The Fourth Dimension of Science Diplomacy*

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In a previous contribution, we highlighted how growing geopolitical tensions were beginning to challenge the principles of openness and international cooperation that have long characterised science.[1] The increasing relevance of research security, trusted research, technology sovereignty and cooperation among like-minded countries has transformed the landscape of scientific cooperation. Consequently, the traditional openness of science can no longer be taken for granted.

This is no longer merely a theoretical concern. As early as 2017, Rania Mokhtar, a Sudanese recipient of the OWSD–Elsevier Foundation Award for Early-Career Women Scientists, was unable to receive the award in person at the AAAS Annual Meeting due to visa restrictions.[2] Although a relatively specific instance, the episode highlights how objectives that the international scientific community regards as fundamental can become subordinated to security considerations.

This evolving context requires broader reflection on science diplomacy itself, beyond solely preserving existing collaborations. The challenge is to ensure that the global scientific system remains resilient when access to knowledge, infrastructures and technological capabilities is increasingly shaped by geopolitical and economic factors.

Even an open scientific system would remain structurally vulnerable if advanced scientific capacities continue to be geographically and economically concentrated. The future of science diplomacy requires not only defending scientific bridges but also strengthening the foundations upon which global scientific cooperation depends.

For over half a century, science diplomacy has fostered international cooperation. During the Cold War, the European Organisation for Nuclear Research (CERN) maintained scientific contacts across the Iron Curtain, and the International Centre for Theoretical Physics (ICTP) bridged between developed and developing countries[3], reflecting the conviction that science could preserve channels of communication beyond conventional diplomacy.

During this period, international mobility expanded, major research infrastructures became increasingly accessible, and the globalisation of science seemed both irreversible and beneficial. The experience of SESAME demonstrates how a shared scientific infrastructure can foster dialogue among countries divided by conflict.[4,5] Today, this vision, reflected most clearly in UNESCO's 2021 Recommendation on Open Science, which places international collaboration and equitable access at the centre of global science policy,[6] is under unprecedented pressure.

Strategic competition among major powers, the wars in Ukraine and the Middle East, and the growing

* This article is dedicated to the memory of the late Prof. Rogelio Rodríguez-Talavera.

importance of AI, quantum technologies, biotechnology, strategic and advanced materials have altered the relationship between science and international politics.

Protecting genuinely sensitive technologies is legitimate. The concern arises when measures intended to protect specific areas reshape the broader culture of scientific cooperation, sometimes with apparent contradictions: CERN took the controversial decision not to renew the cooperation agreements with Belarus and Russia, and one year later, renewed the cooperation agreement with the Joint Institute for Nuclear Research (JINR) located in Dubna near Moscow.[7]

Restrictions on scientific mobility, often justified by conflicting internal policies, tighter controls on international collaborations, expanded export regulations and political scrutiny of universities are becoming familiar features of the international research landscape.[8]

This new vocabulary reflects a profound change: the guiding principle of scientific cooperation moves from openness towards emphasis on security, sovereignty and strategic alignment.

This represents more than a semantic evolution: it reflects a profound shift in priorities, intrinsically linked to the fact that many strategic technologies require investments measured in tens of billions of dollars.

This concentrates advanced scientific capabilities in a limited number of countries and institutions, while governmental priorities increasingly influence research funding and international scientific cooperation, making access to frontier science progressively shaped by geopolitical considerations rather than scientific merit alone.[9]

These developments are unfolding within a broader weakening of multilateralism. International organisations and institutions struggle to maintain the influence they exercised only a decade ago, while new geopolitical coalitions and transactional alliances increasingly shape global agendas.[10]

Science diplomacy, once widely regarded as an effective instrument for maintaining dialogue across political divides, has become progressively less visible in international decision-making.

The situation in Gaza illustrates this challenge. Different actors have approached the crisis with different priorities, including security concerns, governance arrangements and competing visions of reconstruction. These differences reflect distinct objectives and expectations, and even the concept of reconstruction is not understood the same way by all actors. Yet, beyond these differences, one element should become a shared priority: rebuilding universities, research institutions and scientific capacity. Scientific institutions should not be regarded as a luxury to be restored only after political solutions have been achieved; they are among the foundations upon which long-term recovery and durable peace depend.

This example highlights a deeper challenge: the resilience of international science is more than maintaining existing collaborations: it also means ensuring that, if weakened or disrupted, scientific capacity be rebuilt and developed.

The globalisation of research rested on an implicit assumption: although advanced scientific infrastructures would remain concentrated in relatively few countries, they would remain broadly accessible. Synchrotron light sources, neutron facilities, astronomical observatories, high-performance computing centres, and genomic platforms increasingly functioned as global scientific resources, while international mobility compensated for their unequal geographical distribution.

That assumption can no longer be taken for granted. As geopolitical considerations increasingly influence scientific cooperation, dependence on infrastructures located elsewhere becomes a structural vulnerability.

This is particularly true for countries in the Global South. Their scientific development has depended on access to facilities abroad and participation in international research networks. If access to these infrastructures becomes conditioned by geopolitical considerations, scientific inequalities may deepen even without any formal exclusion from international collaboration. This dimension has received surprisingly little attention within discussions of science diplomacy.[11]

The objective of preserving bridges between scientific communities separated by political differences

remains essential for science diplomacy, but in the present geopolitical environment, bridges alone are no longer sufficient. They require strong foundations at both ends.

During the globalisation era, unequal access to research infrastructures was mitigated by the openness of scientific networks and the mobility of researchers and knowledge. If these access mechanisms become less reliable, the geographical concentration of advanced facilities poses a systemic vulnerability to global science.

Open Science, therefore, requires more than open publications, open data, and international collaboration. It requires a broader distribution of advanced scientific infrastructures, technological capabilities and research ecosystems. Openness without active participation risks becoming an aspiration rather than an operational principle.

From this perspective, Big Science infrastructures acquire a significance that extends well beyond their scientific output. ICTP demonstrated that building scientific capacity could narrow the scientific divide between North and South. SESAME demonstrated that a shared research infrastructure could itself serve as an instrument of diplomacy. More recently, Sirius in Brazil[12] and initiatives such as the projects of an African[13] or a Greater Caribbean Light Source[14-15] illustrate a broader evolution: the development of regional Big Science infrastructures in the Global South is becoming an essential condition for a more open, resilient and sustainable global scientific system.

These initiatives should not be interpreted as steps toward scientific fragmentation or self-sufficiency. Their purpose is precisely the opposite. Indeed, African Light Source (AfLS) and Greater Caribbean Light Source Initiative (GCLSI) are part of a broader project for the Global South aimed at strengthening participation in global science, recognised by UNESCO as one of the projects of the Decade of Science for Sustainable Development.[16] GCLSI has also been identified as one of the three most significant emerging scientific infrastructure projects in Latin America.[17]

A more balanced geographical distribution of scientific capacity and infrastructure makes international cooperation less vulnerable to geopolitical tensions and allows partnerships to develop on a more equal basis. This evolution also suggests that the traditional conceptual framework of science diplomacy warrants reconsideration.

Establishing regional research infrastructures, multinational centres of excellence, and long-term scientific training programs should become explicit objectives of science diplomacy, rather than simply desirable outcomes of successful diplomatic relations.

Preserving international science will therefore require not only defending existing collaborations but also reducing the structural vulnerabilities created by the unequal geographical distribution of advanced scientific capacities. Investing in shared Big Science infrastructures, particularly across the Global South, is no longer simply a matter of scientific development; it is becoming a prerequisite for a resilient international scientific system and a fourth dimension of science diplomacy itself.

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