. Regarding training courses, making online resources available to everyone and in different languages can be a step toward justice.

Data, resources, and infrastructure: Global South struggles

The Global South participants reported significant challenges including lack of infrastructure, access to cutting-edge technology, electricity, internet, technical support, data availability, and computer resources. In contrast, the only resource that occasionally limits the Global North participants was funding (Figs. 1 and S4).

One of the main difficulties for the Global South participants is the lack of data in their Global South study areas and the challenges of accessing existing data. They also spend a lot of time dealing with issues related to computer resources, internet connectivity, and infrastructure due to limited technical support, whereas the Global North participants reported dedicated institutional support for these tasks.

At the international level, basic infrastructure needs could be addressed through development assistance and investment by large Global North funding agencies. Supporting scholarships and research placements for Global South researchers in Global North institutions could encourage and strengthen long-term collaboration. Projects focused on Global South issues need funding, including expenses like software licenses and access to scientific databases. The extensive production of high-quality open source data and software is another way to help reduce resource barriers.

At the national level, Global South researchers communities need to lobby their governments to support research and to provide the infrastructure to enable cutting-edge research.

Fair pay, opportunities near home, and stable careers are global challenges. Although they face different challenges, greater job stability is crucial in both the Global North and Global South (Figs. 1 and S5).

Global South participants noted unfair competition for jobs: they often compete with Global North researchers with more attractive curriculum vitae, influenced by the inequalities reported above. Secondly, although some Global South countries may offer relatively easier access to permanent jobs, salaries are typically insufficient to cover living costs. In contrast, in some Global North countries it can be challenging to obtain a permanent position, but postdoctoral salaries are often sufficient to cover living costs. This leads the Global South participants to consider relocating to countries of the Global North, despite the challenges of securing permanent employment there.

To tackle key environmental challenges, Global South science bodies need to increase the number of positions in Earth sciences; better salaries are required to attract and retain talented scientists. At the international level, the development of collaborations and funding programmes that specifically support Global South researchers in their home countries could be encouraged. Global North-funded projects that are developed in the Global South would ensure the employment and contribution of local Global South researchers.

Bridging the gap. As a scientific community, we are challenged to increase the relevance, impact, and utility of our research for science and society. We need to drive transformative actions in the context of the urgent need to address sustainability¹⁰. Adding to this global challenge, geographical inequalities further hinder research and its impact.

The experiences shared in the workshop on early- to mid-career perspectives on Global South-North inequalities highlight significant disparities in the production of Earth science knowledge. The Global South participants mainly shared challenges, while Global North participants described both positive and negative experiences (Fig. 1).

As a result of these persistent inequalities, the scientific communities of the Global South are being held back in their contribution to Earth science knowledge creation, to the detriment of their societies. This leads to unequal adaptation to environmental risks, aggravating climate injustice.

To balance the seesaw, we propose the following actions:

- **Individual researchers:**
 - *Promote fair collaborations by recognizing their privileges and avoiding discrimination.*
 - *Practice clear communication that is conscious of language barriers.*
- **Publishers:**
 - *Offer fee waivers for Global South researchers.*
 - *Include Global South researchers on editorial boards.*
 - *Adopt double-anonymized peer reviews to minimize bias.*
 - *Account for resources and data limitations when evaluating submissions.*

- Publish regional submission and acceptance statistics.
- **International organizations and institutions:**
 - Host events in countries with fewer visa barriers.
 - Offer scholarships to support Global South researchers.
 - Foster Global South-North and South-South collaborations.
- **Conference organizers:**
 - Facilitate visa applications for Global South participants.
 - Ensure diverse representation among speakers.
- **Governments and funding agencies:**
 - Invest in research infrastructure and data access in the Global South.
 - Ensure access to long-term, fairly paid job opportunities.

If we are to seek an equitable way to sustainability, we can no longer ignore Global South-North science inequality. As a united Earth science community, we have the agency and responsibility to take action and promote fair global scientific collaboration.

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Received: 12 August 2024; Accepted: 12 December 2024;
Published online: 11 January 2025

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Acknowledgements

We would like to thank the Young Earth System Scientists (YESS) community for supporting the activity and the World Climate Research Programme (WCRP) for allowing us to develop the Town Hall session during the 2nd Open Science Conference. We also thank the editor Heike Langenberg and Regina Rodrigues for their support in publishing the outcomes of the activity. We would also like to thank all the other participants of the Town Hall session for sharing their experiences and ideas during the activity.

Author contributions

N.T.: Conceptualization, Data Analysis, Data Curation, Investigation, Methodology, Supervision, Visualization, Writing - original draft. L.M.C.; L.B.D.; C.P.; V.R.: Conceptualization, Data Analysis, Data Curation, Investigation, Methodology, Visualization, Writing - original draft. J.M.: Conceptualization, Methodology, Visualization, Writing - review. R.B.; D.T.D.; I.D.; I.M.L.; M.O.; A.T.E.: Writing - review.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1038/s43247-024-01964-w>.

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