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Task Force 3: Science and Digitalization for a Better Future

Science and Digitalization for a Better Future

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Abstract

Global challenges such as climate change, biodiversity loss, and the global debt crisis call for more cooperation among nations. Yet instead of well-coordinated, wise cooperation for the global common good, geopolitical tensions are rising and protectionism seems to have become a "new normal". As a consequence, the delivery of the United Nations Sustainable Development Agenda 2030 has been dramatically slow and the benefits of growth policies are imbalanced across high-, low-, and middle-income countries just as within them.

In 2020, a global response to the COVID-19 pandemic was made possible—however imperfect—by keeping borders open, avoiding unconsidered export restrictions, and pushing for cooperation for large-scale public goods, including the development and distribution of vaccines, even though insufficient. Today we are tasked with consolidating the lessons from the pandemic in terms of international scientific cooperation, science-to-policy interaction, and multilateral science policy making. Compared with the pre-pandemic times, the world has become riskier and more uncertain in just a few years. The dynamics unfolding between different crises and their cascading effects at combined global and local scales pose a new urgency to act in a multilaterally coordinated manner.

The Group of Seven (G7), representing countries of significant scientific and innovative might, is thus tasked with the responsibility of global intellectual and technological leadership, besides and in addition to economic and political leadership. First, the acceleration of digitalization and progress made in a number of scientific domains can play a crucial role in strengthening human capabilities to deal with the risks ahead, cognizant that they are also part of such risks. Second, whereas social, economic, or environmental risks are global in nature, science and innovation should pay much more attention to responses that fit and stem from local, societal contexts. Third, nationally organized science systems should give way to transregional, cross-border cooperation that is not limited to a specific group of nations (such as the G7). Fourth, regionally differentiated, empirically substantiated science and research out of different societal contexts will require much more focus to make an effective impact and contribute to global development and environmental goals.

Adapted and distributed science systems can go beyond addressing risks and create pathways to alternative modalities of living and co-existing which would be inherently less risky, while embodying transformed societies. The concept of "just transition" recently initiated by the G7 in the field of energy and greenhouse gas emissions seems a relevant fit to ensure that science systems, which integrate diverse perspectives, and are based on interdisciplinary research to globally provide context-sensitive outcomes, address the most urgent priorities, and ensure a structural shift to alternative economic and social well-being at national and subnational levels. Policy making informed by science is the cornerstone of globally coordinated responses to current challenges. Advancements in the field of digitalization can substantially support transformational processes in societies across the globe. Last but not least, both science and digitalization policy making are crucial for fostering joint communication and action frames across transnational and geopolitical differences.

Challenges

To fully capture what is at stake and why a new approach to scientific cooperation and investment is called for, it is worth identifying the full implications of achieving the United Nations (UN) Sustainable Development Goals (SDGs) and the Paris Climate Agreement targets for decarbonization. Every aspect of how we live through infrastructure systems, how we consume and house ourselves, move around, and interact with natural systems has to change if we are to simultaneously advance decarbonization, build resilience to the ongoing impacts of climate change, restore and strengthen biodiversity, and reverse the alarming intensification of multi-dimensional inequality (gender, income, wealth, education, health, and access to digital infrastructure and data).

Are we collectively equipped to do so? We are in the midst of profound demographic transitions—becoming a predominantly urbanized world coupled with aging in the Global North and robust youthful population growth in Africa and parts of South Asia. New ways of infrastructure design, settlement organization, and mobility systems are therefore required to ensure sustainable urbanization, symbiotic urban–rural dynamics, and opportunities for an expanding labor force. This must be embedded in emergent systems of green industrialization catalyzed by new classes of investment associated with policy priorities of socially-just transitions of production systems and consumption behavior, thus assuring the stabilizing of our climate. In the following, we refer to this as just transition, analogous to the international political debate.

The operating model of our economic systems, trade relations, natural resources, and what is valued is not consistent with achieving the global goals associated with just transition. Research and science play an important role in fostering social progress through education, and technological, institutional, and social innovations. By reimagining and changing our settlement systems in both urban and rural areas, we can begin the societal effort of learning to live within environmental guardrails and more equitably. This implies environmentally sound infrastructure technologies that touch lightly on the ground in terms of environmental impact, and ideally play a structuring role in regenerating badly damaged ecosystem services. This in turn implies novel models of land use and land valuation that are not tied to profit maximization, but rather environmental and social justice, such as providing incentives to farmers to manage and ensure broad access to ecosystem services and help vulnerable communities adapt to changing climates. Land stores profound cultural meaning and value, which can only be grasped through respectful engagement with indigenous communities and those who rely on the land for subsistence and livelihood. Significantly, rapidly expanding capability to analyze digital datasets through artificial intelligence and other computational tools greatly enhance our potential to calibrate these simultaneous and interdependent transitions. Thus, universal digital infrastructure and access are critical to meeting our planetary challenges.

It is not self-evident what kind of knowledge, data, and scientific analysis will enable us to transition from an extractive global system of land use, resource consumption, and waste production to a more resilient, regenerative, and circular system that meets the needs of all of humanity and the planet. It is not self-evident because multiple forms of knowledge are required, as recognized by the International Science Council (International Science Council 2021). The council argues for transformative science that involves codesigned and transdisciplinary processes of knowledge production and deployment. This challenges scientific systems and universities to be restructured to ensure "framing the [policy] question and research across knowledge disciplines (physical, natural, social and humanistic sciences), sectors of society, genders, generations, geographies and different knowledge systems, by working closely from the outset with knowledge users in identifying problems, defining research questions, as well as in generating and integrating that knowledge for application" (International Science Council 2021, p.16). This is a challenging undertaking, but the urgency of our climate crisis and biodiversity crises demands that political leaders and the Group of Seven (G7) nations confront these challenges. These challenges will become more acute as digitalization advancements make large categories of formal employment redundant without there being adequate mechanisms to transition workers into new occupational categories (Manyika et al. 2017; WEF 2020).

Against the backdrop of today's geopolitical tensions, science cooperation can further serve as a tool to maintain exchange and continued academic collaboration between countries and regions where political cooperation is impossible. Yet, current science systems and formats for knowledge cooperation are not flawless. To develop new and effective solutions to deal with global challenges like pandemics, the climate crisis, and biodiversity loss, the potential of science comprising research, tertiary education, think tank policy advisory work, and transnational knowledge cooperation, needs to be maximized. The G7, representing some of the strongest science and innovation systems worldwide, is challenged with spearheading a less fragmented global science system that integrates diverse perspectives, disciplines, and expertise to ensure that its outcomes reach and effectively target those that are most vulnerable to these very challenges.

A Fragmented Science System

The existing global science system is fragmented and characterized by substantial differences in financial and personnel capacity. Over the past years, some progress has been made, as a number of middle-income economies invested in their science systems and actively sought partnerships with typical funders for knowledge transfer to empower autonomy and localized innovation. Emerging countries' national agricultural research systems, such as those of the People's Republic of China (PRC), India, Brazil, and South Africa have grown and now have unique research and development (R&D) programs of their own, including collaboration among themselves and with less prosperous countries. Despite these advances, the global science landscape continues to be fragmented and driven by agendas from high-income countries (rather than being demand driven by cooperation with beneficiaries). In agricultural science, for example, genome editing is dominated by rich countries in patent filing, while in low- and middle-income countries (LMICs), knowledge, capital, and awareness of patent application and its benefits is lacking. In 2019, 96.4% of patents registered at the world's five largest patent offices were made by countries belonging to the Group of Twenty (G20) (UNESCO 2021). It should be pointed out that the PRC has been at the forefront of the number of patent applications since the early 2010s, even though the statistics are not specific to agriculture. While India remains behind, it is catching up rapidly. Substantial differences between countries can also be observed with regard to agricultural R&D. African Science and Technology Indicators (ASTI) indicate that since 2000, the percentage of R&D in agricultural value added dropped significantly (Lowder 2018). In 2014, 29 of the 36 countries in Sub-Saharan Africa for which data were available invested less than 1% of their agricultural gross domestic product (GDP) in R&D. This implies that R&D spending is not in line with the goal of increasingly knowledge-based agricultural development. Also, with regard to R&D sources, ASTI show major differences, with basically all spending coming from the national budget in Namibia and higher dependency on donor funding in Kenya and Tanzania (Lowder 2018).

Gross domestic expenditures in R&D (public and private) is an internationally recognized indicator for the performance of the formal science system of a country. Here, international best performers (Israel, the Republic of Korea) approach 5%, the European Union set the target of 3%, and the African Union, 1% (UNECA 2018). Thus, none of the best-equipped and highest-performing science and innovation systems globally is located in the Global South (UNESCO Institute for Statistics 2023). This strong fragmentation and uneven distribution of resources to support and fund research are problematic as they mark a substantial discrepancy between those countries that conduct research on current global challenges and those most affected by them (Hornidge, Partelow, and Knopf 2023; Partelow et al. 2020). Investing in a global research system that ensures a more equal distribution of resources and integrates a plurality of disciplines, knowledge, and perspectives is therefore essential to enhance the efficiency, effectiveness, and legitimacy of research and science.

Insufficient Consideration of Alternative Forms of Knowledge and Perspectives of Marginalized Groups

"Conservation"-focused discourses have substantially gained traction in international and national science systems, politics, and societies (Kates et al. 2001), along with the broader recognition of ecological limits to growth (Rockström et al. 2017). This challenges the former underlying logic of scientific knowledge production to act as an engine of linear growth and demands a reflection of scientific knowledge production itself, as well as science-to-policy and science-to-practice interfaces (Sumberg et al. 2017). A profound change from the inherited global, regional, and national systems of research and knowledge production is required to generate science and innovation systems that offer globally informed and holistic perspectives on how the world can be differently organized.

Building on this changing understanding and role of science in debates about and for (sustainable) development, there is an increasing recognition that other forms of knowledge are also important in shaping transformational processes toward sustainability. One such form of knowledge with particular relevance is local knowledge (Okere, Njoku, and Devisch 2005). These knowledge systems may not homogeneously position themselves with regard to "sustainability", but are clearly distinct from scientific knowledge systems that often are empirically biased regarding OECD contexts and lack local embedding.

Scientific research agendas remain largely determined by the scientific communities of high-income economies and the countries of the science donors, reproducing structural inequalities by further fostering epistemic inequalities (Hornidge, Partelow, and Knopf 2023). The Intergovernmental Panel on Climate Change's Sixth Assessment Report emphasizes the urgent need to enhance technology innovation systems for lowering greenhouse gas emissions (mitigation) as well as building technological and institutional adaptation capacities in societies, with a particular focus on those most affected in Africa, Asia, and Latin America (IPCC 2023). Demand-oriented economic policies are superseded by heavily subsidized supply strategies that fuel an intense geostrategic competition such as between the G7 and the PRC and even among the G7 countries. Moreover, while small farmers in the Global South account for up to one-third of food production, they only receive 1.7% of climate funding (IFAD 2020). The framing of global solutions mirrors the allocation of resources for research.

Science and innovation capacities have to be localized to assure that developed solutions fit the local context (Bijker and Law 1997). Most development solutions require a biophysical region that incorporates rural and urban settlements as its primary catchment. The Kunming–Montreal Global Biodiversity Framework speaks of "biodiversity-inclusive urban planning" and "sustainable urbanization" under SDG12 (UN 2022). A practical example of this is the need to move away from global value chains for various goods and services to cross-border regional and local value chains. This will induce more resilience in the system and reduce the dependence on external (to the bioregion) sources of energy, raw materials, design and manufacturing capacity, and retail infrastructure. For example, at the moment, steel and cement comprise more than 90% of building materials in construction and account for 7.0% and 6.5% of global CO_2 emissions, respectively (Fennel et al. 2022), but we need to transition to biobased materials well before 2050. By reorganizing construction materials around locally grown biobased materials, e.g., timber, hemp, clay, bamboo, etc., a regional catchment can transform this sector and the firms in the numerous backward and forward linkages. Additionally, the over-resilience on a few foods produced in a small number of countries such as Brazil, the Russian Federation, and Ukraine, is undermining our ability to strengthen societies' resilience in the realm of nutrition. Diversity of production and consumption can boost the overall resilience of food systems against economic and climate shocks. Low-carbon, highly nutritious foods can transform this sector and firms in numerous backward and forward linkages.

To anchor innovation ecosystems at the local level and to generate transdisciplinary science and innovation systems in which the knowledge and perspectives of indigenous populations and non-indigenous citizens inform the terms of inquiry, and the use of new knowledge, new platforms and innovative mechanisms are required. This is particularly important as a significant part, some studies state that 80% of the world's biodiversity is found on indigenous lands (Garnett et al. 2018; Schuster et al. 2019). Research outcomes need to ensure that they actually represent those groups they intend to serve and to acknowledge and address topics that figure less prominently on the research agenda of high-income countries. Finding effective solutions and translating them into good political practice is only possible if research is sufficiently grounded in the lived experiences of those most directly affected.

Insufficient Investment in Digital Infrastructure for Promoting the International Exchange of Knowledge, Evidence, and Data

The use of digital technologies during the novel coronavirus disease (COVID-19) pandemic served as an important example to show how artificial intelligence (AI) and internet connectivity helped to track chains of transmission of the virus, while enabling distance learning and working during lockdowns. Moreover, regarding agriculture, digital innovations can increase small-scale farmers' incomes, boost the adoption of better practices, and increase resilience to climate shocks, while reducing the gender gap and managing food system risks (Koo et al. 2022). New AI innovations like ChatGPT and GPT-4 are expected to transform the science system by changing the way we work and learn. Yet, while digital technologies offer great potential to advance the implementation of the UN's 2030 Agenda (WBGU 2019), there are challenges regarding global internet connectivity, the protection of data privacy and human rights in the digital space, and the ethical implications of AI. Internet connectivity continues to expand with 94% of the world's population covered by mobile broadband today. However, there is a substantial digital divide "with 93% of the unconnected around the world living in LMICs" (GSMA 2021a). Over 600 million people and 40% of small farms are still not covered by mobile internet, especially in those countries most dependent on agricultural production. In addition to the digital divide, there is a significant gender gap. Across LMICs, women are 15% less likely than men to use mobile internet (GSMA 2021a) and are 15% less likely to own a smartphone (GSMA 2021b). According to the UN's Roadmap for Digital Cooperation (2020), "Similar challenges affect migrants, refugees, internally displaced persons, older persons, young people, children, persons with disabilities, rural populations and indigenous peoples" (p.10). Supporting gender-sensitive initiatives to expand internet connectivity contributes to reducing extreme poverty in rural and remote areas (World Bank and GSMA 2020) and allows its users to benefit from global scientific outputs through the development of digital advisory businesses that bundle multiple services such as extension, credit, climate information, logics, early warning systems, and insurance while facilitating the creation of agile national and regional systems for monitoring, early warning, and crisis preparedness (McOmber et al. 2013; Zougmoré, Läderach, and Campbell 2021). Vice versa, digital communication technologies are necessary to not only reach but also to communicate with and build on the knowledge and perspectives of more marginalized communities (Steinke and Schumann 2022). The movement toward greater interdisciplinary inquiry and the adoption of transdisciplinary practices depend on being able to draw on large datasets generated by citizens (for example through mobile phone data points) and sensors (such as electronic sensors, biosensors or chemical sensors) embedded in infrastructure, including green systems. Integrating the views, knowledge, and expertise of those who are often most severely affected by global challenges like climate change, loss of biodiversity, or war is crucial to find and implement innovative and effective solutions that are to the benefit of all (Kibe et al. 2022; Mapedza et al. 2023).

Proposals

In order to overcome science system fragmentation and invest in transregional science-based policy dialogue on the international level, we call on the G7 to consider the following recommendations:

Proposal 1: Increase the flow of funding, especially to multilateral research funds with centralized coordination functions, to establish a less fragmented science and research infrastructure

Currently, an agreed instrument for this purpose is lacking. Therefore, we recommend that a jointly negotiated quota of 0.5% of G7 members' national GDP (calculated as part of the gross domestic expenditure on R&D of each country) is administered through multilateral channels for overall R&D funds. Such multilateral envelopes shall enable global challenges-related research and other development research challenges. Further, the national funding to science of countries from the Global South is limited. LMICs lack the financial leverage over multilateral funds to effectively contribute to a research agenda that reflects their own priorities (UN 2017). A financial rebalancing, including mobilization of investment from the private sector, can support greater connectivity between those who produce research and those who use it (including integration and coordination of contextualized knowledge from the bottom-up), working multilaterally and regionally. Research support is essential for addressing issues related to global health, climate change, just as much as for social science research on governance and political challenges, issues of trust, institutional capabilities, human well-being, and planetary health.

Proposal 2: Invest in digital technologies and ensure that future research infrastructure makes use of effective and transparent data sharing

The G7 members have to ensure that future global infrastructure of research, technology development, and learning incorporates knowledge and expertise. Such global infrastructure should make better use of effective, transparent sharing of data and evidence to accept and engage with uncertainty. Therefore, we need a revitalized research infrastructure that links research efforts to adaptive, agile national and regional systems for monitoring, early warning, and crisis preparedness. We also call for investment in digital technologies to support research, evidence, and learning among both policy actors and citizens. Under public or cooperative governance, digital utilities for data should be used to generate a science-based knowledge commons to track access, establish provenance and scientific intent, replicate experiments and innovations, analyze, re-measure, and share knowledge. Governance mechanisms need to be reciprocal, participatory, and democratic—including digital rights management, open access, and fair-benefit sharing models—ensuring that all stakeholders have a say in governance, while benefiting from access that is appropriate to their contribution to the data cooperative or digital data utility. For instance, promoting digital service models that incentivize farmers to share experiences will create further customization and efficiency gains as systems grow and as the data are used to improve recommendations for other farmers. If successful, digital agricultural advisory systems could supply a model for digital development more broadly.

Proposal 3: Support the generation of local knowledge and its integration into transregional science cooperation networks

In close cooperation with the G20, the G7 should provide political and financial support to develop and implement innovative solutions that foster the generation of local knowledge and its integration into transregional science cooperation networks. Knowledge systems that exist alongside scientific knowledge systems are too often insufficiently integrated into established scientific practices and political projects. Yet, their strong embedment into specific local contexts promises to provide more context-sensitive and hence effective solutions. Innovative projects that link local knowledge with established scientific practices can offer timely information on environmental or climatic changes and thus facilitate adequate local responses, for example in the area of water management. For example, by studying the fish response to changes in the myriad of mostly unmeasured water quality variables as well as river discharge, timely management interventions can be implemented by identifying pollution sources and other negative impacts on the ecosystem (Mukuyu 2022).

During the COVID-19 pandemic the globalized economy was crippled by the cessation of production and mobility capacity. This effect could have been diminished by advances in open science, AI, distributed design manufacturing, block chain, and related exchange applications, as they point to radical possibilities for localization without opting out of global systems of solidarity, trade, and exchange. However, local biophysical, cultural, and political contexts vary dramatically even within a country that it is no longer tenable to funnel everything through national and regional scientific systems. Open science creates practical mechanisms for citizens and civic organizations to actively form part of knowledge production and feedback systems.

Supporting the generation of local knowledge and data is also vital to accelerate the implementation of the UN Sustainable Development Agenda 2030. There are great gaps in data that document the status of several SDGs. Innovative approaches like “citizen science” can contribute to closing these data gaps and strengthen local actors’ position in monitoring and responding to issues that directly affect them (Fritz et al. 2019). On an international level, the G7 should lead the way in providing political and financial support to foster the generation of local knowledge and data, while calling for a greater integration of these knowledge systems within their national science systems.

Proposal 4: Expand access to digital infrastructure in LMICs

To globally expand the benefits of new scientific results, scientists and politicians need to ensure that these data actually reach people on the ground. Vice versa, local knowledge and data can only be integrated into established knowledge systems if the owners and/or providers of other knowledge have the willingness and means to share it. Digital infrastructure can play a crucial role in filling this gap, as it facilitates exchange with people living in remote areas. End users, on the other hand, can benefit from digital infrastructure, for example, by making use of communications technologies or early warning systems that provide them with localized weather information that can help farmers adapt to changing climates giving them more autonomy in deciding when to plant, invest in improved varieties, or schedule irrigation services. Moreover, low-cost remote sensing, communications technologies, and more accessible analytics software mean it is now possible to monitor food, water, and land systems in real-time. This can help value chain actors detect potential issues such as high temperatures to prepare for food system shocks such as droughts or floods. To accelerate the global expansion of these services and the benefits they offer to farmers (and other users) worldwide, the G7 should enhance their political and economic support to close the digital gap. In doing so, the G7 must advocate a human-centered approach to digitalization in which the benefit for and protection of people takes center stage. Moreover, initiatives to close the digital gap must be gender sensitive and adopt an intersectional approach, acknowledging that women in LMICs are 15% less likely to use mobile internet than their male counterparts (GSMA 2021a) and that other vulnerable groups face similar obstacles in accessing and using digital technologies (UN 2020). Digital innovations must also be designed responsibly, ensuring the management of sensitive data, and avoiding adverse impacts on women and other vulnerable groups. The development and implementation of AI have to be subject to close and constant scrutiny to acknowledge and consider ethical issues and to mitigate potential harmful implications right from the outset. This can be achieved by adopting a multicultural and multistakeholder approach to develop a good governance framework for AI, co-designing innovations with end users, and adhering to jointly established digital development principles while building their capacity to make use of this information.

Implementation

The focus of current knowledge and science systems is too exclusive to effectively address today's multiple and interlocking crises. With their strong focus on the research agenda of and financial support for national science systems, the G7 members fail to sufficiently include the knowledge and views of those most affected by global crises like climate change or biodiversity loss. Further, as a result of a still unequal access to digital technologies, research outcomes often fail to reach marginalized communities. Therefore, the G7 must seize on economic and political clout and find innovative ways to improve established science and research infrastructure by using and expanding digital services to integrate alternative knowledge systems and the perspectives of the most marginalized groups, while supporting the expansion of digital technologies to better reach hitherto excluded communities.

The G7 members should:

Increase their financial flows into research on a multilateral level. New formats have to be created to enable international agenda-setting and ensure a better distribution of financial,

personal, and technical resources. Therefore, we call on the G7 members to review their current financial allocations and jointly agree on a quota to be provided through multilateral channels. In the long term and once a quota has been established, the G7 members shall monitor and publish data on financial allocations to guarantee a sustained flow of resources. Additional to their financial investment, the G7 members need to demonstrate greater political support for establishing a less fragmented and more equitable global science system. Using their political clout, the G7 should push these topics within established multilateral platforms and call on new mechanisms to improve international scientific collaboration, including the strengthening of:

a. Multilateral science policy making by either creating a UN organization in charge of facilitating cooperation in the field of science policy making, or by mandating UNESCO with this task and equipping it with the required financial and political capital.
b. Existing international platforms for trilateral science funding such as Future Earth and the Belmont Forum.
c. Collaboration between regional science donors, such as between the European Research Council and the science policy arm of the African Union (AU), the Association of Southeast Asian Nations (ASEAN), or the Southern Common Market (MERCOSUR).

Foster the potential of research and science to act as "third player" in situations characterized by geopolitical tension. This particularly includes the fostering of collaboration between science systems, especially in policy-oriented and applied research fields. The Think7- and Think20-engagement groups serve as an example. They bring together think tanks from countries of the G7 and G20 and beyond to advise the G7 and the G20, thus assuring (i) continuity from one presidency to the next, (ii) inclusive expertise from beyond G20 science and research systems, and (iii) G7 and/or G20 collaboration and coordination in exercising intellectual and technological leadership, in addition to an economic and political one.

Finally, we recommend that the G7 members **show strong political action to foster a more inclusive approach to research by promoting a research and evidence infrastructure that has a sufficiently wide-evidence base.** Therefore, the G7 members should advocate the adoption of new innovative approaches to multilateral, regional, and national science policy making that integrate citizens, local communities, and indigenous people, allowing them to benefit from global research outcomes, while effectively contributing to the gathering of data and the development of context-sensitive and sustainable solutions. To do so, the G7 should provide political and financial support to improve access to digital infrastructure, particularly in LMICs, to ensure that marginalized communities benefit from research outcomes and that their perspectives are considered in and integrated into research processes. The G7 should demonstrate leadership in ensuring that digitalization and the expansion of digital technologies is human-centered, encouraging multicultural and multi-stakeholder approaches to jointly develop a good governance framework for the use of digital technology.

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